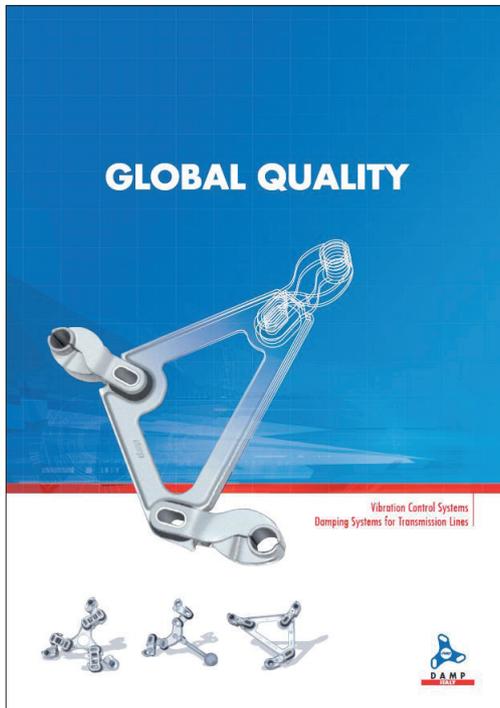


Spacers and spacer dampers

Remark	132
General	132
Material	135
Spacers	135
Spacer damper aluminium, for horizontal twin bundles	138
Spacer damper aluminium, for vertical twin bundles	138
Spacer damper aluminium, for triple bundles	139
Spacer damper aluminium, for quadruple bundles	139
Spacer Aluminium, casted, for twin bundles	140
Spacer aluminium, forged, for twin bundles	140
Spacer aluminium, forged, for triple bundles	141
Spacer aluminium, forged, for quadruple bundles	141
Flexible spacer with neoprene insert	142
Rigid spacer for jumper loop, for twin bundles	143
Rigid spacer for jumper loop, for triple bundles	144
Rigid spacer for jumper loop, for quadruple bundles	144



Remark

Mosdorfer offers a full range of Spacers and Spacer Dampers for bundled lines, including products from vibration control specialist's **DAMP s.r.l.** (www.damp.it) a wholly owned Mosdorfer GmbH company (www.mosdorfer.com) and fully integrated into the Knill Energy group based in Austria (www.knillgruppe.com). By combining years of expertise, long term service and reliability, we offer a full range of spacers and spacer dampers for all types of bundle configuration and conductor applications. DAMP s.r.l. damping products are globally recognised and leaders in Overhead Line Vibration control.

Our full range of spacers and spacer dampers, including **rigid and semi flexible types** complete our catalogue range.

General

Overhead line spacers add reliability and protection to the conductor bundle, by separating conductors preventing clashing under operating conditions. To provide this protection, it is necessary to install the correct number of spacers precisely positioned within each span. The spacing system protects the conductors from high wind and ice loadings by preventing sub-conductor clashing within the span. Spacers have controlled flexibility to also withstand high short circuit currents loads in compression and tension, to protect both conductors and spacers from damage.

For both single and bundled conductor systems, wind induced vibration can occur. On bundled systems, flexible spacers are recommended. Where high level system protection is required, spacers with energy absorption capabilities (damping elements) are recommended =

spacer dampers.

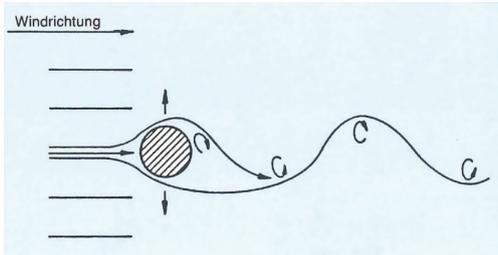
On tensioned overhead conductors, wind flow leads to high-frequency vibrations, with amplitudes in the magnitude of one conductor diameter. This is caused by vortex shedding, which excites the conductor into Aeolian vibrations at right angles to the wind direction. Aeolian vibration occurs at wind velocities of approximately 1-7m/s causing vibration frequencies of 5-100 Hz dependent on conductor diameter and tension.



