Lightning protection

Edition 2023/04

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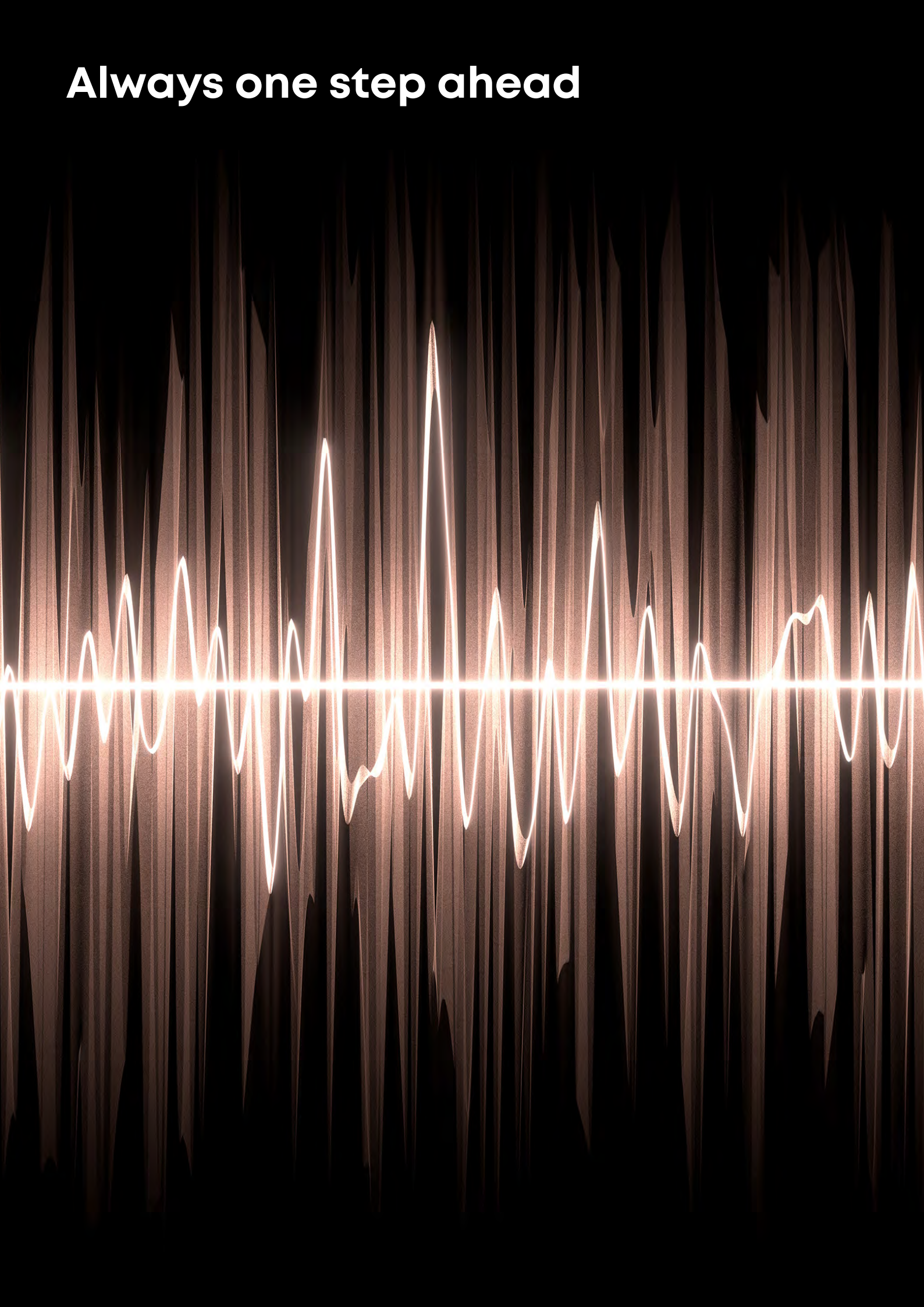
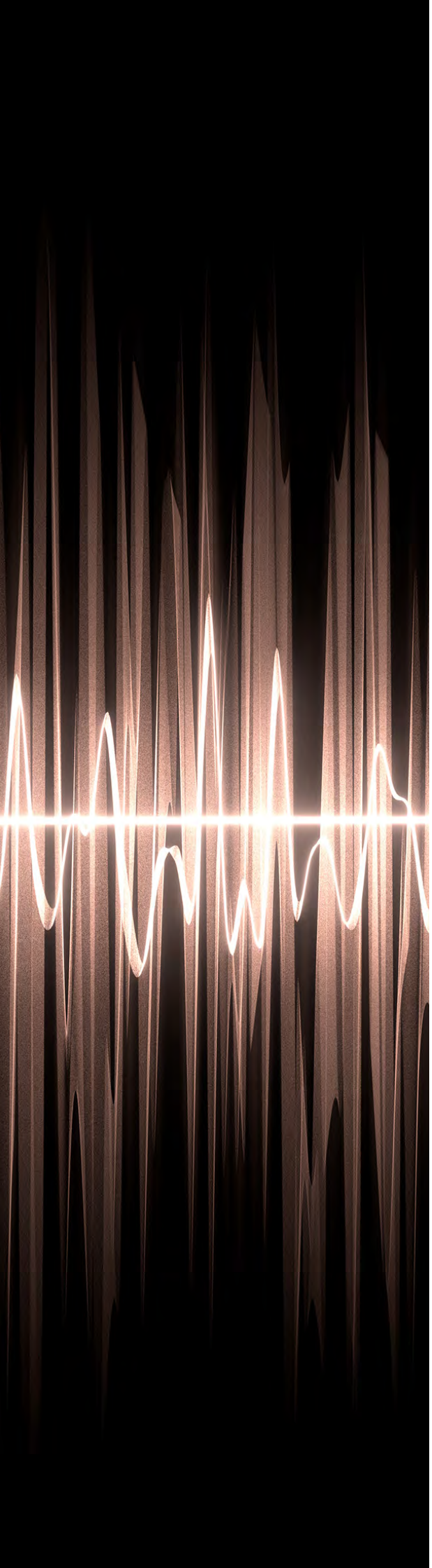
HUBER+SUHNER

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.

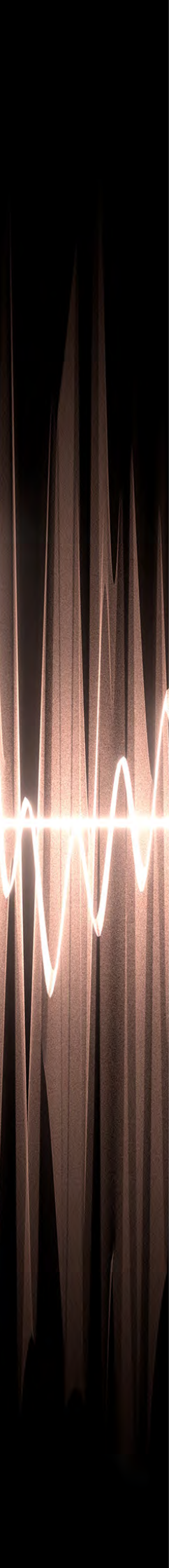
Four decades of experience in developing and manufacturing coaxial lightning EMP and NEMP protectors are the foundation of the current HUBER+SUHNER RF protection portfolio.

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 worldwide patents.

Contents



Introduction

Roots

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 miniaturisation 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 referred as SPD (Surge Protective Devices) designed to ensure maximum quality and reliability.

In telecommunications equipment, special attention shall 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 minimising 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.

Our strength, 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:

Protection effectivity
- Residual pulse voltage and energy
- Lightning current handling capability

Transmission excellence
- Passive intermodulation characteristics
- Operation frequency range
- Reflection characteristics (VSWR or return loss)
- Insertion loss

The mastery of these obove 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 (PIM) 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 standardisation 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 PIM 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 PIM 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 con-tact 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 is a nickel-free alloy offering both, an excellent contact surface for RF applications – including low PIM values – and outstanding corrosion resistance.

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

Gas discharge tube lightning EMP protector with SUCOPLATE® surface

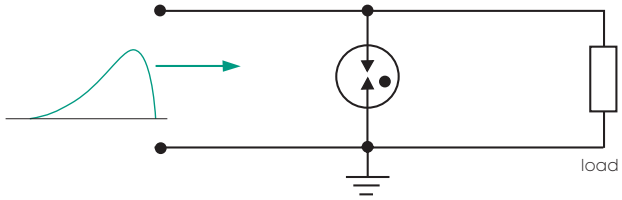
RF lightning EMP protector principles

Overvoltage protection in the field of RF engineering shall meet special requirements in comparison with general, low frequency signal transmission and power supply applications. In particular, coupling capacitances towards ground shall be mini-mised in order to prevent any significant loss of the transmitted RF signals.

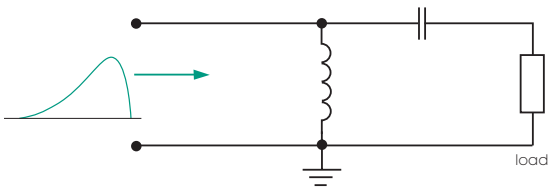
This essentially rules out the wide-band application of varistors and semiconductor diodes.

There are three major principles for coaxial lightning EMP protective devices in RF applications:

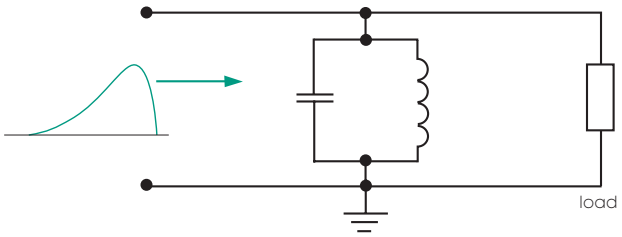
Gas discharge tube (spark gap) principle
The well-known principle in electronics for many decades, and in addition, the following two principles which make use of the limited frequency range of the lightning electromagnetic pulse (LEMP) and the nuclear electromagnetic pulse (NEMP) (refer to page 131, illustration «Comparison of the frequency spectra of a genuine lightning current surge and a test current surge 10/350 µs»). They allow to transmit only RF signals only within a certain specified range.



High-pass principle
A principle which allows only limited lightning current handling capability but features rather large bandwidths and very low residual energy.

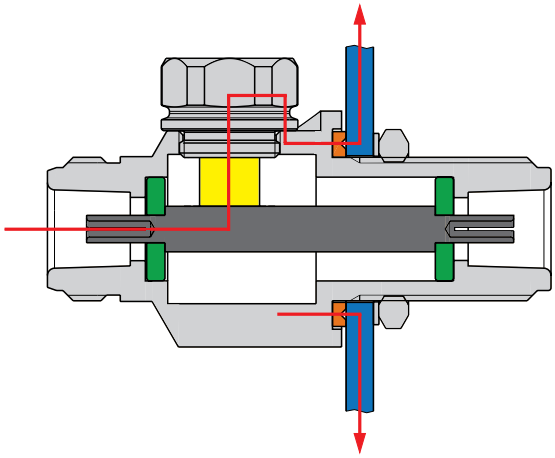


Band-pass principle
A very effective principle which HUBER+SUHNER employs with its quarter-wave shorting stub protectors featuring the lowest possible residual pulse. The operation frequency band can be properly adjusted to any application.



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 equalisation 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

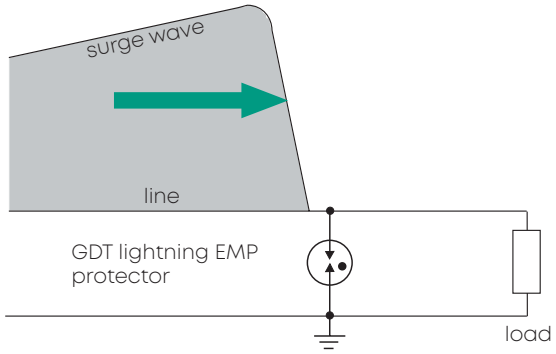
If lightning strikes the antenna mast or the antenna itself of a transceiver system, a current will flow toward the transceiver. Part of the current will be directly discharged through the antenna mast to the ground, and the other part will flow through the RF cable to the lightning EMP protector installed 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 a cell site/antenna system, causing a surge current to flow toward the equipment.

The GDT incorporated in the lightning EMP protector sparks over (thereby becoming low-ohmic), equalising the potential between the inner conductor and the ground. The current and thereby the energy of the lightning are discharged to the ground. Care shall 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.

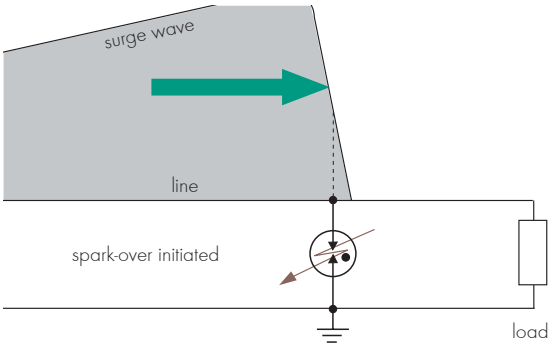
To understand the existing interrelationships and also to compare this system to other principles, let's consider the mode of operation for the gas discharge tube:

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



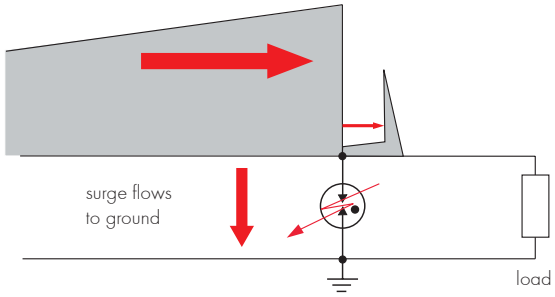
The gas discharge tube consists of two electrodes that are insulated by a small ceramic tube. It's static sparkover voltage is determined by the gas properties, its pressure and the electrode gap.

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

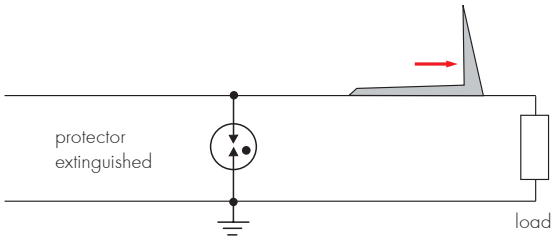


RF lightning EMP protector principles

The voltage across the gas discharge tube then rises very rapidly. When the dynamic sparkover 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 equalisation 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).

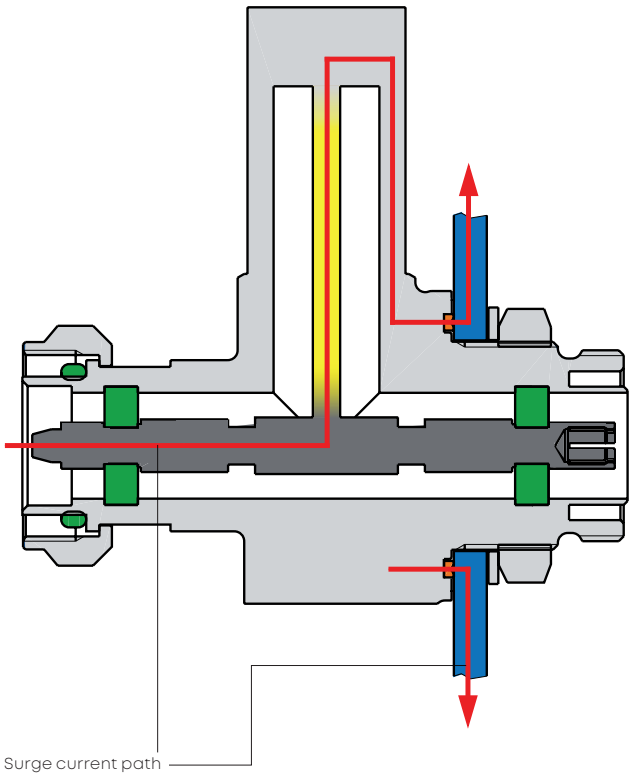


After the interference has subsided, the gas discharge tube is extinguished, reverting to its original high-ohmic condition.

Gas discharge tube protectors can generally be used in wideband applications from DC 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 or lambda/4 (λ/4) shorting stub (QWS)
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 band-pass filter. Its bandwidth can be adjusted up to ± 50 % of the centre frequency.

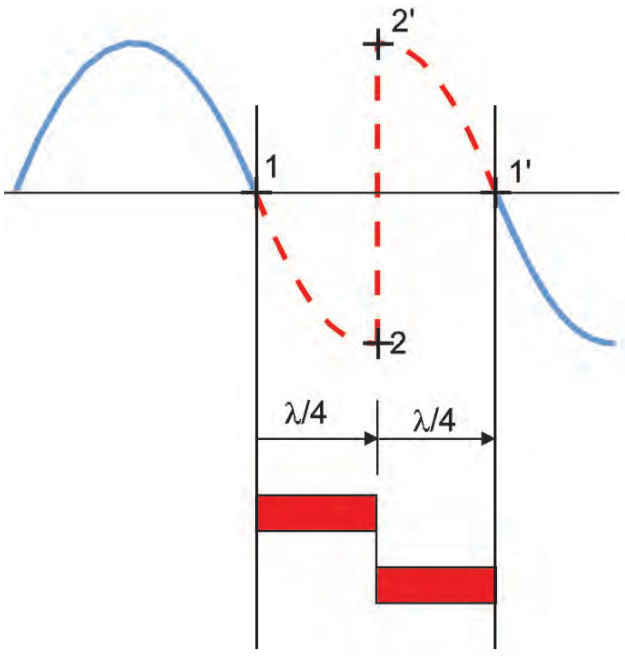


Operating principle of quarter-wave lightning EMP protectors

Since lightning interferences have a low frequency spectrum (see chapter «Lightning phenomenon and characteristics» illustration on page 124) 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 shorting stub 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.



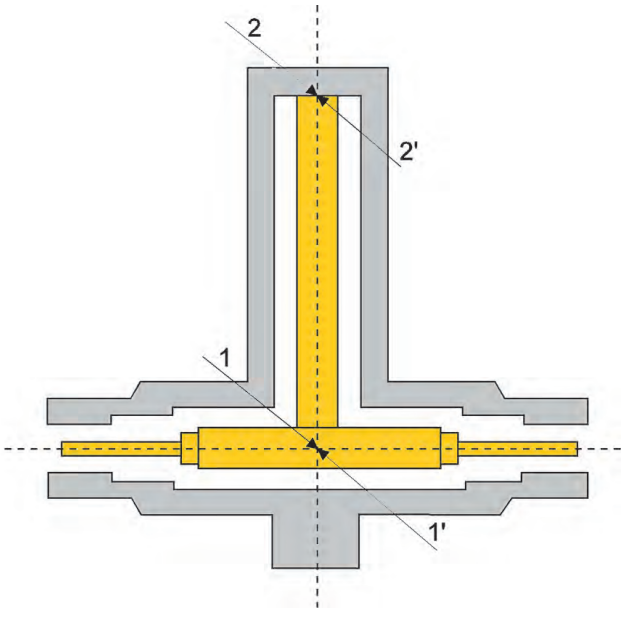
Standard quarter-wave shorting stub lightning EMP protectors are limited in bandwidth compared with GDT protectors, but offer considerably lower residual pulses and a high-current-handling capability. This is maintained even under multiple loading.

The operating principle of QWS lightning EMP protectors allows them to be manufactured for operating frequencies ranging from some MHz to more than 18 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 QWS lightning EMP protector has a considerably lower voltage amplitude (and thereby also energy) than that of the GDT protector.

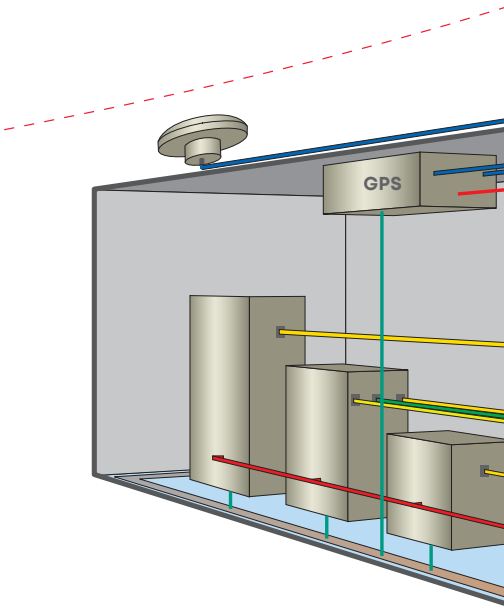
Unlike the gas discharge tube lightning EMP protector, it is not possible to carry any DC here, since the inner conductor is connected directly to the ground.



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. Roof-top 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 50).



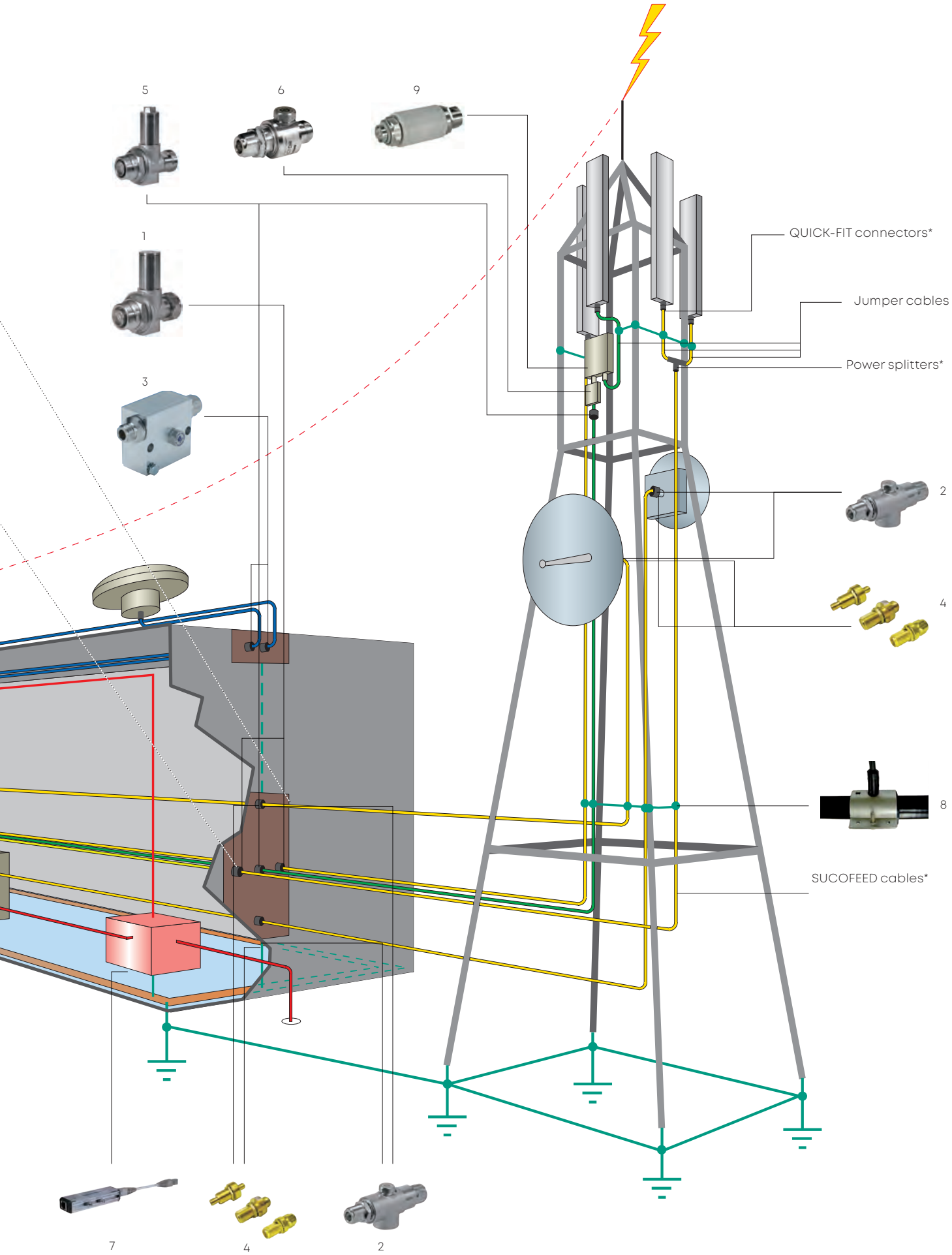
Installation recommendation

- 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 7/16 products are waterproof).
- Integrated in a bonding bar right behind the wall as an alternative.

Recommended HUBER+SUHNER protector group

	Protector series portraits	Detail specification
1. Quarter-wave shorting stub protectors series 3400 + 3407	16	26, 58
2. Gas discharge tube protectors series 3401/02 + 3408	16	34, 40, 64
3. Fine protectors series 3403	17	46
4. Slim line gas discharge tube protectors series 3406	17	54
5. High-power/low IM series 3409 + 3410 (DC injection)	18	66, 72
6. Semper GDT protectors	–	91
7. Signal/data line protectors series 3414	18	76
8. Grounding kits	–	95
9. High voltage DC block series 9077	–	98

For more familiarity with our protection principles and configuration definitions refer to the chapter «Introduction – RF lightning EMP protector principles» (page 10ff) and the chapter «Surge protective devices» (page 25ff) with its SPD series portraits.



* Further information can be found in the following HUBER+SUHNER RF product catalogues: Distributed Antenna Systems (DAS) and Wireless Infrastructure (Solutions for remote radios and cell sites). Please see our website hubersuhner.com – search – literature.

Protector series portraits

Basic properties of HUBER+SUHNER protector principles

Quarter-wave shorting stub protectors series 3400, 3407

- Broadband and narrowband units available
- Maintenance-free
- Highest surge current handling capability
  – N: 50 kA (8/20 µs test pulse)
  – 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 26
series 3407 on page 58

Gas discharge tube protectors series 3401, 3402

- Broadband operation
  – series 3401: DC up to 1 GHz
  – series 3402: DC up to 3 GHz
- DC/AC powering via coax cable (not series 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

Detailed data:
series 3401 on page 34
series 3402 on page 40
series 3408 on page 64

Fine protectors series 3403

- Broadband operation
- Essentially increased protection compared to standard gas discharge tube protectors
- DC/AC powering via coax possible (bypass feature)
- Surge current handling capability
  box design: 30 kA once and 20 kA multiple
  barrel design: 20 kA once and 10 kA multiple
  see page 46
- Residual surge pulse energy reduced by about factor 100 compared to standard gas discharge tube protector

Detailed data:
series 3403 on page 46

Slim line gas discharge tube protectors series 3406

- Wide-band operation DC up to 6 GHz
- Surge current handling 10 kA once and 5 kA multiple
- Gas discharge tube fix installed
- Slim in-line design
- DC/AC powering via coaxial cable
- Bulkhead mounting/grounding

Detailed data:
series 3406 on page 54

Protector series portraits

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

- 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 66
series 3410 on page 72

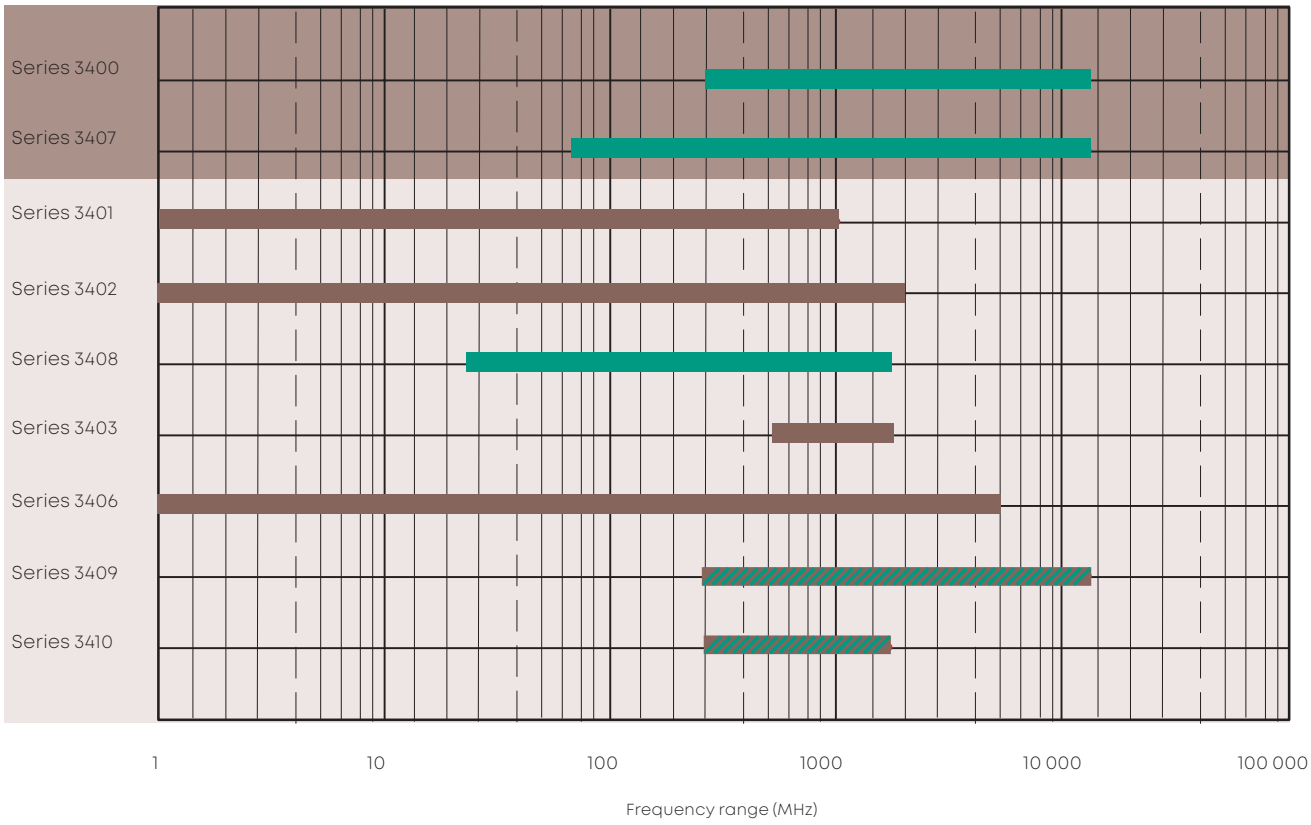
Data line protectors series 3414

- Data line coarse and fine protection solution for high speed data transmission on STP / UTP lines
- Different DLP units available up to Cat 6 in channel class E
- 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 802.3bt for high speed Ethernet data transmission equipment

Detailed data:
series 3414 on page 76

Protector series frequency map

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 shorting stub technology

Gas discharge tube technology

DC/AC continuity for remote powering via coaxial cable possible

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

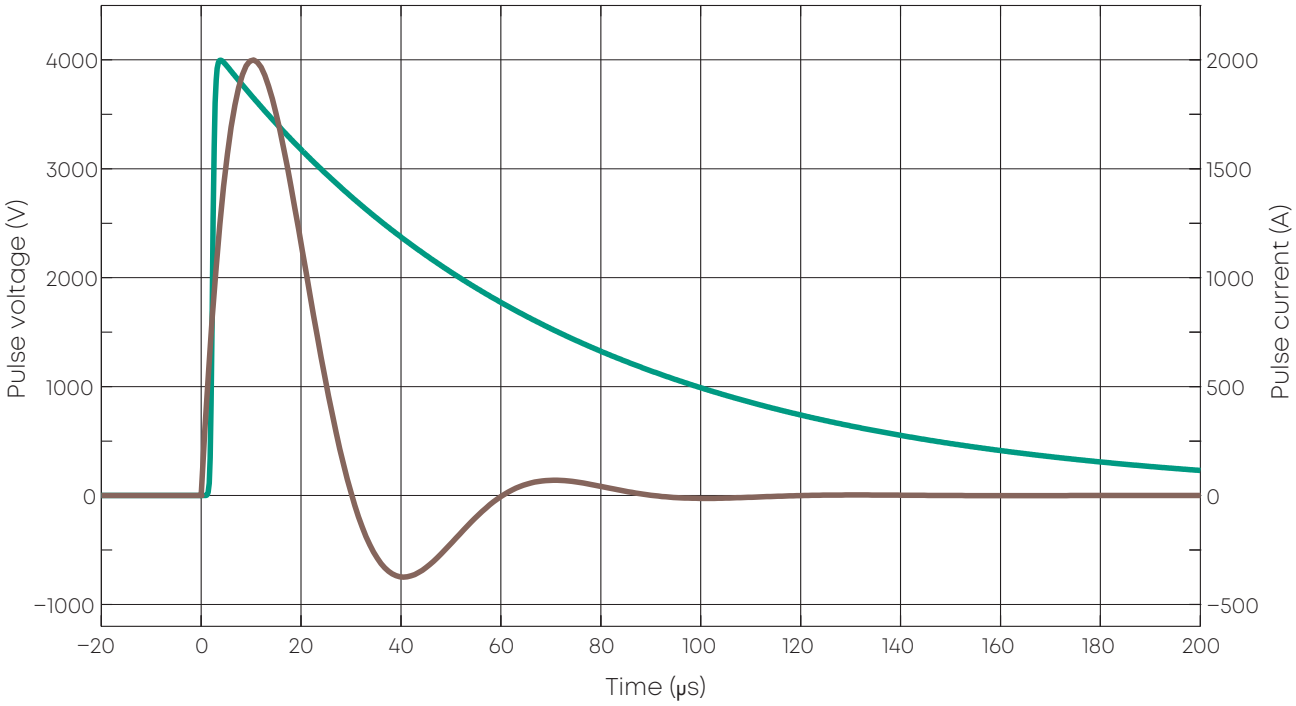
DC/AC continuity for remote powering via coaxial cable possible and products available within this frequency range but with limited bandwidth (according to shown product detail specification)

Protection effectiveness

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.

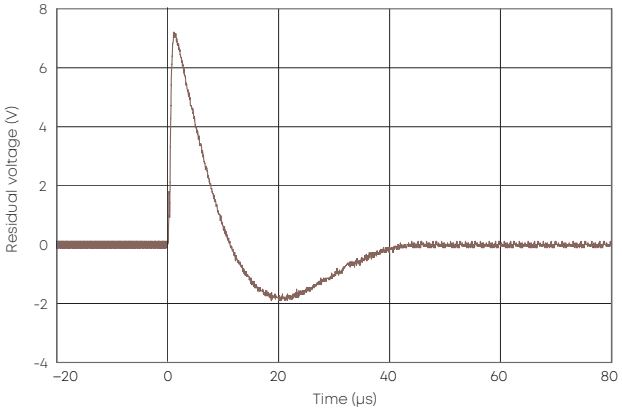
HUBER+SUHNER owns standardised generators for generating surge currents with amplitudes up to 25 kA for 10/350 µs test pulses (first stroke) and up to 100 kA for 8/20 µs test pulses. NEMP can also be tested up to 12 kV; 5/200 ns.

Input surge pulse of a combined surge voltage / current generator

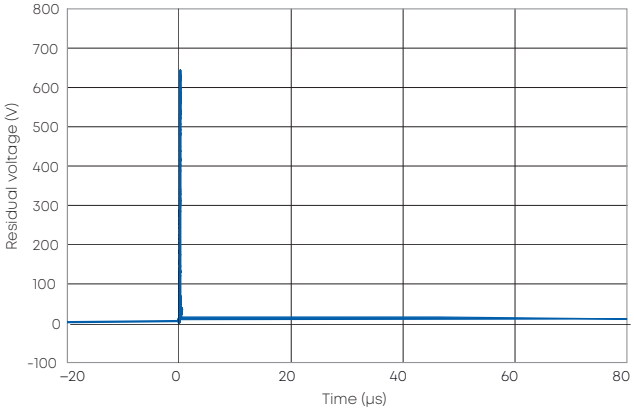


Voltage and current test pulse of the combined 1.2/50 µs, 8/20 µs standard surge test pulse according to IEC 61000-4-5

Output / residual voltage pulse



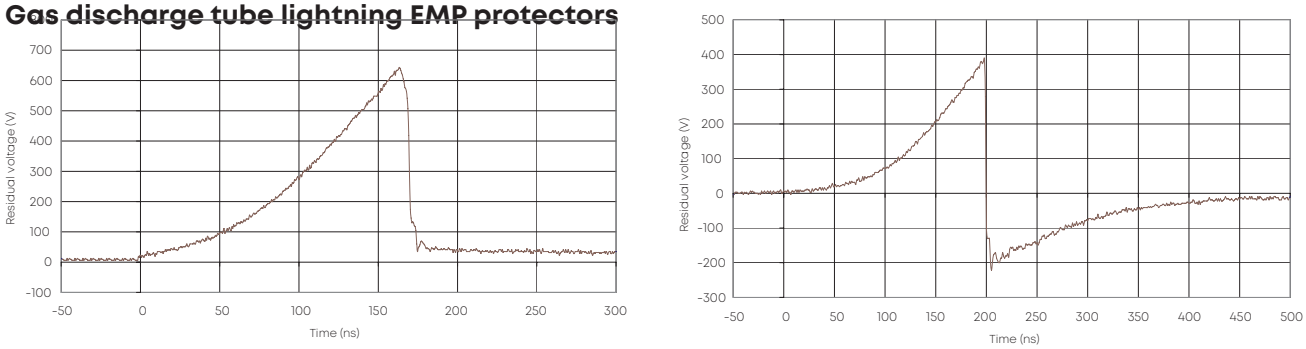
Quarter-wave shorting stub technology



Gas discharge tube technology

Typical residual pulse characteristic of HUBER+SUHNER protector series, tested with input test pulse 4 kV 1.2/50 µs, 2 kA 8/20 µs

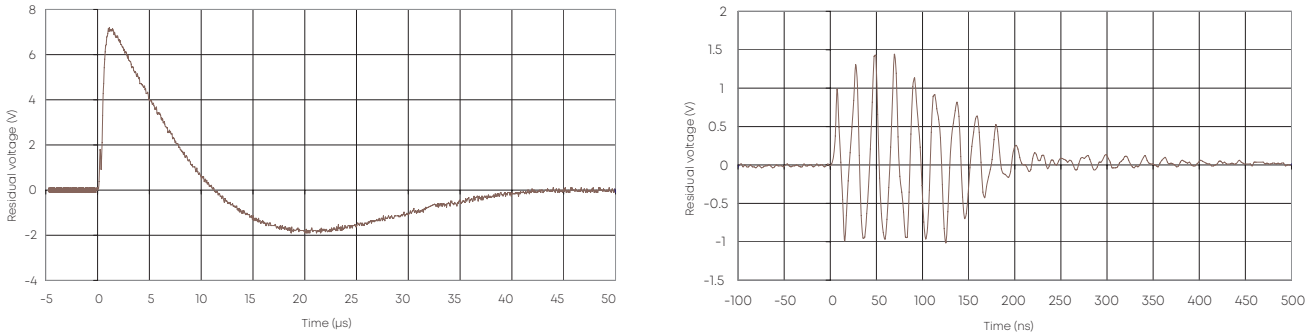
Gas discharge tube lightning EMP protectors



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

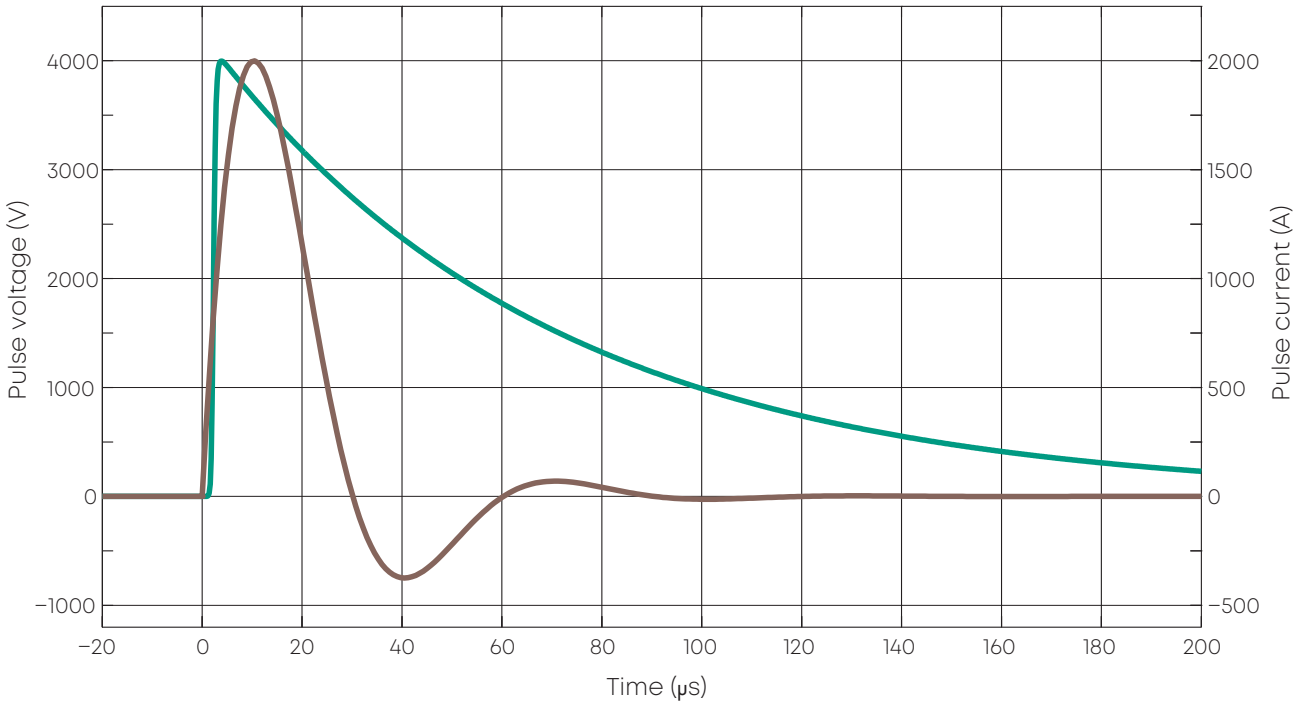
The quarter-wave lightning EMP protector does not require any response time. With its filter characteristic, it reduces the standardized input pulse to a residual voltage of approx. 7 V. This translates into a residual energy that is 70 times lower than that of GDT protectors without high-pass filter. 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 100 000 compared to a standard GDT protector.

Protection effectiveness

Lightning current handling capability

HUBER+SUHNER tests with lightning 10/350 µs and surge 8/20 µs current pulse generators up to 100 kA to verify the current handling capability of Lightning / EMP protectors.

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

Protection effectiveness

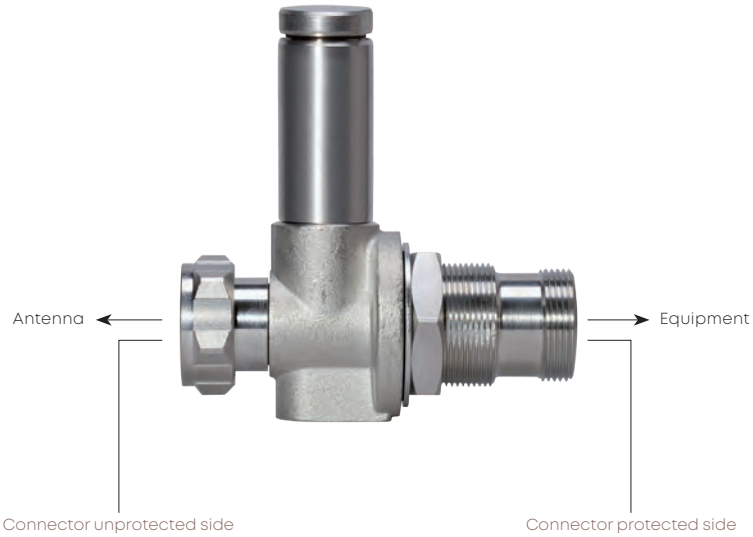
The following table shows the surge current handling capability of HUBER+SUHNER lightning EMP protection devices on the basis of the standardised test pulses:

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 7/16	8 kA	30 kA
	3406	all interfaces	2.5 kA	10 kA
Quarter-wave shorting stub	3400, 3407	7/16	50 kA	100 kA
		N	25 kA	50 kA

Product configuration

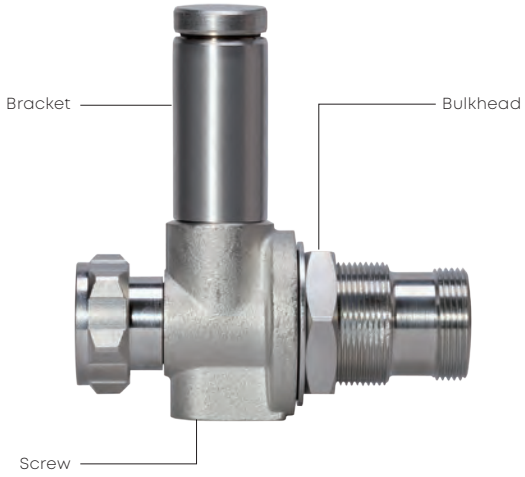
The design of HUBER+SUHNER lightning EMP protectors allows for distinguishing between the «protected» (equipment) and «unprotected» (antenna) side.

