

## Contents

### SPACER DAMPERS

|                                        |     |
|----------------------------------------|-----|
| <b>General</b> .....                   | 2-3 |
| for twin, triple and four bundle ..... | 4   |

### SPACERS

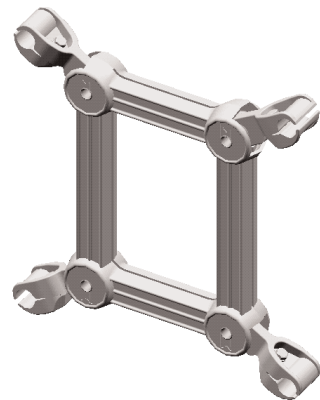
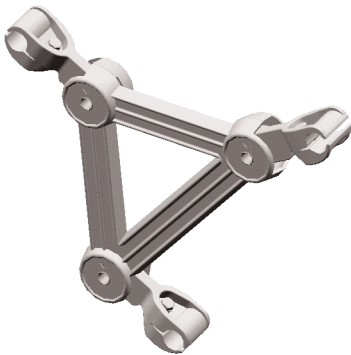
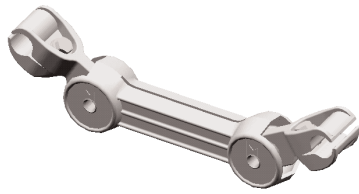
|                                                             |      |
|-------------------------------------------------------------|------|
| <b>Semi-flexible spacers</b><br>with neoprene inserts ..... | 5, 9 |
| <b>Flexible Spacers</b><br>with neoprene washers .....      | 6    |
| <b>Flexible Spacers</b><br>with reinforcing sleeve .....    | 7    |
| <b>Spacers</b><br>with straps .....                         | 8    |
| <b>Rigid spacers</b><br>for jumper connections .....        | 9    |

|                            |   |
|----------------------------|---|
| <b>PHASE SPACERS</b> ..... | 9 |
|----------------------------|---|

## SPACER DAMPERS

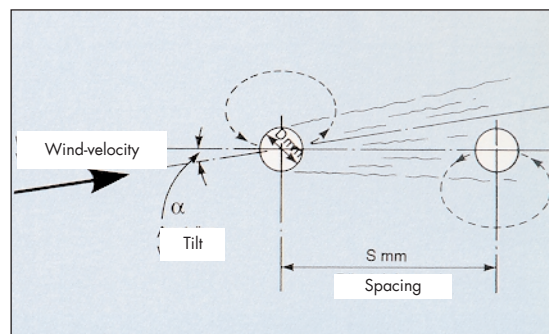
### GENERAL

Wind induced vibrations on high voltage overhead lines can be categorised according to their induced frequencies as follows: High frequency vibration (Karman or aeolian vibrations), low-frequency oscillations (conductor galloping) and subspan oscillations or bundle conductor oscillations.



|            | Aeolian vibrations                                                                | Galloping                            | Oscillations of bundled conductors                                                                                                    |
|------------|-----------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Wind       | constant                                                                          | constant                             | constant                                                                                                                              |
| Speed      | 1–7 m/s (9 m/s)                                                                   | 7–18 m/s                             | 4–18 m/s                                                                                                                              |
| Frequency  | (3) 5–50 (100) Hz                                                                 | 0.1–3 Hz                             | 0.15–3 (10) Hz                                                                                                                        |
| Amplitude  | up to 3 (5) cm                                                                    | up to 10 m                           | Subconductor vibrations up to 50 cm<br>Fixed vibration range up to 2 m                                                                |
| Conditions | Tensile stress<br>Self-damping of conductors<br>Armour rods<br>Dampers<br>Terrain | Climatic conditions (icing)          | Distance of the subconductors<br>Inclination of the conductors<br>Positioning of the conductors<br>distribution of the spacer-dampers |
| Damage     | Conductor wires<br>Fittings                                                       | Conductors<br>Fittings<br>Insulators | Conductors<br>Fittings<br>Dampers<br>Spacers                                                                                          |

Four kinds of subspan oscillations exist, three forms of rigid body modes and the most dangerous so called subconductor oscillation. Most reports of subconductor vibrations pertain to lines located in terrain that is either generally flat or gently rolling. There is a minimum, or threshold, wind velocity (approx 4 m/s) and a certain inclination of the conductors required to initiate motion. The oscillations of the leeward conductor are self-induced, where the energy input of the wind will be dissipated by the conductor. The frequencies appearing here are lower than 5 Hz and the amplitudes could reach a value which will lead to clashing of the conductors.