High-voltage line with spacer dampers



Short circuit test made on spacer dampers

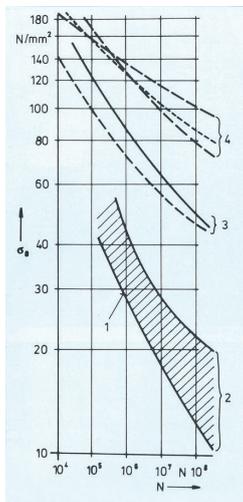


Wind induced vibrations vertical to the wind flow

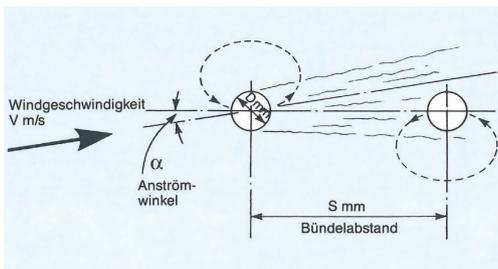
These vibrations will lead to internal conductor fatigue stress at suspension and tension fittings, applying compression and bending loads at conductor support points. As vibration increases, higher tensile loads are applied. Line routes along flat terrain or spanning valleys require higher levels of protection, particularly where prevailing wind directions are perpendicular to the line route.

Fatigue stresses will damage the conductor, causing strand breakage and cable failure. Insulator string ball fittings and turnbuckles are particularly at risk due to their specific shapes.

For conductor bundle tension and support fitting protection, spacer dampers offer a level of protection that reduce stresses within the system to safe operating levels, protecting long term fatigue failures during the operational life of the network.

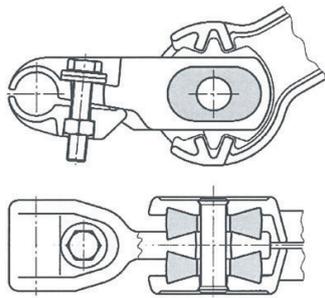


Safe border line for an Al-alloy cable



Subconductor vibration

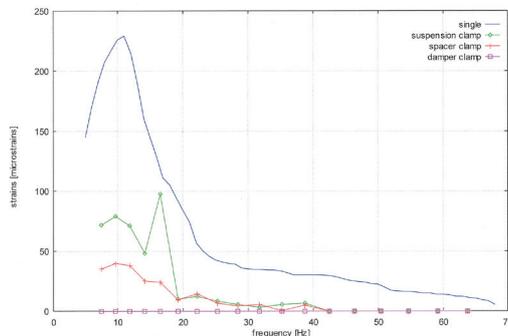
As well as higher frequency vibrations, lower frequency sub-conductor vibrations are also present. These occur at wind velocities of approx. 4-18 m/s and move conductors towards one another at frequencies ≤ 5 Hz. The spacing system also provides protection against sub-conductor clashing at these lower frequency-higher amplitude vibrations.



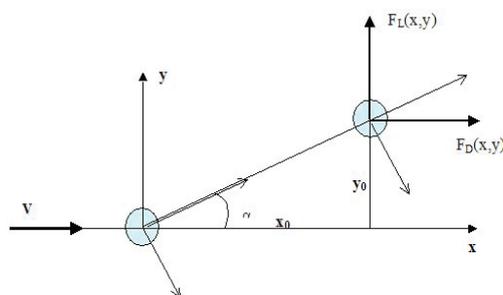
Arrangement of the damping elements

Spacer dampers consist of conductor clamps, a connecting frame with damping elements. These elements are manufactured from highly elastic macro-molecular elastomers with high energy absorption properties that damp harmful vibrations. These elements also provide the necessary flexibility and stiffness in all directions of installed conductor movement and motion.