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.

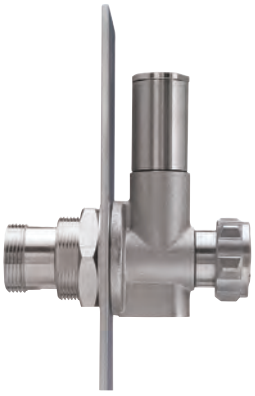
All protectors featuring N and 7/16 connectors are waterproof and therefore can be installed outdoor partially or completely. HUBER+SUHNER bulkhead mounting provides waterproof panel sealing.



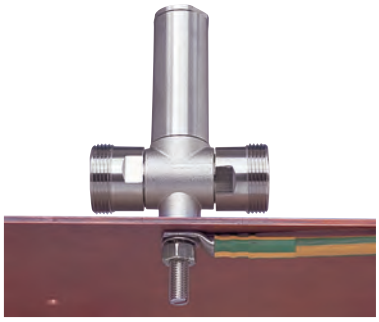
Product configuration

Most frequently used mounting and grounding options

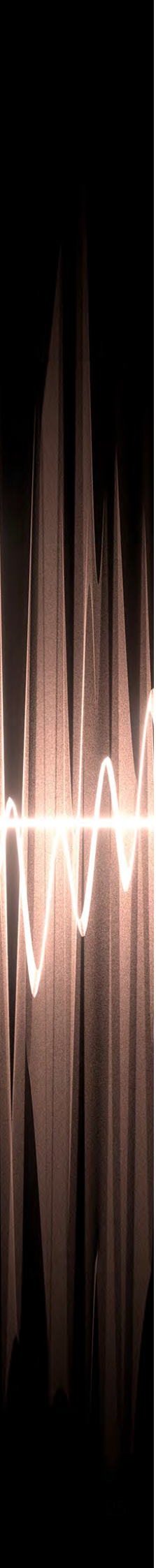
Bulkhead mount



Screw mount



Bracket mount



Surge protective devices

Series 3400 lightning EMP protectors

Quarter-wave shorting 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 connectorisation and mounting principle, the frequency range has to be selected properly due to their generally limited bandwidth.

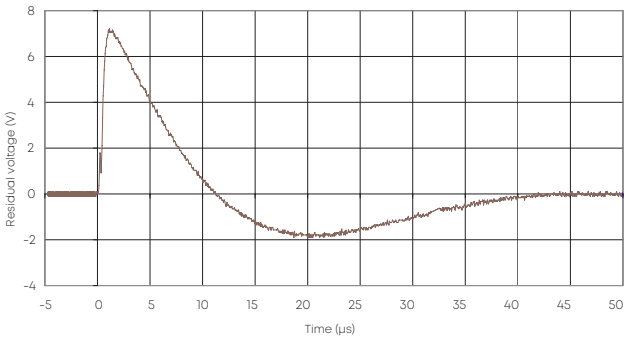
Features
- Broadband
- Available for application bands between 380 MHz and 18 GHz (N, SMA)
- Best PIM performance
- Highest current handling capability up to 100 kA max.
- Maintenance-free

General specification

Electrical data			
RF characteristics			
Impedance	50 Ω		
Frequency range	according to product detail specification (data sheet)		
Return loss (RL)	20 dB min.		
Insertion loss (IL)	0.1 dB max. (0.2 dB max. for f ≥ 3 GHz)		
Passive intermodulation (PIM)	according to product detail specification (data sheet) typ. –160 dBc 3rd order at 2 x 20 W / 2 x 43 dBm		
RF power transmission	according to product detail specification (data sheet)		
Protection characteristics			
Surge current handling capability	**test pulse**	**N**	**7/16**
	8/20 µs multiple 10/350 µs	50 kA 25 kA	50 to 100 kA 50 kA
	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 according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:

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



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque*/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

* For HUBER+SUHNER types made of aluminium see specific mounting and grounding instruction!

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition A

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	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Frequency range 380 to 512 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	**Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».**	**MH – hole for «b» M – screw**	**dB**	**dB**		
3400.17.0388	380 – 512	N (m) – N (f), b	MH74,M8	20	0.1	IP65	1
3400.41.0196	380 – 512	7/16 (f) – 7/16 (f), b	MH74,M8	20	0.1	IP65	2
3400.41.0203		7/16 (m) – 7/16 (f), b				IP67	3

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

All dimensions in mm

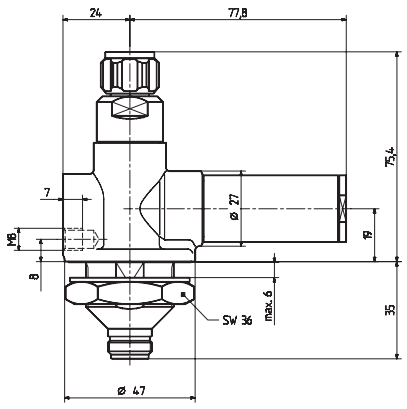


Fig. 1

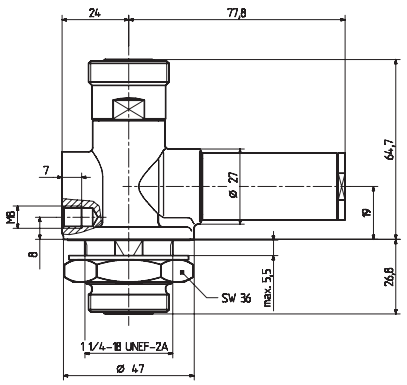


Fig. 2

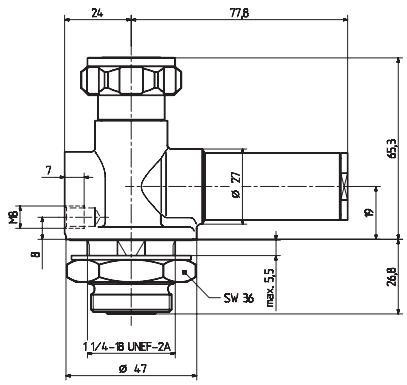


Fig. 3

All mounting holes are shown on pages 174 – 175.

Broadband, frequency range 700 to 2700 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3400.17.0254	1000 – 1100	N (f) – N (f), b	MH12	20.8	0.1	IP65	1
3400.17.0385	950 – 1450	N (f) – N (f), b	MH25, M8	20.0	0.1	IP65	2
3400.17.0416	1000 – 1100	N (f) – N (f), b	MH25, M8	20.0	0.1	IP65	3
	2700 – 2900						
3400.17.0377	806 – 2500	N (m) – N (f)	M8	20.8	0.15	IP65	4
	806 – 960			26.0			
	1710 – 2500			26.0			
3400.17.0431	690 – 2200	N (m) – N (f), b	MH170, M8	23.0	0.15	IP67	5
	690 – 960			24.0			
	1700 – 2200			24.0			
3400.31.0001	690 – 2700	4.3-10 (m) – 4.3-10 (f), b	MH110, M8	24.0	0.1	IP67	6
3400.41.0204	806 – 2500	7/16 (m) – 7/16 (f)	M8	20.8	0.15	IP65	7
	806 – 960			26.0			
	1710 – 2500			26.0			
3400.41.0216	806 – 2500	7/16 (f) – 7/16 (f)	M8	20.8	0.15	IP65	8
	806 – 960			26.0			
	1710 – 2500			26.0			
3400.41.0217	806 – 2500	7/16 (m) – 7/16 (f), b	MH74, M8	20.8	0.15	IP65	9
	806 – 960			26.0			
	1710 – 2500			26.0			
3400.41.0257**	790 – 2620	7/16 (m) – 7/16 (f), b	MH110, M8	20.8	0.10	IP68	10
	824 – 960			24.0			
	1710 – 2200			24.0			
3400.41.0266	690 – 2690	7/16 (m) – 7/16 (f), b	MH110, M8	28.0	0.1	IP67	11
3400.41.0267	690 – 2690	7/16 (m) – 7/16 (f), b	MH110, M8	26.0	0.1	IP67	12

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

All mounting holes are shown on pages 174 – 175.

Frequency range 380 to 512 MHz

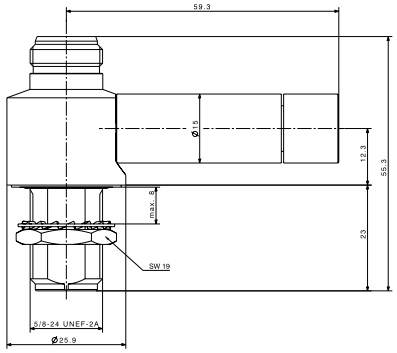


Fig. 1

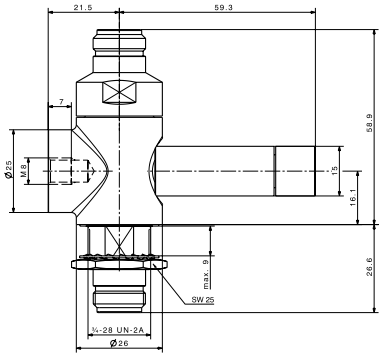


Fig. 2

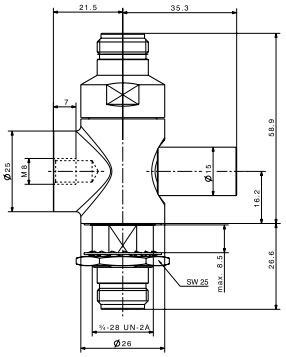


Fig. 3

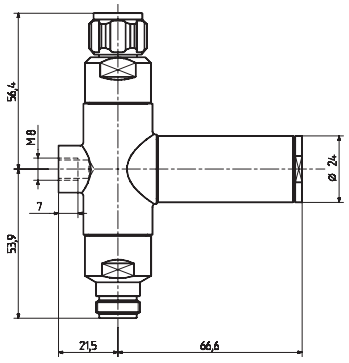


Fig. 4

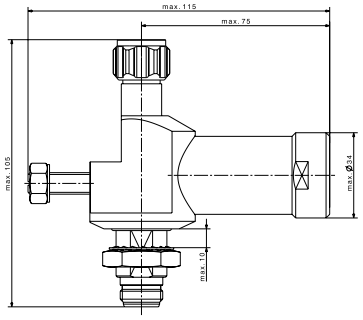


Fig. 5

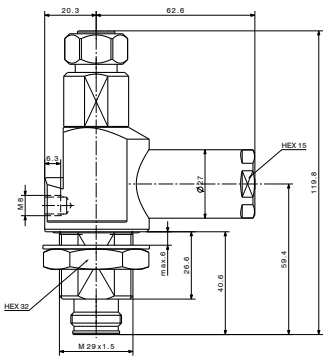


Fig. 6

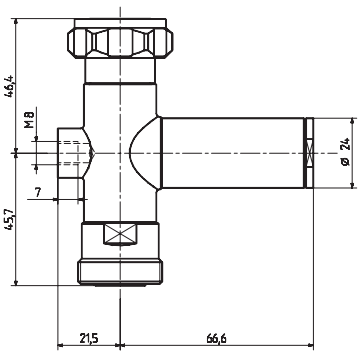


Fig. 7

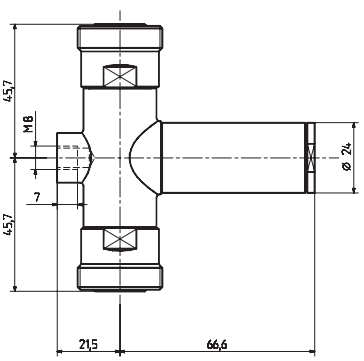


Fig. 8

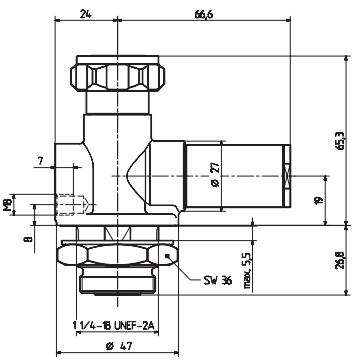


Fig. 9

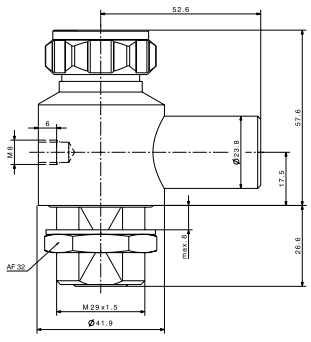


Fig. 10

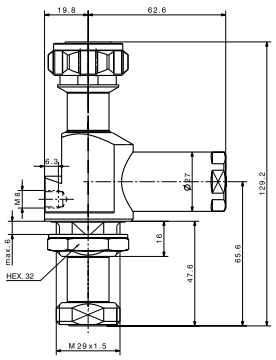


Fig. 11

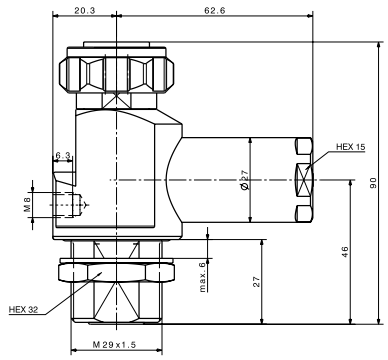


Fig. 12

All mounting holes are shown on pages 174 – 175.

Frequency range 2000 to 18000 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3400.17.0235	5000 – 7000	N (f) – N (f), b	MH25, M8	20	0.25	IP65	1
3400.17.0247	2400 – 3600	N (m) – N (f), b	MH50, M8		0.15	IP66	2
3400.17.0380	6000 – 18000	N (f) – N (f), b	MH69		0.30	IP65	3
3400.17.0410	2000 – 6000	N (m) – N (f)	M8		0.20	IP65	4
3400.17.0426**		N (f) – N (f), b	MH170			IP68	5
3400.17.0428**		N (m) – N (f), b	MH170			IP68	6

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

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

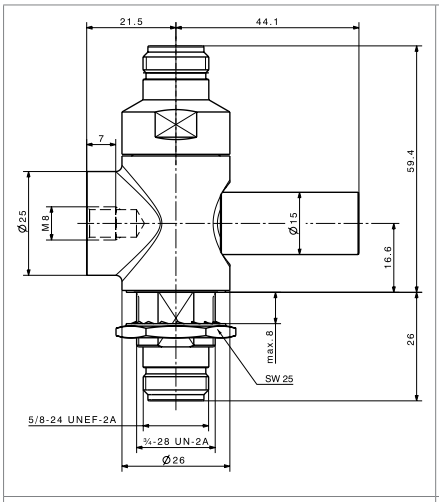


Fig. 1

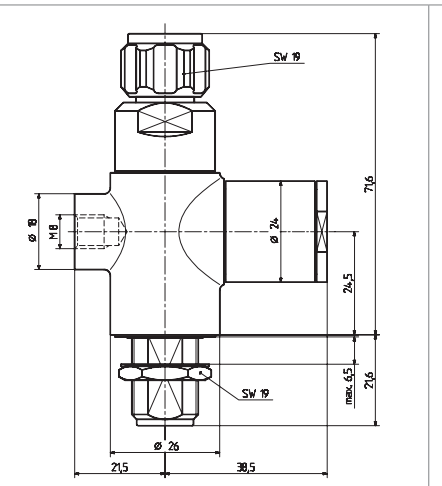


Fig. 2

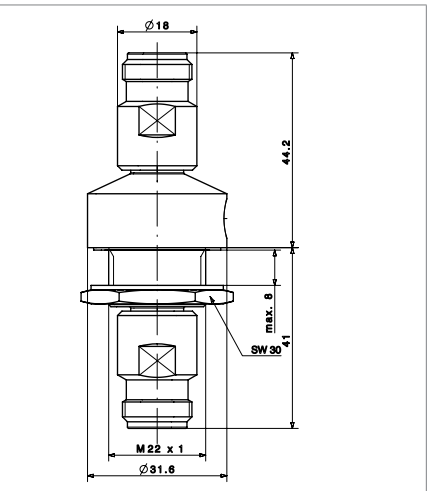


Fig. 3

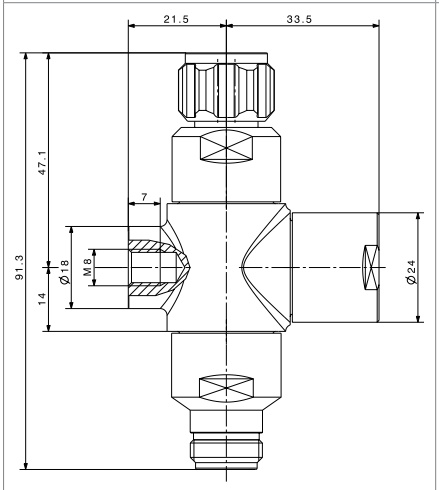


Fig. 4

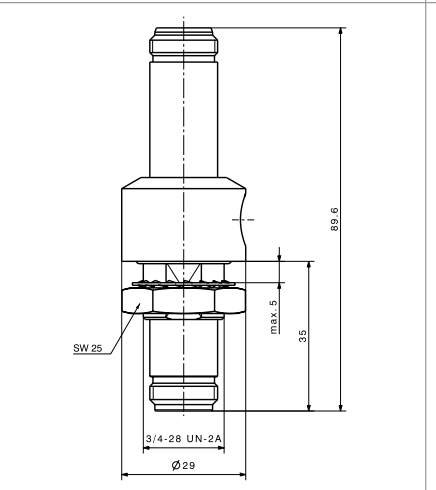


Fig. 5

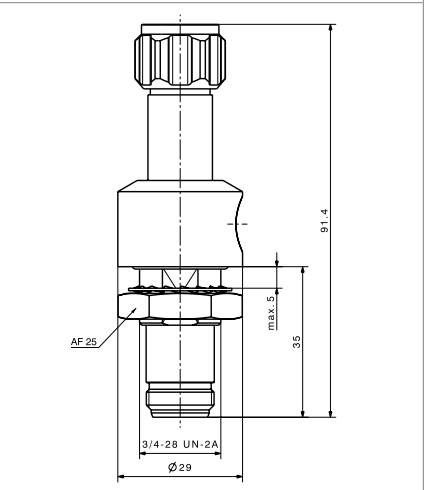


Fig. 6

All mounting holes are shown on pages 174 – 175.

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 continuity for remote powering
- Gas discharge tube replaceable
- Easy maintenance
- Semper self-extinguishing functionality optional (see page 91)

General specification

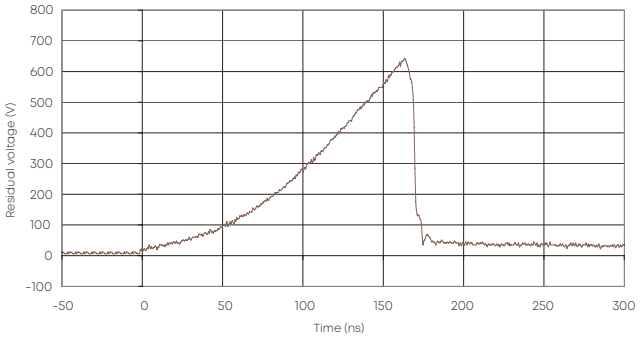
Electrical data		
RF characteristics		
Impedance	50 or 75 Ω	
Frequency range	DC – 1000 MHz	
Return loss* (RL)	20 dB min.	
Insertion loss* (IL)	0.2 dB max.	
RF power transmission	according to selected gas discharge tube – refer to page 86	
DC current rating	refer to data in chapter «General information – Connector interfaces» and product detail specification (data sheet)	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs single 8/20 µs multiple 10/350 µs	30 kA 20 kA 8 kA
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 according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:

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

* With 230 V gas discharge tube (9071.99.0547)



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition 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	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Coaxial, characteristic impedance 50 Ω

Gas discharge tube normally to be selected and ordered separately – refer to pages 86 – 90.

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3401.00.0022	DC – 1000	N (f) – SMA (f), b	MH12	20	0.2	IP67	1
3401.01.A	DC – 300	BNC (f) – BNC (f), b	MH12	26	0.1	IP20	2
	300 – 1000			19			
3401.01.C	DC – 300	BNC (m) – BNC(f), b	MH12	26	0.1	IP20	3
	300 – 1000			19			
3401.17.0033	DC – 1000	N (f) – N (f), b	MH12, M8	20	0.2	IP65	4
3401.17.0048-EX**		N (f) – N (f), b	MH12	24	0.1		5
3401.17.0057-EX**		N (m) – N (f), b	MH12	24	0.1		6
3401.17.A		N (f) – N (f), b	MH12	26	0.1	IP66	7
3401.17.C		N (m) – N (f), b	MH12	26	0.1	IP65	8
3401.26.A	DC – 300	TNC (f) – TNC (f), b	MH12	26	0.1	IP64	9
	300 – 1000			19			
3401.26.C	DC – 300	TNC (m) – TNC (f), b	MH12	26	0.1	IP20	10
	300 – 1000			19			
3401.26.0012-EX**	DC – 1000	TNC (f) – TNC (f), b	MH12	19	0.1	IP64	11

* Recommendation only, reverse installation possible without any impact on performance
** Semper GDT 230 V (9071.99.0647) – for detailed information see page 91

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

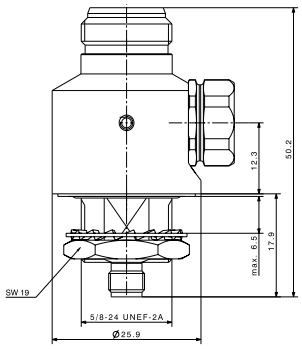


Fig. 1

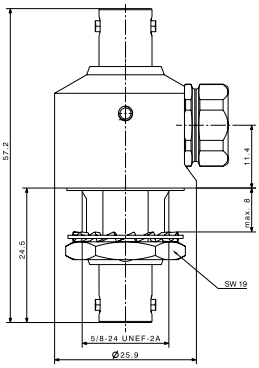


Fig. 2

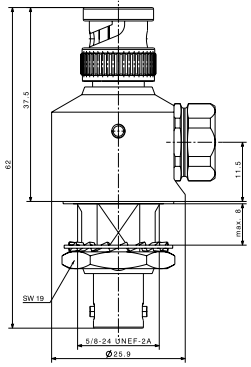


Fig. 3

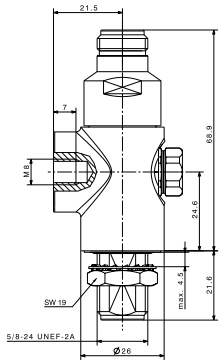


Fig. 4

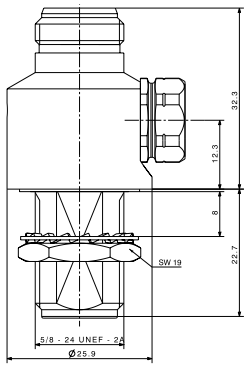


Fig. 5

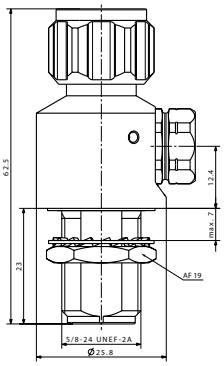


Fig. 6

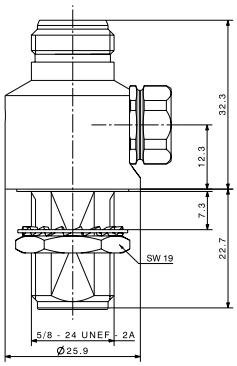


Fig.7

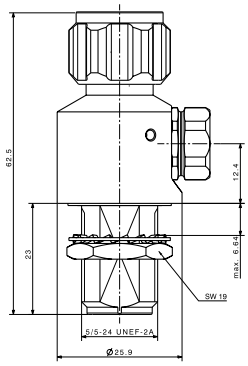


Fig. 8

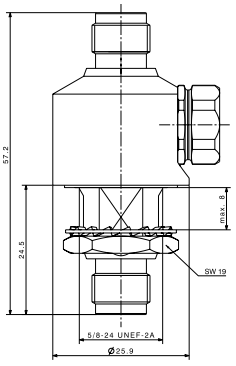


Fig. 9

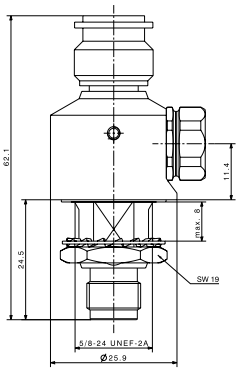


Fig. 10

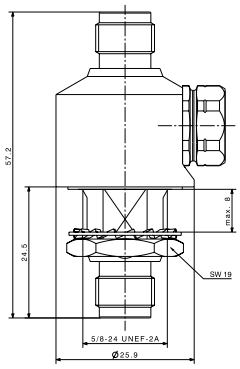


Fig. 11

All mounting holes are shown on pages 174 – 175.

Coaxial, characteristic impedance 75 Ω

Gas discharge tube normally to be selected and ordered separately – refer to pages 86 – 90.

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	**Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».**	**MH – hole for «b» M – screw**	**dB**	**dB**		
3401.02.A	DC – 400	BNC (f) – BNC (f), b	MH12	20.0	0.1	IP20	1
	400 – 1000			15.0	0.2		
3401.18.A	DC – 500	N (f) – N (f), b	MH12	20.8	0.1	IP65	2
3401.99.0020**	DC – 1000	F (f) – F(f), b	MH12	–	0.2	IP65	3

* Recommendation only, reverse installation possible without any impact on performance
** Gas discharge tube included (230 V, 9071.99.0547)

All dimensions in mm

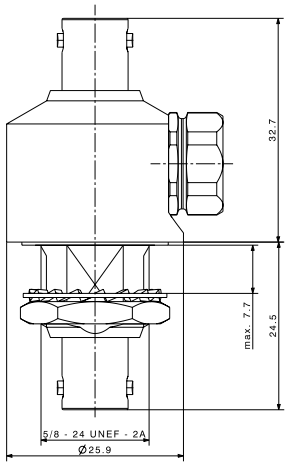


Fig. 1

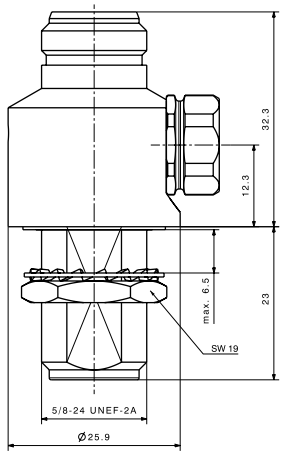


Fig. 2

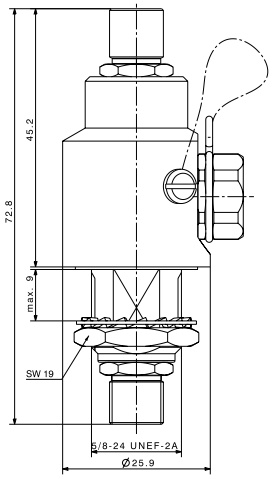


Fig. 3

All mounting holes are shown on pages 174 – 175.

Triaxial, characteristic impedance 50 Ω

Gas discharge tube normally to be selected and ordered separately – refer to pages 86 – 90.

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

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

All dimensions in mm

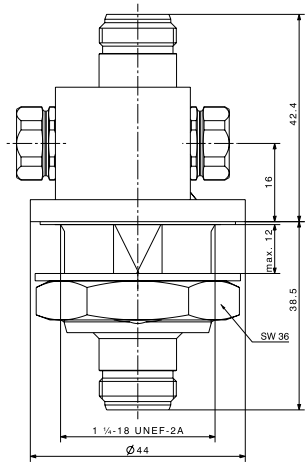
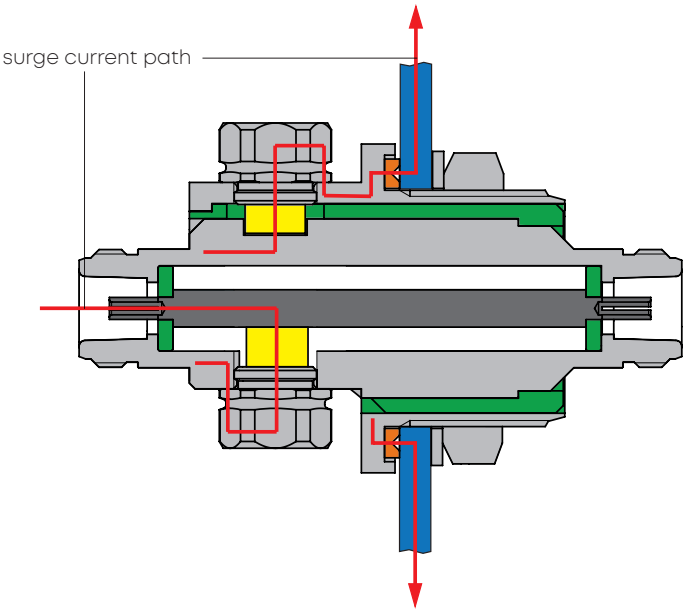


Fig. 1

Triaxial structure illustration



All mounting holes are shown on pages 174 – 175.

Series 3402 lightning EMP protectors

Gas discharge tube (GDT) technology up to 3 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 2.5 GHz respectively up to 3 GHz for platform 3000.

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 3 GHz
- DC continuity for remote powering
- Gas discharge tube replaceable
- Easy maintenance
- Semper self-extinguishing functionality optional (see page 91)

General specification

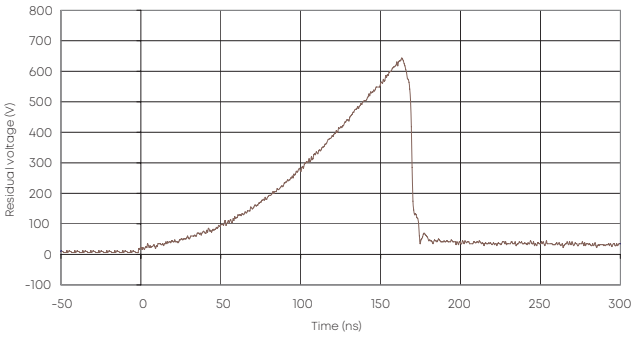
Electrical data		
RF characteristics		
Impedance	50 or 75 Ω	
Frequency range	DC – 2.5 GHz, standard configuration DC – 3 GHz, platform 3000 (some types different according to shown specification, but 2 GHz min.)	
Return loss* (RL)	20 dB min.	
Insertion loss* (IL)	0.2 dB max.	
RF power transmission	according to selected gas discharge tube – refer to page 86	
DC current rating	refer to data in chapter «General information – Connector interfaces» and product detail specification (data sheet)	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs single 8/20 µs multiple 10/350 µs	30 kA 20 kA 8 kA
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 according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:

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

* With 230 V gas discharge tube (9071.99.0547)



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition 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	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Characteristic impedance 50 Ω

Gas discharge tube normally to be selected and ordered separately – refer to pages 86 – 90.

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3402.17.0043	DC – 2500	N (m) – N (f), b	MH12, M8	20	0.2	IP65	1
3402.17.0044		N (f) – N (f), b	MH12, M8				2
3402.17.0072-EX**		N (f) – N (f), b	MH25				3
3402.17.A		N (f) – N (f), b	MH25			IP66	4
3402.17.C		N (m) – N (f), b	MH25			IP65	5
3402.26.0004		TNC (m) - TNC (f), b	MH25	20	0.2	IP65	6
3402.41.0037	DC – 2500	7/16 (m) – 7/16 (f), b	MH74, M8	20	0.2	IP65	7
3402.41.0038		7/16 (f) – 7/16 (f), b	MH74, M8				8
3402.41.A		7/16 (f) – 7/16 (f), b	MH72			IP67	9
3402.17.3001	DC – 3000 ***	N (f) – N (f), b	MH170	20	0.2	IP67	10
3402.17.3002		N (m) – N (f), b					11
3402.26.3001		TNC (f) – TNC (f), b			0.3	IP65	12

* Recommendation only, reverse installation possible without any impact on performance
** Semper GDT 230 V (9071.99.0647) – for detailed information see page 91
*** Platform 3000

All dimensions in mm

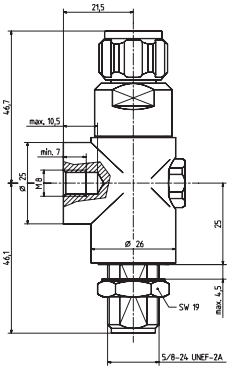


Fig. 1

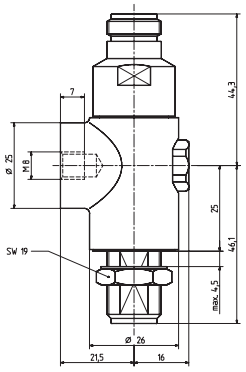


Fig. 2

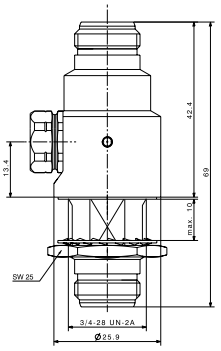


Fig. 3

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

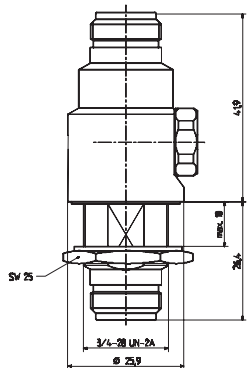


Fig. 4

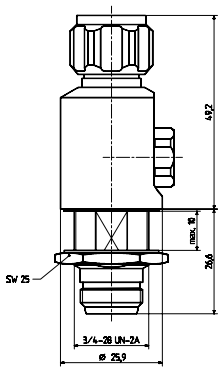


Fig. 5

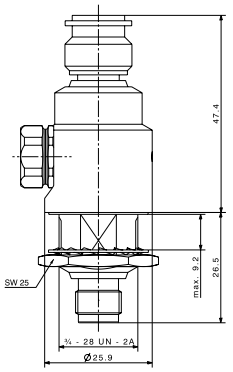


Fig. 6

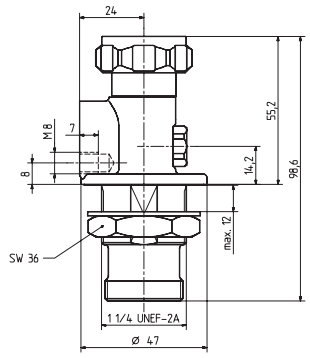


Fig.7

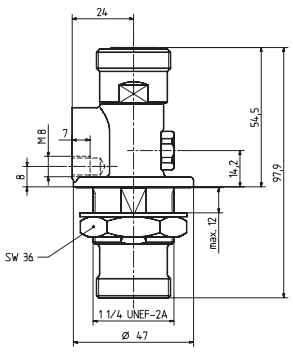


Fig. 8

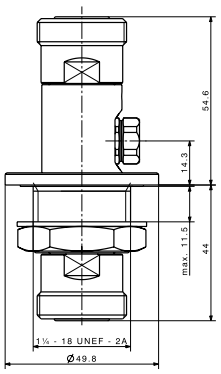


Fig. 9

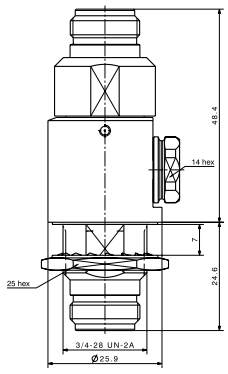


Fig. 10

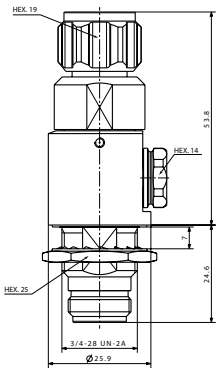


Fig. 11

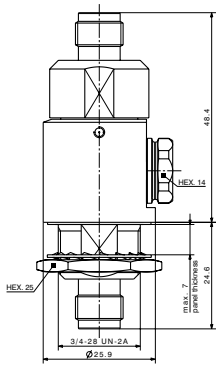


Fig. 12

All mounting holes are shown on pages 174 – 175.

Characteristic impedance 75 Ω

Gas discharge tube normally to be selected and ordered separately – refer to pages 86 – 91

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

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

All dimensions in mm

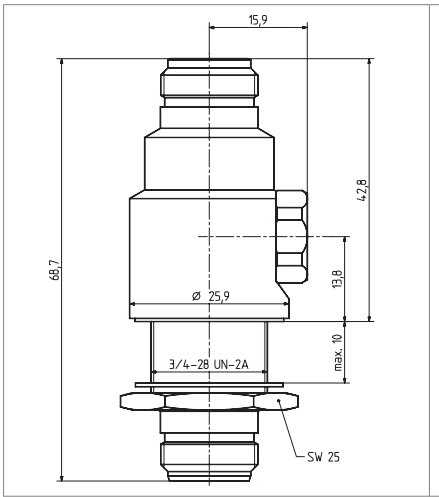


Fig. 1

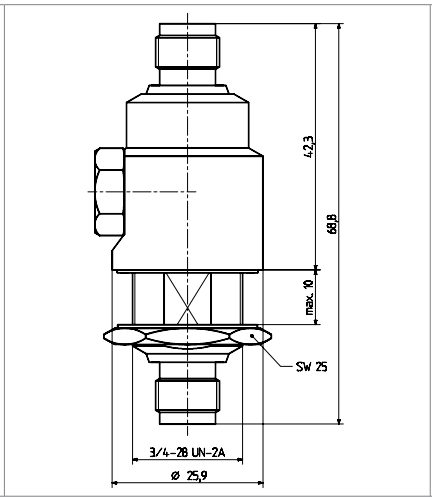


Fig. 2

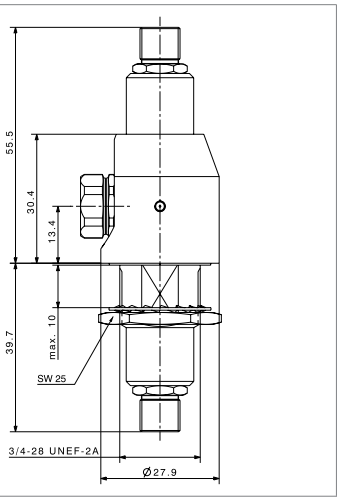


Fig. 3

All mounting holes are shown on pages 174 – 175.

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 communication systems.

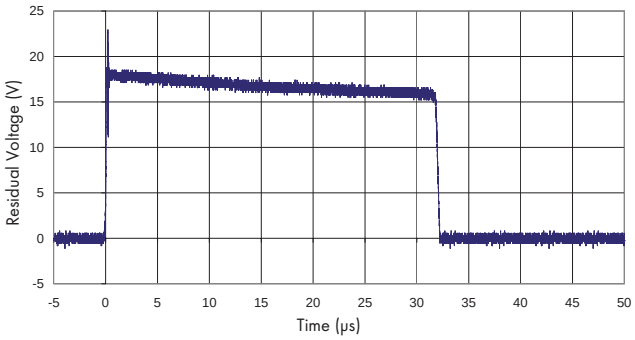
Features
- Rugged, stable and reliable fine protectors with very low residual pulse energy
- DC continuity for remote powering
- Easy installation – screw or bulkhead
- Full lightning protection as standard gas discharge tube (GDT) protectors
- Gas discharge tube included
- Waterproof IP65

General specification

Electrical data			
RF characteristics			
Impedance	50 Ω		
Frequency range	650/800 to 2500 MHz (box/barrel design) or 5 to 400 MHz (barrel design)		
Return loss (RL)	20 dB min.		
Insertion loss (IL)	0.5 dB max.		
RF power transmission	50 W max.		
DC current rating	according to design – refer to page 48		
Protection characteristics			
Surge current handling capability	**test pulse**	**box design**	**barrel design**
	8/20 µs single 8/20 µs multiple 10/350 µs	30 kA 20 kA 8 kA	20 kA 10 kA 5 kA
Residual pulse energy	for typical values refer to the following diagram		

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

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



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque*/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

* For HUBER+SUHNER types made of aluminium see specific mounting and grounding instruction!