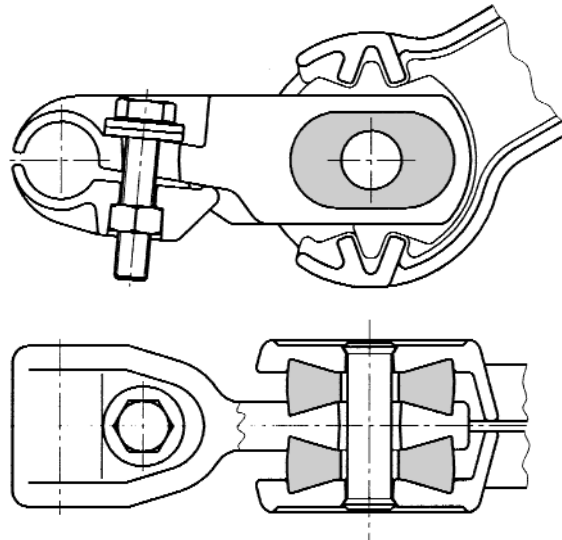


Subspan oscillation.

## Design and function

Spacer dampers consist of clamps, a connecting frame and the damping elements. The damping elements, which are made of highly flexible macromolecular elastomere, guarantee a certain mobility of the damper clamp. Additionally the damping elements are designed in respect of temperature resistance, environmental conditions and to be free of corona.

All types of spacers have passed strict type tests in order to guarantee suitability.

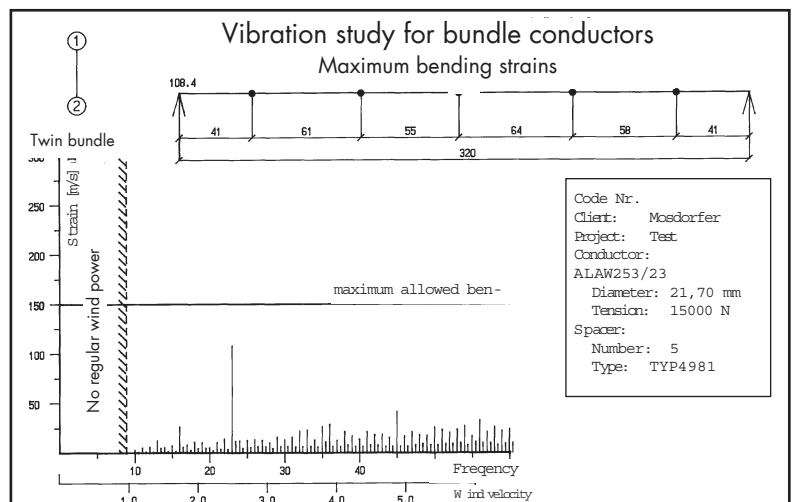


Placement of the damping elements.

## Computer programme High-frequency vibrations

The maximum bending strain at different frequencies, at the suspension point of the conductor or at the clamping area of the spacers, with various configurations of conductor bundles, with or without vibration dampers can be calculated with a special computer programme.

As well as parameters of the spacer dampers capability established in the laboratory, line parameters supplied by the customer are also taken into account in the computer programme.

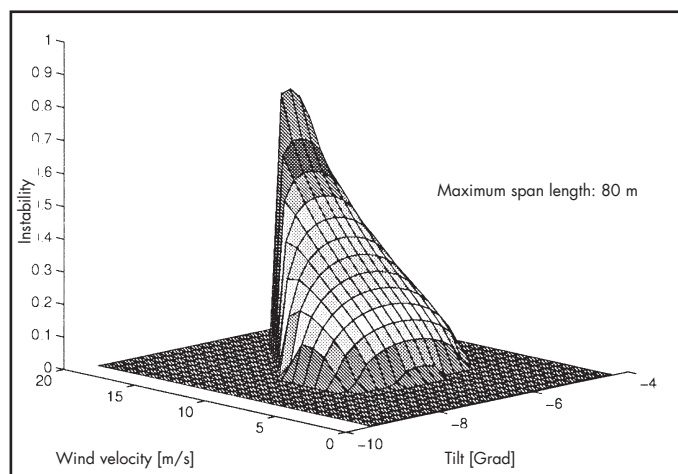


Maximum bending strain of conductors and spacers.