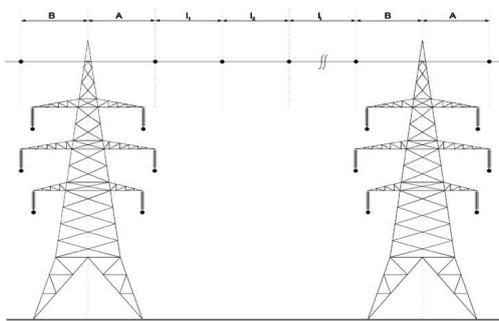
SPACERS AND SPACER DAMPERS



Simulation of a vibration



Mechanism of bundle conductor vibrations



Installation distances of spacers



Vibration recorder

Computational programs

Mosdorfer and DAMP have developed computational programs for all bundle configurations for high-frequency aeolian vibrations (Karman vibrations) including subconductor vibrations. For high-frequency vibrations, maximum bending stresses at the clamp outlet and fastening points of spacers will be calculated depending on the frequency. The use of Stockbridge dampers can also be considered and integrated into calculations. These computations are based on the principle of energy balance. According to this principle, energy fed by wind will be withdrawn from the system by the self-damping power of the conductors and damping of the spacer dampers. The principle of energy balance also forms the basis for calculating the bundle conductor vibrations caused by coupling of the conductor that is in the wake. Coupling will lead to instabilities of the so-called "flutter type". The dynamic bending stresses, forces and rotation of the spacer clamps will be calculated. The system also calculates bundle separation of spacers, which avoids higher stress caused by possible resonance within the span.

Field measurements on existing overhead lines

Existing vibration measurements from existing lines contain valuable data for making vibration studies.

Mosdorfer - DAMP are active making field measurements, which assist with system life expectancy calculations. By using these measurements, (each taking approximately 3 months), combined with conductor self damping tests in Mosdorfer own laboratory, our recommendations can be optimised to offer economic solutions for system protection.

Material

Spacers are made of very different materials, high-grade cast aluminium are preferred for frames and clamps.

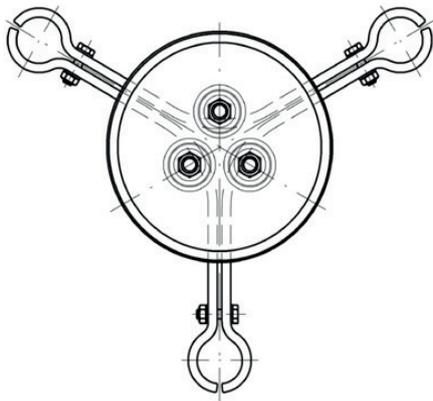
Some spacer bodies are also partly forged. For clamps, high-strength screws with or without shear head huts are mostly be used.

Damping element elastomers have high fatigue life, resistant to UV and ozone attack with high energy absorption properties.

High temperature resistant elastomer clamp liners can be specified for conductor temperatures $\leq 235^{\circ}\text{C}$.

All products are manufactured in accordance to IEC 61854 - Overhead lines - Requirements and tests for spacers - and special customer requirements. This includes high corona resistant clamps for ultra- high system voltages.

We offer many product variants adapted for specific customer requirements. Our standard range only is included within the catalogue. Examples of other types are described in detail below:



Rigid spacers for jumpers with counterweights

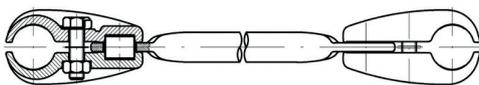
Spacers

Rigid spacers for jumpers for vertical and horizontal twin bundles

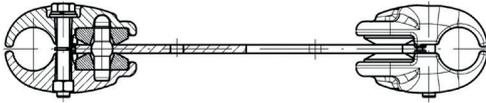
Where conductor connections are short, it is not always necessary to use more expensive flexible spacers. This type is also available for triple and quadruple bundles shown in the Tables. Other designs are also available. Rigid spacers for jumper loops are often equipped with counterweights to create tower clearance. These variants can be used for all bundle configurations.