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition A

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	aluminium	
Connector bodies	brass	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	**Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».**	**MH – hole for «b» M – screw**	**dB**	**dB**		
3403.17.0060**/*** [1]	800 – 2500	N (f) – N (f), b	MH12	26.4	0.3	IP67	1
3403.17.0063**/*** [1]		N (f), b – N (m)	MH12	26.4	0.3		2
3403.17.0049* [2]	650 – 2500	N (m) – N (f), b	MH119, M6/2 x Ø 4.2	20.8	0.5	IP65	3
3403.17.0050* [2]		N (f) – N (f), b	MH119, M6/2 x Ø 4.2	20.8	0.5		4
3403.17.0051* [2] HEMP	806 – 2500	N (m) – N (f)	M6/2 x Ø 4.2	20.8	0.5	IP65	5
3403.17.0069**/*** [3]	5.5 – 40	N (f) – N (f), b	MH12	10.0	1.0	IP67	6
	40 – 55			20.0	0.25		
	55 – 400			26.0	0.25		
3403.17.0075** [1]	800 – 2500	N (f) – N (f), b	MH12	26.4	0.3		7
3403.26.0002**/*** [4]	800 – 2500	TNC (f) – TNC (f), b	MH12	23.0	0.3	IP67	9
	1500 1700			26.4	0.3		

* Gas discharge tube included (90 V, 9071.99.0548)
** Permanently installed GDT
*** Material: aluminium
1) = barrel design, bypass voltage 6 V, DC current 4 A
2) = box design, bypass voltage 15 V, DC current 3 A
3) = barrel design, bypass voltage 60 V, DC current 4 A
4) = barrel design, bypass voltage 6 V, DC current 3 A

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

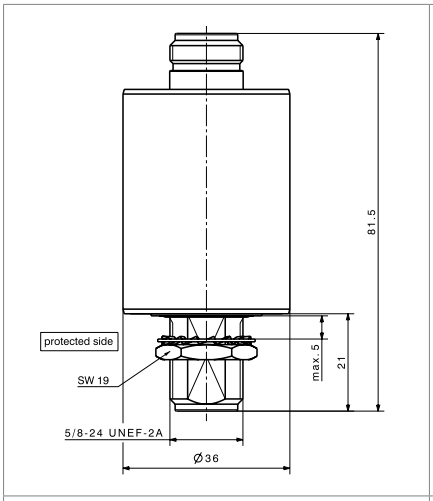


Fig. 1

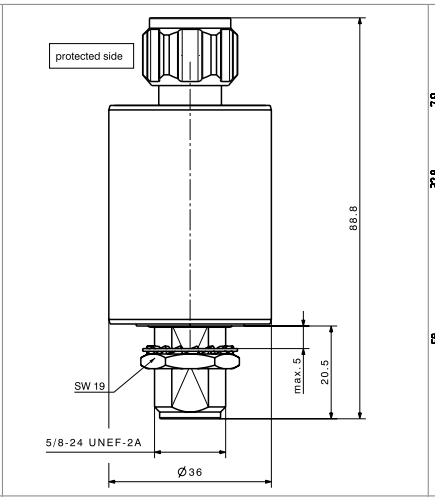


Fig. 2

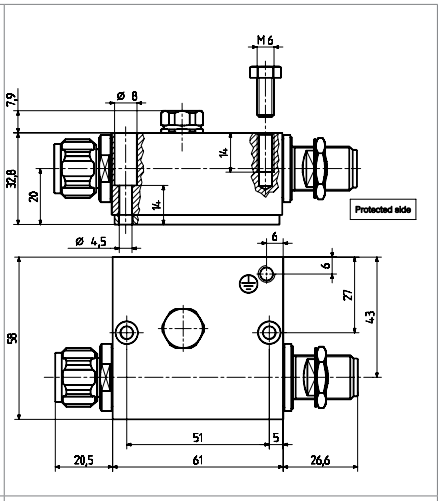


Fig. 3

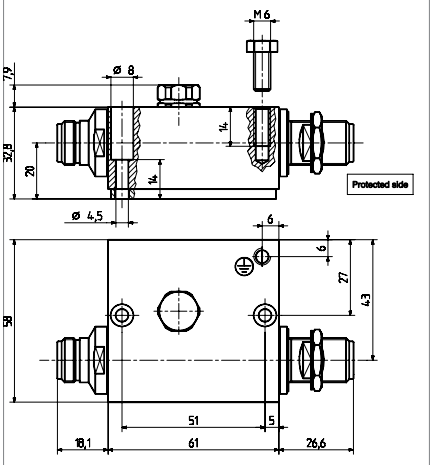


Fig. 4

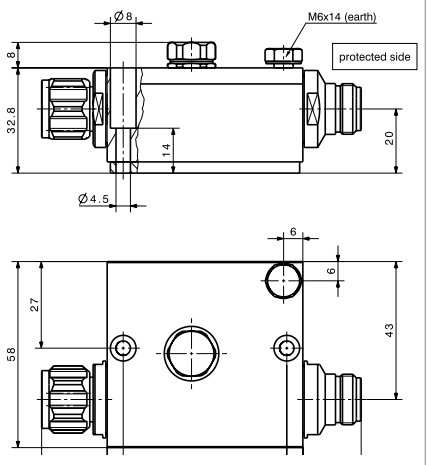


Fig. 5

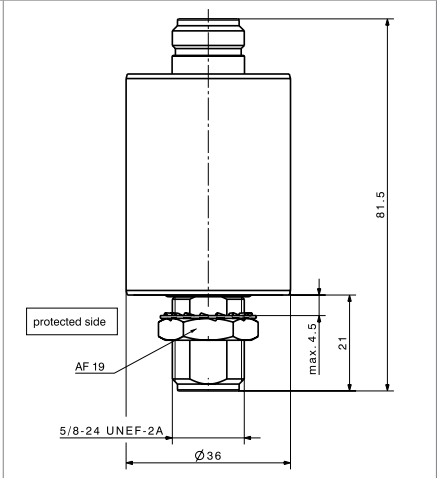


Fig. 6

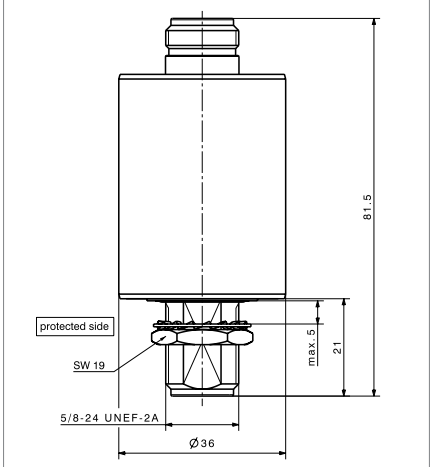


Fig. 7

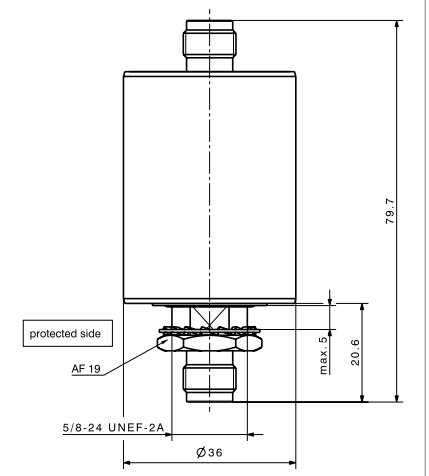


Fig. 8

All mounting holes are shown on pages 174 – 175.

Series 3404 lightning EMP protectors

Miniature gas discharge tube (GDT) technology

Description
HUBER+SUHNER miniature gas discharge tube protectors are designed to protect against multiple electromagnetic threats including SURGE, NSL, ESD or (H)EMP.

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.

Different or additional protectors need to be applied for lightning protection.

Features
- Waterproof interface even in un-mated conditions
- Low contact resistance between protector body and mounting wall
- Space saving inline design
- Broadband DC to 3 GHz
- Surge current handling capability up to 5 kA (8/20 µs)
- DC continuity for remote powering
- Fix installed GDT, static spark over-voltage nom. 150 V
- In conformity with the LPZ concept at the boundaries from 0B – 1 and higher

General specification

Electrical data		
RF characteristics		
Impedance	50 Ω	
Frequency range	DC to 3 GHz, according to product detail specification	
Return loss (RL)	according to product specification (data sheet)	
Insertion loss (IL)	according to product specification (data sheet)	
DC and RF power transmission	DC: 50 W max.	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs multiple	5 kA

Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium according to product detail specification	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition 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 or stainless steel	SUCOPLATE® or passivated
Male contacts	brass	gold plating
Female contacts	copper beryllium alloy or bronze	gold plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3404 lightning EMP protectors

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3404.00.0006**	DC – 1000	TNC (f) – MCX (f), b	MH4	26	0.3	IP20	1
	1000 – 2000			17	0.6		
3404.26.0002**	DC – 1000	TNC (f) – TNC (f), b	MH4	23	0.2	IP20	2
	1000 – 2000			17	0.3		
3404.00.0011	DC-3000	TNC(f)-MMCX(f)	MH119	20	0.25	IP68	3
3404.00.0012	DC-3000	N(f)-MMCX(f)	MH119	20	0.25	IP68	4

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

** Permanently installed GDT 230 V

All dimensions in mm

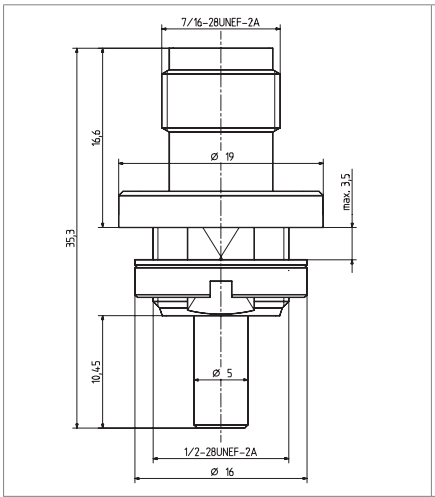


Fig. 1

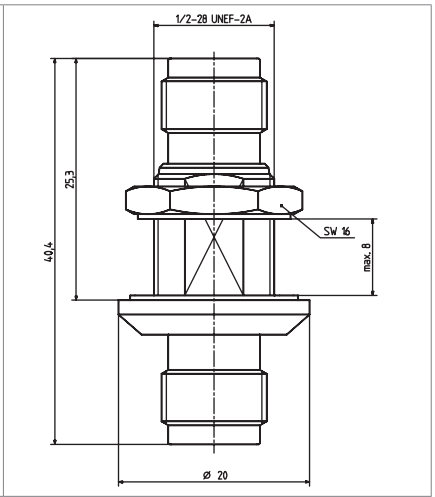


Fig. 2

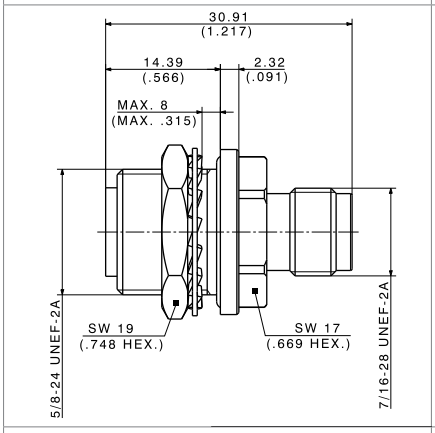


Fig. 3

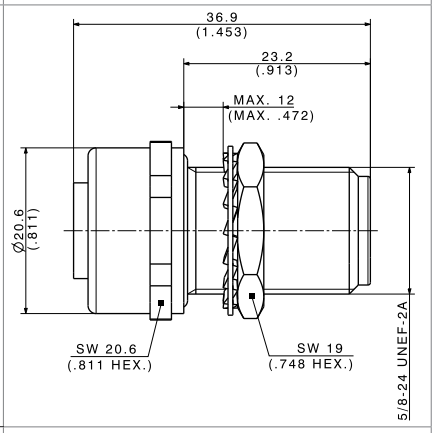


Fig. 4

All mounting holes are shown on pages 174 – 175.

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 6 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.

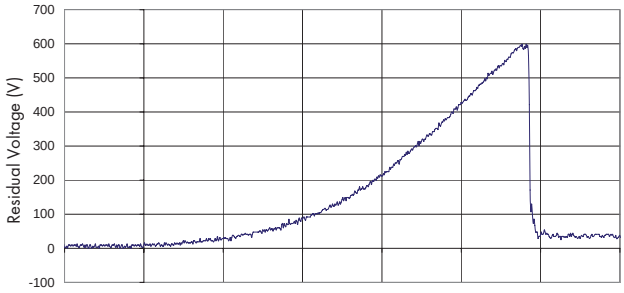
Features
- Broadband operation from DC up to 6 GHz (BNC = DC up to 4 GHz)
- DC continuity for remote powering
- Slim in-line design
- Permanently installed gas discharge tube
  – GDT static sparkover voltage typ. 150 to 250 V (100 V/s)
  – GDT dynamic sparkover voltage typ. ≤ 700 V (1 kV/µs)

General specification

Electrical data		
RF characteristics		
Impedance	50 Ω	
Frequency range	DC to 6 GHz, refer to product detail specification (data sheet)	
Return loss (RL)	20 dB typ. according to product detail specification (data sheet)	
Insertion loss (IL)	0.2 dB typ. according to product detail specification (data sheet)	
RF power transmission	60 W max.	
DC current rating	refer to data in chapter «general information - connector interfaces» and product detail specification (data sheet)	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs single 8/20 µs multiple 10/350 µs	10 kA 5 kA 2.5 kA
Residual pulse voltage and energy	for typical values refer to the following diagram	

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

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



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition 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	copper beryllium alloy or bronze	gold plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3406 lightning EMP protectors

Broadband, frequency range DC – 6000 MHz

Characteristic impedance 50 Ω

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	GHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3406.01.0003	DC – 4.0	BNC (m) – BNC (f), b	MH4	20.0	0.2	IP20	1
3406.17.0027	DC – 4.0	N (f) – N (f), b	MH24	20.0	0.2	IP68	2
3406.17.0028		N (m) – N (f), b					3
3406.17.0009	DC – 5.6	N (f) – N (f), b	MH24	20.0	0.2	IP67	4
	5.6 – 5.8			18.5	0.2		
	5.8 – 6.0			15.0	0.3		
3406.17.0012	DC – 5.6	N (m) – N (f), b	MH24	20.0	0.2	IP67	5
	5.6 – 5.8			18.5	0.2		
	5.8 – 6.0			15.0	0.3		
3406.19.0003	DC – 5.6	SMA (f) – SMA (f), b	MH3	20.0	0.2	IP65	6
	5.6 – 5.8			18.5			
3406.19.0004	DC – 5.6	SMA (m) – SMA (f), b	MH3	20.0	0.2	IP65	7
	5.6 – 5.8			18.5			
3406.26.0004	DC – 5.6	TNC (m) – TNC (f), b	MH4	20.0	0.2	IP20	8
	5.6 – 5.8			18.5			
3406.26.0010	DC – 2.0	TNC (m) – TNC (f), b	MH4	20.0	0.2	IP65	9

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

Characteristic impedance 75 Ω

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3406.99.0016	DC – 2000	F (f) – F (f), b	MH71	20.0	0.2	IP67	10
	2000 – 3000			20.0	0.4		

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

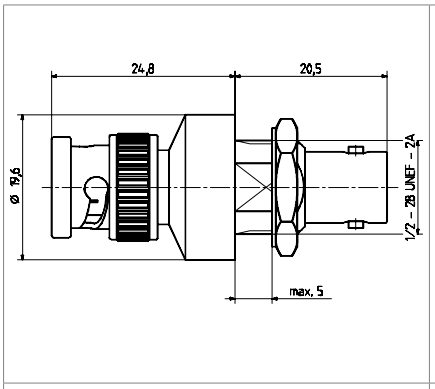


Fig. 1

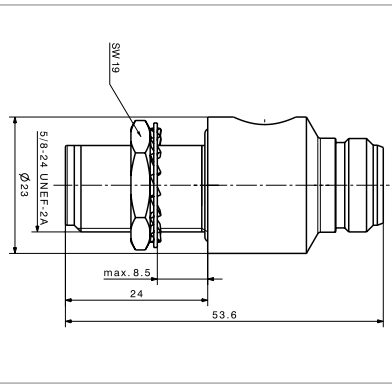


Fig. 2

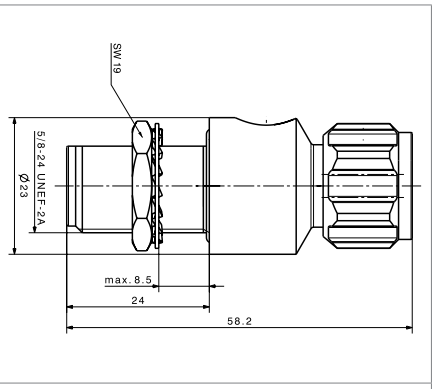


Fig. 3

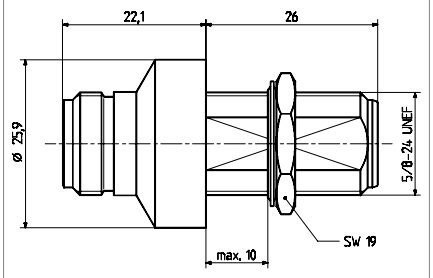


Fig. 4

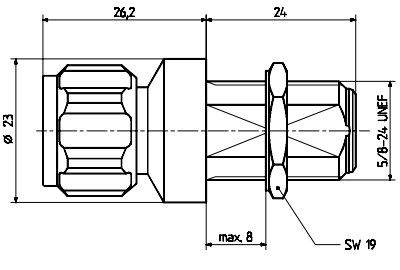


Fig. 5

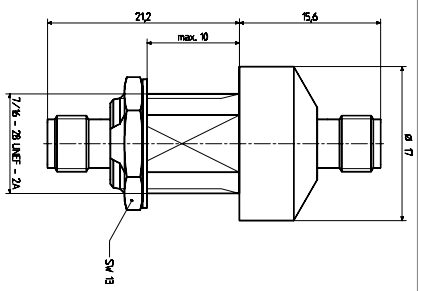


Fig. 6

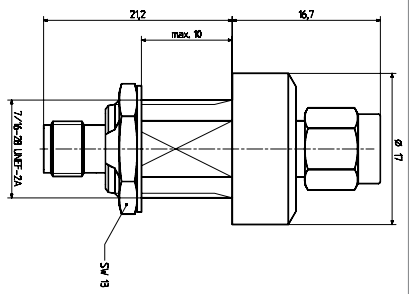


Fig. 7

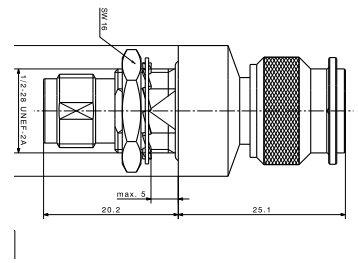


Fig. 8

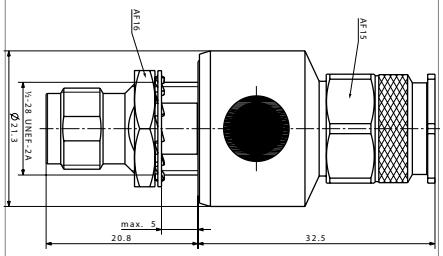


Fig. 9

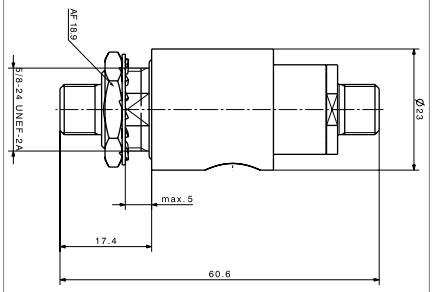


Fig. 10

All mounting holes are shown on pages 174 – 175.

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.

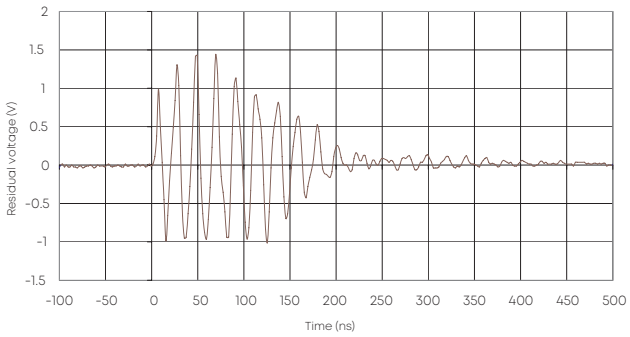
Features
- Residual voltage reduced by 80 % compared to standard types of series 3400
- Residual energy reduced up to factor 2000 (more than 99.9 %) compared to the series 3400
- DC-blocking on protected side of the device (galvanic isolation)
- Available for applications from 70 MHz to 18 GHz (N, SMA)

General specification

Electrical data			
RF characteristics			
Impedance	50 Ω		
Frequency range	according to product detail specification,		
Return loss (RL)	20 dB min.		
Insertion loss (IL)	0.2 dB max.		
Passive intermodulation (PIM)	according to product detail specification (data sheet)		
RF power transmission	according to product detail specification (data sheet)		
Protection characteristics			
Surge current handling capability (shorting stub design)	**test pulse**	**N**	**7/16**
	8/20 µs multiple 10/350 µs	50 kA 25 kA	50 to 100 kA 50 kA
	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 according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:

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



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque*/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

* For HUBER+SUHNER types made of aluminium see specific mounting and grounding instruction!

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition A

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	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Frequency range 74 to 420 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3407.17.0022	74 – 180	N (f) – N (f), b	MH74,M8	20	0.15	IP66	1
3407.17.0054	140 – 180	N (m) – N (f), b	MH12,M8	20	0.20	IP65	2
3407.17.0088	74 – 420	N (m) – N (f), b	MH74,M8	23	0.15	IP67	3
3407.17.0089	74 – 420	N (f) – N (f), b	MH74,M8	23	0.15	IP67	4

All dimensions in mm

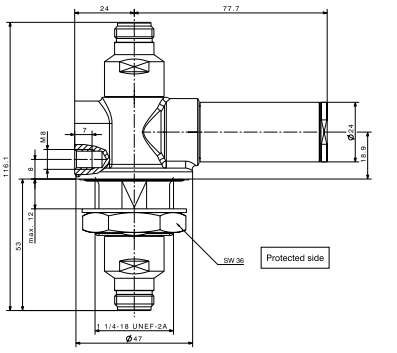


Fig. 1

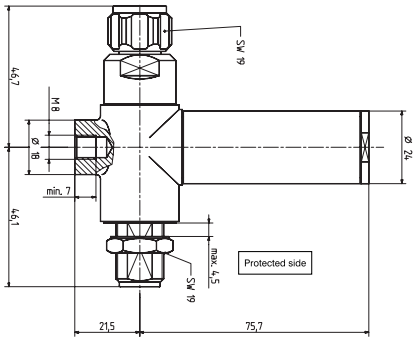


Fig. 2

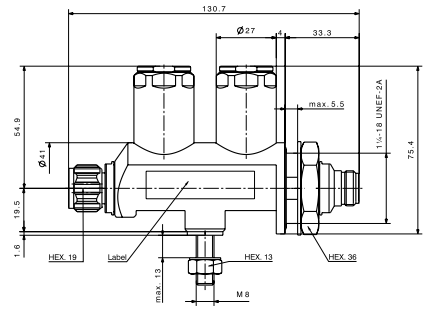


Fig. 3

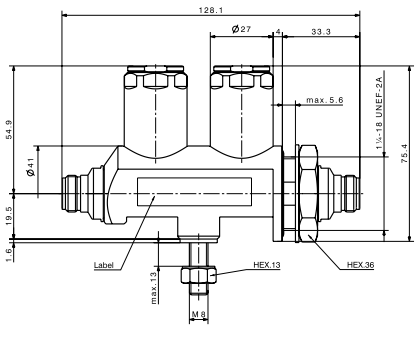


Fig. 4

All mounting holes are shown on pages 174 – 175.

Frequency range 300 to 800 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3407.17.0023	220 – 450	N (f) – N (f), b	M74, M8	20	0.1	IP65	1
3407.17.0053	320 – 512	N (m) – N (f), b	M12, M8	20	0.2	IP65	2
3407.41.0038	380 – 512	7/16 (m) – 7/16 (f)	M8	20	0.2	IP65	3

All dimensions in mm

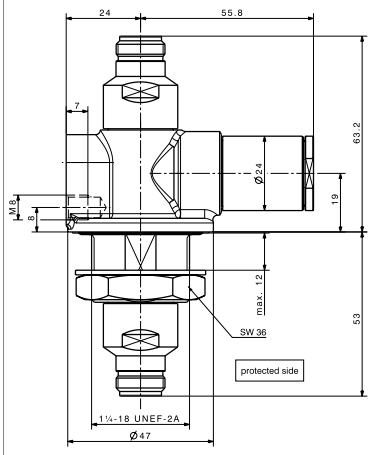


Fig. 1

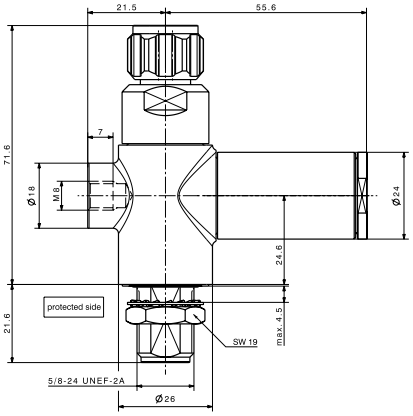


Fig. 2

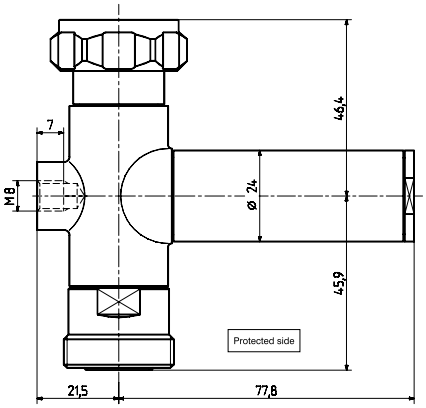


Fig. 3

All mounting holes are shown on pages 174 – 175.

Broadband, frequency range 700 to 6000 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Wateproof	Fig.
	MHz	Unprotected/protected side If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3407.17.0086*	690 – 2700	N (f) – N (f), b	MH71	24	0.15	IP68	1
3407.17.0067	806 – 2500	N (f) – N (f), b	MH110, M6	26	0.10	IP65	2
3407.17.0068		N (m) – N (f), b					3
3407.17.0085*	2000 – 6000	N (m) – N (f), b	MH170	20	0.2	IP68	4
3407.41.0051	690 – 2700	7/16 (m) – 7/16 (f), b	MH110, M6	23	0.10	IP67	5
3407.41.0052		7/16 (f) – 7/16 (f), b					6

* Material: aluminium

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

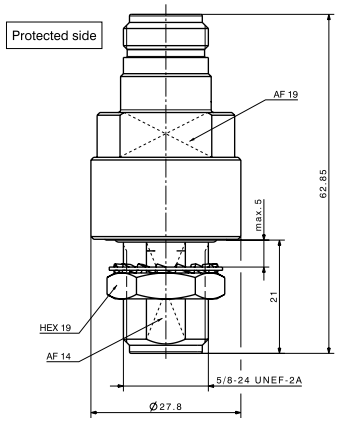


Fig. 1

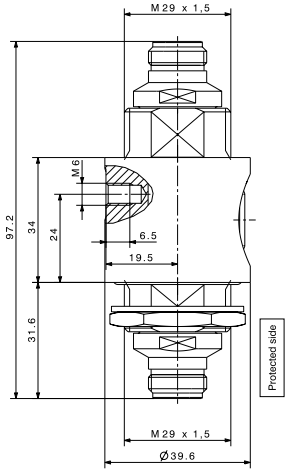


Fig. 2

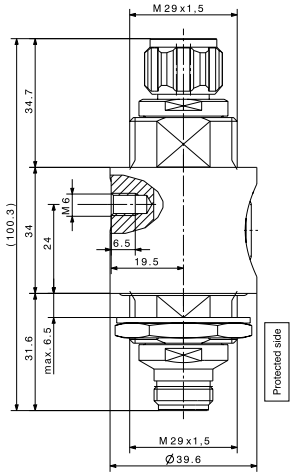


Fig. 3

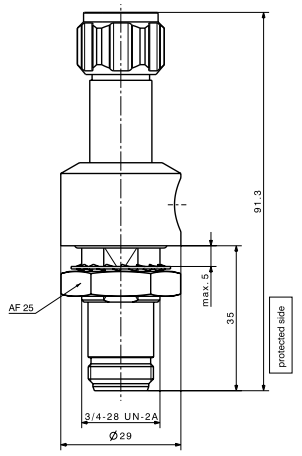


Fig. 4

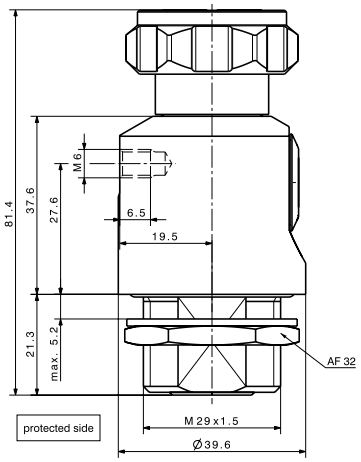


Fig. 5

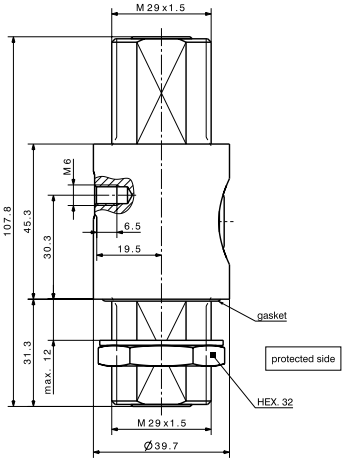


Fig. 6

All mounting holes are shown on pages 174 – 175.

Series 3408 lightning EMP protectors

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

Description
HUBER+SUHNER gas discharge tube (GDT) protectors with integrated 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 compo-nents like a transient voltage suppressor (diode or MOV)
- DC-blocking on protected side of the device (galvanic isolation)

General specification

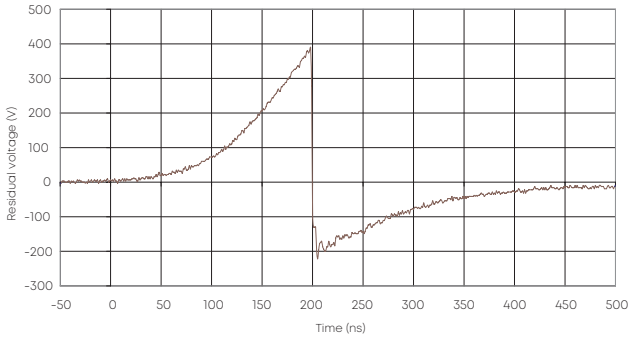
Electrical data		
RF characteristics		
Impedance	50 Ω	
Frequency range	25 – 1000 MHz or 2500 MHz min.	
Return loss* (RL)	20 dB min.	
Insertion loss* (IL)	0.2 dB max.	
RF power transmission	according to selected gas discharge tube – refer to page 86	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs single 8/20 µs multiple 10/350 µs	30 kA 20 kA 8 kA
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 according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:

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

* With 230 V gas discharge tube (9071.99.0547)



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition 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 addition al 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	copper beryllium alloy or bronze	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 3 GHz). In addition, the protection performance is superior to existing standard GDT protectors.

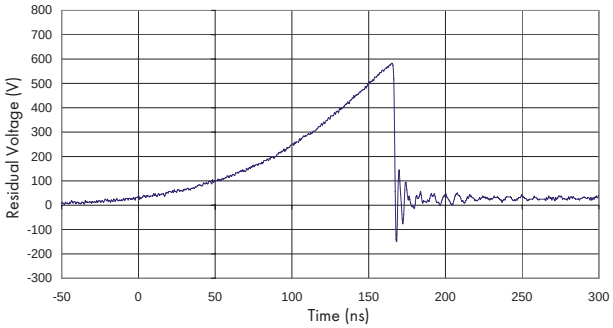
Features
- DC continuity for remote powering
- RF peak power not limited by gas discharge tube
- Superior RF performance
- Excellent low PIM performance
- Availability for application bands between 380 MHz and 18 GHz (N interface)
- Safe extinguishing of gas discharge tube under the influence of RF power
- Up to 99 % reduced residual pulse energy
- Waterproof IP65 min.
- Semper self-extinguishing functionality included (see page 91)
- Gas discharge tube installed (90 V)
- AISG transmission capability (optional)

General specification

Electrical data		
RF characteristics		
Impedance	50 Ω	
Frequency range	according to product detail specification (data sheet)	
Return loss (RL)	20 dB min., refer to product detail specification (data sheet)	
Insertion loss (IL)	0.2 dB max., refer to product detail specification (data sheet)	
Passive intermodulation (PIM)	according to product detail specification (data sheet) typ. –160 dBc 3rd order at 2 x 20 W / 2 x 43 dBm	
RF power transmission and DC current ratings	refer to data in chapter «general information - connector interfaces» and product detail specification (data sheet)	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs single 8/20 µs multiple 10/350 µs	30 kA 20 kA 8 kA
Residual pulse voltage and energy	for typical values refer to the following diagram	

Typical residual pulse for series 3409 with
90 V gas discharge tube
test pulse according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:

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



Mechanical data		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque*/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

* For HUBER+SUHNER types made of aluminium see specific mounting and grounding instruction!

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F) lightning protection functionality –20 up to +85 °C (–4 up to +185 °F) Semper functionality
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition A

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	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Frequency range 380 to 512 MHz

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		
3409.41.0054-EX**	380 – 512	7/16 (m) -7/16 (f)	M8	20	0.1	IP65	1

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

** Semper GDT 230 V (9071.99.0747) – for detailed information see page 91

All dimensions in mm

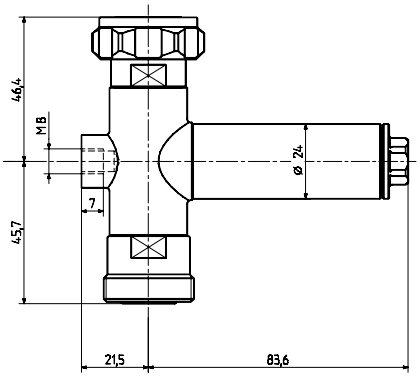


Fig. 1

All mounting holes are shown on pages 174 – 175.

Broadband, frequency range 700 to 2700 MHz

HUBER+SUHNER type **	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Fig.
Optimised for 2.176 MHz AISG carrier	**MHz**	**Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».**	**MH – hole for «b» M – screw**	**dB**	**dB**		
3409.17.0027-EX**	806 – 2500	N (m) – N (f)	M8	20.8	0.15	IP65	1
	806 – 960			26.0			
	1710 – 2500			26.0			
3409.17.0031-EX**	806 – 2500	N (f) – N (f), b	MH74,M8	20.8	0.15	IP65	2
	806 – 960			26.0			
	1710 – 2500			26.0			
3409.31.0001	690 – 2700	4.3-10 (m) – 4.3-10 (f), b	MH110, M8	24.0	0.10	IP67	3
3409.31.0002	790 – 2700	4.3-10 (m) – 4.3-10 (f)	M8	20.0	0.15	IP65	9
3409.41.0044-EX**	806 – 2500	7/16 (m) – 7/16 (f)	M8	20.8	0.15	IP65	4
	806 – 960			26.0			
	1710 – 2500			26.0			
3409.41.0051-EX**	806 – 2500	7/16 (f) – 7/16 (f)	M8	20.8	0.15	IP65	5
	806 – 960			26.0			
	1710 – 2500			26.0			
3409.41.0085***	820 – 2500	7/16(f) – 7/16 (f), b	MH74, M8	20.8	0.10	IP65	6
	820 – 970			23.2			
	1700 – 2500			23.2			
3409.41.0090	690 – 2690	7/16 (m) – 7/16 (f), b	MH110, M8	28.0	0.10	IP67	7
3409.41.0092	690 – 2690	7/16 (m) – 7/16 (f), b	MH110, M8	26.0	0.10	IP67	8

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

** Semper GDT 90 V (9071.99.0748) – for detailed information see page 91

*** Material: aluminium

All mounting holes are shown on pages 174 – 175.

All dimensions in mm

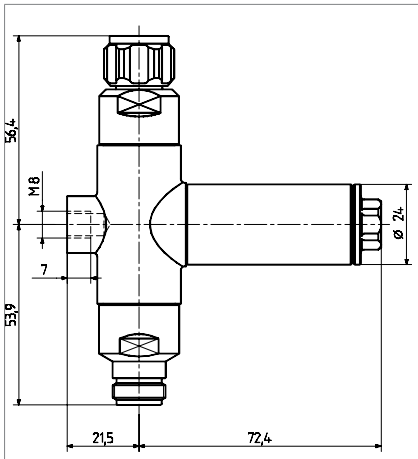


Fig. 1

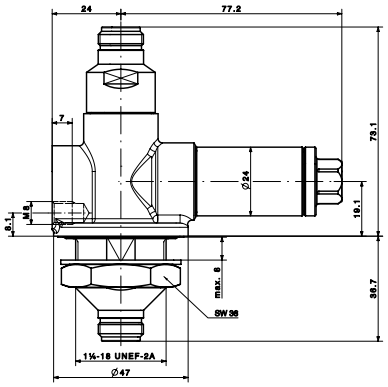


Fig. 2

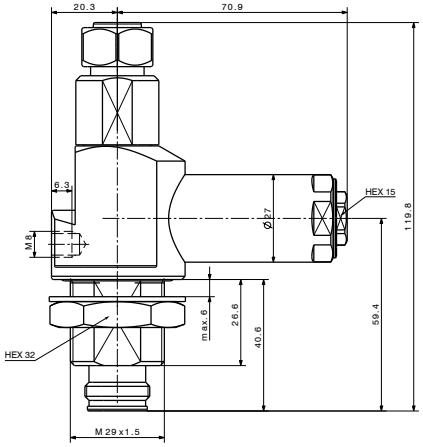


Fig. 3

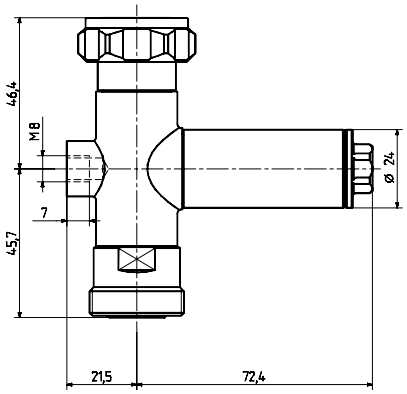


Fig. 4

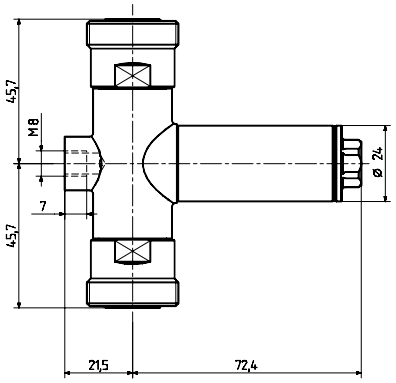


Fig. 5

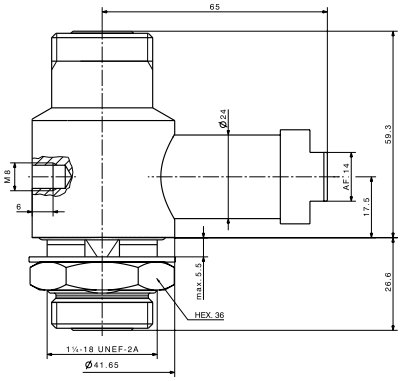


Fig. 6

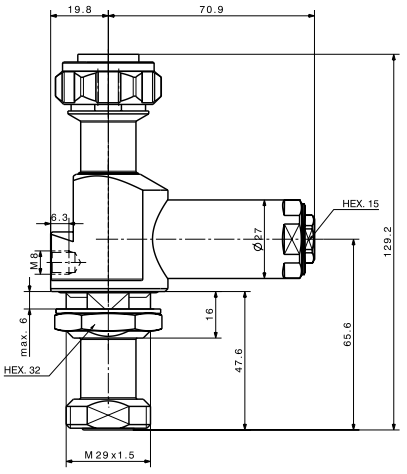


Fig. 7

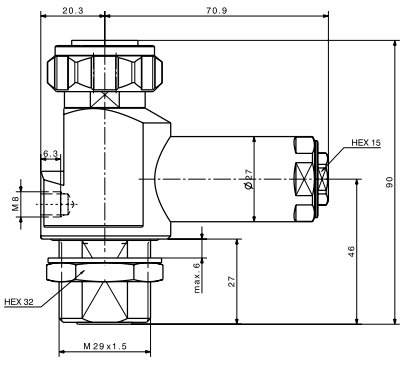


Fig. 8

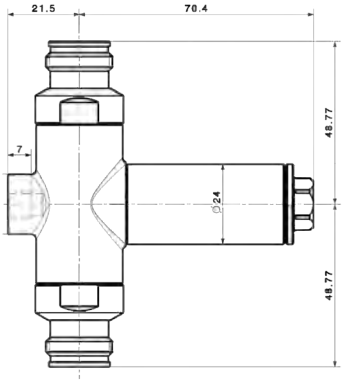


Fig. 9

All mounting holes are shown on pages 174 – 175.

Series 3410
Bias-T 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.

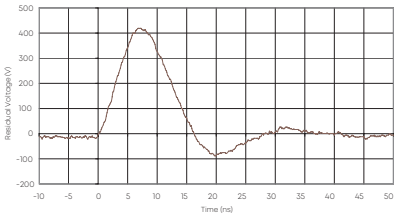
The integrated high-pass provides an improved protection performance to series 3409 protectors. As the high-pass filter means a DC-blocking on the protected side of the component, this design is especially suitable for products with integrated DC injection facility.

Features
- DC-blocking on protected side of the device (galvanic isolation)
- DC injection up to 48 V
- RF peak power not limited by gas discharge tube
- Superior RF performance, PIM level lower –150 dBc available
- Excellent low PIM performance
- Availability for application bands between 690 MHz and 2700 MHz
- Safe extinguishing of gas discharge tube under the influence of RF power
- Waterproof IP65
- Gas discharge tube installed (90 V, 9071.99.0548 for Semper 9071.99.0747)
- AISG transmission capability (optional)
- Semper self-extinguishing functionality (optional, see page 91)

General specification

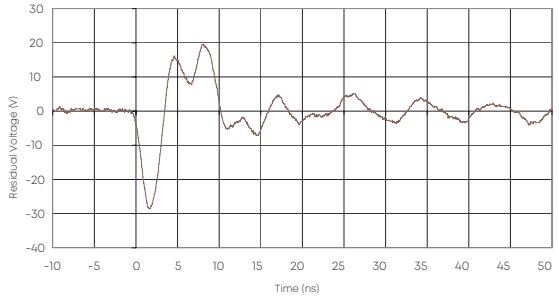
Electrical data		
RF characteristics		
Impedance	50 Ω	
Frequency range	according to product detail specification (data sheet)	
Return loss (RL)	20 dB min., refer to product detail specification (data sheet)	
Insertion loss (IL)	0.2 dB max. refer to product detail specification (data sheet)	
Passive intermodulation (PIM)	according to product detail specification (data sheet) typ. –160 dBc 3rd order at 2 x 20 W / 2 x 43 dBm	
RF power transmission and DC current ratings	according to product detail specification (data sheet)	
Protection characteristics		
Surge current handling capability	**test pulse**	
	8/20 µs single 8/20 µs multiple 10/350 µs	30 kA 20 kA 8 kA
Residual pulse voltage and energy	according to product detail specification	

Typical residual pulse for series 3410 with
90 V gas discharge tube,
test pulse according to IEC 61000-4-5
4 kV 1.2/50 µs; 2 kA 8/20 µs:



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		
Coupling nut torque force	according to IEC/MIL-STD (refer to page 178)	
Durability (matings of coupling nut)	500 min. for HUBER+SUHNER types made of aluminium see product detail specification (data sheet)	
Bulkhead mounting nut torque (WAF: Width Across Flats) Number of mountings: max. 5 cycles	Nut size, WAF/mm (in)	Torque*/Nm (lb-ft)
	≤ 13 (1/2")	3 to 5 (2.2 to 3.7)
	16 (5/8")	10 to 15 (7.4 to 11.1)
	19 to 25 (3/4" to 1")	15 to 20 (11.1 to 14.8)
	≥ 30 (1 1/8")	30 to 40 (22.1 to 25.8)
Screw mounting	M6	5 to 8 (3.7 to 5.9)
	M8	15 to 20 (11.1 to 14.8)

* For HUBER+SUHNER types made of aluminium see specific mounting and grounding instruction!

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F) lightning protection functionality –20 up to +85 °C (–4 up to +185 °F) Semper functionality
Waterproof degree (IEC 60529)	according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition A

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	copper beryllium alloy or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

Series 3414 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 Cat 5 in channel class D and Cat 6 in channel class E. Possible interconnections are made via the industrial standard RJ45 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 according to IEEE 802.3bt).