## Subconductor oscillations

To give an answer about the damper to a specific configuration of a conductor bundle, the characteristics of such a configuration will be simulated by an analytical model. All parameters of the spacer dampers, their location, the movements of the conductor bundle caused by wind as well as conductor tensile stresses will be taken into consideration.

This calculation gives information about the critical wind velocity and reflects a factor to estimate the probability that subconductor vibrations will occur.



Example of a study of sub span oscillation.

## Spacer Dampers

for twin-, triple- and four bundles

for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

| Material: Frame: cast aluminium<br>Clamp: cast aluminium                                                                                                                                                                                                                                                                                             |       |       |       |       | Damping element: neoprene<br>Bolts: steel, hot dip galvanised |                 |                                                                                                                                                                                                                                                                                                                                                           |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|---------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|
|   <b>L.-Nr.</b>   |       |       |       |       | Dimensions in mm                                              |                 | Weight kg     |      |      |      |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       |       | Conductor Ø                                                   | Bundle distance |                                                                                                                                                                                                                                                                                                                                                           |      |      |      |
| 4980.                                                                                                                                                                                                                                                                                                                                                | 4981. | 4982. | 4983. | 30/40 | 19,0–21,5                                                     | 400             | 2,00                                                                                                                                                                                                                                                                                                                                                      | 2,10 | 3,80 | 5,10 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/45 | 21,6–23,9                                                     | 400             | 2,00                                                                                                                                                                                                                                                                                                                                                      | 2,10 | 3,80 | 5,10 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/50 | 24,0–25,9                                                     | 400             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 3,90 | 5,20 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/55 | 26,0–29,0                                                     | 400             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 3,90 | 5,20 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/60 | 29,1–30,7                                                     | 400             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 3,90 | 5,20 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/65 | 30,8–33,0                                                     | 400             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,00 | 5,30 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/70 | 33,1–35,5                                                     | 400             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,00 | 5,30 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 30/75 | 35,6–38,0                                                     | 400             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,00 | 5,30 |
| 4980.                                                                                                                                                                                                                                                                                                                                                | 4981. | 4982. | 4983. | 40/40 | 19,0–21,5                                                     | 450             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 4,00 | 5,50 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/45 | 21,6–23,9                                                     | 450             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 4,00 | 5,50 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/50 | 24,0–25,9                                                     | 450             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,10 | 5,60 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/55 | 26,0–29,0                                                     | 450             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,10 | 5,60 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/60 | 29,1–30,7                                                     | 450             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,10 | 5,60 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/65 | 30,8–33,0                                                     | 450             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,20 | 5,70 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/70 | 33,1–35,5                                                     | 450             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,20 | 5,70 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 40/75 | 35,6–38,0                                                     | 450             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,20 | 5,70 |
| 4980.                                                                                                                                                                                                                                                                                                                                                | 4981. | 4982. | 4983. | 45/40 | 19,0–21,5                                                     | 457             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 4,00 | 5,50 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/45 | 21,6–23,9                                                     | 457             | 2,10                                                                                                                                                                                                                                                                                                                                                      | 2,20 | 4,00 | 5,50 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/50 | 24,0–25,9                                                     | 457             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,10 | 5,60 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/55 | 26,0–29,0                                                     | 457             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,10 | 5,60 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/60 | 29,1–30,7                                                     | 457             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,10 | 5,60 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/65 | 30,8–33,0                                                     | 457             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,20 | 5,70 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/70 | 33,1–35,5                                                     | 457             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,20 | 5,70 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 45/75 | 35,6–38,5                                                     | 457             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,20 | 5,70 |
| 4980.                                                                                                                                                                                                                                                                                                                                                | 4981. | 4982. | 4983. | 50/40 | 19,0–21,5                                                     | 500             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,30 | 5,80 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/45 | 21,6–23,9                                                     | 500             | 2,20                                                                                                                                                                                                                                                                                                                                                      | 2,30 | 4,30 | 5,80 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/50 | 24,0–25,9                                                     | 500             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,40 | 5,90 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/55 | 26,0–29,0                                                     | 500             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,40 | 5,90 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/60 | 29,1–30,7                                                     | 500             | 2,30                                                                                                                                                                                                                                                                                                                                                      | 2,40 | 4,40 | 5,90 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/65 | 30,8–33,0                                                     | 500             | 2,40                                                                                                                                                                                                                                                                                                                                                      | 2,50 | 4,50 | 6,00 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/70 | 33,1–35,5                                                     | 500             | 2,40                                                                                                                                                                                                                                                                                                                                                      | 2,50 | 4,50 | 6,00 |
|                                                                                                                                                                                                                                                                                                                                                      |       |       |       | 50/75 | 35,6–38,5                                                     | 500             | 2,40                                                                                                                                                                                                                                                                                                                                                      | 2,50 | 4,50 | 6,00 |

L-Nr. are valid for standard clamps.