Flexible spacers for horizontal and vertical twin bundles with bodies made of aluminium (System LORÜNSER)

These spacers are made of moving clamp bodies connected by means of a spacing piece. The clamp bodies are guided over steel bolts and are free to move in one direction. To provide the optimum bolt connection, the bore in the link is equipped with a stainless sleeve for high durability.



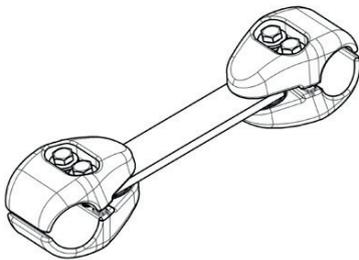
Flexible spacer



Flexible spacer with Neoprene washers

Flexible spacers with neoprene washers for horizontal and vertical twin bundles.

These spacers are made of moving clamp bodies connected by means of a spacing piece. The clamp bodies are guided over steel bolts and are free to move in all directions. Neoprene washers fixed between the body and clamps have some damping effect preventing noise. To protect the conductors, neoprene washers are shaped to reduce connecting stresses during bundle movement.



Flexible spacer for big conductors

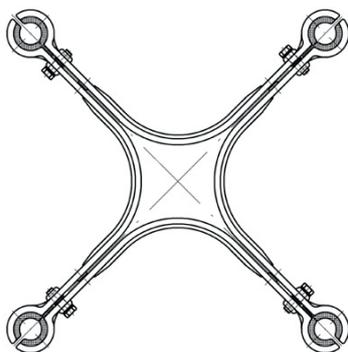
For big conductors and assemblies using heliformed rods, a double bolt clamp type is available.



Spacer with neoprene inserts for a twin bundle

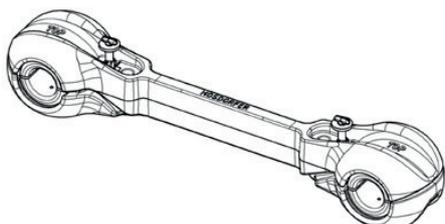
Spacers with neoprene inserts

These spacers are made up of two frames with electrically semi-conducting neoprene inserts, linked by a hinge and fixed to the frames. They have no moving parts avoiding damage by vibration.



Forged spacer for a quadruple bundle

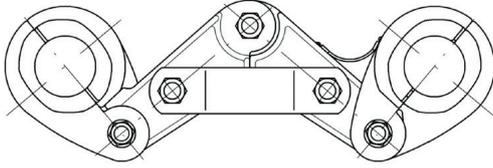
Movements between conductors are absorbed by the neoprene inserts. Alternatively, spacers can be equipped with equipotential bonding. The types with forged aluminium bodies are available for twin, triple and quadruple bundles. The cast version is available for twin bundles.



Spacer with a hinge type clamp

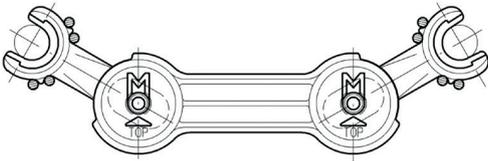
Model with a hinge type clamp and tensioning bolt

Due to its shape, this spacer has a corona extinction voltage that is particularly high. Tensioning bolts fixed by means of a special tool assist with easy and quick assembly. For high-temperature conductor application, a heat resistant silicone blend used.



Rotary spacer with damping links

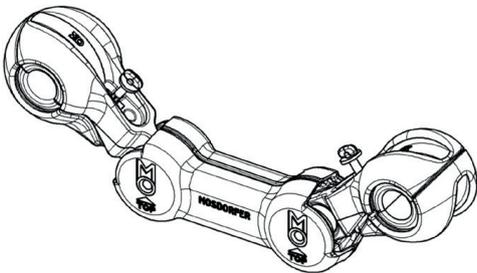
Rotary spacer with damping links for suspension strings with horizontal twin bundle conductors and for four bundle conductors. The idea behind this is that each of the conductors arranged horizontally is separately fixed to an insulator. The live connection of the insulator is provided by the rotary spacers arranged at a distance of approx. 1 m. If one string breaks, the loads will be transmitted from the intact string extremely gently.