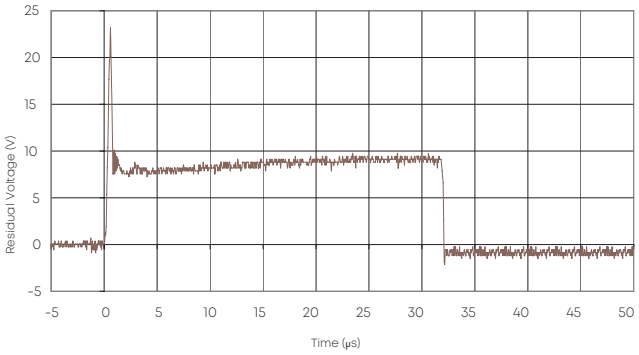
Features

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 according to IEC 61000-4-5
1.2/50 µs 4 kV; 8/20 µs 2 kA:

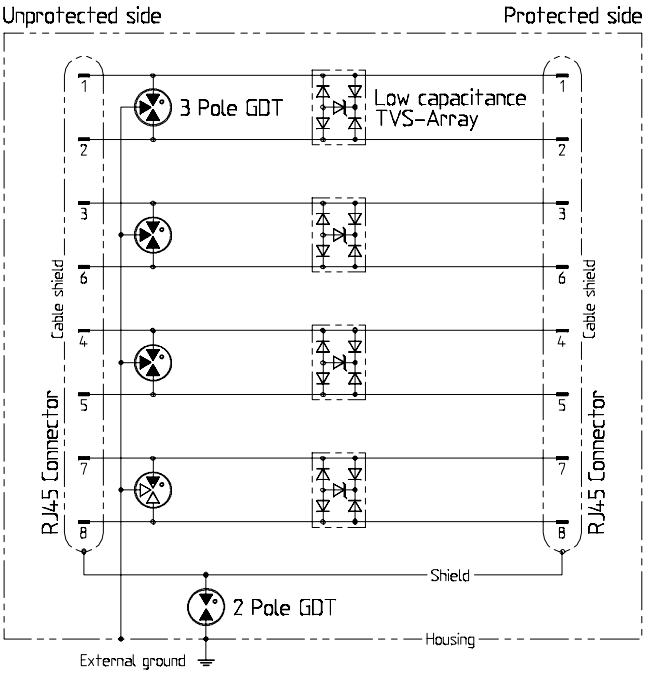
Residual pulse voltage: typ. 25 V
Residual pulse energy: typ. 50 µJ



Protectors for Ethernet Cat 5 in channel class D

Description

These optimised 3414 data line protectors can be used in state of the art Ethernet twisted pair systems Cat 5 in channel class D,
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 category 5 in channel D (ISO/IEC 11801, EN 50173-1)
- Conform to category 5e (ANSI/EIA/TIA-568-C.2)
- Suitable for Ethernet
- Supports «Power over Ethernet» (PoE according to IEEE 802.3bt)
- 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

General specification

Electrical data		
DC/RF characteristics		
Data transmission rate	1000 Mbps	
Frequency range	DC – 100 MHz	
Impedance	100 Ω	
Operating voltage U_c max.	60 V DC, 42.4 V AC (pair to pair)	
Operating current I_L	1.5 A (per pair)	
Connector interfaces	RJ45 jack	
Protection characteristics		
Surge current handling capability	**test pulse 8/20 µs**	
	100 A 10 kA total 6 kA	line to line all lines to PE shield to PE

Environmental data	
Operating temperature range	–40 up to +85 °C (–40 up to +185 °F)

Protectors for Ethernet Cat 5 in channel class D

Ethernet lines

HUBER+SUHNER type	Waterproof	Mounting/grounding	Description	Option	Fig.
3414.99.0003*	IP20	wire, screw	general purpose		1
3414.99.0008	IP68	wire, screw, clamp (incl.)	waterproof metal housing for permanent outdoor installations		2
3414.99.0009	IP68	bulkhead, MH180	rugged metal housing for temporary outdoor installations	optional interconnect accessories	3

* Patch cable 25 cm (9.84 in) included** DC injection port SMB (f)
*** Optimised for 2.176 MHz AISG carrier

All dimensions in mm

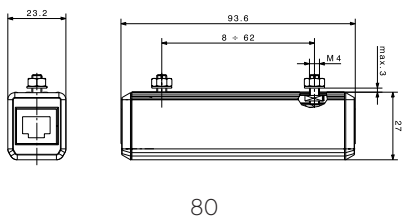


Fig. 1

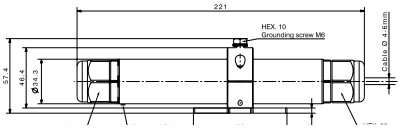


Fig. 2

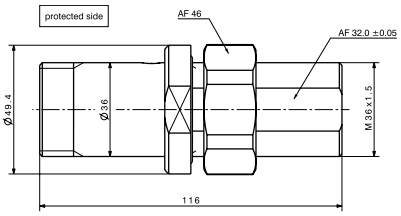


Fig. 3

Accessories for 3414.99.0009 data line protector

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

All dimensions in mm

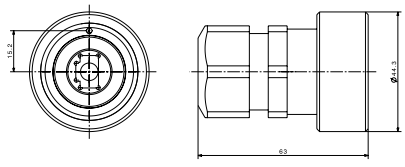


Fig. 4

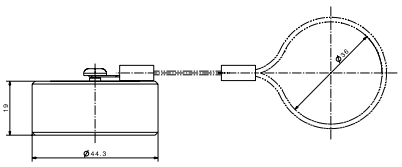


Fig. 5

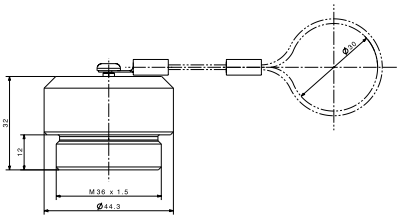


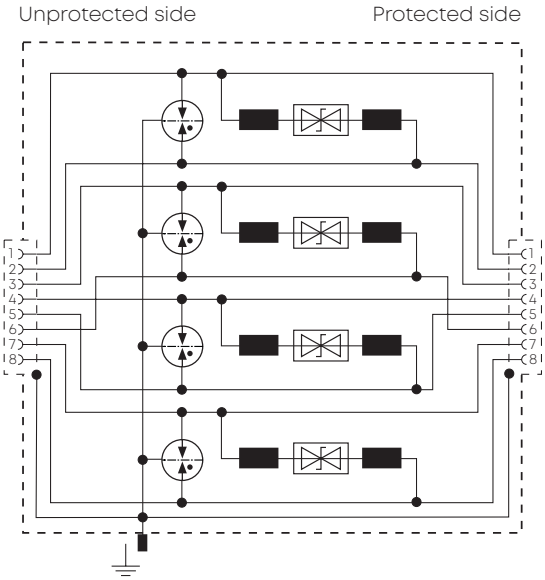
Fig. 6

All mounting holes are shown on pages 174 – 175.

Protectors for Ethernet Cat 6 in channel class E

Description

These optimised 3414 data line protectors can be used in state of the art Ethernet twisted pair systems Cat 6 in channel class E, 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 category 6 in channel class E (ISO/IEC 11801, EN 50173-1)
- Conform to category 6 (ANSI/EIA/TIA-568-C.2)
- Suitable for Ethernet
- Supports «Power over Ethernet» (PoE according to IEEE 802.3bt)
- Interface RJ45
- All eight lines protected
- Shield through-connected
- Several grounding and mounting options
- Waterproof versions up to IP rating IP68 (according to product detail specification)
- Easy mountable
- Maintenance free

General specification

Electrical data		
DC/RF characteristics		
Data transmission rate	1000 Mbps	
Frequency range	DC – 250 MHz	
Impedance	100 Ω	
Operating voltage U_c max.	58 V DC, 41 V AC (pair to pair)	
Operating current I_L	2 A (per pair)	
Connector interfaces	RJ45 jack (8 pin)	
Protection characteristics		
Surge current handling capability	**test pulse 8/20 µs**	
	150 A 10 kA total 180 V 500 V	line to line all lines to PE line to line line to PG

Environmental data	
Operating temperature range	–40 up to +80 °C (–40 up to +185 °F)

Protectors for Ethernet Cat 6 in channel class E

HUBER+SUHNER type	Waterproof	Mounting/grounding	Description	Option	Fig.
3414.99.0021	IP20	wire, screw	general purpose		1
3414.99.0022	IP68	bulkhead, MH180	rugged metal housing for temporary outdoor installations	optional interconnect accessories	3

All dimensions in mm

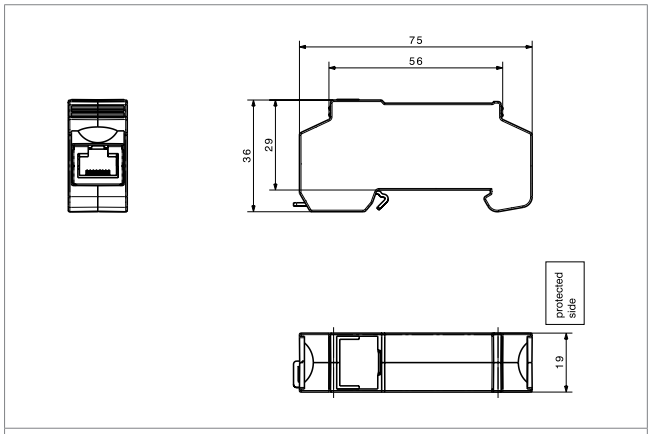


Fig. 1

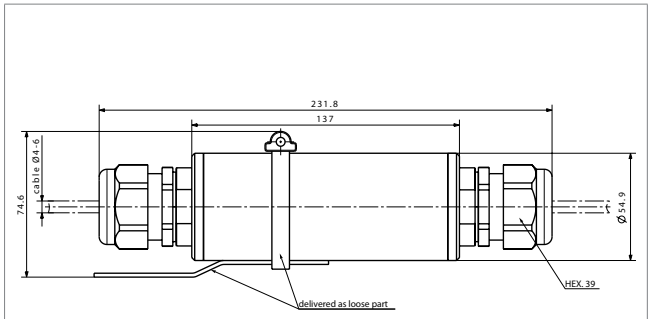


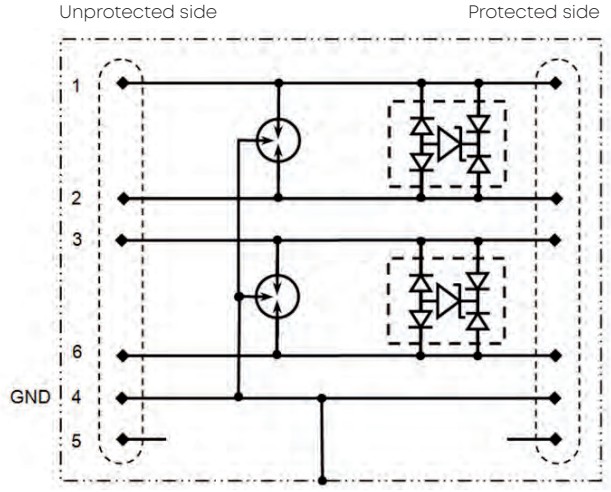
Fig. 2

All mounting holes are shown on pages 174 – 175.

Data line protectors for circular MIL connector D38999

Description

This optimised 3414 data line protector for MIL Connector D38999/24F, circular, size 9 can be used for twisted pair system Cat 4 in channel class C or other data transmission application. Series 3414 includes hybrid units which integrate first stage and fine protector.



Features

- Coarse and fine protection
- Fast response time
- DC continuity for remote powering (between pair 60 V DC)
- Circular D38999/24F, size 9 Interface
- All 4 lines (2 pair) are protected
- Feed trough mounting for installation in Faraday cages
- Waterproof degree IP68
- Easy mountable
- Maintenance free

General specification

Electrical data		
DC/RF characteristics		
Data transmission rate	16 Mbps	
Frequency range	DC – 20 MHz	
Impedance	100 Ω	
Operating voltage U_c max.	60 V DC, 42.4 V AC (pair to pair) 6 V DC between pair	
Operating current I_L	2 A (per pair)	
Connector interfaces	D38999/24F, size 9	
Protection characteristics		
Surge current handling capability	**test pulse 8/20 µs**	
	100 A 2.5 kA 10 kA	within pair line to ground all lines to ground

Environmental data	
Operating temperature range	–40 up to +80 °C (–40 up to +185 °F)

Data line protectors for circular MIL connector D38999

HUBER+SUHNER type	Waterproof	Mounting/grounding	Description	Fig.
3414.99.0024	IP68	bulkhead, MH181	metal housing for outdoor installation	1

All dimensions in mm

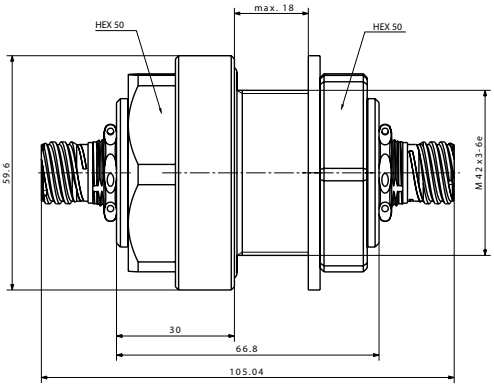
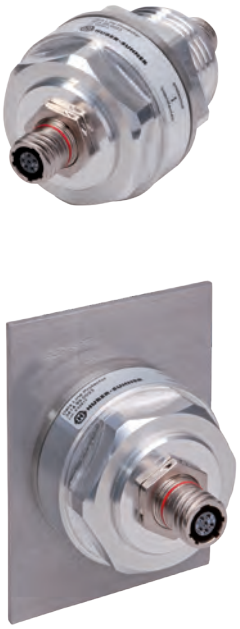


Fig. 1



Accessories for 3414.99.0024 data line protector

HUBER+SUHNER type	Description	Fig.
9073.99.0005	protective cap for D38999/24F interface	1

All dimensions in mm

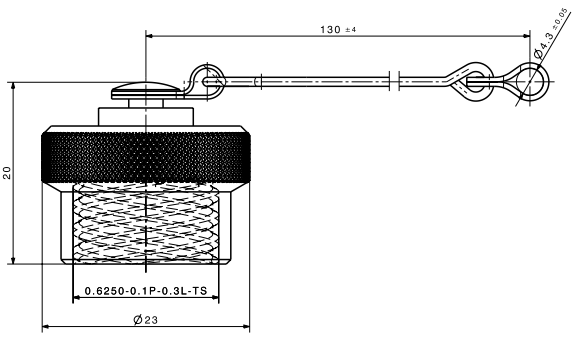


Fig. 1

All mounting holes are shown on pages 174 – 175.

Series 3420 – overvoltage protection for PTTA

Overvoltage protection for DC powered PTTA – power to the antenna equipment

Power distribution box with overvoltage protection circuits series 3420

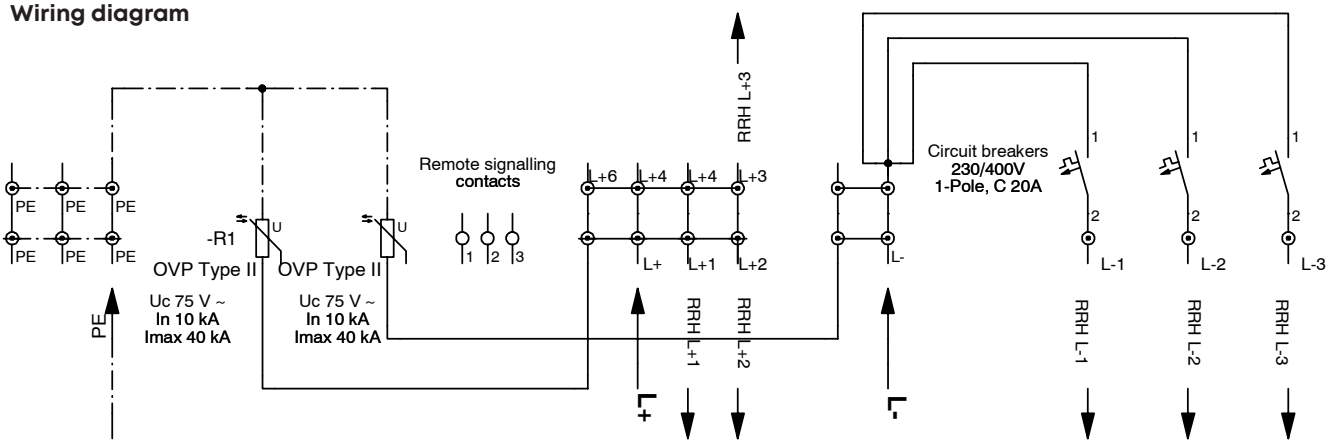
Features

- SPD according to IEC 61643-11 class II
- SPD according to EN 61643-11 type 2
- SPD according to UL 1449 type 4
- Power splitting 1:3
- Circuit breakers for each RRH
- Including mounting material

Electrical data	
DC/RF characteristics	
Voltage rating Uc / MCOV	60 V DC / 75 V AC
Circuit breaker	one per RRU, current rating 10 A DC
Protection characteristics	
Surge protection configuration	L+ to PE and L– to PE
Nom. discharge current I_n	20 kA 8/20 µs
Max. discharge current I_{max}	80 kA 8/20 µs
Voltage protection level U_p	≤ 400 V
Voltage protection rating VPR	500 V peak

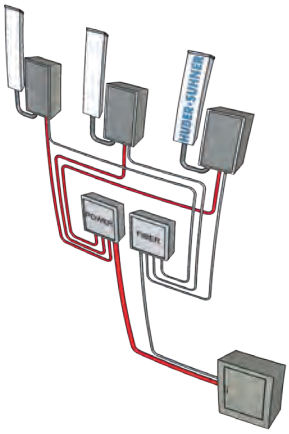
Environment data	
Waterproof degree	IP66
Operating temperature range	–40 to 70 °C (–40 to 158 °F)

Wiring diagram

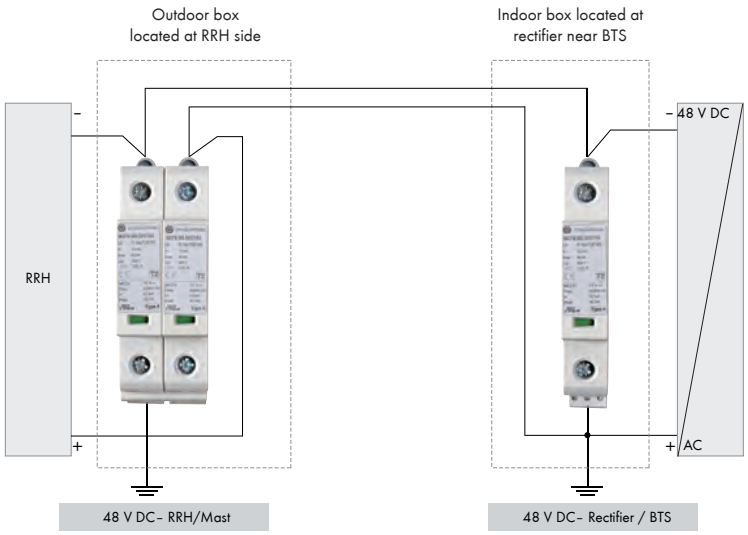


Outdoor and indoor overvoltage protection circuits series 9079

RRH protection circuits for 48 V DC – 80 A
SPD according to IEC 61643-11 class II
SPD according to EN 61643-11 type 2
SPD according UL 1449 type 4



OVP circuit configuration



Configuration			
Protection layout	L– to PE	L+ to PE	L– to L+ / PE
Surge protective device	9079.99.0001	9079.99.0001	9079.99.0001

Electrical data			
Max. continuous operating voltage Uc	DC AC	100 V 75 V	100 V 75 V	100 V 75 V
Max. discharge current (8/20 µs) I_{max}, per box		80 kA		40 kA
Max. discharge current (8/20 µs) I_{max}, per SPD		40 kA	40 kA	40 kA
Nominal discharge current (8/20 µs) I_n, per box		20 kA		10 kA
Nominal discharge current (8/20 µs) I_n, per SPD		10 kA	10 kA	10 kA
Voltage protection level U_p		≤ 0.4 kV	≤ 0.4 kV	≤ 0.4 kV
Response time t_A		≤ 25 ns	≤ 25 ns	≤ 25 ns
Max. backup fuse (L–L')		125 A gL/gG	125 A gL/gG	125 A gL/gG

Gas discharge tube and selection of 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.

Protectors with replaceable gas discharge tube
- Series 3401 – GDT technology up to 1 GHz
- Series 3402 – GDT technology up to 2.5/3.0 GHz
- Series 3403 – fine protectors (for cube design types)
- Series 3408 – GDT technology with integrated high-pass filter
- Series 3409 – high-power/low-IM protectors
- Series 3410 – high-power/low-IM protectors with integrated high-pass filter and DC injection

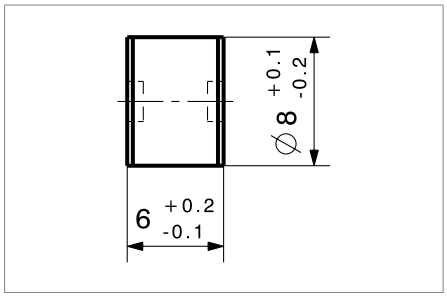
Specification		**Requirements**	**Limits**
Insulation resistance		100 V (50 V for 9071.99.0X48)	10^{10} Ω
Glow voltage	V_B	10 mA	~70 V
Arc voltage	V_{ARC}	>1 A	~10 – 15 V
Glow-arc transition current			< 0.5 A
Capacitance		1 MHz	<1 pF typ.
Impulse discharge current	I_{SG} I_S	30 kA, 8/20 µs 20 kA, 8/20 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-T K.12

Gas discharge tubes without replacement holder

HUBER+SUHNER type	U_{Zstat}	U_{Zdyn} max.	I_s 8/20 µs	I_{SG} 8/20 µs	RF power max. (single carrier) at VSWR 1.22:1 with 1.5 securtiy margin
	V	V	kA	kA	W
9071.99.0547	230 ±15 %	675	20	30	140
9071.99.0548	90 ±20 %	500			20
9071.99.0549	350 ±15 %	875			325
9071.99.0550	470 ±15 %	1000			590
9071.99.0551	600 ±15 %	1100			960

All dimensions in mm



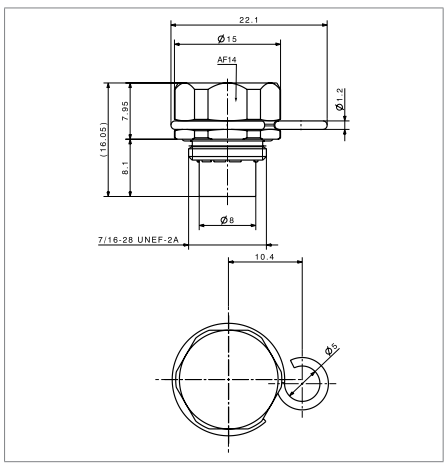
Suitable for the following installed GDT holders:

Gas discharge tubes with holder (not suitable for 3000 series protectors)

HUBER+SUHNER type	U_{Zstat}	U_{Zdyn} max.	I_s 8/20 µs	I_{SG} 8/20 µs	RF power max. (single carrier) at VSWR 1.22:1 with 1.5 securtiy margin
	V	V	kA	kA	W
9071.99.0447	230 ± 15 %	675	20	30	140
9071.99.0448	90 ± 20 %	500			20
9071.99.0449	350 ± 15 %	875			325
9071.99.0450	470 ± 15 %	1000			590
9071.99.0451	600 ± 15 %	1100			960

* 6 × 8 mm gas discharge tube same as of the tabel above together with holder with groove

All dimensions in mm



Suitable for the following installed GDT holders:

Gas discharge tube and selection of GDT

Semper GDT units for retrofit and replacement for series 3401 and 3402

HUBER+SUHNER type	U_{Zstat}	U_{Zdyn} max.	I_S 8/20 µs	I_{SG} 8/20 µs	RF power max. (single carrier) at VSWR 1.22:1 with 1.5 securtiy margin	Fig.
	V	V	kA	kA	W	
9071.99.0647 *	230 ± 15 %	675	20	30	140	1
9071.99.0648	90 ± 20 %	500			20	1
9071.99.0649	350 ± 15 %	875			325	1
9071.99.0650	470 ± 15 %	1000			590	1
9071.99.0651	600 ± 15 %	1100			960	1

* Nato stock number 5920-66-156-1512

Semper GDT units for retrofit and replacement for series 3402 platform 3000 [1)]

HUBER+SUHNER type	U_{Zstat}	U_{Zdyn} max.	I_S 8/20 µs	I_{SG} 8/20 µs	RF power max. (single carrier) at VSWR 1.22:1 with 1.5 securtiy margin	Fig.
	V	V	kA	kA	W	
9071.99.0947	230 ± 15 %	675	20	30	140	2
9071.99.0948	90 ± 20 %	500			20	2
9071.99.0949	350 ± 15 %	875			325	2
9071.99.0950	470 ± 15 %	1000			590	2
9071.99.0951	600 ± 15 %	1100			960	2

All dimensions in mm

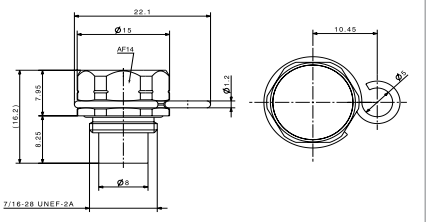


Fig. 1

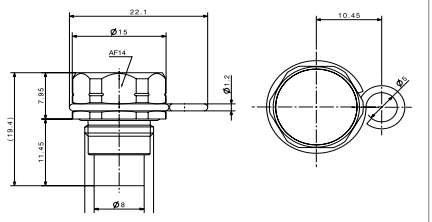


Fig. 2

Semper GDT units for retrofit and replacement for series 3409

HUBER+SUHNER type	U_{Zstat}	U_{Zdyn} max.	I_S 8/20 µs	I_{SG} 8/20 µs	RF power max. (single carrier) at VSWR 1.22:1 with 1.5 securtiy margin	Fig.
	V	V	kA	kA	W	
9071.99.0747	230 ± 15 %	675	20	30	140	3
9071.99.0748	90 ± 20 %	500			20	3

All dimensions in mm

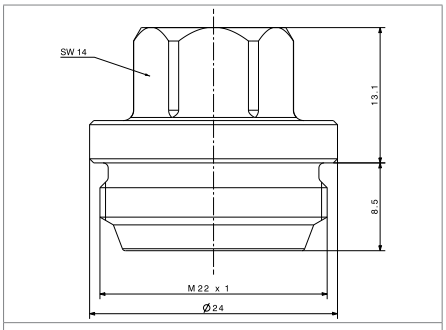


Fig. 3

[1)] Platform 3000 is a term for series 3402 protectors with a specified bandwidth of DC – 3000 MHz
Examples: 3402.17.3001, 3402.17.3002, 3402.26.3001

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
T_1, front time/T_2, time to half value

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

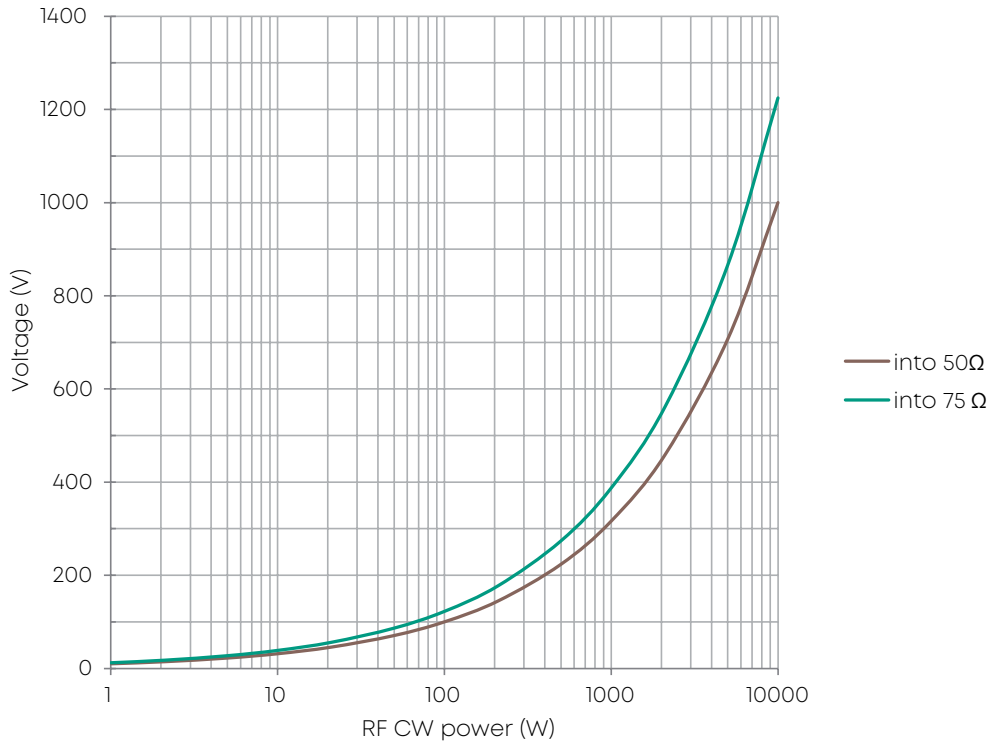
Glow discharge voltage – residual voltage across the GDT capsule when the discharge current operates the GDT in the glow state,
typically at 10 mA.

U_{ARC}

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

Peak RF voltage

Single frequency RF power into 50/75 Ω at VSWR 1.0:1



Gas discharge tube and selection of GDT

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 are important:

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

The required static spark-over voltage is 1.5 times of the total peak voltage on the transmission line. The following formula is applicable to evaluate the peak voltage at VSWR =1.0:1.
Refer to tables on pages 87 and 88 and consider the lowest possible voltage from the tolerance range!

$$U_{Zstat} \geq 1.5 \cdot \hat{U}_{max.}$$

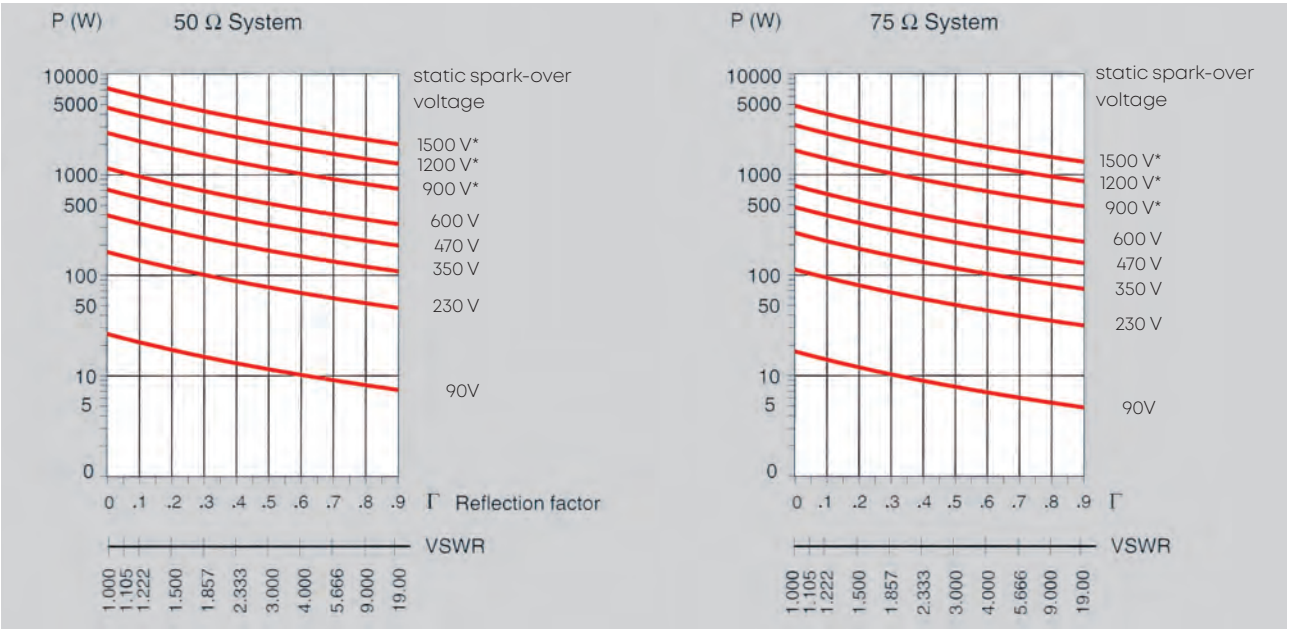
$$\hat{U}_{max.} = \sqrt{2PZ} \cdot (1 + \Gamma) + U_{DCsup}$$

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

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

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

The max. admissible RF power transmission for a single carrier (CW) versus the VSWR is shown in the following diagrams for 50 Ω and 75 Ω systems of several gas discharge tubes (see pages 86 – 90 for detailed GDT characteristics).



* Non-standard values on request.

Semper self-extinguishing GDT

Semper – self-extinguishing gas discharge tube (GDT) protector

Description
The patented 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 a unique concept of self-extinguishing GDT protectors. The unique and patented Semper solution is realised as a simple unit which enables the use of the comprehensive range of HUBER+SUHNER GDT protectors with a replaceable GDT. An easy retrofit of existing GDT protectors is possible or available as complete Semper protectors in a variety of configurations.

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
- DC transmission for remote powering
- 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

Semper self-extinguishing GDT

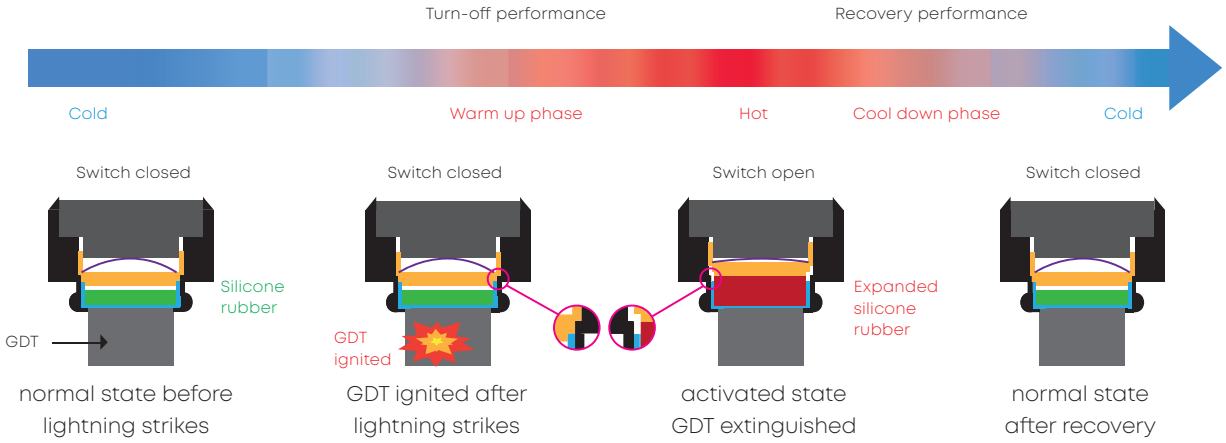
Specifications

Electrical data	
DC current max.	2.5 A at 48 V 4.0 A at 27 V 6.0 A at 24 V 13.0 A at 17 V
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

Environmental data	**Requirements/test conditions**
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F) lightning protection functionality –20 up to +85 °C (–4 up to +185 °F) Semper functionality
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Life (at elevated ambient temperature)	MIL-STD-202, method 108, condition C
Vibration, high frequency	MIL-STD-202, method 204, condition D

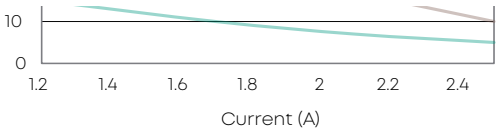
Material data Semper unit		
Piece parts	**Material**	**Surface plating**
Body	brass	SUCOPLATE® or gold
Contact	copper beryllium alloy or brass	silver plating
Insulator	PTFE/AL_2O_3	
Gasket	NBR (nitrile butadiene rubber)	
Insert	MVQ (methyl silicone rubber)	

Basic working principle

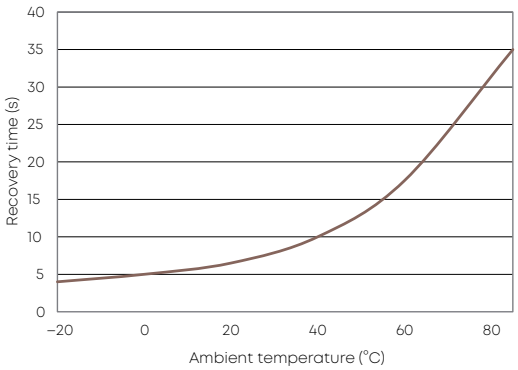


Thermal state/phase	Cold	Warm up phase	Hot and entering cool down phase	Cold
GDT	passive mode/ isolated state	activated/ conductive mode	returned to passive mode/ isolated state caused by the opened switch which was forced by the expanded silicon	passive mode/ isolated state
Silicone rubber	contracted	starting expansion	expanded and staring to contract	contracted
Switch	closed	closed	open	closed

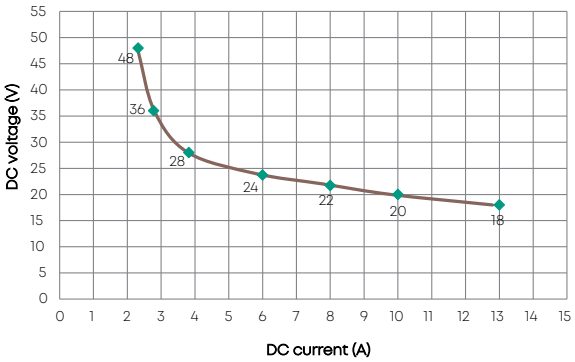
Turn-off performance



Recovery performance at 25 °C



Voltage vs. current limiting graph



This graph defines the admissible maximum supply current (A) at a given supply voltage (V).

Semper self-extinguishing GDT

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.

HUBER+SUHNER type	Frequency range MHz	Connectors Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	Static sparkover voltage	GDT unit included
3401.17.0048-EX	DC – 1000	N (f) – N (f), b	230 V	9071.99.0647 *
3401.17.0057-EX	DC – 1000	N (m) – N (f), b		
3401.26.0012-EX	DC – 1000	TNC (f) – TNC (f), b		
3402.17.0072-EX	DC – 2500	N (f) – N (f), b		
3402.17.0076-EX	DC – 2500	N (m) – N (f)		
3409.17.0032-EX	380 – 512	N (m) – N (f), b	230 V	9071.99.0747 *
3409.41.0054-EX	380 – 512	7/16 (m) – 7/16 (f)		
3409.17.0027-EX	806 – 2500	N (m) – N (f)	90 V	9071.99.0748 *
	806 – 960			
	1710 – 2500			
3409.17.0031-EX	806 – 2500	N (f) – N (f), b		
	806 – 960			
	1710 – 2500			
3409.41.0044-EX	806 – 2500	7/16 (m) – 7/16 (f)		
	806 – 960			
	1710 – 2500			
3409.41.0051-EX	806 – 2500	7/16 (f) – 7/16 (f)		
	806 – 960			
	1710 – 2500			
3409.41.0052-EX	806 – 2500	7/16 (f) – 7/16 (f), b		
	806 – 960			
	1710 – 2500			
3409.41.0053-EX	806 – 2500	7/16 (m) – 7/16 (f), b		
	806 – 960			
	1710 – 2500			

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

For further details see in corresponding product series section.

Grounding kits

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.

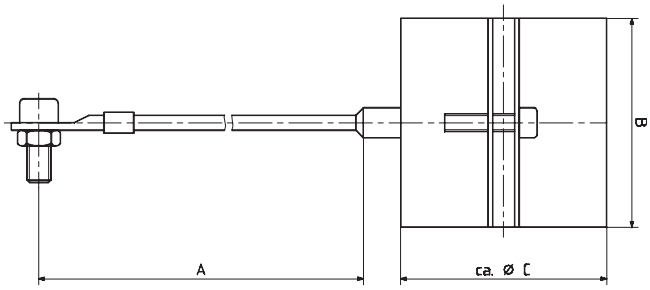
Features

- 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
- Operating temperature –40 to 85 °C

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

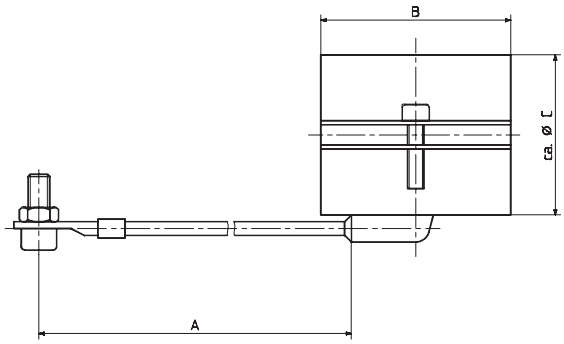


HUBER+SUHNER type	For cable size	«A»	«B»	«C»	Stripping length	Grounding screws	Weight	Cable diameter
	Sucofeed, Andrew, Nokia, Kabelmetal, RFS, Eupen, etc.	mm	mm	mm	mm		g	mm
9076.99.N012-50	1/2"	500	50	32	26	M8	255	16 – 17
9076.99.N013-50	1/2" highflex	500	50	32	26	M8	255	13 – 14
9076.99.N014	1/4", RG213/214 and 3/8" highflex	840	50	28	26	M8	280	10 – 11
9076.99.N038	3/8"	840	50	28	26	M8	280	12 – 13
9076.99.N078-50	7/8" and 7/8" highflex	500	50	44	26	M8	280	26 – 28
9076.99.N114-50	1-1/4"	500	50	59	26	M8	490	38 – 40
9076.99.N158	1-5/8"	840	70	69	30	M8	585	50 – 52

Grounding kits

Grounding kit P-style

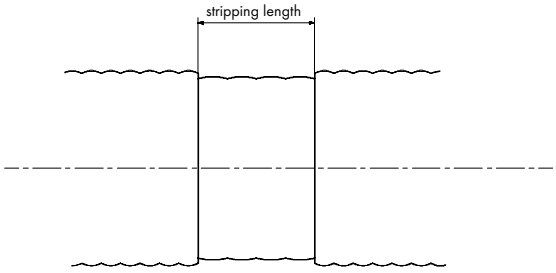
- Parallel grounding cable connection
- Alligned to corrugated copper tube cable

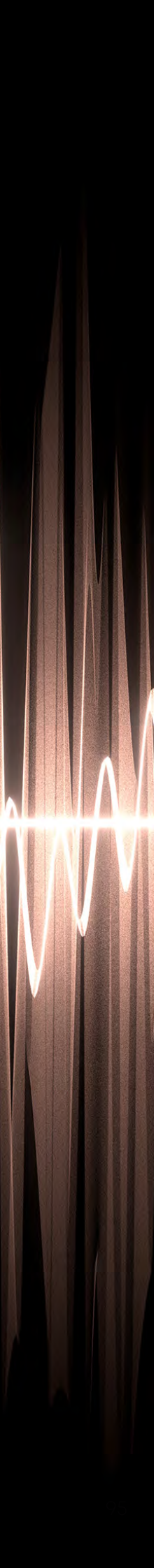


HUBER+SUHNER type	For cable size	«A»	«B»	«C»	Stripping length	Grounding screws	Weight	Cable diameter
	Sucofeed, Andrew, Nokia, Kabelmetal, RFS, Eupen, etc.	**mm**	**mm**	**mm**	**mm**		**g**	**mm**
9076.99.P012	1/2"	840	50	32	26	M8	310	16 – 17
9076.99.P013	1/2" highflex	840	50	32	26	M8	310	13 – 14
9076.99.P014	1/4", RG213/214 and 3/8" highflex	840	50	28	26	M8	285	10 – 11
9076.99.P038	3/8"	840	50	28	26	M8	285	12 – 13

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. Installation temperature range is between –15 and 50 °C.

The mounting instruction is shipped with every kit.





High voltage DC blocks

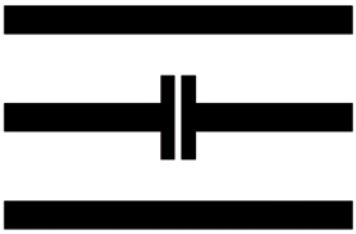
Series 9077 – high voltage DC blocks

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
DC and DC-DC blocks are coaxial components which block the flow of DC and low frequency signals up to 100 kHz while permitting RF signals to flow without loss through the component. They are used in line with coaxial feeder cables within communication installations.

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 inner and/or outer conductor
- Blocking DC voltage up to 15 kV
- Broadband operation up to 3000 MHz
- Low intermodulation performance
- Bulkhead mounting and grounding
- Waterproof design
- Maintenance free
- Protects against electromagnetic interference caused by traction return current

DC block



Outer conductor

Inner conductor

Outer conductor

DC-DC block

1 kV broadband HV DC block

General specifications

Electrical Data	
RF characteristics	
Impedance	50 Ω
Frequency range	from 350 to 3000 MHz
Return loss (RL)	20.0 dB min. from 350 to 3000 MHz 26.5 dB min. from 650 to 2700 MHz
Insertion loss (IL)	0.1 dB max.
Passive intermodulation (PIM)	–160 dBc typ.
RF power transmission	370 W CW, 25 kW PIP
DC characteristics	
Leakage current	5 µA
Test leakage current	10 µA
Blocking voltage	1000 V (only galvanic DC isolation in centre conductor)

Mechanical data	
Coupling nut torque force	according to IEC/MIL-STD (refer to page 172)
Durability (matings)	500 min.

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP67 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Vibration, high frequency	MIL-STD-202, method 204, condition 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	silver plating
Female contacts	bronze	silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

HUBER+SUHNER type	Connectors port 1 – port 2 side of bulkhead marked «b».	Mounting/grounding MH – hole for «b»	Fig.
9077.41.0035	7/16 (f) – 7/16 (m)	M6	1

All dimensions in mm

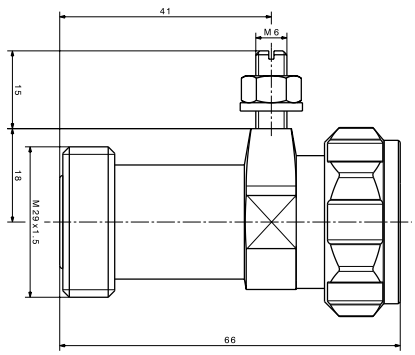


Fig. 1

1 kV broadband HV DC-DC block

General specifications

Electrical Data	
RF characteristics	
Impedance	50 Ω
Frequency range	from 360 to 3000 MHz
Return loss (RL)	20 dB min. from 360 to 3000 MHz 26 dB min. from 650 to 2700 MHz
Insertion loss (IL)	0.1 dB max.
Passive intermodulation (PIM)	–160 dBc typ.
RF power transmission	750 W CW, 25 kW PIP
DC characteristics	
Leakage current	5 µA
Test leakage current	10 µA
Blocking voltage	1000 V (galvanic DC isolation in centre conductor and outer conductor)

Mechanical data	
Coupling nut torque force	according to IEC/MIL-STD (refer to page 172)
Durability (matings)	500 min.

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP67 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Vibration, high frequency	MIL-STD-202, method 204, condition 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 / POM	SUCOPLATE®
Male contacts	brass	silver plating
Female contacts	bronze	silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

HUBER+SUHNER type	Connectors port 1 – port 2 side of bulkhead marked «b».	Mounting/grounding MH – hole for «b»	Fig.
9077.41.0036	7/16 (f) - 7/16 (m)	MH110	1

*Suitable mounting bracket 9075.99.0095

All dimensions in mm

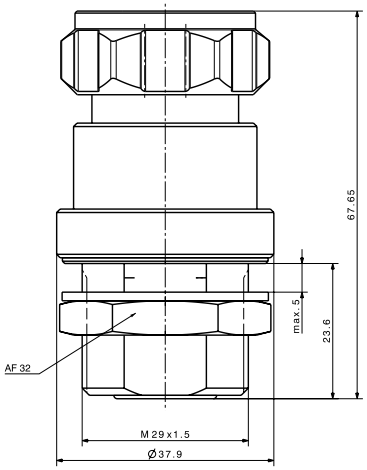


Fig. 1

All mounting holes are shown on pages 182 – 183.

4 kV broadband HV DC block

General specifications

Electrical Data	
RF characteristics	
Impedance	50 Ω
Frequency range	from 140 to 2500 MHz
Return loss (RL)	16 dB min. from 140 to 200 MHz 20 dB min. from 200 to 2500 MHz
Insertion loss (IL)	0.5 dB max.
Passive intermodulation (PIM)	–150 dBc typ.
RF power transmission	80 W CW
DC characteristics	
Leakage current	5 µA
Test leakage current	100 µA
Blocking voltage	4000 V (only galvanic DC isolation in centre conductor)

Mechanical data	
Coupling nut torque force	according to IEC/MIL-STD (refer to page 172)
Durability (matings)	500 min.

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Vibration, high frequency	MIL-STD-202, method 204, condition 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	silver plating
Female contacts	copper beryllium or bronze	silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

HUBER+SUHNER type	Connectors port 1 – port 2 side of bulkhead marked «b».	Mounting/grounding MH – hole for «b»	Fig.
9077.17.0015	N (f), b – N (f)	MH110	1
9077.17.0016	N (m) – N (f), b		2
9077.41.0015	7/16 (f), b – 7/16 (f)		3
9077.41.0016	7/16 (m) – 7/16 (f), b		4

* Suitable mounting bracket 9075.99.0095

All dimensions in mm

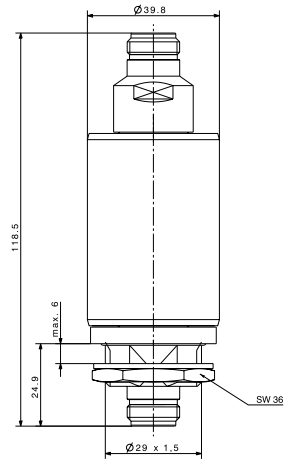


Fig. 1

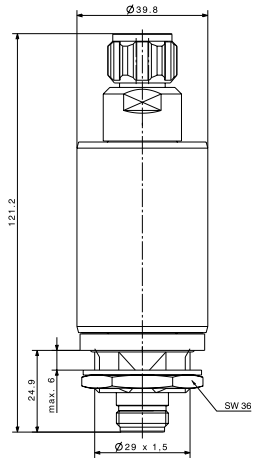


Fig. 2

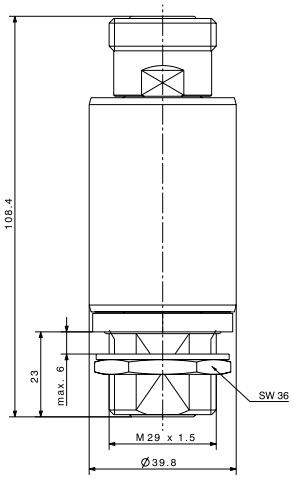


Fig. 3

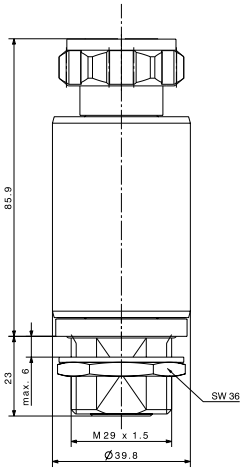


Fig. 4

All mounting holes are shown on pages 182 – 183.

4 kV broadband HV DC-DC block

General specifications

Electrical Data	
RF characteristics	
Impedance	50 Ω
Frequency range	from 160 to 3000 MHz
Return loss (RL)	22.0 dB min. from 160 to 3000 MHz 26.4 dB min. from 300 to 2500 MHz
Insertion loss (IL)	0.1 dB max.
Passive intermodulation (PIM)	–150 dBc typ.
RF power transmission	500 W CW
DC characteristics	
Leakage current	5 µA
Test leakage current	10 µA
Blocking voltage	4000 V (galvanic DC isolation in centre and outer conductor)

Mechanical data	
Coupling nut torque force	according to IEC/MIL-STD (refer to page 172)
Durability (matings)	500 min.

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Vibration, high frequency	MIL-STD-202, method 204, condition 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 / POM	SUCOPLATE®
Male contacts	brass	silver plating
Female contacts	copper beryllium or bronze	silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

HUBER+SUHNER type	Connectors port 1 – port 2 side of bulkhead marked «b».	Mounting/grounding MH – hole for «b»	Fig.
9077.17.0031	N (f), b – N (f)	MH110	1
9077.17.0030	N (m) – N (f), b		2
9077.17.0035 **	N (m) – N (f), b		
9077.41.0031	7/16 (f), b – 7/16 (f)		3
9077.41.0032	7/16 (m) – 7/16 (f), b		4

* Suitable mounting bracket 9075.99.0095

** Extended frequency range: 160 to 3000 MHz and 4900 to 6000 MHz

All dimensions in mm

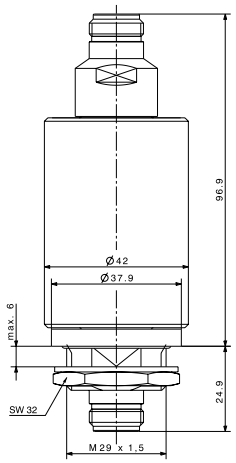


Fig. 1

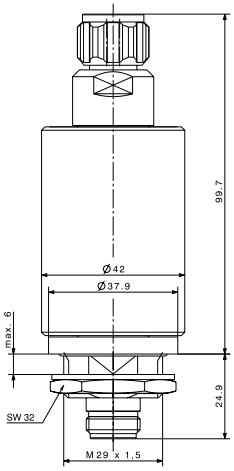


Fig. 2

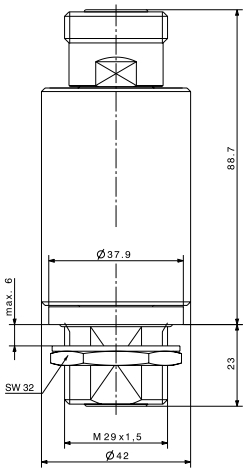


Fig. 3

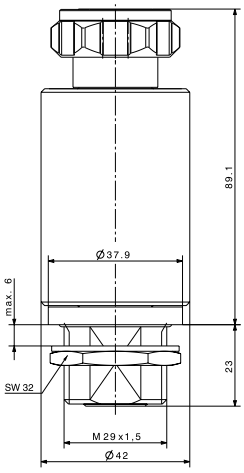


Fig. 4

All mounting holes are shown on pages 182 – 183.

15 kV broadband HV DC-DC block

General specifications

Electrical Data	
RF characteristics	
Impedance	50 Ω
Frequency range	from 180 MHz to 3000 MHz
Return loss (RL)	16 dB min. from 180 to 380 MHz 20 dB min. from 380 to 3000 MHz
Insertion loss (IL)	0.5 dB max.
Passive intermodulation (PIM)	–150 dBc typ.
RF power transmission	80 W CW
DC characteristics	
Leakage current	50 µA
Test leakage current	100 µA
Blocking voltage	15000 V (galvanic DC isolation in centre and outer conductor)

Mechanical data	
Coupling nut torque force	according to IEC/MIL-STD (refer to page 172)
Durability (matings)	500 min.

Environmental data	
Operation temperature range	–40 up to +85 °C (–40 up to +185 °F)
Waterproof degree (IEC 60529)	IP65 min., according to shown product specification, data refer to the coupled state
Moisture resistance	MIL-STD-202, method 106
Thermal shock	MIL-STD-202, method 107, condition B
Vibration, high frequency	MIL-STD-202, method 204, condition 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 / POM	SUCOPLATE®
Male contacts	brass	gold or silver plating
Female contacts	copper beryllium or bronze	gold or silver plating
Insulators	PTFE	
Gaskets	elastomer rubber	

HUBER+SUHNER type	Connectors port 1 – port 2 side of bulkhead marked «b».	Mounting/grounding MH – hole for «b»	Fig.
9077.17.0022	N (f), b – N (f)	MH110	1
9077.17.0006	N (m) – N (f), b		2

* Suitable mounting bracket 9075.99.0095

All dimensions in mm

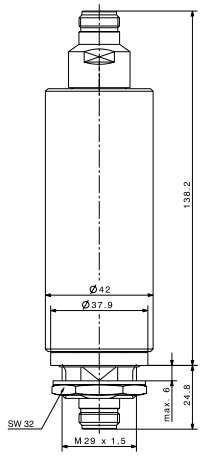


Fig. 1

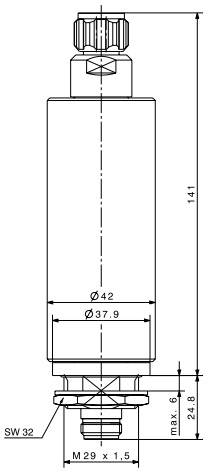
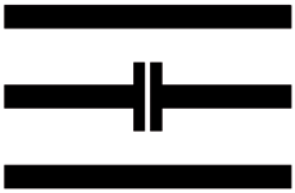


Fig. 2

All mounting holes are shown on pages 182 – 183.

High voltage DC and DC-DC blocks for communication applications

Models with inner conductor blocked



DC block

Models with inner and outer conductor blocked

DC-DC block

DC and DC-DC blocks are coaxial components which block the flow of DC and low frequency signals up to 100 kHz while permitting RF signals to flow without loss through the component. They are used in line with coaxial feeder cables within communication installations.

In this application note you find a selection of high voltage DC and DC-DC block applications as well as the HUBER+SUHNER product portfolio for these applications:

Eliminate ground loops in installations where system equipment is installed/bonded to different earth potential

Communication equipment installed on high tension power line poles

On or in close vicinity of high tension power line poles the so called ground potential rise (GPR) can lead to destruction of installed communication equipment.

GPR is caused

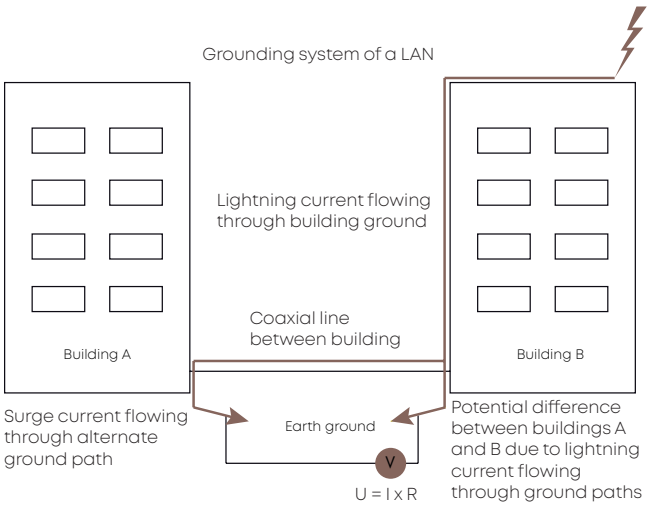
a) By unsymmetrical current distribution through the 3 phases of the power lines,

b) By a short circuit between two or more wires (phase) or between phase and ground.

Since the communication equipment is powered by the public mains supply, there is a voltage difference between the local earth and the far earth of the public mains supply. Besides an isolated installation of the communication hardware DC-DC blocks are one element to prevent destructive fault currents and increase safety on the site.

Communication equipment installed at sites with different earth potential

Cables bridging the distance between two sites which are installed/bonded to different earth potential must carry electric stray currents on the outer conductor. DC-DC blocks are used as corrective measure to interrupted such currents.



Reduce noise and improve the signal to noise ratio of the system

Communication installations near railways or on trains are affected by inductive coupling of the traction currents

The traction currents of electric trains create extensive magnetic fields which lead to inductive coupled signal disturbance in communication cables which are placed along the tracks or within the train. This interference is typically at 16.7 Hz, 50 Hz and 300 Hz, but due to the use of converters the disturbing signals can reach 100 MHz. communication installations within tunnels have to deal with the additional problem that the return currents of the trains engine create high local earth potential when passing-by. This is due to the fact that the earth resistance within tunnels are high. DC blocks and DC-DC blocks help in above described cases.

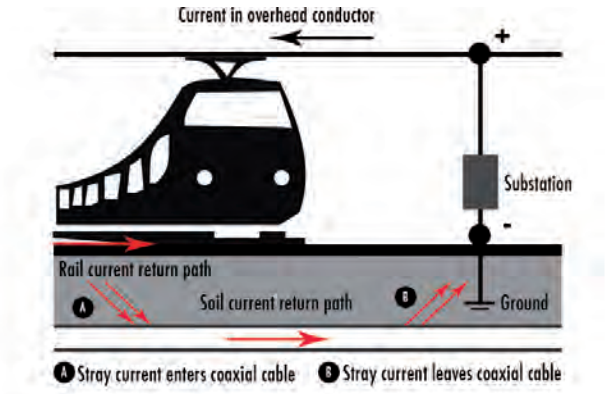
Installations in industrial environment are affected by electromagnetic radiation from heavy induction engines, frequency and AC/DC power converters etc.

In the classic industrial environment the electromagnetic pollution caused by engines couples into communication systems and causes signal disturbance. DC Blocks will stop the low frequency interference before entering the sensitive receiver hardware.

Prevent the flow of DC stray current in coaxial cables which causes galvanic (electrolytic) corrosion

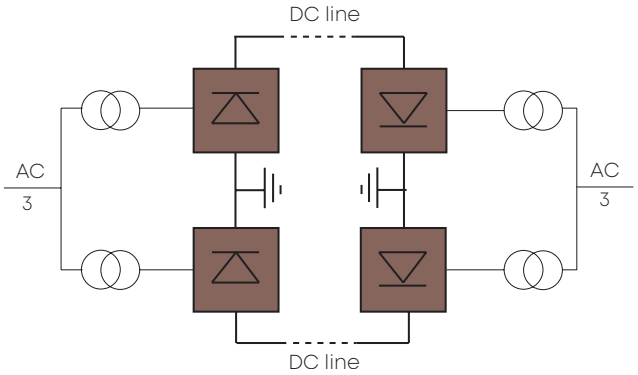
Near DC powered railways (subway or tram systems) stray currents originating from the trains return currents

DC powered trains or trams create stray currents flowing along the track path. These currents flow in any metallic subjects, such as cables and create electrochemical corrosion at the place where the stray current leaves the RF cable or connector. DC-DC blocks in line with the coaxial cables prevent the DC stray current to flow within the RF cable and therefore prevent destructive long-term corrosion.



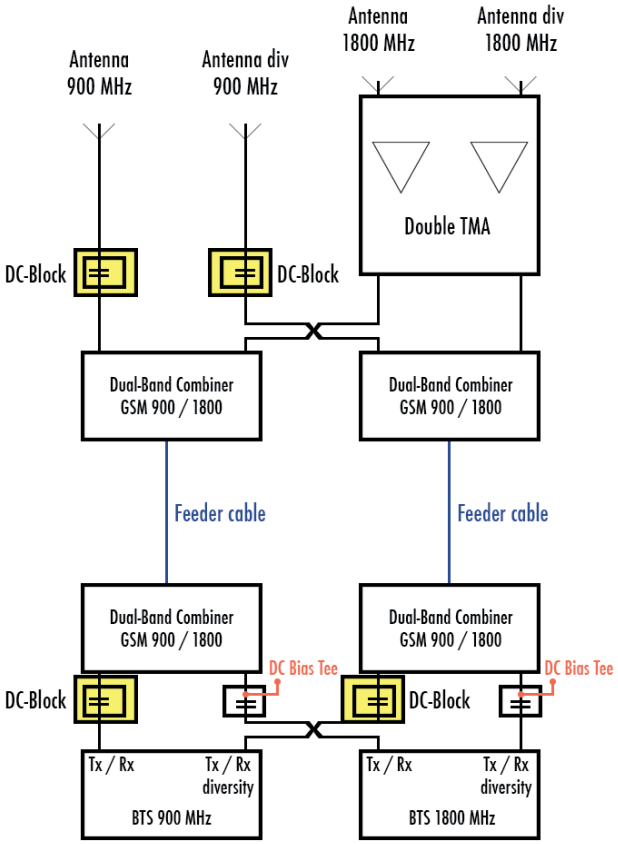
Close to high voltage DC transmission systems (HVDC)

The same effect (stray current and electrochemical corrosion in metallic conductors) happens in the vicinity of high voltage DC transmission systems (HVDC). DC-DC blocks in line with the coaxial cables prevent the DC stray current to flow within the RF cable and therefore prevent destructive long-term corrosion.



Routing DC to tower-mounted amplifiers in dual- or multiband cell site installations where only specific frequencies demand for TMA's

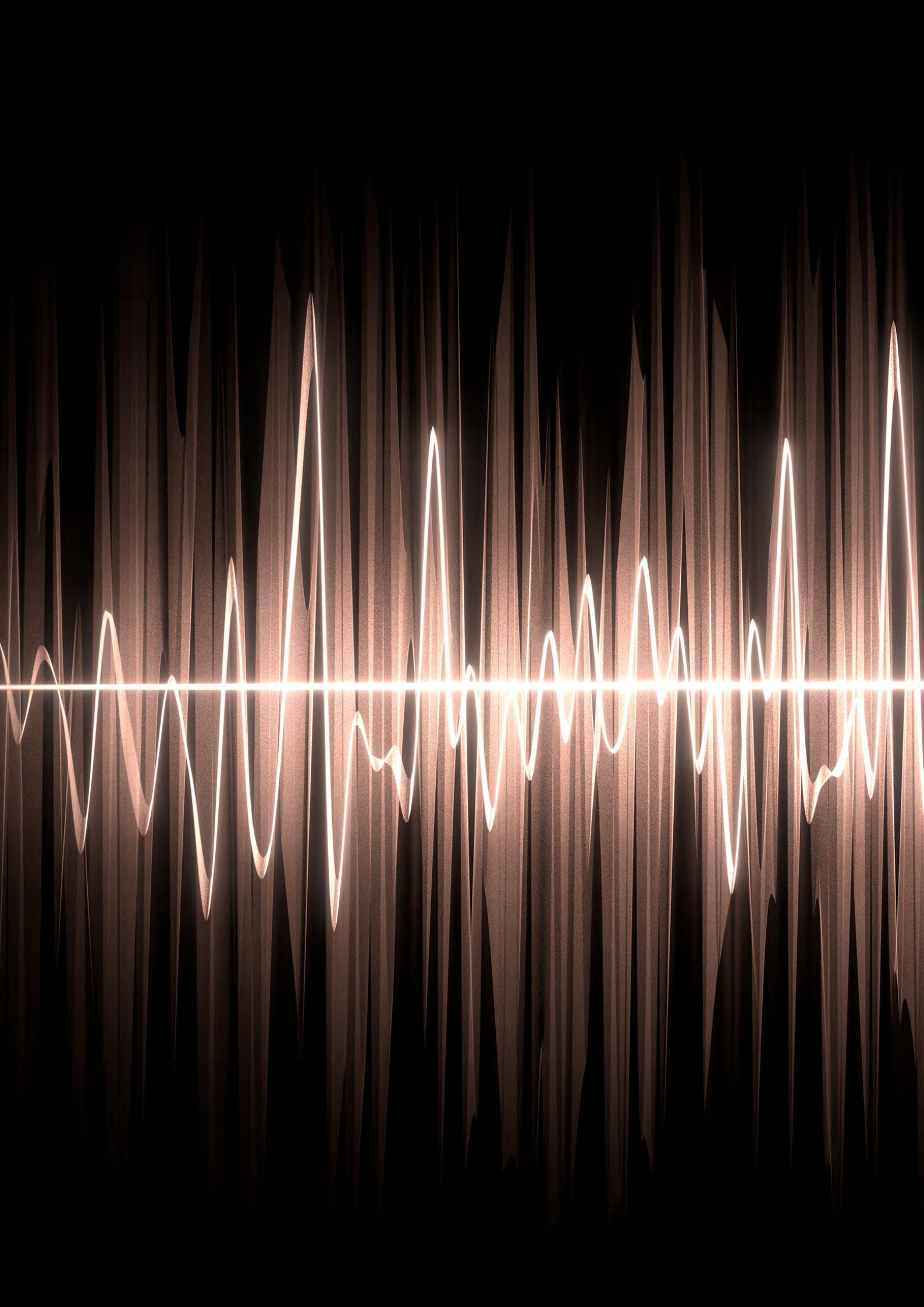
In cellular BTS sites where multiple antennas (services) are supplied through the same coaxial feeder cable DC blocks are used to guide DC to the amplifier ports and block DC in front of equipment which is DC shorted.

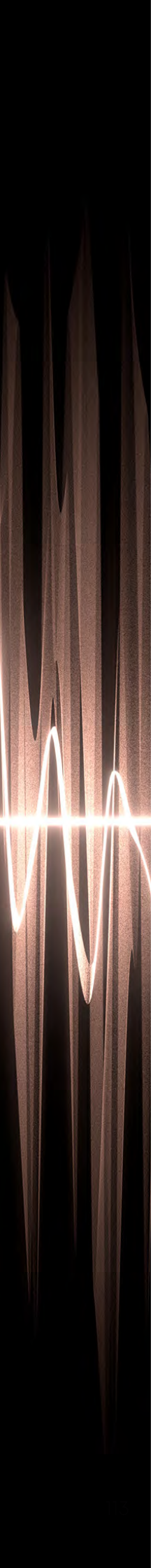


Provide isolation as specified in the safety regulations

Depending on the country and the application, the safety rules and regulations demand blocking of dangerous voltage potential by means of DC-DC blocks of the appropriate blocking voltage.

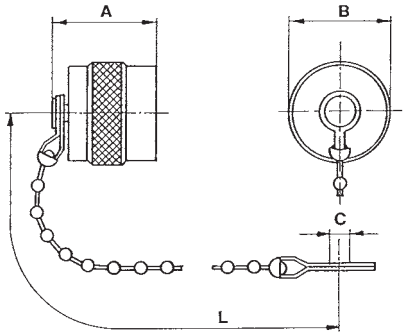
For all of the above mentioned applications it is important to select the correct DC blocking voltage.





Accessories

Protective caps



HUBER+SUHNER type	Suitable for connector interface	Dimensions mm (in)			
		A	B	C	L
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)

* 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

HUBER+SUHNER type	Thread size	Screw length	Wall thickness max.
9075.99.0096	M6	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

All mounting holes are shown on pages 182 – 183.

Bulkhead mounting sets

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

according to protector design and original delivery

HUBER+SUHNER type	**Suitable for protectors with mounting hole (MH dimensions refer to pages 176 – 177)**
9075.99.0036	MH12, MH24, MH50, MH71, MH119 nut thickness 4.75 mm (3/16")
9075.99.0043	MH25, MH70, MH170
9075.99.0074	MH72, MH74, MH101
9075.99.0085	MH69

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

according to protector design and original delivery

HUBER+SUHNER type	**Suitable for protectors with mounting hole (MH dimensions refer to pages 176 – 177)**
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")

All mounting holes are shown on pages 182 – 183.

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.

HUBER+SUHNER type	Suitable for mounting hole (MH dimensions refer to pages 176 – 177)	Thread length
9075.99.0056	MH12, MH24, MH50, MH71	11.5 mm (0.453 in)
9075.99.0061	MH74	23.6 mm (0.929 in)

All mounting holes are shown on pages 182 – 183.

Grounding rings

Cable terminals for HUBER+SUHNER lightning EMP protectors with N and TNC interface

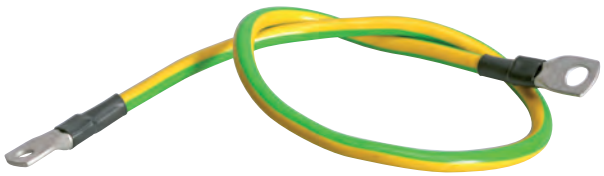
To be applied directly on the bulkhead fixation thread of the protector, if it is not possible to provide a proper bonding/grounding via bulkhead. Installation outside of the protected area recommended.

HUBER+SUHNER 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 to 20 mm (0.669 to 0.787 in)	MH25, MH70, MH170
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 or 16 mm^2

Grounding cables

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



All mounting holes are shown on pages 182 – 183.

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: 76 x 76 mm (3.00 x 3.00 in)
  – small hole face: 50 x 76 mm (2.00 x 3.00 in)

HUBER+SUHNER type	Suitable for protectors with mounting hole	Fig.
9075.99.0028	MH69, MH12, MH24, MH50, MH71, MH119	1
9075.99.0030	MH80, MH118, MH25, MH70	2
9075.99.0095	MH110	3
9075.99.0105*	MH12, MH24, MH50, MH71, MH119	4
9075.99.0106*	MH25, MH70, MH170	5

* Material: aluminium

All dimensions in mm

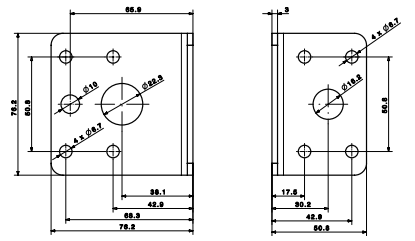


Fig. 1

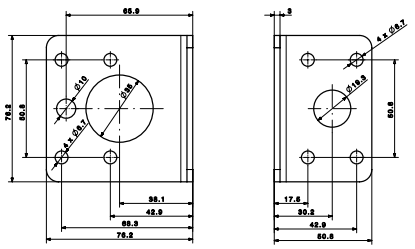


Fig. 2

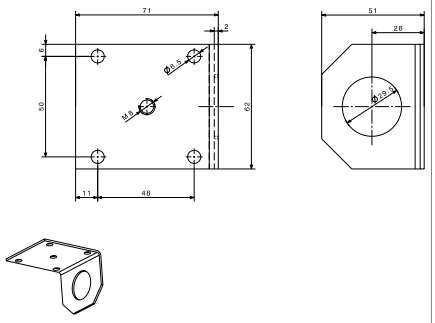


Fig. 3

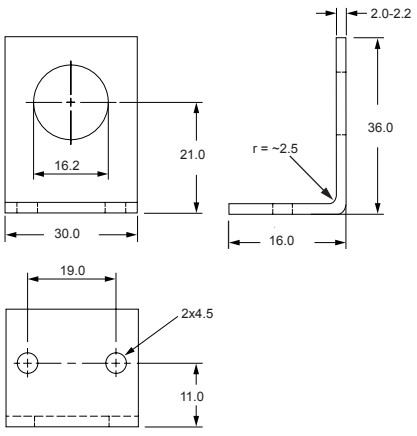


Fig. 4

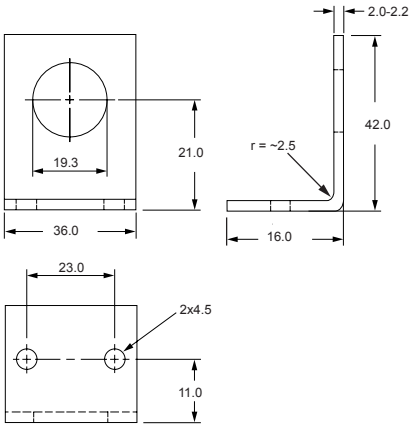
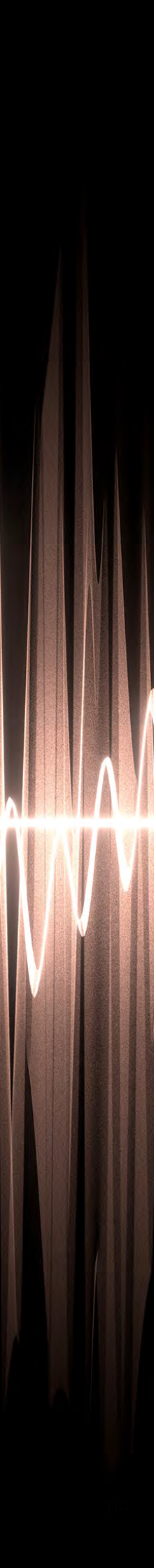


Fig. 5

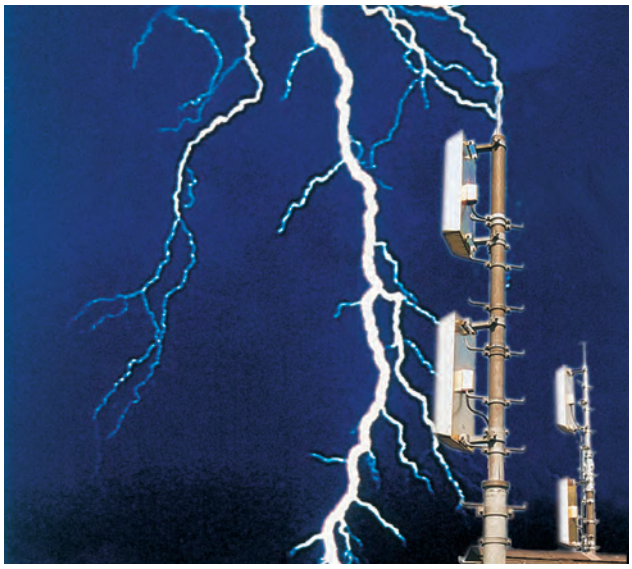
All mounting holes are shown on pages 182 – 183.



Protection basics

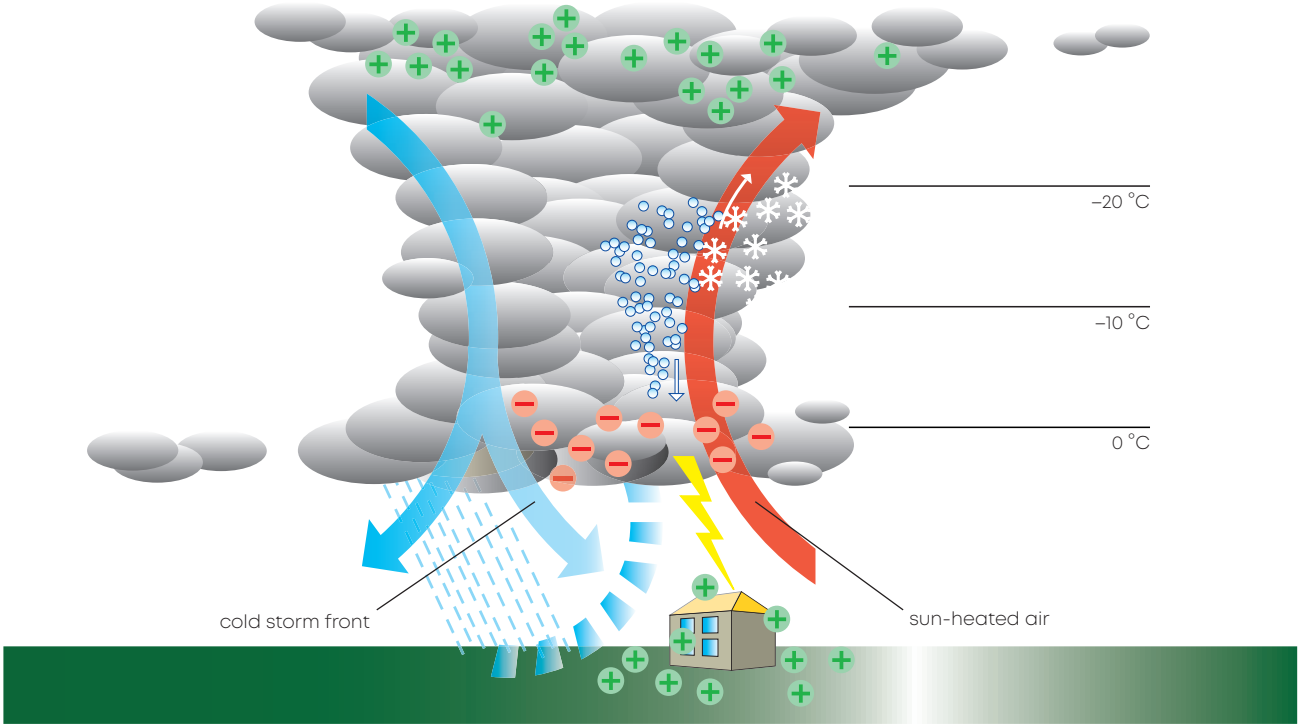
Lightning phenomenon and characteristics

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.



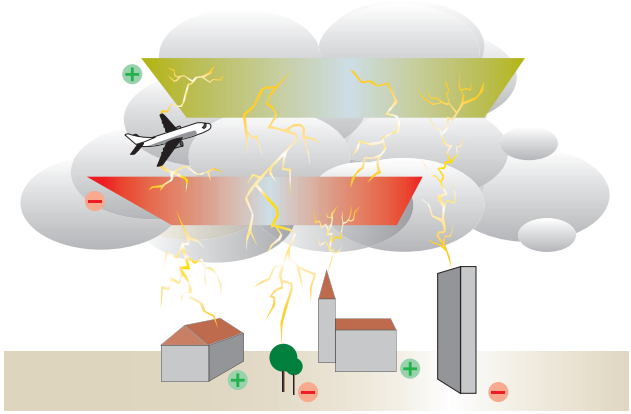
Creation and threat of lightning

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.



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.

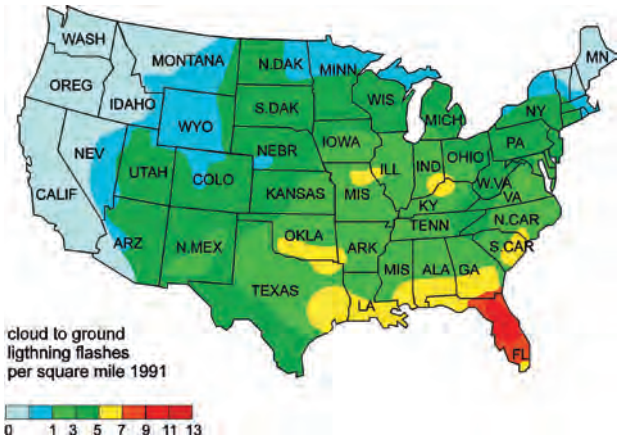


Lightning variants

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

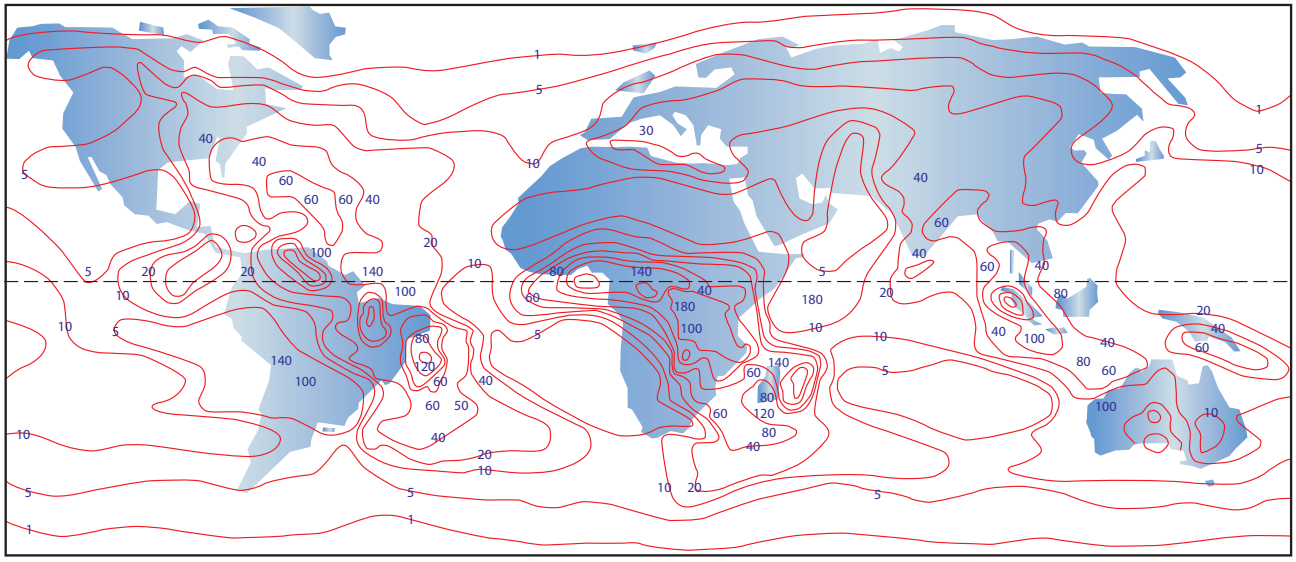
At any given time, almost 2000 thunderstorms are in progress on earth, and every 1/100 second or 6000 times a minute a bolt of lightning strikes the earth.

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.



GFD map of the USA

In the USA alone, lightning strikes 40 million times each year. Its occurrence in the USA is greatest within a 100 kilometre 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)

Lightning phenomenon and characteristics

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.

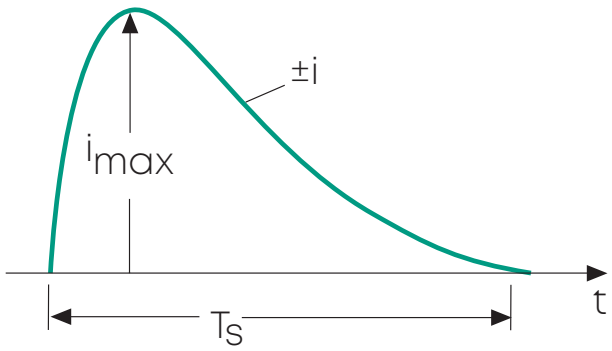
Electrical specifications and effects of earth lightning
Here, we will only consider cloud-to-earth lightning, which has the greatest damage potential. This type of lightning is divided into positive and negative lightning, depending on the polarity of the cloud charge.

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.

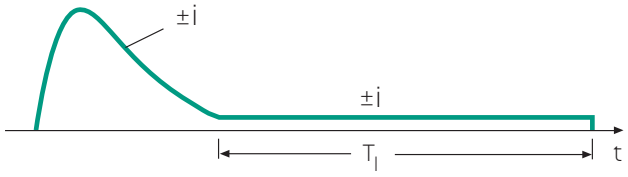
Negative cloud-to-earth lightning starts with a lightning current pulse whose maximum amplitude amounts also to several 10 kA, but lasts merely 1/10 of the time of a positive one. Its peculiarity lies in the subsequent smaller multiple discharges, which may result in a total duration of the lightning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

This produces the following basic, schematic lightning current patterns:

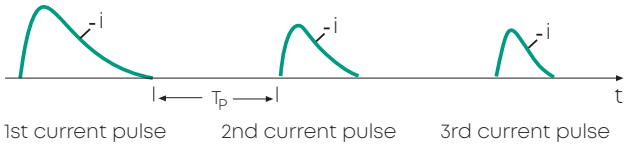
Pattern 1
Positive or negative lightning current pulse of several 10 kA and less than 2 ms duration (T_S).



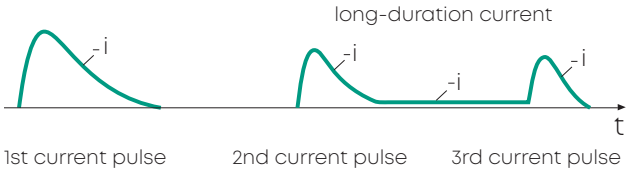
Pattern 2
Positive or negative lightning current pulse as pattern 1, with subsequent long-duration current of about 100 A during a period of less than 500 ms (T_l).



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 time between the lightning current pulses are shorter than 100 ms (T_P).

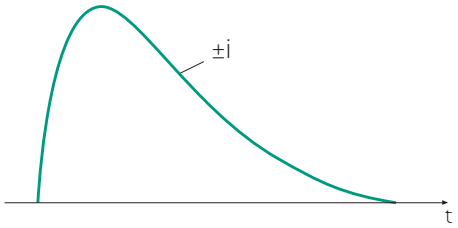


Pattern 4
Sequence of negative lightning currents according to pattern 3, with integral long-duration current according to pattern 2.