Spacer damper, fixing with heliformed rods

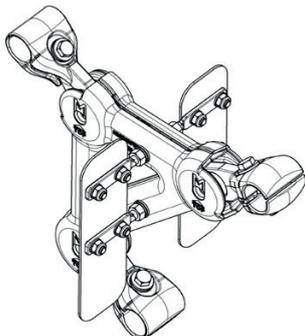
Spacer dampers

The spacer dampers described in the tables are a selection of types most commonly used, where the system of fastening to the conductor can be varied e.g. clamps fixed by using heliformed rods with neoprene clamp liners to offer added conductor protection.



Spacer damper with a hinge type clamp and a tensioning bolt

As previously described, non-damping spacers, and spacer dampers include models with hinge type clamps and tensioning bolts. Both types have excellent corona behaviour.

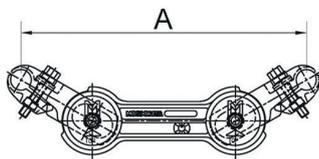


Spacer dampers with areas warning birds

Wildlife protection

Bird Flight Diverters can also be fitted.

Spacer damper aluminium, for horizontal twin bundles



material: aluminium, **casted**; steel, hot dip galvanized; Neoprene

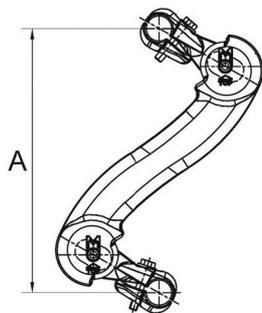
L.-Nr.	cond. Ø (mm)	A (mm)	kg
4980.030/40	19,0 - 21,5	400	2,32
4980.030/45	21,6 - 23,9	400	2,40
4980.030/50	24,0 - 25,9	400	2,10
4980.030/55	26,0 - 29,0	400	2,10
4980.045/55	26,0 - 29,0	450	2,40
4980.030/60	29,1 - 30,7	400	2,10
4980.030/65	30,8 - 33,0	400	2,10
4980.040/65	30,8 - 33,0	450	2,40
4980.030/72/K	33,1 - 35,5	400	2,30
4980.030/75	35,6 - 38,5	400	2,37
4980.040/75	35,6 - 38,5	450	2,40

Models with clamps of the hinge type or clamps with neoprene inserts and fixing with heliformed rods are available upon request.

All types can be delivered with shear head hats and a flexible potential equalisation.

Other dimensions are available upon request.

Spacer damper aluminium, for vertical twin bundles



material: aluminium, **casted**; steel, hot dip galvanized; Neoprene

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4981.30/45	21,6 - 23,9	400	3,50
4981.30/65	30,8 - 33,0	400	3,60
4981.30/75	35,6 - 38,5	400	3,60

Models with clamps of the hinge type or clamps with neoprene inserts and fixing with heliformed rods are available upon request.

All types can be delivered with shear head hats and a flexible potential equalisation.

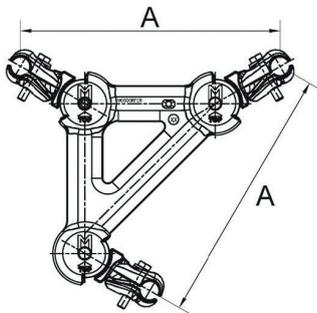
Other dimensions are available upon request.