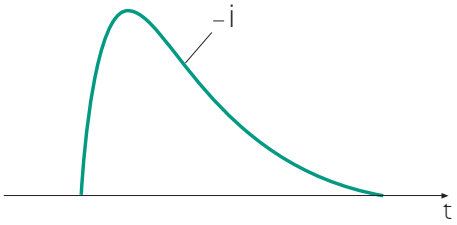


On the basis of these lightning current patterns, CIGRÉ and IEC 62305 defined 3 groups of laboratory-simulated lightning currents:

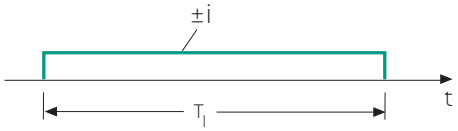
Group 1: first stroke
Lightning current of positive or negative polarity, first stroke– wave form 10/350 µs



Group 2: subsequent stroke
Lightning current of negative polarity, subsequent stroke– wave form 0.25/100 µs



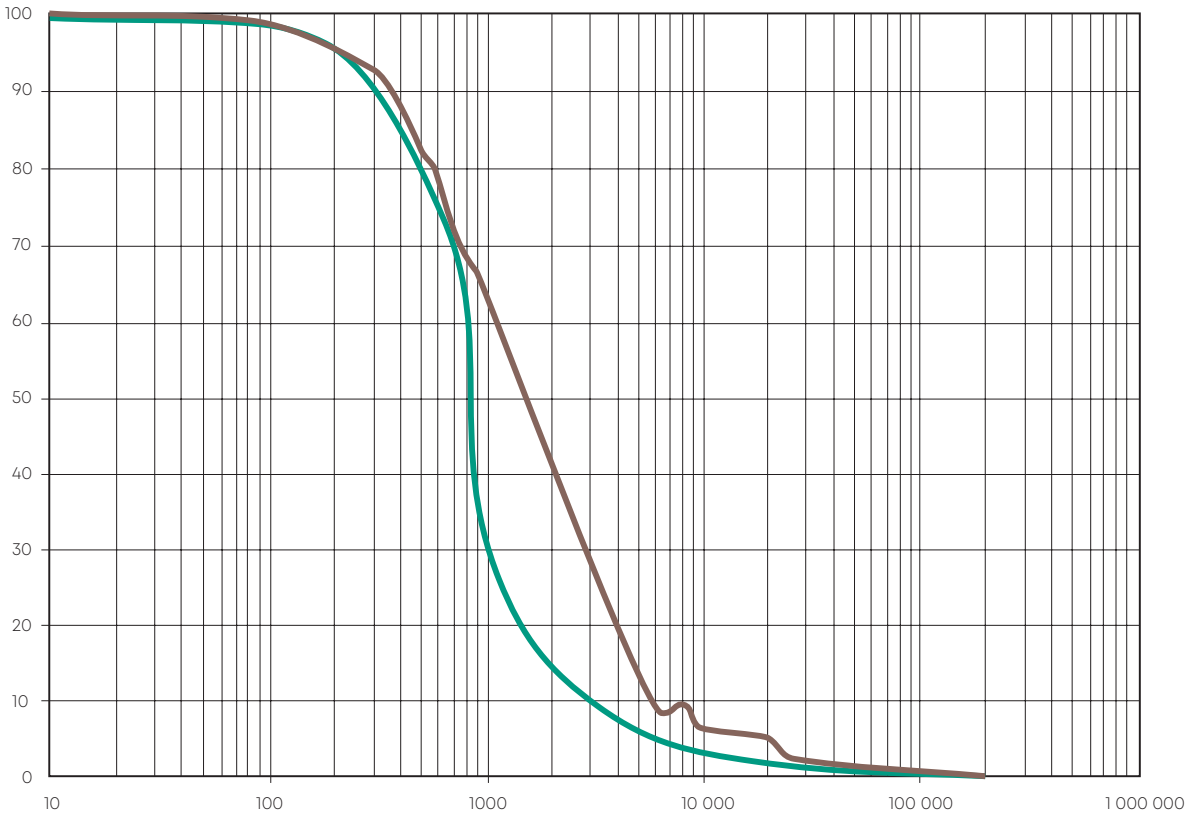
Group 3: long stroke
Lightning current of positive or negative polarity, long-duration stroke
– T_{long} = 0.5 s.



Lightning phenomenon and characteristics

The most important parameters of lightning are the following:

- Lightning current amplitude «i» determines the resistive effects mentioned below
- Average steepness of the lightning current di/dt determines the resistive and magnetic coupling effects mentioned below.
- Total charge
  $Q = \int i \cdot dt$ (unit As or C)
  determines the energy release/conversion at the hit point.
- Specific energy (action integral)
  $W/R = \int i^2 \cdot dt$ (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 lightning electromagnetic pulse (LEMP) 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.

Coupling effects of lightning into systems

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

  $U_E = i \cdot R_E$.

  Assuming realistic values of i = 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

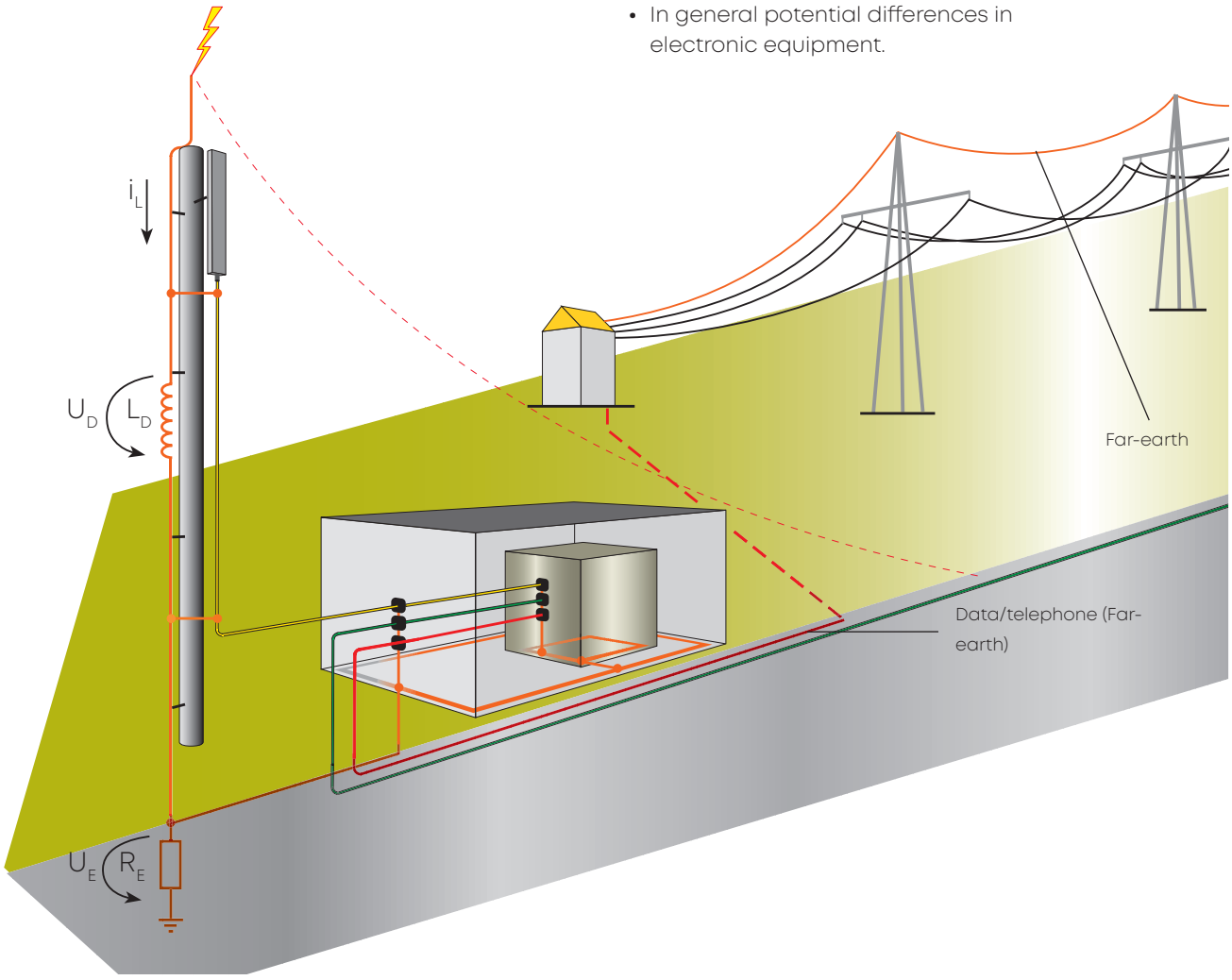
  $U_D = L_D \cdot di/dt$.

  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.

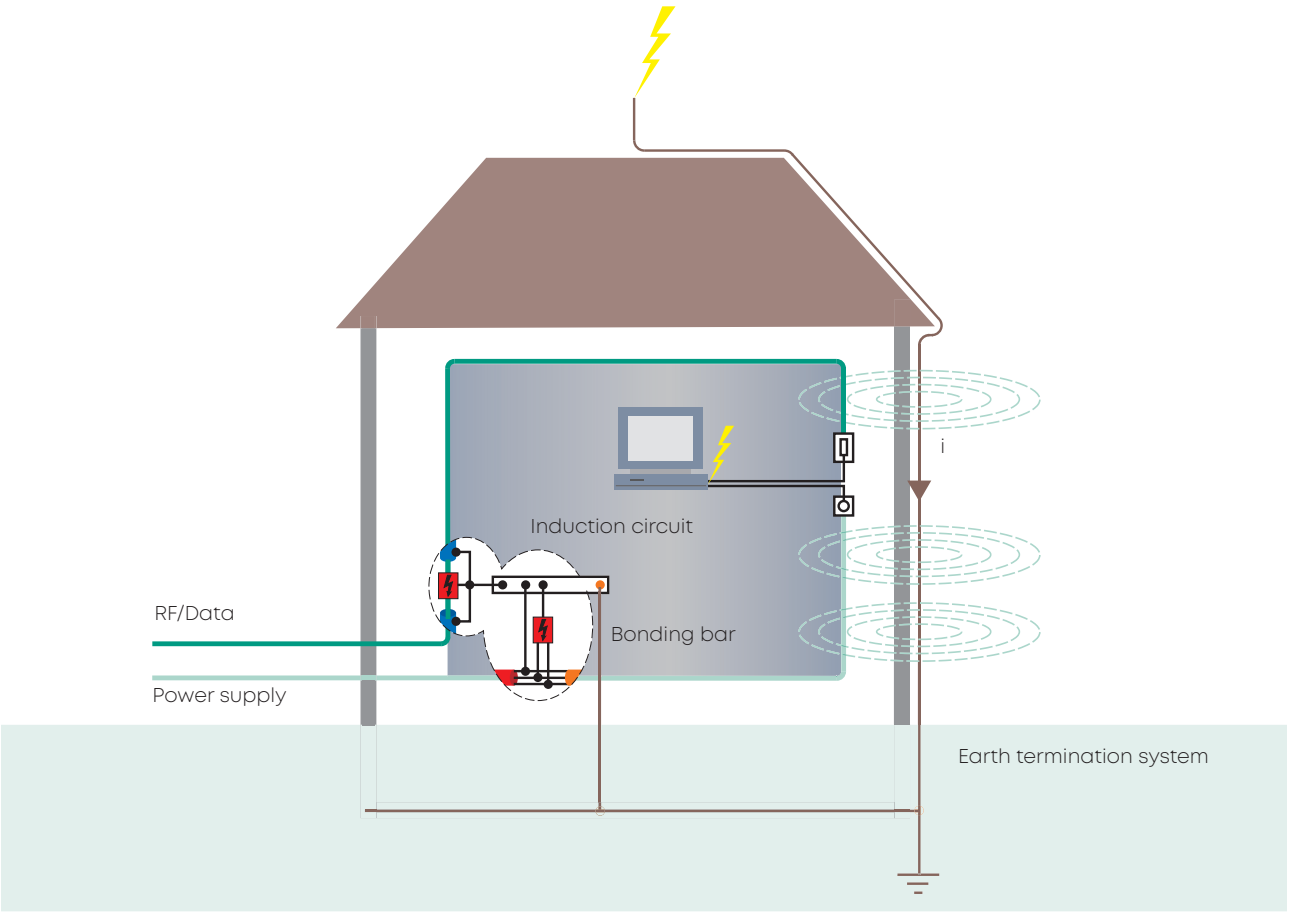


Lightning effects in radio transceivers

Coupling effects of lightning into systems

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:

$U = -M \cdot di/dt$ (M for mutual inductance)



Electromagnetic interference of nearby lightning hits or even the LPS itself

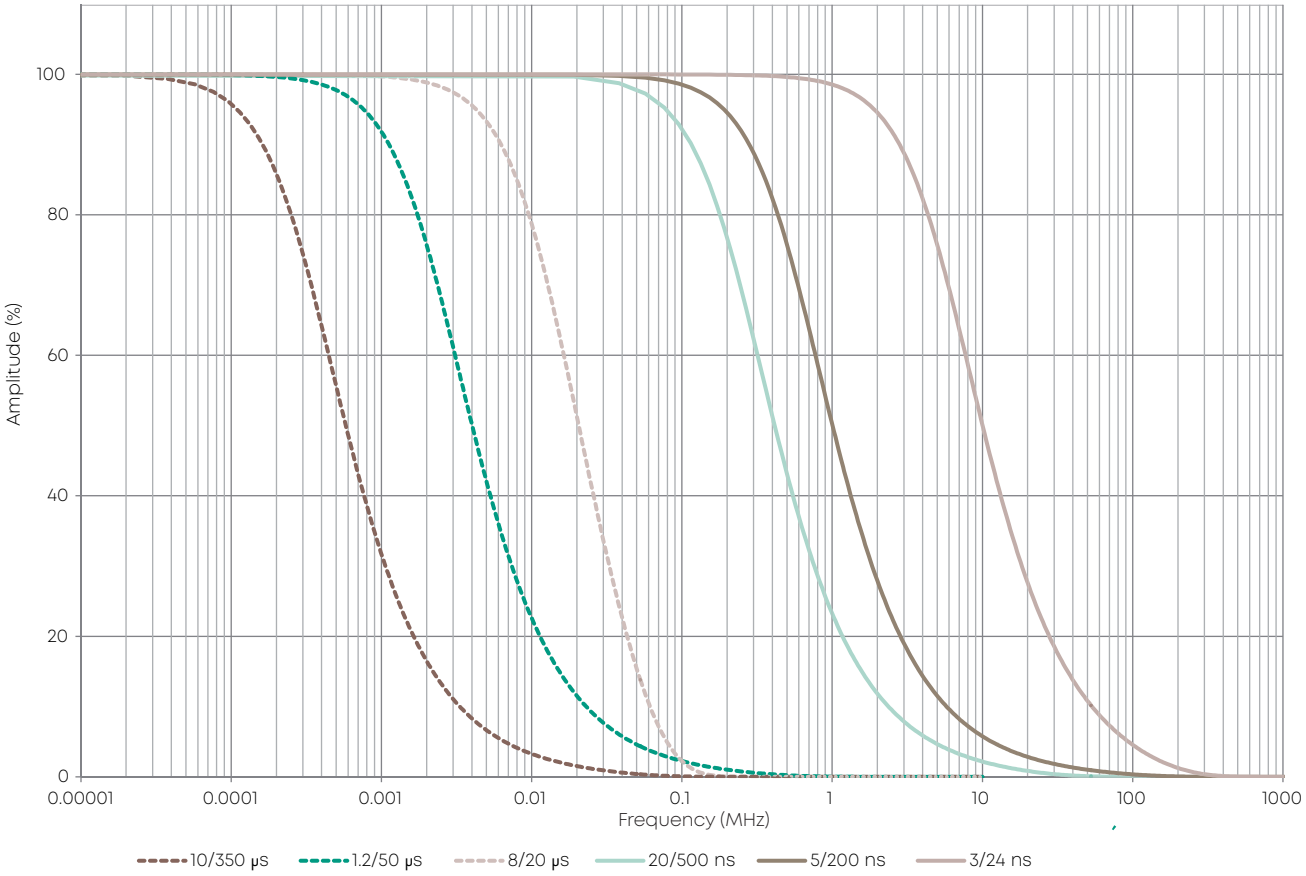
Electric field coupling
The effects of the high and changing electrical field strength, right before the hit occurs, is normally negligible when considering a minimum of protection measures.

Protection against electromagnetic fields (LEMP/NEMP/HEMP)

Sensitive and safety related systems shall be protected from the negative effects of electromagnetic fields such as nuclear electromagnetic pulse (N)EMP. The extremely short rise and fall times of only a few nanoseconds (ns) and huge field strength up to some 10 kV can couple amounts of energy into systems which is far in excess of peak parameters of modern electronics. Irreversible damage and blackout of the systems is the inevitable result. Modes of entry are through antennas, transmission and utility lines as well as through direct penetration of shields and enclosures.

Lightning (LEMP) represents a threat of similar importance. Rise as well and fall times of a LEMP are longer when compared with a NEMP. The field strength is decreasing rapidly already within small distances from the striking point. However, the threat represented by lightning is not just due to induction effects. A direct stroke with peak currents ≥100 kA represents an additional threat.

The following graph shows the frequency response and the relative amplitude of various standardised (N) EMP and (L)EMP pulses.

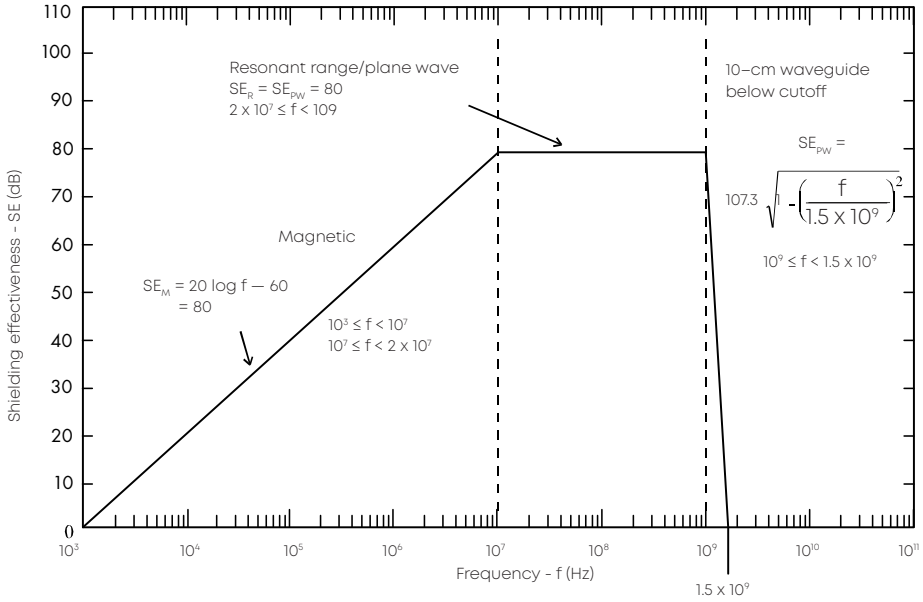


1.2/50 µs	Frequency spectrum of the indirect lightning pulse (voltage) accordig to IEC 61000-4-5 and VG 96903-76
8/20 µs	Frequency spectrum of the indirect lightning pulse (current) according to IEC 61000-4-5 and VG 96903-76
10/350 µs	Frequency spectrum the direct lightning pulse (current) according to IEC 62305
5/200 ns	Exo-NEMP frequency spectrum according to MIL-STD-188-125-1 and MIL-STD-188-125-2
20/500 ns	Exo-NEMP earl time waveform (E1) frequency spectrum according to MIL-STD-188-125-1
3/24 ns	Exo-NEMP frequency spectrum according to VG 95371-10 resp. IEC 61000-2-9

Protection against electromagnetic fields (LEMP/NEMP/HEMP)

Shielding encompasses all measures to attenuate the (N) EMP fields within a specially protected area or room. Such areas can be, bunkers, fix installed containers, vehicles or equipment chassis all built as Faraday cage.

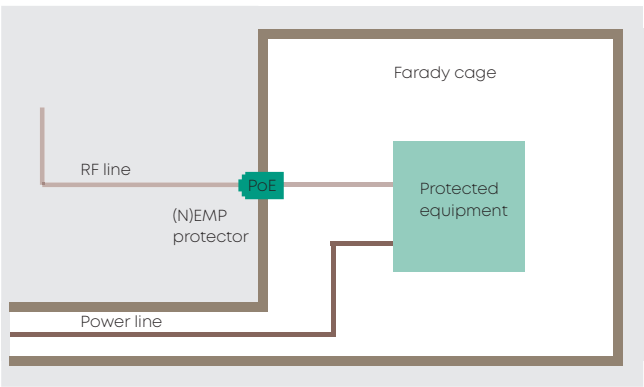
According to MIL-SDT-188-125 part 1 and part 2, the screening efficiency of a metallic enclosure (Faraday cage) shall achieve a minimum level of 80 dB for frequencies ≥ 10 MHz.



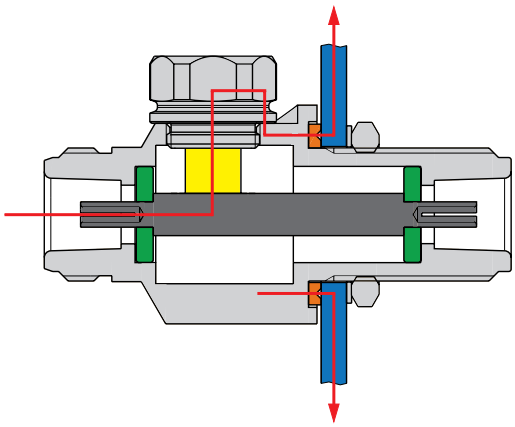
Minimum HEMP shielding effectiveness requirements acc. MIL-SDT-188-125 part 1 and part 2

But, the entire system cannot be shielded since antennas, transmission lines or other collectors of EMP signals which must interface with the system equipment cannot be completely enclosed within a metallic shield. Any entry into an shielded room will have a negative impact on its screening effectiveness such that it becomes more difficult to meet the MILSTD-188-125 requirements. It is therefore of utmost importance that the installation of cable feed-troughs and (N)EMP protection components is carried out in a professional way which shall be in line with the latest EMI / EMC installation rules. In particular, the exclusive use of cable feed-troughs and (N)EMP protection products which guarantee a screening efficiency >> 80 dB when installed is recommended.

When looking at a typical coaxial port of entry (PoE) (see picture below) the transition from the housing (outer conductor) to the wall of the faraday cage is essential. To reach a high screening effectiveness between the unprotected and the protected area of an installation this transition shall be realised with low-inductance and low-resistance. In addition it shall be ensured that these values will stay stable over the full lifetime of the system.



Example of a protection concept



Lightning protection principles

Basic principles of lightning protection
To protect electronic equipment, several different aspects shall be considered. Well-proven basic principles are shielding (Faraday 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.

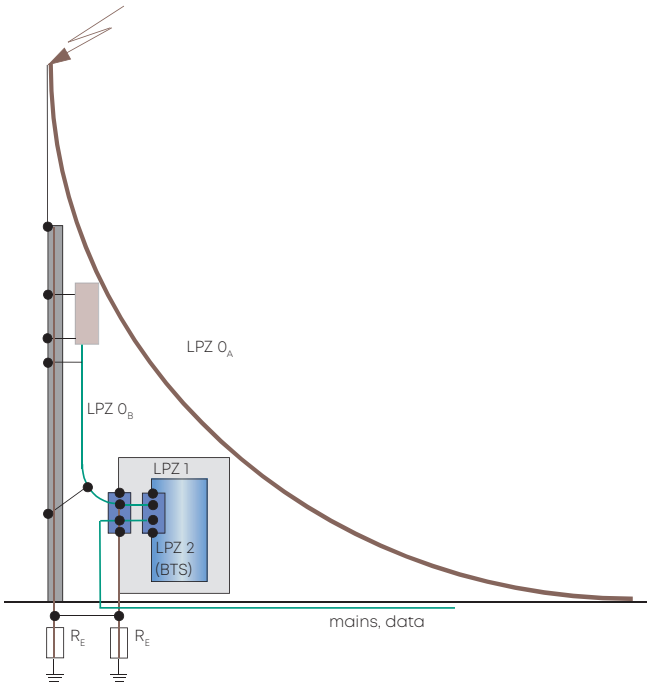
Account shall be taken of the most important international standards, such as IEC 62305 protection of

- 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 shall be capable of carrying the full lightning current. Also, the un-attenuated 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 un-attenuated 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.

The transition between LPZ 0 and LPZ 1 is the most important one. At this point all crossing conductive parts shall 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).

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 should be protected by surge protective devices (8/20 µs). They may be based on a number of different operating principles.

If a further reduction of the current or of the electric field is necessary, additional subsequent zones shall be established (LPZ 2, etc.). Additional surge protective devices shall be applied at each zone transitition (e.g. LPZ 1 / LPZ 2 ….).

For optimum protection, all electric supply and signal lines should enter the protected area at one single place. At this point, they shall be connected to the bonding bar by surge protective devices. At every interface between one LPZ and the next, the potential equalization shall 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.

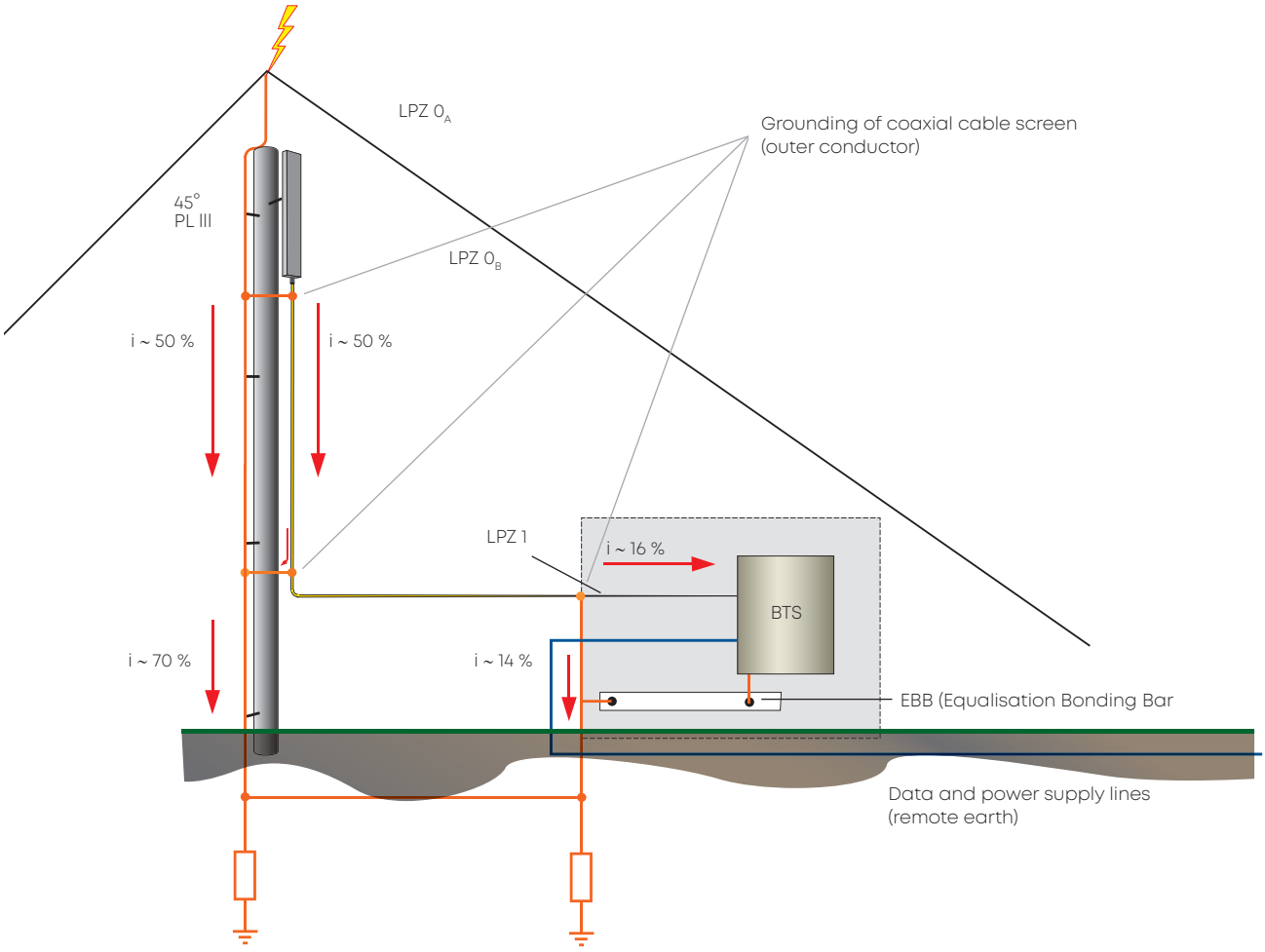
Special lightning protection principles for RF applications allow a continuous bonding of lines. The grounding shall always be in accordance with IEC 62305. The grounding of the installed lightning EMP protectors, their connections to the bonding bar of the structure or equipment have to be prepared very carefully to achieve the lowest possible resistance and inductance to ground (refer to section «application notes»).

Lightning current evaluation on an antenna site

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):

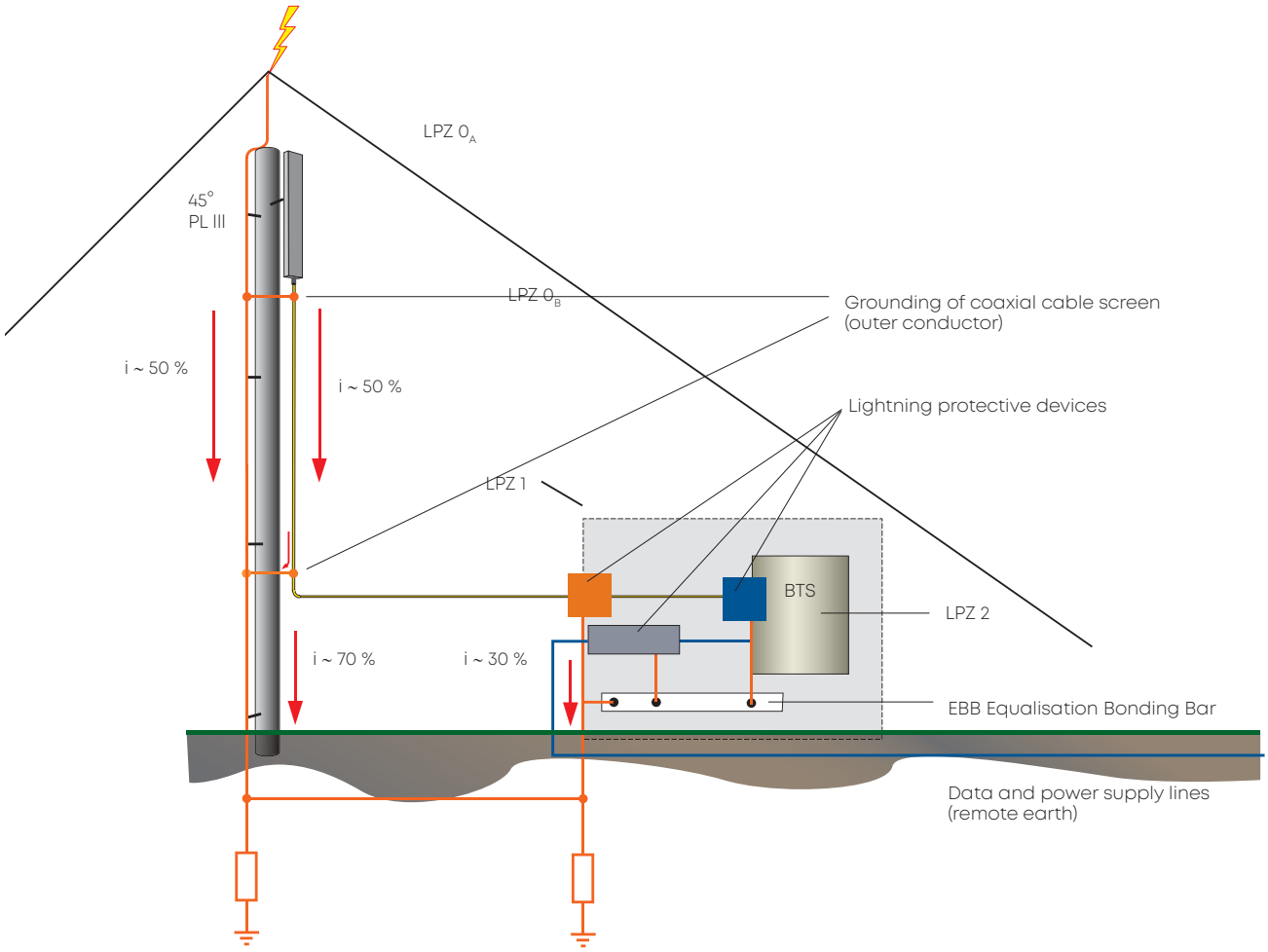
Current distribution without application of lightning EMP protection device



Abbreviations according to IEC 62305

LPZ: Lightning protection zone
PL: Protection level

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 LPZ 0_B of the external lightning protection system (LPS) according to IEC 62305 (protection against lightning: air-terminations, down-conductors and earth-termination). 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).

Logitudinal voltage on cables

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 over-voltages 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 U_L 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 U_L 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

Loop voltage

A surge protective device 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:

$U = -M_2 \cdot di/dt$ M_2 – mutual inductance of the loop

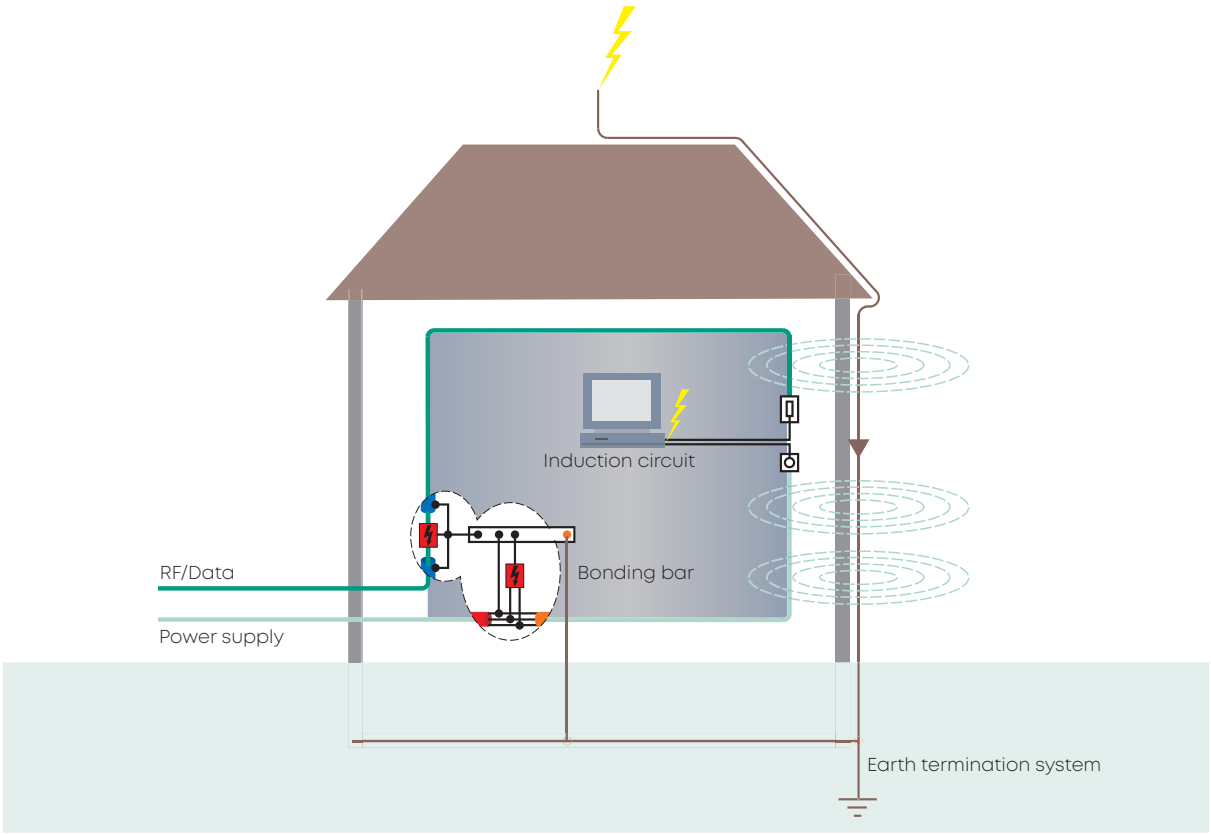
First partial lightning strokes show a current rate of change of up to 20 kA/µs, subsequent lightning strokes even of up to 200 kA/µs. The loop inductivity depends on the loop circumference and on the distance to the lightning stroke channel. Larger loops – e.g. 40 m – possess a M_2 of about 1.5 mH at 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 minimise 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 shall 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.



Installation of surge protective devices

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 interference 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 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 shall offer good electrical conductivity (contact points shall 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 shall 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 characterised by their quick, easy, and at the same time reliable installation methods. The preferred variant is single-hole mounting as wall feed-through. 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 next pages.

General mounting and grounding instruction (refer to DOC-0000176104)

CE Series 3400, 3401, 3402, 3403, 3404, 3405, 3406, 3407, 3408, 3409, 3410

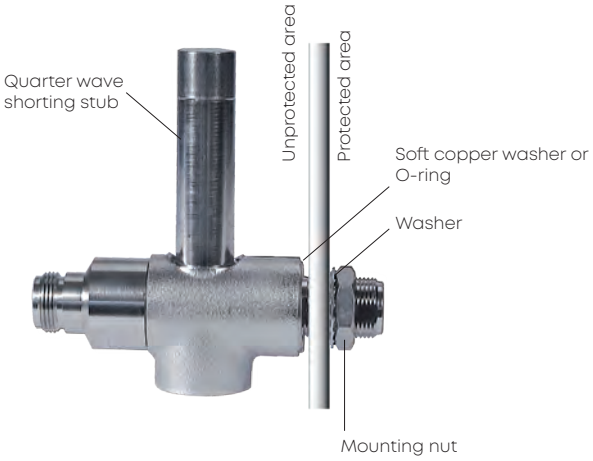
RoHS compliant

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 to IEC 62305 the protective device integration is based on the lightning protection zone (LPZ) concept with bonding and shielding.

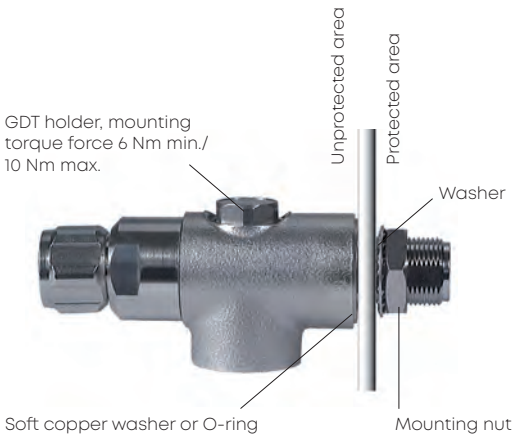
1. Preferred installation
The protection zone principle favours the feed-through installation in a well conductive and grounded panel, which is simultaneously the boundary to the higher protection zone containing the equipment to be protected. It is recommended to place quarter-wave (QW) or gas discharge 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



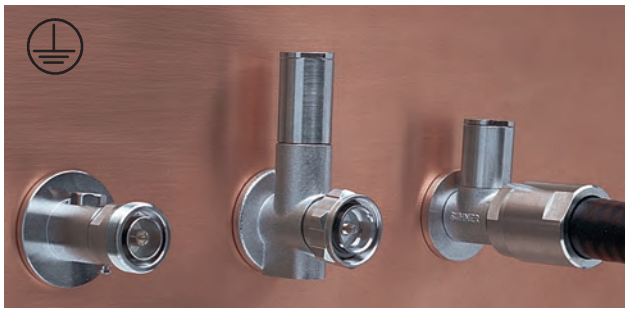
Well conducting and grounded bulkhead

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

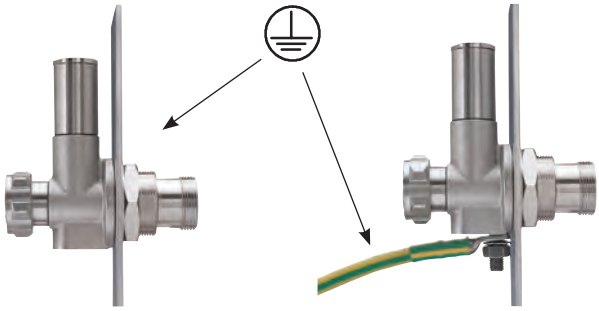


Well conducting and grounded bulkhead

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 into and inside of the protected area where they could induce secondary surge signals.

Bulkhead mounting nut torque	**Nut size, WAF/mm**	**(in)**	**Torque*/Nm**	**(lb-ft)**
(WAF: Width Across Flats) Number of mountings: max. 5 cycles	≤ 13	(1/2")	3 to 5	(2.2 to 3.7)
	16	(5/8")	10 to 15	(7.4 to 11.1)
	19 to 25	(3/4" to 1")	15 to 20	(11.1 to 14.8)
	≥ 30	(1 1/8")	30 to 40	(22.1 to 25.8)
Screw mounting	M6		5 to 8	(3.7 to 5.9)
	M8		15 to 20	(11.1 to 14.8)

* For lightning protectors made of aluminium the torque may be lower see specific instruction DOC-0000447876.

2. Alternative installation possibilities

The protectors can be installed to the equipotential bonding bar (EBB).

If this is not possible, 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.).

The following shows the most common variants:

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 possible (not via the connected cable screen), to keep the ground connection as short as possible.
- Make sure the contact transitions are clean and smooth when installing. This is also important for waterproof bulkhead installations.
- Waterproof installations require suitable IEC/MIL conform counter connectors (male connectors include sealing ring), which shall 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.
- Select the GDT with the lowest suitable static sparkover voltage to achieve best protection. Generally the minimum value of the static sparkover voltage shall not be lower than 1.5 times the peak voltage

  $\hat{U}max.= \sqrt{2}PZ \cdot (1 + \Gamma) + U_{DC\_SUP}$

  (RF and DC supply voltage) on the line.

- Recommended GDT holder torque force:
  min. 6 Nm (4.4 lb-ft); max. 10 Nm (7.4 lb-ft)
- 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.
- Coupling nut torque forces shall not exceed IEC standard or manufacturer detail specifications.
  7/16: min. 25 Nm (18.4 lb-ft); max. 30 Nm (22.1 lb-ft)
  N: min. 0.68 Nm (6.0 lb-in); max. 1.13 Nm (10.0 lb-in)
- If exposed to harsh environment, especially icy conditions or polluted atmosphere, the protector should be covered with a self-vulcanising tape or a cold shrink tube.
- When installing and grounding protectors the electrochemical potential between different metallic contacts should not exceed 250 mV (acc. to MIL-F-14072). If exceeding, the contact area must be taped, coated or sealed in order to minimize electrochemical corrosion.
- Especially protectors made of copper alloy base material and trimetal plating mated with connectors made of aluminium or vice versa shall be taped to improve long-term durability.
- Any liability or responsibility for the result of improper installation is disclaimed.
- Maximum continuous operating voltage Uc:
  0 V for quarter-wave shorting stub/filter high-pass protector devices
  48 V for protectors with inserted GDT, except for fine protector types series 3403, see specific type label

⚠ 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 make sure that the GDT has been properly installed before putting the equipment into operation.

For lightning EMP protectors made of aluminium see page 177

Maintenance

According to IEC 62305, all lightning protection systems (LPS) and surge protective devices (SPD) should be inspected and tested on a regular basis for its proper function. The interval between the inspections of an LPS or SPD depends on the lightning protection class (I to IV) of the structure and the local environment. This is determined by a risk analysis according to IEC 62305-2 and the application field. Only the operator or his local planer can judge the inspection requirements of their equipment according to the actual exposure.

Quarter-wave technology lightning EMP protectors
Quarter-wave lightning EMP protectors are basically maintenance-free. However, the inspection activities shall be carried out on the basis of the standard and the technical principles of IEC 62305-3. We recommend to check the condition of the grounding and /bonding system, connection of the interface and the functionality of the QWS. QWS protectors 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 or by an ohmic test. Pass criteria is: zero ohm between inner conductor to ground.

Gas discharge tube technology lightning EMP protectors
Gas discharge tube (GDT) protectors have various geometries, They can withstand multiple surge currents and are very reliable. 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 direkt hit 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 event and a service will be necessary anyway. HUBER+SUHNER protectors feature an easy access to the GDT and the exchange is quickly made.