Spacer damper aluminium, for triple bundles



material: aluminium, **casted**; steel, hot dip galvanized; Neoprene

L-Nr.	cond. Ø (mm)	A (mm)	kg
4982.030/50	24,0 - 25,9	400	4,30
4982.050/50	24,0 - 25,9	500	4,60
4982.030/55	26,0 - 29,0	400	4,30
4982.050/55	26,0 - 29,0	500	4,60
4982.030/60	29,1 - 30,7	400	4,30
4982.030/65	30,8 - 33,0	400	4,30
4982.030/75	35,6 - 38,5	400	4,30



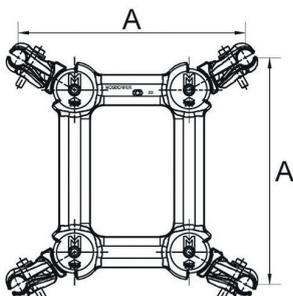
Models with clamps of the hinge type or clamps with neoprene inserts and fixing with heliformed rods are available upon request.
All types can be delivered with shear head hats and a flexible potential equalisation.
Other dimensions are available upon request.

Spacer damper aluminium, for quadruple bundles



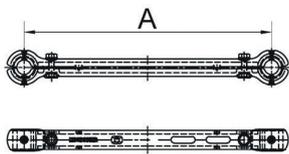
material: aluminium, **casted**; steel, hot dip galvanized; Neoprene

L-Nr.	cond. Ø (mm)	A (mm)	kg
4983.030/45	21,6 - 23,9	400	5,20
4983.030/50	24,0 - 25,9	400	5,20
4983.030/55	26,0 - 29,0	400	5,20
4983.030/60	29,1 - 30,7	400	5,20
4983.030/65	30,8 - 33,0	400	5,00



Models with clamps of the hinge type or clamps with neoprene inserts and fixing with heliformed rods are available upon request.
All types can be delivered with shear head hats and a flexible potential equalisation.
Spacers for diamond quadruple bundles are available upon request.
Other dimensions are available upon request.

Spacer Aluminium, casted, for twin bundles



material: aluminium, **casted**; steel, hot dip galvanized; Neoprene

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4974.40/00	18,1 - 20,0	400	1,10
4974.40/02	20,1 - 22,0	400	1,00
4974.40/03	22,1 - 24,0	400	1,10
4974.40/04	24,1 - 26,0	400	1,00
4974.45/04	24,1 - 26,0	450	1,10
4974.40/05	26,1 - 28,0	400	1,10
4974.40/06	28,1 - 30,0	400	1,10
4974.45/06	28,1 - 30,0	450	1,50
4974.40/07	30,1 - 32,0	400	1,10
4974.45/07	30,1 - 32,0	450	1,50
4974.52/08	32,1 - 34,0	520	1,30
4974.40/09	34,1 - 36,0	400	1,10

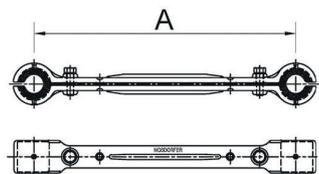
All parts are captive. The small connecting loop of the neoprene parts tightly mounted in the clamp body ensures ease of assembly without the field spacer having to be dismantled.

Sufficient movement within the conductor is guaranteed by elastic neoprene.

These field spacers with a semi-conducting neoprene insert can also be delivered with a contact spring to enable potential equalisation.

Other dimensions are available upon request.

Spacer aluminium, forged, for twin bundles



material: aluminium, **forged**; steel, hot dip galvanized; Neoprene

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4976.12	18,1 - 20,0	400	1,00
4976.02/P	20,1 - 22,0	400	0,98
4976.03	22,1 - 24,0	400	0,90
4976.04	24,1 - 26,0	400	0,95
4976.05	26,1 - 28,0	400	0,90
4976.06	28,1 - 30,0	400	1,10
4976.07/1	30,1 - 32,0	400	1,12
4976.08	32,1 - 34,0	400	1,10

All parts are captive. The small connecting loop of the neoprene parts tightly mounted in the clamp body ensures ease of assembly without the field spacer having to be dismantled.

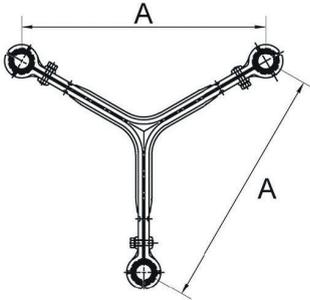
Sufficient movement within the conductor is guaranteed by elastic neoprene.