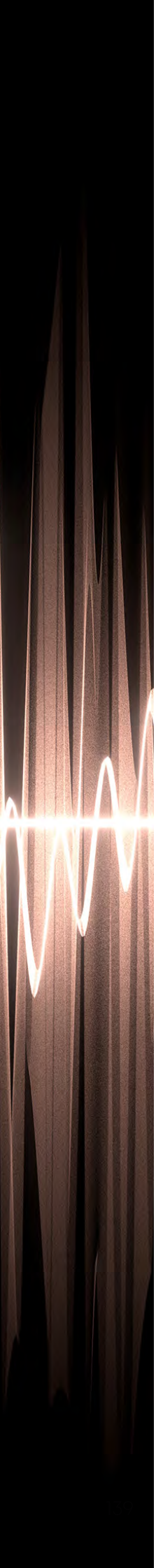
Recommendation
HUBER+SUHNER recommend to check:

1. the condition of the grounding and bonding system
2. connection of the interface
3. measuring of the static spark-over voltage of the GDT

For this, HUBER+SUHNER can offer a suitable test unit type 9075.99.0053.

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

Field experience shows that lightning EMP protectors are not the only devices which can be affected in the case of a heavy direct hit. A general check of the connected devices, cables and antennas is recommended in this case.



Application notes on lightning and surge protection

Protection of LTE systems

Highest reliability, lowest risk, fast site approval, reduced maintenance cost
The perfect coaxial lightning protector for LTE installations is the one which archives best protection results while at the same time it is not degrading the RF systems performance at all. Starting with the RF performance this means that it shall accomplish the full LTE bandwidth (690 to 2690 MHz) with highest possible return loss (RL). LTE is a high power, multicarrier application which demands for lowest passive intermodulation products distortion. Certainly the lightning protection parameters shall be of the highest standards in order to increase system reliability, lower risk and reduce maintenance cost.

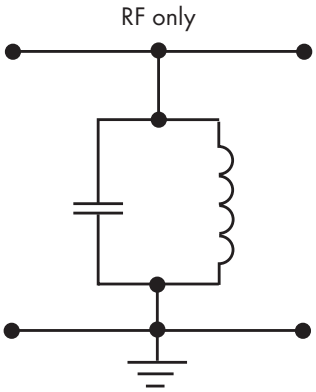
HUBER+SUHNER set industry standard
At the advent of digital mobile communications HUBER+SUHNER set the industry standard in coaxial lightning protection with its quarter-wave shorting stub lightning protectors series 3400 the patented GDT hybrid protectors series 3409 and the self-extinguishing GDT protectors «Semper».

HUBER+SUHNER offers a portfolio of lightning protectors for the LTE application which represents the state of the art in this domain.

RL	≥ 28 dB from 690 to 2690 MHz
PIM	≤ –160 dBc
Surge current	up to 100 kA
Residual energy	11 µJ

Quarter-wave shorting stub technology
For all applications which do not apply DC power on the feeder cable the series 3400 (quarter-wave shorting stub principle) with its excellent lightning protection parameters represents the best possible technology.

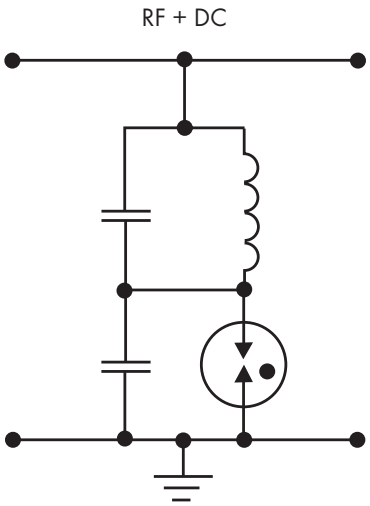
Quarter-wave (λ/4) shorting stub



GDT gas discharge tube hybrid technology

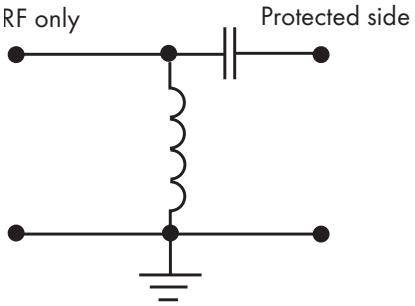
Applications in which apply RF and DC is applied on the feeder line are best served with the series 3409 GDT hybrid technology which HUBER+SUHNER invented and brought to the market in 1998. The series 3409 performs lowest passive intermodulation values and can handle peek envelope power (PIP) up to 25 kW.

GDT on top of QW shorting stub



LC filter technology

For the use in less lightning prone installation areas we offer protectors based on LC filter technology series 3407 they feature a smaller footprint.



Products and characteristics

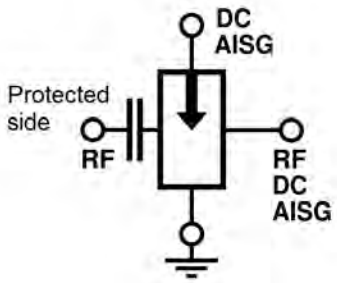
HUBER+SUHNER type	Frequency range	Connectors	RL min.	IL max.	PIM max.	Residual energy typical	Current handling capability (sing./ mult.)
	MHz		dB	dB	dBc	µJ	kA
3400.31.0001	690 – 2700	4.3-10 (m) – 4.3-10 (f), b	24	0.1	–160	11	100/80
3400.41.0266	690 – 2690	7/16 (m) – 7/16 (f), b	28	0.1	–160	11	100/80
3400.41.0267	690 – 2690	7/16 (m) – 7/16 (f), b	26	0.1	–160	11	100/80
3409.31.0001	690 – 2700	4.3-10 (m) – 4.3-10 (f), b	24	0.1	–160	350	30/20
3409.41.0090	690 – 2690	7/16 (m) –7/16 (f), b	28	0.1	–160	350	30/20
3409.41.0092	690 – 2690	7/16 (m) – 7/16 (f), b	26	0.1	–160	350	30/20
3407.41.0051	690 – 2700	7/16 (m) – 7/16 (f), b	23	0.1	–150	0.03	25/20
3407.17.0086	690 – 2700	N (f) – N (f), b	24	0.1	–150 (typ.)	0.01	20/10

Protection of LTE systems

Bias-T` s

To round up the LTE portfolio, HUBER+SUHNER offer Bias-T's with integrated lightning protectors. A Bias-T or DC-injector as it is sometimes called is suitable to „feed-in" or „pick-off" DC current/voltage and AISG signals into or from the feeder cable of a cell site tower installation.

Coaxial Bias-T



Products and characteristics

HUBER+SUHNER type	Frequency range	Connectors Unprotected/protected side* side of bulkhead marked „b".	RL min.	IL max.	PIM max.	Residual energy typical	Current handling capability (sing./mult.)	Fig.
	MHz		dB	dB	dBc	µJ	kA	
3410.41.0038 **	690 – 2700	7/16 (m) – 7/16 (f), b *	26	0.2	–160	20	30/20	1
3410.41.0039 **	690 – 2700	7/16 (f), b – 7/16 (m) *	26	0.2	–160	20	30/20	2

* DC injection port TNC (f)

** AISG compliant for 2.176 MHz carrier

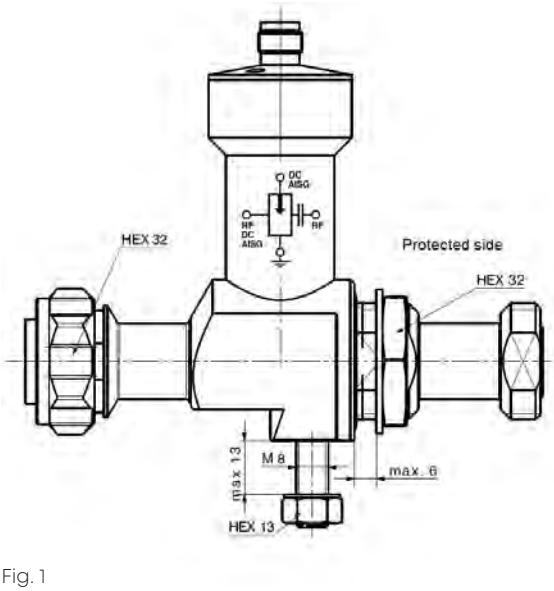


Fig. 1

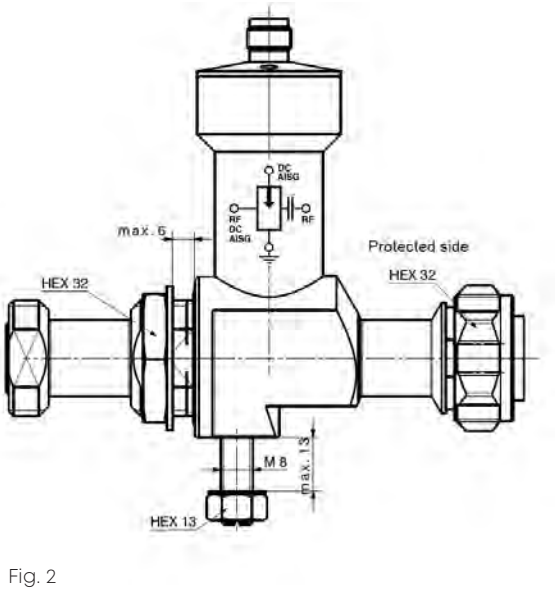


Fig. 2

Protectors for broadband wireless access equipment

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 stub technology 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, 7/16 available
- Optional high-pass functionality for even reduced residual voltages combined with quarter-wave technology
- Aluminium light-weight designs available

HUBER+SUHNER type	Frequency range	Connectors	Mounting/grounding	RL min.	IL max.	Waterproof	Weight
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB		g
3400.17.0426**	2000 – 6000	N (f) – N (f), b	MH170	20	0.2	IP68	94
3400.17.0428**		N (m) – N (f), b					108
3407.17.0085**		N (m) – N (f), b					108
3406.17.0027	DC – 4000	N (f) – N (f), b	MH24				77
3406.17.0028		N (m) – N (f), b					75

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

** Material: aluminium

Frequency spectrum allocations

	Standardisation body	Center frequency
ISM	ITU-R Rec. 5.150	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)

Protection of Point-to-Point or Point-to-Multipoint radio equipment

Highest reliability, lowest risk, fast site approval, reduced maintenance cost

A Point-to-Point (PTP) radio link is a radio communications channel between two distant stations located at specified fixed points. Radio links are commonly used for high data rate con-nections between two or more network points and are popular for many users including fixed and mobile phone operators, broadcasters, public utilities and the emergency services. Some operators use radio links as an economic alternative to leased lines and optical fibre.

PTP or PTM (Point-to-Multipoint) links are all-weather systems and need to perform under worst environmental conditions. System availability is therefore a key parameter.

- With 99.95 % availability: the radio link may fail during 262.8 minutes per year
- With 99.99 % availability: the radio link may fail during 5.26 minutes per year

Radio receivers with high sensitivity are capable to process low level signals but at the same time they are vulnerable to electromagnetic interference such as caused by lightning. That is why lightning/EMP protectors shall be installed.

A complete PTP system consists of an indoor unit (IDU) and an outdoor unit (ODU) which is installed close to the antenna.

The connection between IDU and ODU can be performed in three ways:

A) Digital data stream over twisted pair lines/Ethernet
B) Optical signal over FO cables
C) RF signal over coaxial copper cables

The various Point-to-Point radio link technologies call for different lightning/EMP protection technologies. The table below shows all the protection solutions available from HUBER+SUHNER for the three PTP system technologies:

Solution			
A	**B**	**C**	
Digital data stream over twisted pair	**Digital data stream over glass fiber**	**RF signal over coxial cable**	
		Option 1	**Option 2**
Series 3414 **Data line protectors (Ethernet)**	**Series 9079** **DC power line protectors**	**Series 3401/3402/3406** **GDT protectors**	**Series 3403** **Fine protector with low frequency telemetry band**
			
Choose between: - Cat 5 and - Cat 6 models	Choose between: - type1/class I and - type 2/class II models	Choose between: - 3401 and - 3402 models Semper available	3403.17.0069 - supports 5 to 400 MHz

Protection of Point-to-Point or Point-to-Multipoint radio equipment

Digital data stream over twisted pair lines/ethernet
The data which is supplied on 4 twisted pair wires (8 wires) connected through RJ45 shall be protected. If the DC supply voltage is fed on the same cable (Power over Ethernet standard) the presented protectors will protect the DC lines as well.

For this application we offer data line protectors of the series 3414 that as specified as:

- Cat 5 in channel class D
  (see page 77 in this catalogue, series 3414)
- Cat 6 in channel class E
  (see page 79 in this catalogue, series 3414)
- Both above mentioned products are available as indoor (IP20) and outdoor (IP68) rated
- Both versions support PoE according to IEEE 802.3at

Optical signal over FO cables
Only the DC supply lines shall be protected in this application

We offer products for DC protection as:

- type 1/class I and type 2/class II
  (see page 85 in this catalogue, series 9079)
- both above mentioned products are available wired and ready to use within indoor and outdoor protected boxes

RF signal over coaxial copper cables
Point-to-Point systems realised in RF technology consists of the following components:

- The ODU or outdoor unit
- The IDU or indoor unit
- The coaxial cable which connects the ODU with the IDU

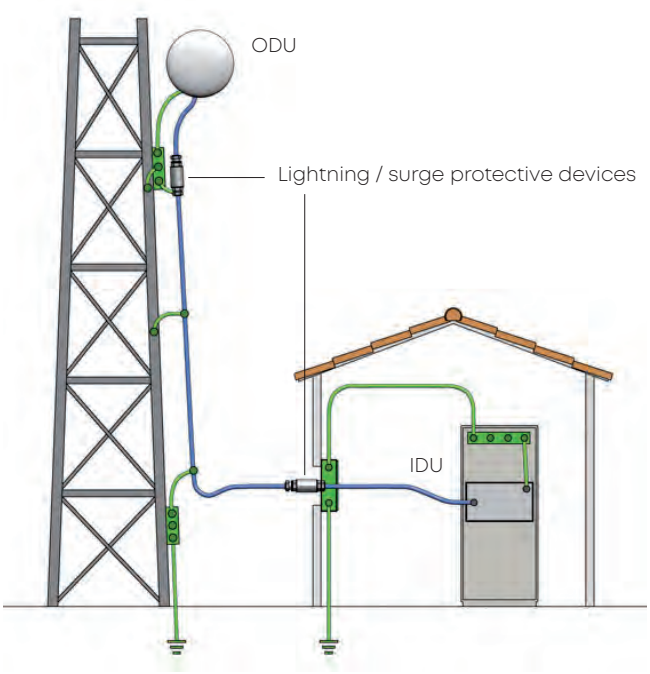
The outdoor unit and indoor unit contains microwave circuitries used to up-convert the baseband signal into an intermediate frequency (IF) and down-convert the microwave signal received by the antenna to IF level.

The RX/TX frequencies in PTP systems vary between 2 GHz to 95 GHz, depending on the purpose of the installed link (distance, amount of data traffic, application).

The conversion of the RX/TX signal to IF frequencies is done in order to reduce the loss in the coaxial link between IDU and ODU. IF frequencies are, depending on the system architecture in the range between 140 MHz and 2000 MHz.

Some PTP systems use additional frequencies between 5 to 25 MHz for the exchange of control/telemetry signals.

Coaxial lightning protectors which support the demanded frequency band shall be installed in front of the indoor and outdoor unit!



In this application we distinguish between two options:

Option 1
Systems with IF between 400 MHz to 2 GHz
For this application customer generally choose the GDT protectors out of the Series 3401, 3402 or 3406. The state of the art products for this category are the GDT protectors with the self-extinguishing GDT function known as Semper.

Option 2
Systems with IF between 140 to 400 MHz and additional telemetry channels between 5 and 25MHz
For this application with IF frequencies and telemetry channels in the low VHF band it is necessary to use the hybrid fine protection technology. The major reason for this is, that the operating frequency is rather near the frequency spectrum of the lightning. As such the higher amount of lightning energy must be diminished by a two stage protector also called fine protector see HUBER+SUHNER type 3403.17.0069 in this catalogue on page 48.

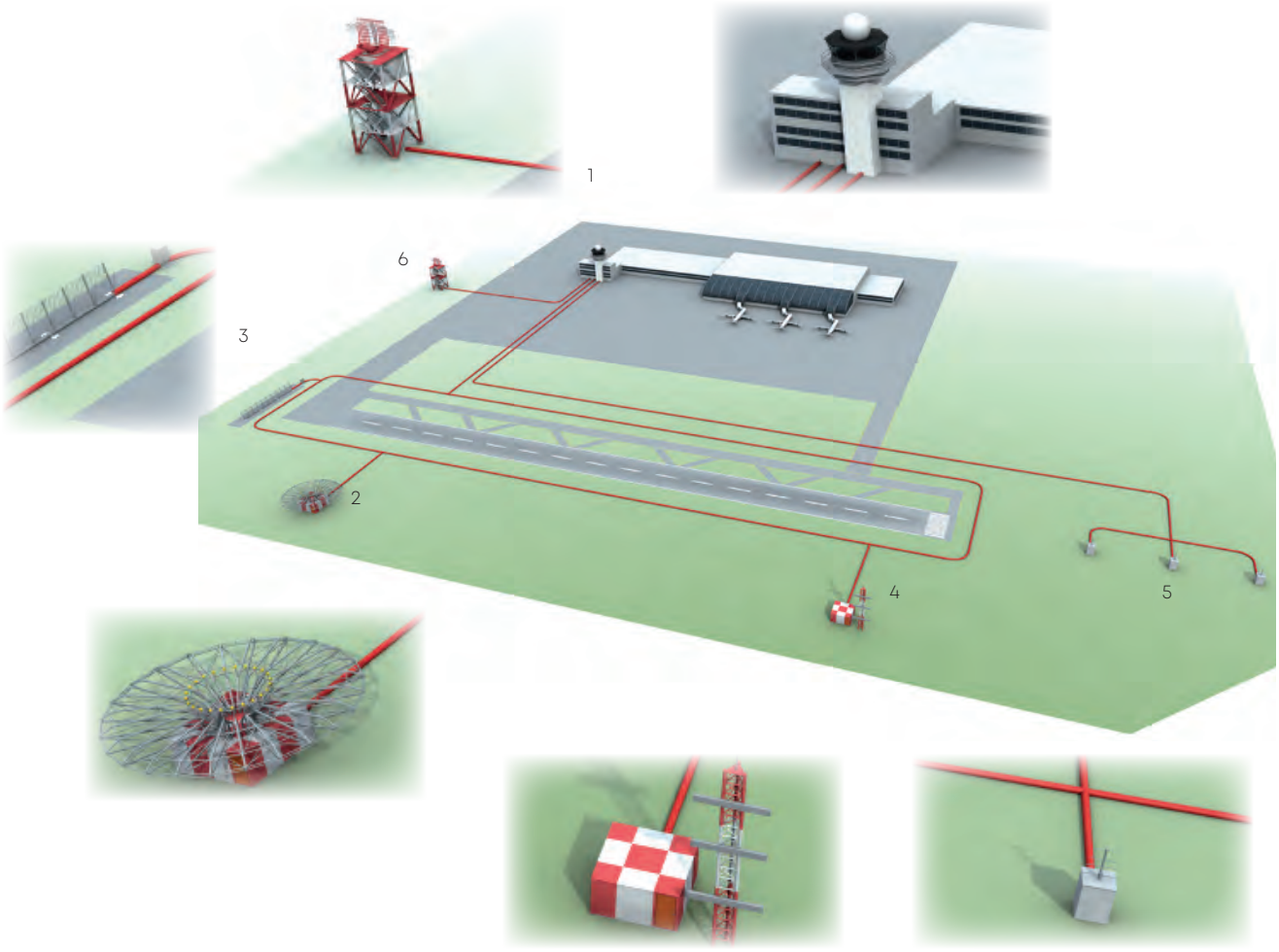
Table of recommended products

Protector series	HUBER+SUHNER type	Frequency range	RF power (CW) max.	GDT stat. spark-over voltage	Connectors	Ingress protection
		MHz	W	V		
Series 3401 GDT protectors	3401.17.0048-EX	DC – 1000	≤ 150	230 *	N (f) - N (f)	IP65
Series 3402 GDT protectors	3402.17.0088 3402.17.0089 3402.17.0072-EX	DC – 2500	depending on GDT	not included ** not included ** 230 *	N (f) - N (f) N (m) - N (f) N (f) - N (f)	IP65
Series 3406 GDT protectors (fix installed GDT)	3406.17.0027 3406.17.0028	DC – 4000	≤ 60	90	N (f) - N (f) N (m) - N (f)	IP65
Series 3403 Fine protector with low frequency telemetry band	3403.17.0069	DC and 5.5 – 400	≤ 100	60 (hybrid: GDT + Diode)	N (m) - N (f)	IP67
Series 3414 Data line protector CAT5 (ethernet)	3414.99.0001 3414.99.0003	DC – 100	n.a.	n.a.	RJ45	IP20 (indoor) IP68 (outdoor)
Series 3414 Data line protector CAT6 (ethernet)	3414.99.0021 3414.99.0022	DC – 250	n.a.	n.a.	RJ45	IP20 (indoor) IP68 (outdoor)
Series 9079 DC power line protectors	9079.99.0001	DC (100 Vmax.)	n.a.	n.a.	screw terminals	IP20 (indoor)

* Pre-installed Semper GDT unit
** Select from catalogue

Protection of air navigation and aeronautical radio communication systems

To protect air navigation and aeronautical radio communication equipment from the destructive effects of lightning, operators of instrument landing systems (ILS) traditionally use gas discharge tube (GDT) protection technology. In aeronautical applications availability and reliability are of utmost importance. It is for this reason that HUBER+SUHNER has developed an attractive lightning protector portfolio which can handle higher lightning currents than the traditionally used GDT protectors and reduce the residual energy at the output of the protective device to only a fraction of that performed by traditional GDT protectors. This technology is known as the «quarter-wave shorting stub» principle.



1 Ground to air communication system
2 VHF Omnidirectional Radio (VOR) or alternatively Distance Measurement Equipment (DME)
3 Localizer (LOC/LLZ)
4 Glide Path (GP)
5 Marker Beacon (MB)
6 Radar (ASR and SSR)

Frequencies of RF/microwaves systems operated on airports

Abbreviation	System name	Frequency range
	Aeronautical Communication Civil	117.95 – 137 MHz
	Aeronautical Communication Military	137 – 420 MHz
GNSS	Global Navigation Satellite System	1200 – 1600 MHz
Equipment for long distance navigation		
NDB	Non Directional Beacon	190 – 1750 kHz
VOR	Very High Frequency Omnidirectional Beacon	108 – 117.95 MHz
DME	Distance Measurement Equipment	962 – 1213 MHz
Equipment for approach navigation		
MB	Marker Beacon	75 MHz
LOC/LLZ	Localizer Transmitter (Runway)	108 – 111.975 MHz
GP	Glide Path Transmitter	328 – 336 MHz
DME	Distance Measurement Equipment	962 – 1213 MHz
SSR	Secondary Surveillance Radar	1030 – 1090 MHz
ASR	Air Surveillance Radar	2700 – 2900 MHz
Alternative navigation system		
MLS	Microwave Landing System	5031 – 5091 MHz

GDT protectors vs. quarter wave shorting stub designs

Comparison of key parameters between the traditionally used gas discharge tube technology of series 3401 and new improved designs of series 3400 and 3407

	Series 3401	**Series 3400**	**Series 3407**
	GDT technology	**Quarter-wave shorting stub technology**	**Quarter-wave shorting stub technology with high-pass filter**
Lightning current handling capability (8/20 µs)	20 kA multiple 30 kA single	50 kA multiple	50 kA multiple
Residual peak voltage Input pulse: 4 kV 1.2/50 µs 2 kA 8/20 µs	650 V (peak)	< 20 V	< 15 V
Residual energy Input pulse: 4 kV 1.2/50 µs 2 kA 8/20 µs	350 µJ	< 5 µJ	< 1 µJ

Lightning protectors for ILS

Gas discharge tube (GDT) protectors
NDBs, Marker beacons, VOR, Localizer, Glide Path and Communication equipment can be protected by means of series 3401 and 3402 GDT protectors. If you decide to use GDT technology we recommend choosing Semper products which you can recognise in the following table at the suffix «-EX»

System	System frequency range	HUBER+SUHNER type	Frequency range of the component	Connectors	Mounting/ grounding	RL min.	IL max.
	MHz		MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB
NDB MB VOR, LOC GP COM	190 – 1750 kHz 75 108 – 117.95 328 – 336 117.975 – 137	3401.17.A*	DC – 1000	N (f) – N (f), b	MH12	26	0.1
		3401.17.C*		N (m) – N (f), b			
		3401.17.0048-EX **		N (f) – N (f), b		24	
		3401.17.0057-EX **		N (m) – N (f), b			
DME	962 – 1213	3402.17.A*	DC – 2500	N (f) – N (f), b	MH25	20	0.2
		3402.17.C*		N (m) – N (f), b			
		3402.17.0072-EX **		N (f) – N (f), b			
		3402.17.0076-EX **		N (m) – N (f), b			

* GDT not included
** 230V Semper GDT unit included

Quarter-wave shorting stub protectors

Benefits
- For higher reliability
- Reduced risk
- Maintenance-free

If you decide to build your air traffic control (ATC) system with highest reliability we clearly recommend to select quarterwave shorting stub protectors out of the following list. These products guarantee multiple lightning current handling capability of 50 kA (8/20 µs) and feature much lower residual voltage and energy when compared with GDT protectors. We offer products which can handle several applications within its operating bandwidth.

System	System frequency range	HUBER+SUHNER type	Frequency range of the component	Connectors	Mounting/ grounding	RL min.	IL max.
	MHz		MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB
MB VOR, LOC COM	75 108 – 117.95 117.975 – 137	3407.17.0022	74 – 180	N (f) – N (f), b	MH74, M8	20	0.15
GP	328-336	3407.17.0023	220 – 450	N (f) – N (f), b	MH74, M8	20	0.1
		3407.17.0053	320 – 512	N (m) – N (f), b	MH12, M8		0.2
MB VOR; LOC GP COM	75 108 – 117.95 328 – 336 117.975 – 137	3407.17.0088	74 – 420	N (m) – N (f), b	MH74, M8	23	0.15
		3407.17.0089		N (f) – N (f), b			
DME	962 – 1213	3400.17.0385	950 – 1450	N (f) – N (f), b	MH25, M8	20	0.1

System	System frequency range	HUBER+SUHNER type	Frequency range of the component	Connectors	Mounting/ grounding	RL min.	IL max.
	MHz		MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	MH – hole for «b» M – screw	dB	dB
DME SSR	962 – 1213 1030 – 1090	3400.17.0385	950 – 1450	N (f) – N (f), b	MH25, M8	20	0.1
SSR	1030 – 1090	3400.17.0254	1000 – 1100	N (f) – N (f), b	MH12	20	0.1
SSR ASR	1030 2700 – 2900	3400.17.0416	1000 – 1100 2700 – 2900	N (f) – N (f), b	MH25, M8	20	0.1
ASR MLS	2700 – 2900 5031 – 5091	3400.17.0410	2000 – 6000	N (m) – N (f), b	M8	20	0.2
MLS	5031 – 5091	3400.17.0235	5000 – 7000	N (f) – N (f), b	MH25, M8	20	0.25

Protection of GNSS systems

The spectrum of applications using signals from GNSS (Global Navigation Satellite Systems) satellites is rapidly growing. We distinguish between navigation, location determination, tracking and timing applications. Many of these GNSS based applications boost the productivity in a wide range of the economy such as construction, mining, surveying, farming or logistical supply chain management. Today's communications networks, power grid systems, and other wireless systems are dependent on GNSS for the exact timing synchronization.

A large number of defense and civil GPS navigation and timing application based on Global Navigation Satellite System (GNSS) and using the GPS, GLONASS, Galileo or BeiDou systems. Many ot these application are of high strategic and vital importance.

All of the above GNSS are working in the two frequency bands between 1100 to 1300 MHz and 1500 to 1600 MHz. While the upper frequency band is dedicated for civil use, the lower band is used for military application which allows to navigate with higher resolution and accuracy.

It is in the nature of navigation installations that the antennas must be installed outdoors with an unobstructed view to the sky. Ideally this will be the case within 360° circumference. Therefore the antenna installations are placed within a zone where one must count with indirect lightning strikes. On the one hand GNSS receivers shall be capable to process small signals, on the other hand this attribute makes such equipment vulnerable against electromagnetic interference. Especially if the GNSS networks are located in areas with severe lightning activity it is advisable to install surge/lightning protectors to dissipate the lightning strike energy and to avoid damaging of the equipment or interrupting the data flow.

Typical installation
Lightning protectors shall be installed in front of active GNSS electronics (active antennas and receivers) which has no protectors built-in.

HUBER+SUHNER offers various lightning/surge protectors designed to protect GPS hardware of which we present typical units in the table below:

HUBER+SUHNER type	Frequency range	Connectors	RL min.	IL max.	Residual energy typ.	Current handling capability (single/multiple)	Fig.
	MHz	Unprotected/protected side* If bulkhead mount version, side of bulkhead marked «b».	dB	dB	µJ	kA	
3402.17.A	DC – 2500	N (f) – N (f)	20.0	0.2	350	30/20	1
3403.17.0050*	620 – 2500	N (f) – N (f)	20.8	0.5	6	30/20	2
3403.17.0060*	800 – 2500	N (f) – N (f)	26.4	0.3	6	20/10	3
3403.26.0002*	800 – 2500	TNC (f) – TNC (f)	26.4	0.3	6	20/10	4

* The series 3403 protectors are designed as a hybrid two stage protector which reduces the residual pulse energy and voltage optimal.

Notes:

1. All of the above protectors are capable of carrying DC supply voltage.
2. 3402.17.A and 3403.17.0050 are equipped with replaceable gas discharge tubes. 3403.17.0060 has a fix installed GDT.
3. A large selection of GPS protectors with different interfaces and various mounting options are presented in the lightning protection catalogue in sections «series 3402 and series 3403».

All dimensions in mm

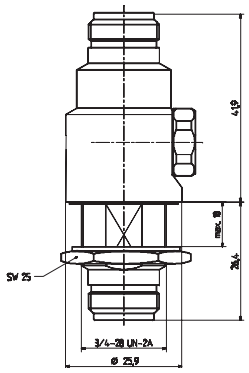


Fig. 1

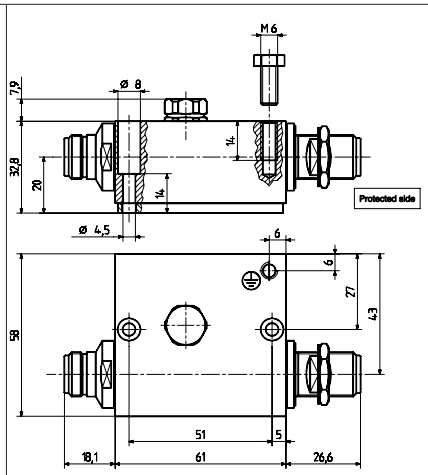


Fig. 2

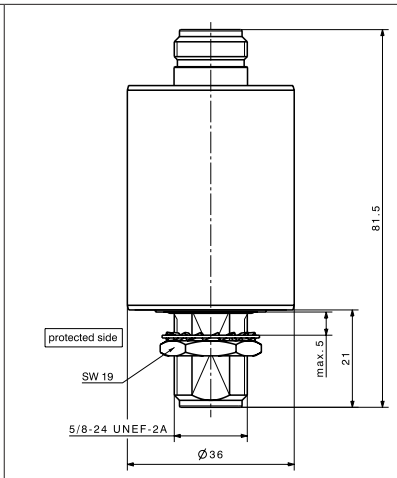


Fig. 3

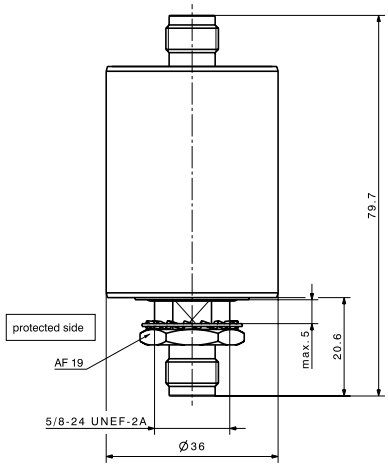
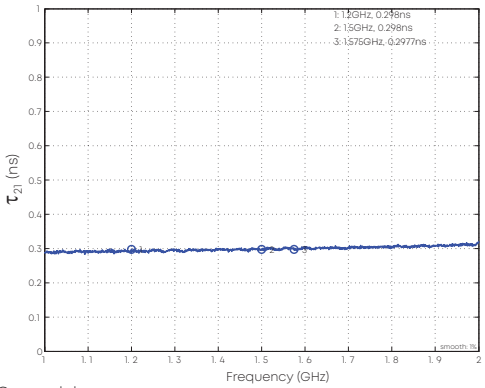


Fig.4

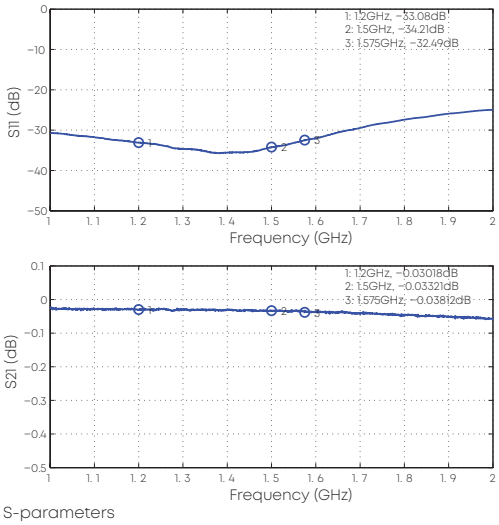
Group delay and S-parameter test results

The phase characteristics as well as the S_{11} and S_{21} parameters are important specifications for components used in GPS systems.

Gas discharge tube protector 3402.17.A

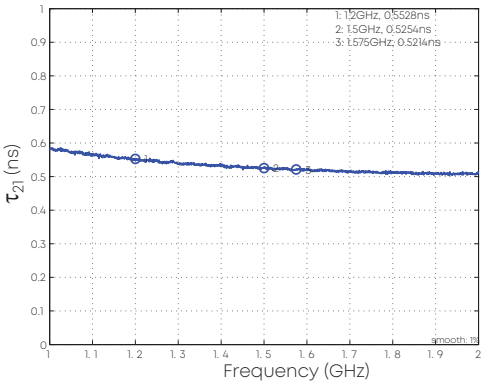


Group delay

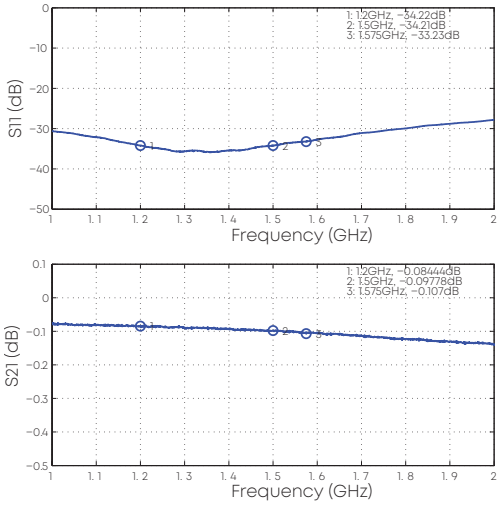


S-parameters

Hybrid fine protector 3403.17.0050

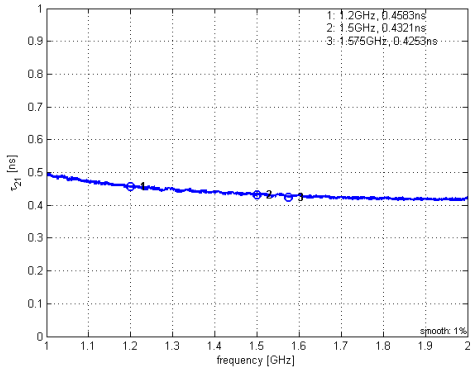


Group delay

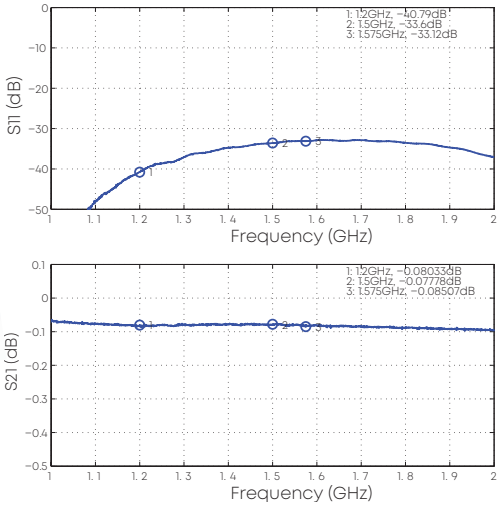


S-parameters

Hybrid fine protector 3403.17.0060 and 3403.26.0002



Group delay

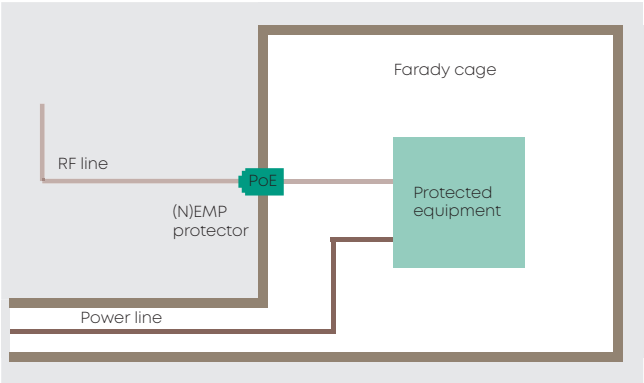


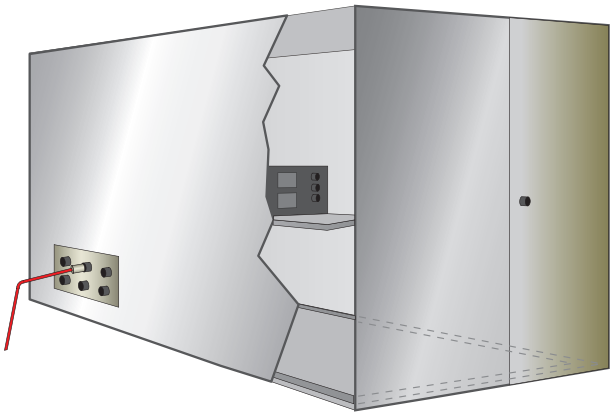
S-parameters

Screening effectiveness and transfer impedance

Installing (N)EMP protection or other feed-through components into shielded rooms, is affecting the rooms screening effectiveness. The negative effects to the shielding performance of the room can be optimised by adjusting the feed through components material and plating to the shielded rooms filter wall.

(N)EMP protected fix installation





To verify the screening effectiveness or screening attenuation and to identify the best possible method to install (N)EMP protectors or other coaxial feed through components HUBER+SUHNER has carried out a series of transfer impedance measurements acc. to IEC 62153-4-10 1. The test series was performed with a combination of different test specimens which simulate various installation approaches, various sample materials with different plating and various installation wall materials. The target was to find the combinations which result in the lowest and most stable transfer impedance

Variation of test specimens and installation wall materials

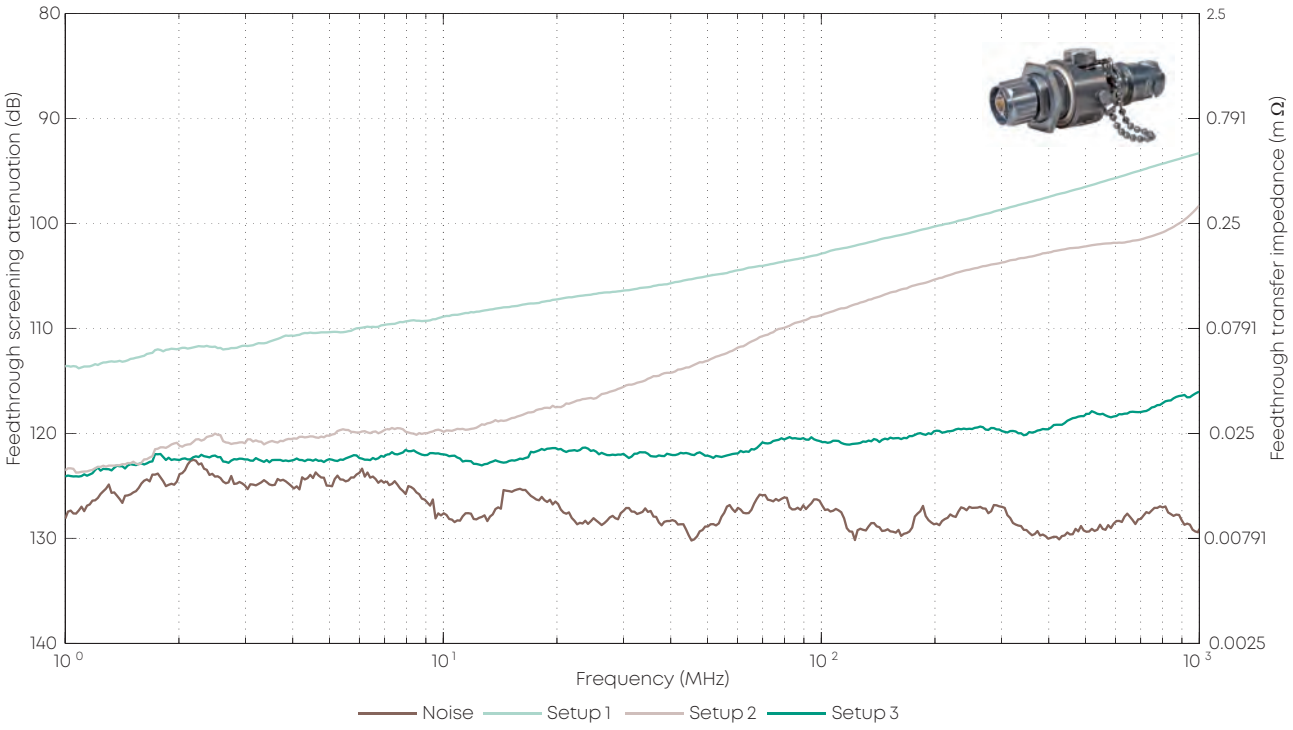
- Feed-through housing materials: brass and aluminium
- Plating materials: SUCOPLATE® 2 , black silver, black chrome , gold, aluminium not plated
- Feed-through designs: 1-hole flange with and without RF sealing (V-groove washer) 4-hole flange
- Wall materials: stainless steel, copper, aluminium

1 EC 62153-4-10 “Metallic communication cable test methods – part 4-10: Electromagnetic compatibility (EMC) – shielded screening attenuation test method for measuring the screening effectiveness of feed-throughs and electromagnetic gaskets double coaxial method”
2 SUCOPLATE® (CuZnSn)

The analysis of the different material combinations shows a wide variation of the measured screening attenuation (effectiveness)

			
	setup 1	setup 2	setup 3
Flange type Washer	4-hole no washer	1-hole no washer	1-hole V-groove washer
Body material Body plating	brass/SUCOPLATE® (trimetal plating: Cu/Sn/Zn)	brass/SUCOPLATE® (trimetal plating: Cu/Sn/Zn)	brass/silver plated
Mounting wall	copper, raw no surface finish	copper, raw no surface finish	copper, raw no surface finish

The direct comparison between the 4-hole flange installation and the 1-hole flange installation (with and without V-groove washer (RFI-gasket)) clearly indicates how poorly the 4-hole flange performs. It also proofs that the mounting principle of the 1-hole flange with additional soft copper V-groove washer (RFI-gasket) supports good screening effectiveness under (N)EMP interference. Such an installation is stable in the long term and guarantees IP65. However, to guarantee good screening effectiveness it is mandatory to install the components with the torque values as specified in the mounting instruction. All tests were executed with a wall surface N7.