These field spacers with a semi-conducting neoprene insert can also be delivered with a contact spring to enable potential equalisation.

The screw configuration will, in combination with the defined supporting points, result in a pre-tensioning force of the clamping body to the conductors.

Other dimensions are available upon request.

Spacer aluminium, forged, for triple bundles

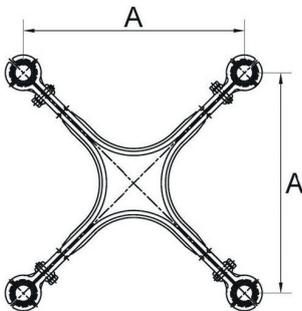


material: aluminium, **forged**; steel, hot dip galvanized; Neoprene

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4977.0003	26,1 - 28,0	400	1,70
4977.0002	28,1 - 30,0	400	1,90
4977.45/06	30,1 - 32,0	450	2,00
4977.11	32,1 - 34,0	450	2,07
4977.40/09	34,1 - 36,0	400	1,90

All parts are captive. The small connecting loop of the neoprene parts tightly mounted in the clamp body ensures ease of assembly without the field spacer having to be dismantled. Sufficient movement within the conductor is guaranteed by elastic neoprene. These field spacers with a semi-conducting neoprene insert can also be delivered with a contact spring to enable potential equalisation. The screw configuration will, in combination with the defined supporting points, result in a pre-tensioning force of the clamping body to the conductors. Other dimensions are available upon request.

Spacer aluminium, forged, for quadruple bundles



material: aluminium, **forged**; steel, hot dip galvanized; Neoprene

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4975.40/12	22,1 - 24,0	400	2,10

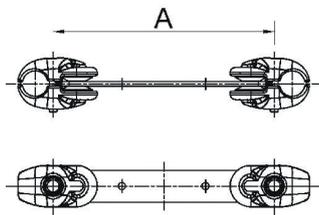
All parts are captive. The small connecting loop of the neoprene parts tightly mounted in the clamp body ensures ease of assembly without the field spacer having to be dismantled. Sufficient movement within the conductor is guaranteed by elastic neoprene. These field spacers with a semi-conducting neoprene insert can also be delivered with a contact spring to enable potential equalisation. The screw configuration will, in combination with the defined supporting points, result in a pre-tensioning force of the clamping body to the conductors. Other dimensions are available upon request.

Flexible spacer with neoprene insert



material: aluminium, **casted**; steel, hot dip galvanized; Neoprene

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4968.0015	23,0 - 24,5	450	3,45
4968.0024	24,5 - 26,0	400	2,40
4968.0019	29,0 - 30,5	400	2,40
4968.0025	30,5 - 32,0	400	2,40
4968.0009	32,0 - 33,5	400	2,40
4968.0001	33,5 - 35,0	400	2,40
4968.0004	33,5 - 35,0	450	2,84
4968.0018	35,0 - 36,5	400	2,40
4968.0003	38,0 - 39,5	400	2,40
4968.30	38,0 - 39,5	450	3,20

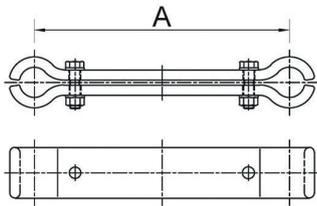


For horizontal and vertical twin bundles.

The neoprene washers fixed between the body and clamps have some damping effect.
Other dimensions are available upon request.