Screening efficiency of installations with different flange mounting options on a copper wall

Transfer impedance versus screening effectiveness
It can be seen from the above graph, that there is a direct relation between the measured transfer impedance and the screening efficiency. The table on the right can be used to convert transfer impedance (ZT) into screening efficiency dB, which is often called screening attenuation.

$$|Z_T| = \frac{|Z_0|}{2} \cdot 10^{-\frac{a_s}{20}}$$

$$a_s = 20 \cdot log_{10}\left|\frac{2Z_T}{Z_0}\right|$$

$a_s =$ screening efficiency (dB)

$Z_0 =$ 50 Ω

$Z_T =$ transfer impedance (mΩ)

Screening attenuation (dB)	Transfer impedance (mΩ) - Z_0 50 Ω
45	141
50	79.1
55	44.5
60	25
65	14.1
70	7.91
75	4.45
80	2.5
85	1.41
90	0.791
95	0.445
100	0.25
105	0.141
110	0.0791
115	0.0445
120	0.025
125	0.0141
130	0.00791
135	0.00445
140	0.0025

The screening effectiveness of an installation is calculated by adding the transfer impedances of all existing cable entries. The sum of these transfer impedances can than be converted into the resulting system screening effectiveness of the Faraday cage.

Quantitativ test results

Mounting wall material	**Base material**									
	Brass with platings								**Aluminium**	
	Black silver		**Black chrome**		**SUCOPLATE®**		**Gold**		**Unplated**	
	1 – 99 MHz	100–1000 MHz	1 – 99 MHz	100–1000 MHz	1 – 99 MHz	100–1000 MHz	1 – 99 MHz	100–1000 MHz	1 – 99 MHz	100–1000 MHz
Copper	> 120 dB*	> 115 dB*	> 105 dB	> 100 dB	> 110 dB	> 98 dB	> 120 dB*	> 110 dB*	> 100 dB	> 90 dB
Stainless steel	> 100 dB	> 95 dB	> 105 dB	> 110 dB	> 113 dB*	> 110 dB*	> 95 dB	> 90 dB	> 105 dB	> 110 dB
Aluminium	> 115 dB	> 105 dB	> 113 dB*	> 110 dB*	> 105 dB	> 98 dB	> 105 dB	> 95 dB	> 115 dB*	> 115 dB*

* Max. value

Qualitative test results
Ranking of the tested combinations

Base material	Plating	Contact area	Wall material		
			Copper	Stainless steel	Aluminium
Brass	SUCOPLATE®	 1-hole flange with V-groove washer	✓ ✓	✓ ✓ ✓	✓ ✓
Brass	gold plated		✓ ✓ ✓	✓	✓ ✓
Brass	black silver		✓ ✓ ✓	✓	✓ ✓
Brass	black chrome		✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Aluminium	unplated		×	✓ ✓	✓ ✓ ✓
Brass	SUCOPLATE®	1-hole flange without V-groove washer	×	×	×
Brass	SUCOPLATE®	4-hole flange without V-groove washer	×	×	×

✓ ✓ ✓ excellent material combination
✓ ✓ recommendable combination
✓ only recommended unter certain conditions
× this combination is not recommended for security-relevant systems

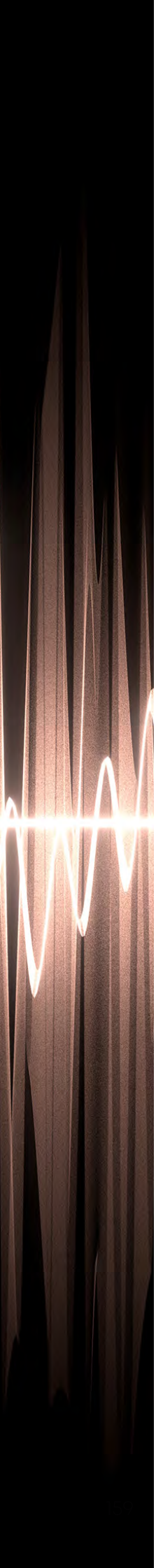
Summary of the transfer impedance measurements

1. Installations with 4-hole flange feed-through components are not recommended.
2. SUCOPLATE® shows the most stable screening effectiveness results to all tested wall materials.
3. The HUBER+SUHNER V-groove washer (RFI-gasket) guarantees high, long-term screening effectiveness.
4. The HUBER+SUHNER V-groove washer (RFI-gasket) guarantees water tightness when mounted on wall material with an N7 surface finish and protect the transition between bulkhead and mounting wall from corrosion.
5. All of the HUBER+SUHNER EMP components and tested combinations comply with 80 dB screening effectiveness as specified in MIL-STD-188-125 part 1 and part 2.

The most important parameters for a good feed-trough screening attenuation are the design of the RF gasket (V-groove washer) and the screw torque. Nevertheless the surface cleanliness of the chassis and the material combination is further important for a low transfer impedance and high screening attenuation of the feed-through.

White paper

More detailed information about the described transfer impedance/screening effectiveness can be found in our white paper DOC-0000446170: «Sreening effectiveness and transfer impedance of (N)EMP protection components in the installed condition».



General information

Selection and Calculation Tool

EMP SELECTION
The EMP SELECTION program is a tool which helps you to find the best suitable surge-, lightning- or EMP protector for the given input parameters.

- The program selects one or more protector families out of a list of nine which fit to the given input data. The selected families are highlighted and gives typical information about:
  Residual energy and residual voltage acc. to IEC 61000-4-5
- Typical PIM level if applicable
- Recommended gas discharge tube (GDT) based on a system VSWR 1.22 : 1

GDT SELECTION
The GDT SELECTION program is a tool which helps you to select the best suitable gas discharge tube (GDT) for the given input parameters.

The program selects the recommended Gas Discharge Tubes out of nine possible GDTs which fits the specific power application.

In addition it lists the peak voltage with a security factor of 1.5, the return loss and the corresponding reflection factor Γ.

HEMP SELECTION

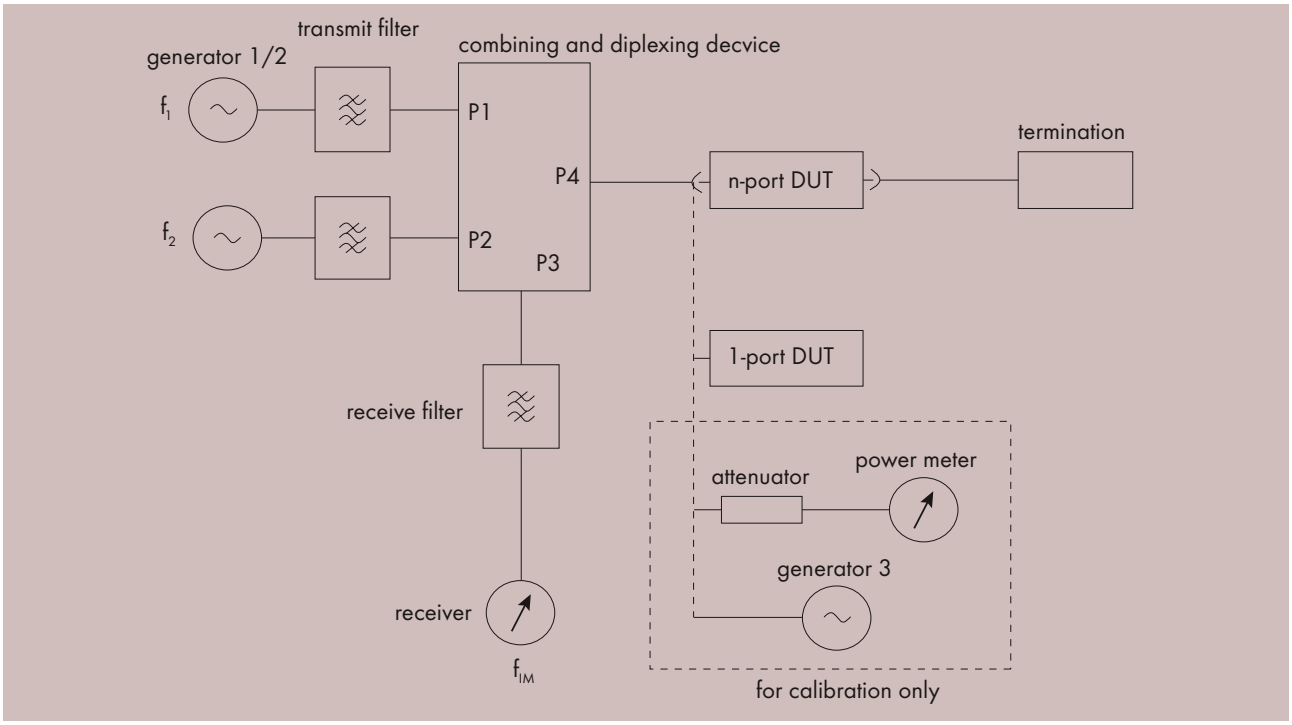
The HEMP CALCULATION program simulates the worst case coupled transient voltage and current of high altitude nuclear pulses (HEMP) into monopole and dipole antennas. The program is working with seven unclassified electromagnetic pulse standards.

The program calculates and plots the selected transient pulse response (voltage/current and energy).

empselector.hubersuhner.com

Passive intermodulation

Measurement of passive intermodulation
The intermodulation (IM) characteristics of lightning EMP protectors are determined in a special, complex test setup described in IEC 62037. It is used for measuring the ratio of the odd orders (3rd, 5th) IM products to the carrier power of 2 x 20 W/2 x 43 dBm, in total 46 dBm.



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

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 Intermodulation Products (IMP)

- Non-linear elements in a signal path, where more than one carrier is applied, generates IMP.
- The occurring spectral lines of the IM products can be described as:

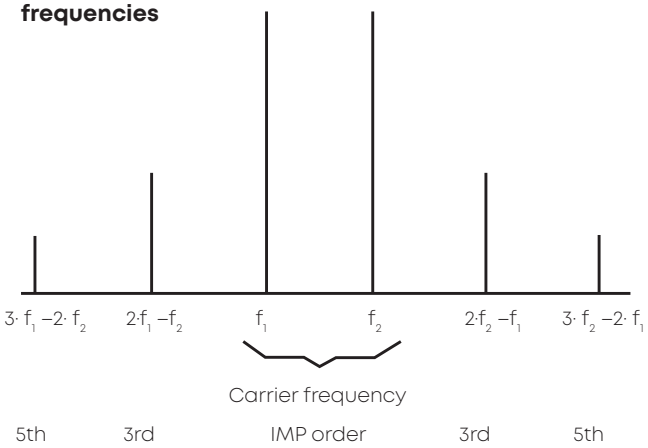
$$fIMP\text{-}O = m \cdot f_1 \pm n \cdot f_2$$

where f_1, f_2 are the used two carrier frequencies
m, n integers
$f_{IMP\text{-}O}$ frequency of one generated IMP of the other O

The other O of IMP-O is driven by the sum of m and n
O = m + n
whereas the odd orders >0

(zero) are only of interest.

IMP spectrum by use of two carrier frequencies



- PIM only occurs in systems where:
  – High transmitter levels
  – Multiple transmit channels
  – High receiver sensitivity
- Absolute linearity exists only as a mathematical idealisation
  – passive elements are all more-or-less slightly non-linear
- 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.

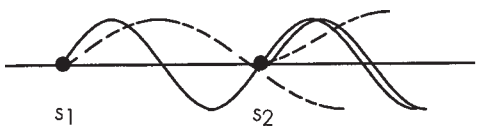
In practice

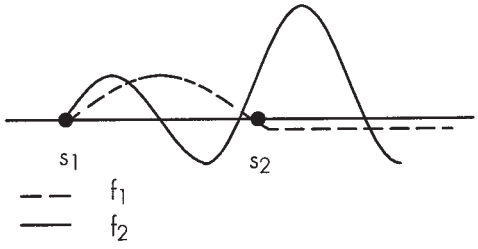
- The PIM level generated over the whole signal path is a result of many PIM sources. The value of the resulting PIM level depends on the phase relation of all these sources (constructive or destructive interference). This phase relation varies with frequency.

IMP of two sources

- 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 acc. IEC 62037.
- All elements in the measurement setup generate PIM. This ground level limits the measurement range typ. –120 dBm.
- Evaluating the PIM level example:
  –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).

Resulting product





Relation between frequency and IM level

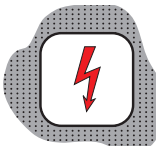
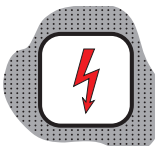
IP rating

Dust and water ingress protection rating (IP)

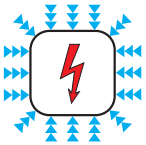
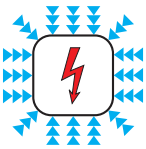
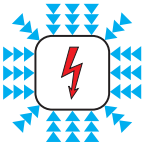
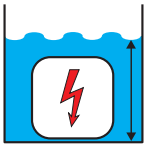
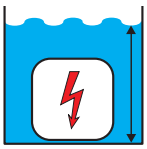
This section is intended to provide a short overview and essentials of the IP classification only. For more details refer to IEC 60529

IP rating, format IPxy

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)

Electrochemical corrosion prevention

Electrochemical potential differences between various materials

When installing and grounding lightning EMP protection devices, consideration shall 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 minimise 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 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 shall 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.

Transition consideration protectors to bulkheads and panels made of 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 equalisation bonding 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 in the following order:

- MIL-STD-202, method 106 (moisture resistance),
- MIL-STD-202, method 101, condition B (salt atmosphere (corrosion)),
- MIL-STD-202, method 106, (moisture resistance).

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

Platings

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® (Cu/Sn/Zn)	0.5 µm (20 µin) over 2.0 mm (80 µin) Ag	2.0 µm (80 µin)

SUCOPLATE® the best–proven outdoor plating over the last 50 years

SUCOPLATE is a copper alloy composed of the three components: copper, tin and zinc. The composition is 55 % copper, 25 % tin and 20 % zinc. Being non-magnetic and non-allergenic (nickel-free), SUCOPLATE is an attractive alternative to nickel plating.

It has a good electrical performance and corrosion resistance. The non-magnetic property in the contact area is also important for obtaining negligible passive intermodulation products (PIM) in communication systems such as base transceiver stations.

SUCOPLATE performs just as well as silver, having a PIM level of less than –155 dBc at a carrier power of 2 × 20 Watts / 2 × 43 dBm.

RF connectors with SUCOPLATE plating meet and even exceed the requirements specified in the international coaxial connector standards MIL-C-39012, IEC 169-1 and CECC 22000. SUCOPLATE provides numerous advantages for contact plating over that of customary silver, tin and nickel based plating materials, including a very attractive finish.

SUCOPLATE offers the following important performance highlights:

- Superior electrical conductivity and low contact resistance
- Non-magnetic
- Excellent passive intermodulation performance equal to silver
- Uniform plating thickness
- High abrasion resistance
- Low surface friction
- Excellent adhesion and ductility (no cracking when bending parts)
- Tarnish-resistant
- High corrosion resistance
- Non-allergenic

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 conventional products of plated brass into question. 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 lightning 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 HUBER+SUHNER 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 shall be protected by means of appropriate measures like taping, coating or sealing, see figure 2 (i.e. wrapping with self-vulcanizing tape).

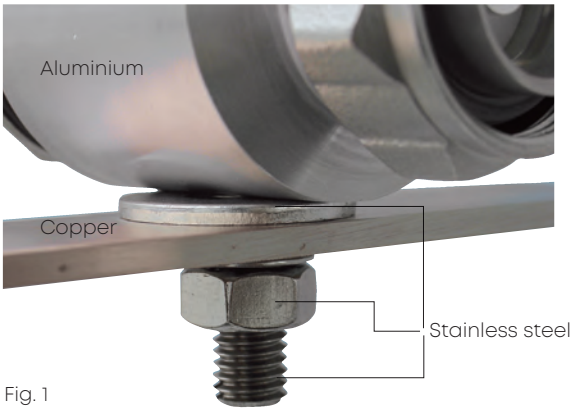


Fig. 1

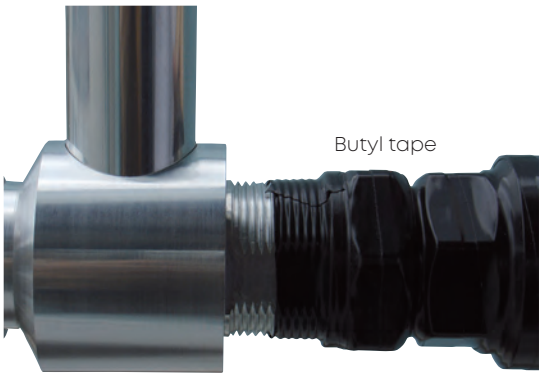


Fig. 2

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

X = not recommended without additional measures as described above.

In order to minimise contact corrosion of metal components in outdoor applications, the difference between the electrochemical potentials of unprotected connections shall not be higher than 300 mV, and for well protected connections not more than 600 mV. Further information can be found in our general mounting and grounding instruction for SPD components mad of aluminium.

Connector interfaces

Series and standards

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. 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: Nm (lb-in)
7/16	IEC 61169-4	25 to 30 (221 to 260)
4.3-10	IEC 61169-54	5 to 8 (44.3 to 70.8)
N	IEC 61169-16, MIL-STD-348/304	0.68 to 1.13 (6.0 to 10.0)
TNC	IEC 60169-17, MIL-STD-348/313	0.46 to 0.69 (4.1 to 6.1)
SMA	IEC 60169-15, MIL-STD-348/310	0.8 to 1.1 (7.1 to 9.7)

* Illustrations on pages 173 – 174

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)
7/16 IEC 61169-4		
	7/16 (m)	7/16 (f)
4.3-10 IEC 61169-54		
	4.3-10 (m)	4.3-10 (f)
N IEC 61169-16 MIL-STD-348/304		
	N (m)	N (f)
QN Quick Lock Formula (QLF)		
	QN (m)	QN (f)

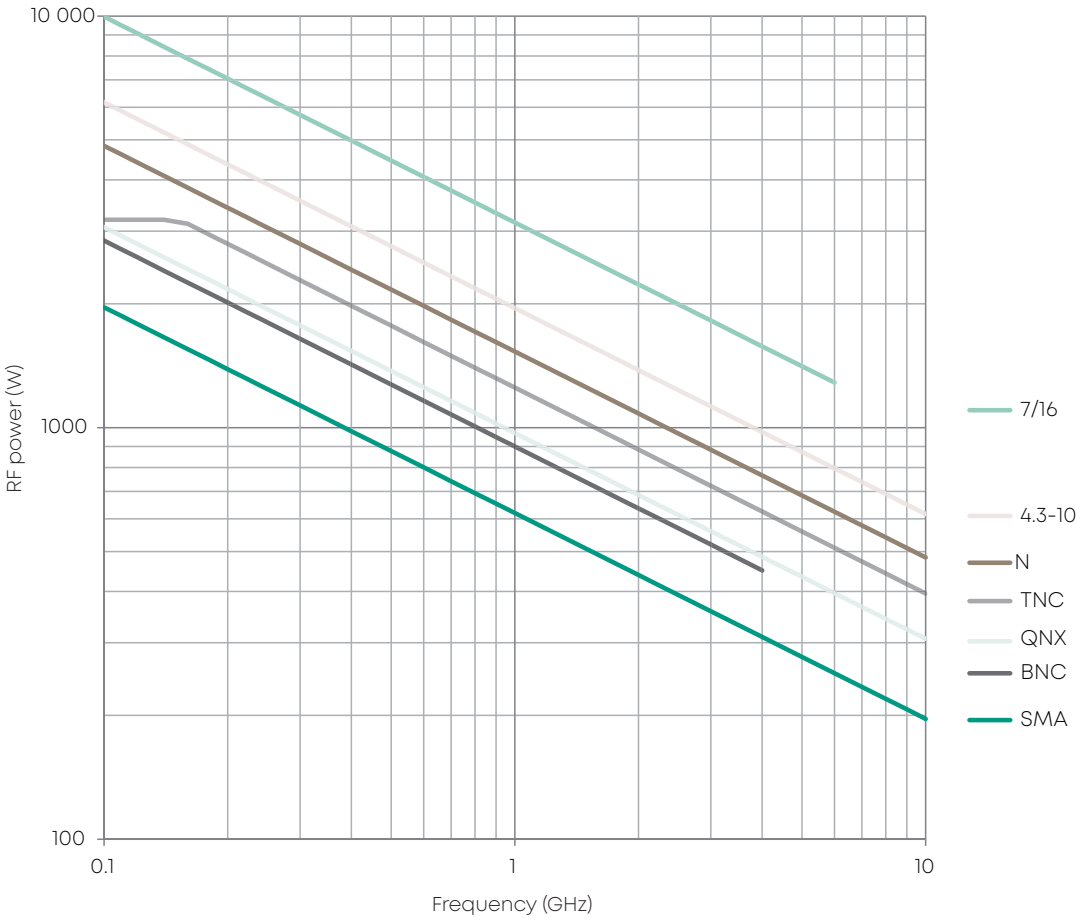
Interface standard	Male connector abbreviation (m)	Female connector abbreviation (f)
TNC IEC 61169-17 MIL-STD-348/313		
	TNC (m)	TNC (f)
BNC IEC 61169-8 MIL-STD-348/301		
	BNC (m)	4.3-10 (f)
SMA IEC 61169-15 MIL-STD-348/310		
	SMA (m)	SMA (f)
F IEC 61169-24 ANSI/SCTE 02		
		F (f)

RF power and DC current ratings

Valid for coaxial interface only! RF power or DC current reductions are caused by several specific protector properties or configurations – e.g. DC injection circuitry, gas discharge tube and others, see product detail specification.

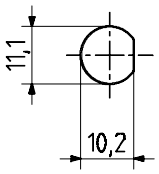
Admissible RF power at 50 Ω for VSWR 1.0:1 at 25 °C ambient temperature and see level

	RF power							DC current
Interface	**W**							**A**
7/16	9961	5751	3765	3320	2348	2124	1917	20.0
4.3-10	6166	3560	2331	2055	1453	1315	1187	14.0
N	4838	2793	1829	1613	1140	1032	931	10.0
TNC	3200	2282	1494	1318	932	843	761	8.0
QN	3067	1771	1159	1022	723	654	590	10.0
BNC	2846	1643	1076	949	671	607	548	8.0
SMA	1961	1132	741	654	462	418	377	6.3
	0.1	0.3	0.7	0.9	1.8	2.2	2.7	
	Frequency (GHz)							



Mounting holes

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



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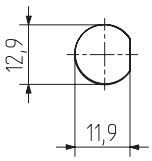

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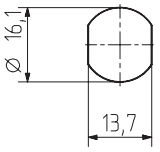

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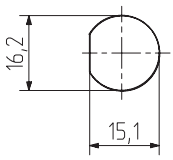

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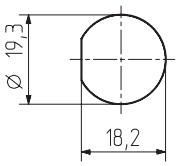

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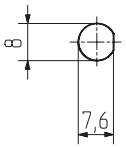

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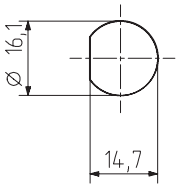

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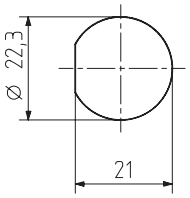

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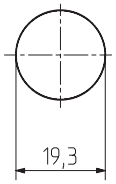

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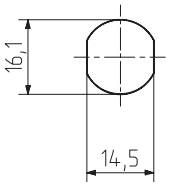

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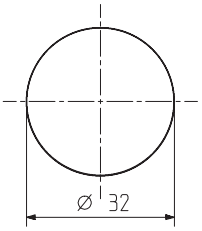

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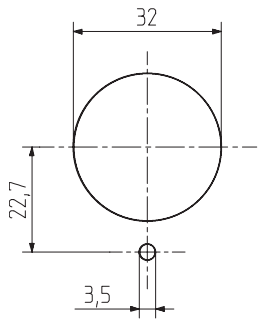

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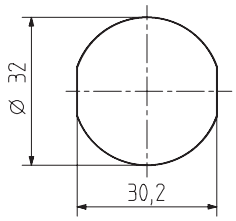

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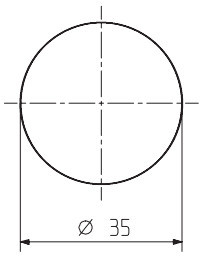

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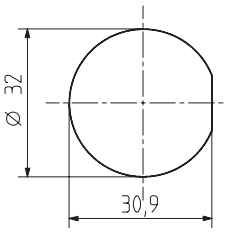

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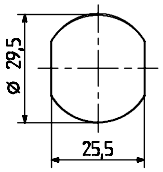

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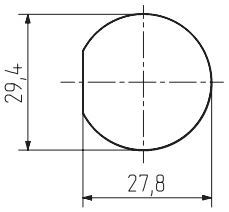

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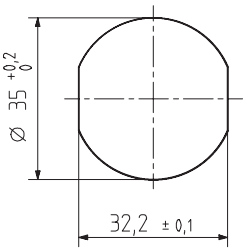

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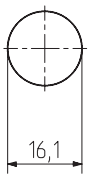

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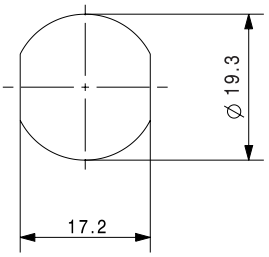

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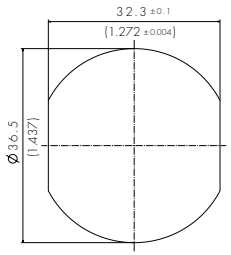

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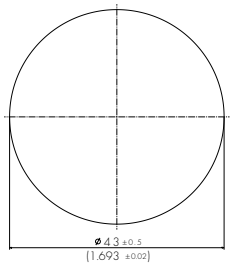


MH181

Certificates and references

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/ISO 14001, which has to 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/ISO 14001 is amply proved by a large number of successfully passed customer audits.

SQS

Certificate

SQS herewith certifies that the company named below has a management system which meets the requirements of the standards specified below.

HUBER+SUHNER AG
9100 Herisau
Switzerland

Certified area

Whole company in Herisau AR and Pfäffikon ZH

Field of activity

Components and systems for electrical and optical interconnection applications in the fields of Communication, Industry and Transportation

Standards

ISO 9001:2008 Quality Management System
ISO 14001:2004 Environmental Management System

Swiss Association for Quality and Management Systems SQS
Bernstrasse 103, CH-3052 Zollikofen
Issue date: November 15, 2012

This SQS Certificate is valid up to and including November 14, 2015
Scope numbers 14, 17, 19, 21
Registration number: 15683

X. Edelmann, President SQS

R. Glauser, Managing Director SQS

Partner of IQNet

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
- General Dynamics
- Harris
- Hensoldt
- Motorola
- Nokia Siemens Network
- NSN Nato Stock Number or National Stock Number
- Samsung
- Thules

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.

Compliancy to CE, RoHS

CE conformity
HUBER+SUHNER lightning EMP protectors comply with legal regulations, as stated in the European Union Directive, low voltage (LVD). 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.

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 2011/65/EU 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.

Warranty

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.

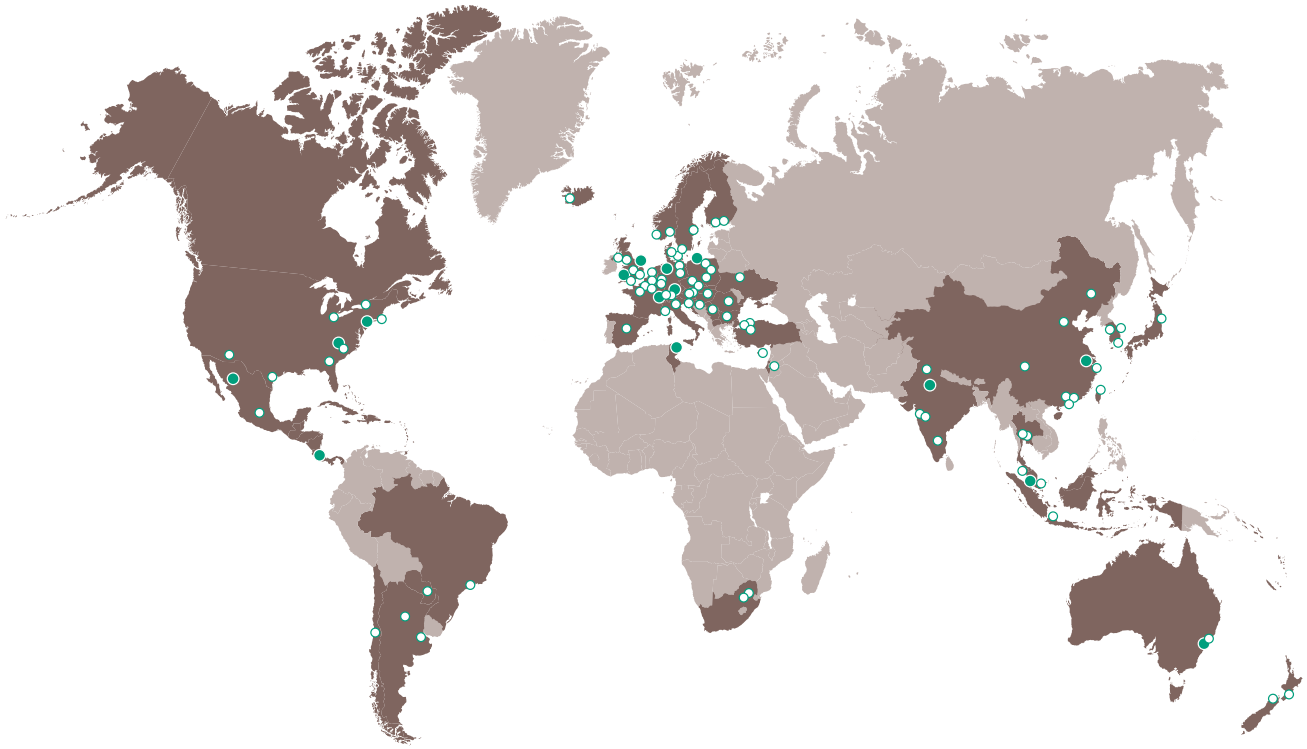
Buyer's sole remedy and manufacturer's sole obligation in the event of any breach of this warranty due to a failure of lightning protection is limited to the repair or the replacement of the damaged lightning EMP protector or to the refund of its purchase price, at the sole discretion of the manufacturer.

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 Radio Frequency 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.

HUBER+SUHNER presence

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 world-wide HUBER+SUHNER distribution network.



● Countries with HUBER+SUHNER representation ○ Sales locations ● Production plants

Non-standard inquiries

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

Frequency bands and services

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

NDB, Non Directional Beacon	190 – 1750 kHz	
MB, Marker Beacon	75 MHz	
VOR, Very High Frequency Omnidirectional Beacon	108 – 117.95 MHz	
LOC/LLZ, Localizer Transmitter	108 – 111.975 MHz	
PMR, Paging	146 – 174 MHz	
GP, Glide Path Transmitter	328 – 336 MHz	
TETRA, TETRAPOL, Terrestrical Trunked Radio	380 – 512 MHz	
LTE, Long Term Evolution	698 – 960 MHz 1710 – 1990 MHz 1920 – 2170 MHz	2100 – 2500 MHz 2500 – 2690 MHz
GSM 850, Global System for Mobile	824 – 894 MHz	
GSM 900, Global System for Mobile	890 – 960 MHz 880 – 960 MHz 876 – 960 MHz	P–GSM E–GSM R–GSM
TACS (N+E), Total Access Communication System	860 – 949 MHz	
TETRA, Terrestrical Trunked Radio	870 – 925 MHz	
DME, Distance Measurement Equipment	962 – 1213 MHz	
SSR, Secondary Surveillance Radar	1030 – 1090 MHz	
IFF, Identification Friend or Foe	1030 MHz	
GNSS, Global Navigation Satellite System	1215 – 1240 MHz	1559 – 1610 MHz
GPS L1, Global Positioning System	1575.4 MHz	
GPS L2, Global Positioning System	1227.6 MHz	
PDC	1429 – 1501 MHz	
GSM 1800	1710 – 1880 MHz	DCS 1800
GSM 1900	1850 – 1990 MHz	DCS 1900
DECT, Digital Enhanced Cordless Telephone	1880 – 1900 MHz	
UMTS, Universal Mobile Telecommunication System	1885 – 2200 MHz	
WCDMA/TD-SCDMA	1850 – 2025 MHz	
ISM, Industrial, Scientific, Medical radio frequency band	2400 – 2500 MHz	5725 – 5875 MHz
WLL (IEEE 802.11), Wireless LAN	2400 – 5825 MHz	
ASR, Air Surveillance Radar	2700 – 2900 MHz	
MLS, Microwave Landing System	5031–5091 MHz	

Glossar

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

BeiDou
Chinese Navigation Satellite System – operation frequencies – 1207.14, 12568.52 and 1561.1 MHz

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 dia-meter 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)

DO-160
Environmental Conditions and Test Procedures for Airborne Equipment

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 1 kV/µs (U_{Zdyn})

E

E1
Early time of the HEMP

E2
Intermediate time HEMP

E3
Late time HEMP (also known as MHDEMP)

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

FTTA
Fibre-to-the-antenna

G

Galileo
European Satellite Navigation System – operation frequencies 1176,45, 1207,14 and 1575,42 MHz

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
Globalnaya Navigationsionnaya Sputnikovaya Sistema is a Russian Aerospace Defense Force operated satellite-based navigation system – operatin frequences – 1204.7, 1246 and 1602 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 (GPS, GLONASS, Galileo and BeiDou)

GPS
Global Positioning System (US military-operated positioning system – operation frequencies 1176.45, 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

HEMP
High attitude Electromagnetic Pulse (EMI caused by nuclear explosion)

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)
Non-linear characteristics of RF devices cause undesirable signals by modulation effects in the case of several carriers being transmitted

Impedance (characteristic, Z0)
Nominal impedance of an RF device

Impulse discharge current (I_s)
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 defi-nition of 8/20 µs (T_1/T_2: T_1 – front time, T_2 – time to half value).

IMT-2000
International Mobile Telecommunication 2000
(1885 to 2025 MHz and 2110 to 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

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

MHDEMP
Magnetohydrodynamic EMP

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_{SC}).

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.

NEX10
Miniature Low PIM RF coaxial connector

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)

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

PIP
Peak Instananeous Power

PIM
Passive Intermodulation

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.

PTTA
Power-to-the-antenna

PTM
Point-to-Multipoint

PTP
Point-to-Point

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

RTCA
Radio Technical Commission for Aeronautics

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 $W/R = \int i^2L \cdot dt$ (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, non-magnetic 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 $Q = \int iL \cdot dt$ (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 a 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

NATO registered protectors

NATO codification system

The NATO Stock Number (NSN) is a 13 digit number and is divided into 3 parts:

- The first part (4 digits): are the NATO Supply Classification Code and relate the item to the group and class of similar items:
  e.g. 5920: 59 for Electrical and Electronic Equipment Components and 5920 Fuses, Arrestors, Absorbers and Protectors.
- The middle part (2 digits): indicate the NCB assigning the NSN:
  country code: e.g. 00/01 for USA, 12 for Germany, 13 for Belgium, 14 for France, 15 for Italy, 17 for Netherlands, 23 for Greece, 33 for Spain, 66 for Australia, 99 for UK
- The final part (7 digits): of the NSN do not have inherent significance. However, the number is assigned to one and to only one Item of supply within the codifying country.

NATO Stock Number (NSN)		
e.g. 5920-12-310-6281		
5920	12	310-6281
NATO Supply Classification Code (NSC)	NATO Code for National Codification Bureau (NCB)	Non significant number
	12-310-6281	
	NATO Item Identification Number (NIIN)	

References of listed protectors with a NATO Stock Number

NSN	HUBER+SUHNER type	Description
5915-13-120-6191	3401.00.0022	50 Ohm, 1 GHz, N (f) – SMA (f)
5920-12-325-4220 5935-99-110-3099 5920-17-106-6384	3401.01.A	50 Ohm, 1 GHz, BNC(f) – BNC(f)
1450-23-113-7610 5920-12-338-0883	3401.02.A	75 Ohm, 0.4 GHz, BNC(f) – BNC(f)
5820-99-726-4346 5920-17-100-7884 5920-66-127-4034	3401.17.A	50 Ohm, 1 GHz, N(f) – N(f), with chain
5920-01-485-4062	3401.17.C	50 Ohm, 1 GHz, N(m) – N(f)
5920-25-134-3502	3401.18.A	75 Ohm, 1 GHz, N(f) – N(f)
5920-17-113-6448 5920-66-138-2463	3401.26.A	50 Ohm, 1 GHz, TNC(f) – TNC(f)
5920-01-615-2087	3402.17.0043	50 Ohm, 2.5 GHz, N(m) – N(f)
5920-99-773-3078 5920-17-105-4779 5920-01-421-4919	3402.17.A	50 Ohm, 2.5 GHz, N(f) – N(f)
5920-01-461-3214 5920-12-330-1428	3402.17.C	50 Ohm, 2.5 GHz, N(m) – N(f)
5920-12-356-2540	9071.99.0447	Gas discharge tube with holder, 230 V
5920-12-356-2327	9071.99.0448	Gas discharge tube with holder, 90 V
5920-66-155-7685	9071.99.0449	Gas discharge tube with holder, 350 V
5920-66-155-7686	9071.99.0450	Gas discharge tube with holder, 470V
5920-12-356-2328 5920-14-542-1015	9071.99.0451	Gas discharge tube with holder, 600 V
5920-01-597-6253 5920-12-371-9741 5920-66-155-7687	9071.99.0547	Gas discharge tube, 230 V
5920-01-565-8253	9071.99.0548	Gas discharge tube, 90 V
5920-66-155-7688	9071.99.0549	Gas discharge tube, 350 V
5920-66-155-7689	9071.99.0550	Gas discharge tube, 470 V
5920-66-156-1512	9071.99.0647	Gas discharge tube, 230 V; self-extinguishing
5895-01-624-3840	9078.17.0013	Limiter, 0.1 – 32 MHz

Type index

Series 3414

Protective caps

Gas discharge tube

Accessories for 3414 data line protectors

Mounting screw set

Bulkhead mounting set

Blanking plugs

Grounding rings

Mounting brackets

Grounding kits

High voltage DC blocks

DC Overvoltage protection

How to select the right protector

Important decision criteria

To find the most appropriate lightning EMP protector we guide you through the following list of criteria to evaluate the specific application requirements.

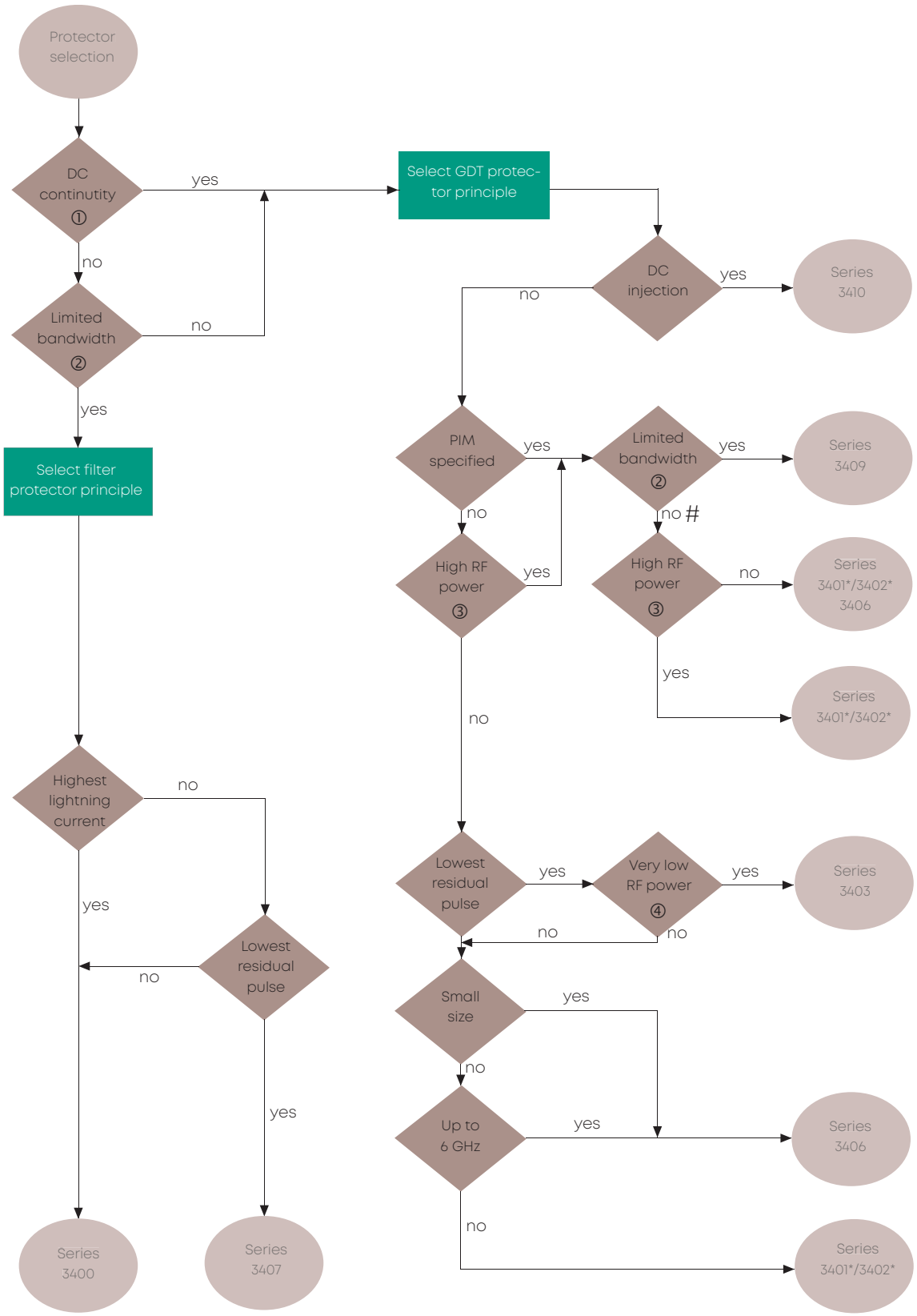
The first four evaluation criteria items are the most important

- DC continuity for powering of remote equipment
  - DC supply voltage
- Frequency range
  - operating band
  - AISG band
  - telemetry band
- Passive intermodulation requirements
- RF power maximum
  - continuous wave
  - peak power
- Protection requirements
  - surge current handling capability
  - residual pulse energy/voltage
- RF requirements
  - return loss (RL)
  - insertion loss (IL)
- Connector interfaces
- Mounting/grounding requirements
  - bulkhead mount
  - screw mount
- Environmental requirements
  - IP rating
- Material requirements
- Selection of the gas discharge tube for GDT lightning EMP protectors according the RF power

These criteria shall be considered with the provided selection flow chart next page. Product details are listed in this catalogue and further information can be found on the related product detail specification/data sheet.

For any support contact HUBER+SUHNER, hubersuhner.com or your local representative.

Selection flow chart for HUBER+SUHNER lightning/EMP protectors



Notes

1	DC continuity	DC can be supplied on the centre conductor for remote powering
2	Limited bandwidth	no broadband operation only specific frequency bands can be transmitted
3	High RF power	application with more than 1 kW (CW) transmission power
4	Very low RF power	application with less than 50 W (CW) transmission power

\# No protector solution available featuring broadband operation and low PIM

* Specific GDT has to be selected according to the transmitted RF power and DC supply voltage

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4036/4743/04.2023

HUBER+SUHNER is certified according to EN(AS) 9100, ISO 9001, ISO 14001, ISO/TS 16949 and IRIS.