Rigid spacer for jumper loop, for twin bundles



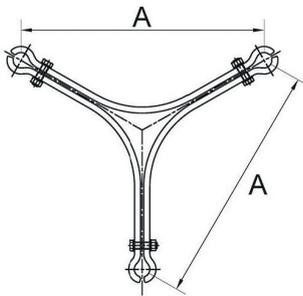
material: aluminium, extruded; steel, hot dip galvanized

L.-Nr.	cond. Ø (mm)	A (mm)	Width (mm)	kg
4972.0101	18,10 - 20,00	200	30	0,50
4972.40/50	18,10 - 20,00	400	50	1,40
4972.20/52	20,10 - 22,00	200	50	0,80
4972.40/52	20,10 - 22,00	400	50	1,40
4972.20/03	22,10 - 24,00	200	30	0,50
4972.20/53	22,10 - 24,00	200	50	0,80
4971.40/53	22,10 - 24,00	400	50	1,40
4971.0016	22,10 - 24,00	450	50	1,20
4972.20/04	24,10 - 26,00	200	30	0,50
4972.40/04	24,10 - 26,00	400	50	1,40
4972.0028	24,10 - 26,00	450	50	1,40
4972.20/05	26,10 - 28,00	200	30	0,40
4972.40/05	26,10 - 28,00	400	50	1,40
4972.0073	26,10 - 28,00	450	50	1,50
4972.20/06	28,10 - 30,00	200	30	0,39
4972.0010	28,10 - 30,00	400	50	1,27
4972.0008	28,10 - 30,00	450	50	1,40
4972.20/07	30,10 - 32,00	200	30	0,40
4972.40/07	30,10 - 32,00	400	50	1,40
4972.0005	30,10 - 32,00	450	50	1,90
4972.20/68	32,10 - 34,00	200	60	0,90
4972.0049	32,10 - 34,00	400	50	1,30
4972.45/68	32,10 - 34,00	450	60	1,90
4972.20/69	34,10 - 36,00	200	60	1,20
4972.20/510	36,10 - 38,00	200	50	0,80
4972.0032	36,10 - 38,00	400	50	1,50
4972.20/611	38,10 - 40,00	200	60	0,93
4972.45/611	38,10 - 40,00	450	60	1,70
4972.0018	40,10 - 42,00	200	60	0,90
4972.0022	42,10 - 44,00	200	50	0,80

These field spacers are exclusively suitable for loops and can also be equipped with counterweights.

Other types are available upon request.

Rigid spacer for jumper loop, for triple bundles



material: aluminium, extruded; steel, hot dip galvanized

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4973.40/04	24,10 - 26,00	400	2,10
4973.0004	28,10 - 30,00	450	2,10
4973.0003	28,10 - 30,00	450	2,30
4973.0021	30,10 - 32,00	400	2,30
4973.0005	32,10 - 34,00	450	2,30
4973.0016	34,10 - 36,00	450	2,30
4973.0017	38,10 - 40,00	450	2,40

These field spacers are exclusively suitable for loops and can also be equipped with counterweights.

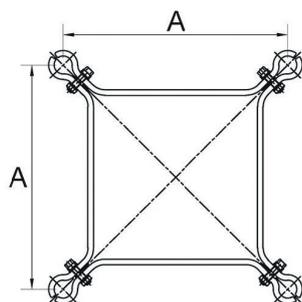
Other types are available upon request.

Rigid spacer for jumper loop, for quadruple bundles



material: aluminium, extruded; steel, hot dip galvanized

L.-Nr.	cond. Ø (mm)	A (mm)	kg
4971.20/03	22,10 - 24,00	200	1,62
4971.40/03/1	22,10 - 24,00	400	2,68
4971.0009	24,10 - 26,00	400	2,70
4971.45/54	24,10 - 26,00	450	3,70
4971.0024	26,10 - 28,00	450	3,20
4971.0002	28,10 - 30,00	200	1,80
4971.0100	28,10 - 30,00	400	2,90
4971.0020	28,10 - 30,00	450	3,20
4971.40/57	30,10 - 32,00	400	2,90
4971.0032	30,10 - 32,00	450	3,30
4971.20/58	32,10 - 34,00	200	1,80
4971.40/58	32,10 - 34,00	400	2,80
4971.0022	34,10 - 36,00	450	3,20
4971.0017	36,10 - 38,00	400	3,00
4971.0023	38,10 - 40,00	450	3,30



These field spacers are exclusively suitable for loops and can also be equipped with counterweights.

Other types are available upon request.