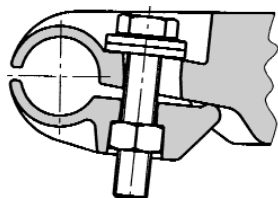
### Special designs:

- stainless steel bolts L-Nr. ...**R**  
e. g.: 4983.50/40**R**

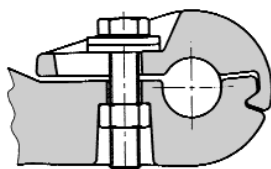
- with shear head nuts  
L-Nr. .../**K**  
e. g.: 4983.50/40/**K**

- with flexible copper bond  
L-Nr. ...  
e. g.: 4983.51/40

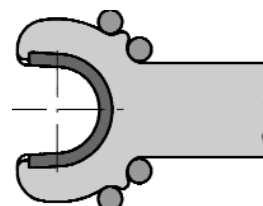
### Clamp designs:



Standard



Hinge type



Fixing with rods

## SPACERS

### Semi-flexible spacers

with neoprene inserts

for horizontal and vertical twin bundles

for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

Semi-flexible spacers consist of two clamp halves with a semi-conducting neoprene-insert, which is solidly connected with the clamp halves. They have no movable components, which means that there will be no damage caused by abrasion. Movements within the conductor bundle will be absorbed by the neoprene-inserts. They also act as protection for the conductor.

The design of connection guarantees easy and cost-effective installation.

| <b>Material:</b> Clamps: aluminium-alloy, forged<br>Inserts: neoprene<br>Bolts: steel, hot dip galvanised |                  |                |         |           |
|-----------------------------------------------------------------------------------------------------------|------------------|----------------|---------|-----------|
| L-Nr.                                                                                                     | Dimensions in mm |                |         | Weight kg |
|                                                                                                           | Conductor Ø      | Width of clamp | Spacing |           |
| 4976.02                                                                                                   | 20,0–22,0        | 40             | 400     | 0,90      |
| 4976.03                                                                                                   | 22,1–24,0        | 40             | 400     | 0,90      |
| 4976.04                                                                                                   | 24,1–26,0        | 40             | 400     | 0,90      |
| 4976.05                                                                                                   | 26,1–28,0        | 40             | 400     | 0,90      |
| 4976.06                                                                                                   | 28,1–30,0        | 50             | 400     | 1,00      |
| 4976.07                                                                                                   | 30,1–32,0        | 50             | 400     | 1,00      |
| 4976.08                                                                                                   | 32,1–34,0        | 50             | 400     | 1,00      |
| 4976.09                                                                                                   | 34,1–36,0        | 50             | 400     | 1,00      |



Other dimensions on request.



Spacers for triple-bundle  
Serial-Nr. 4977...  
L.-Nr. on request



Spacers for four-bundle  
Serial-Nr. 4977...  
L.-Nr. on request

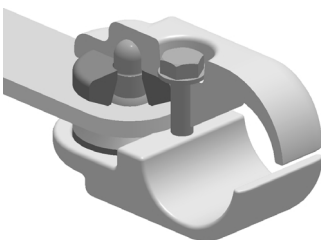
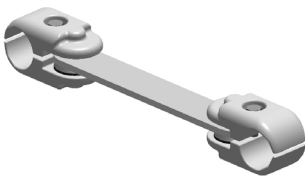
## Flexible Spacers with neoprene washers

for horizontal- and vertical twin bundles

for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

Flexible spacers consist of two movable clamps which are linked with a steel strap. The clamps are made of two clamp halves which are connected by a steel bolt, to give them optimum movement in all directions in case of relative movements of the conductors of the bundle. The neoprene-inserts mounted between steel-strap and clamps have a damping characteristic and prevent noise and abrasion.

To protect the conductors the neoprene-inserts are designed so that a retrograde trend in movement will be achieved.



Neoprene-washer

**Material:** Clamps: aluminium-alloy, forged  
Strap: steel, hot dip galvanised  
Washers: neoprene  
Linking bolt: stainless steel  
Bolts: steel, hot dip galvanised

| L.-Nr.      | Dimensions in mm |             |         | Weight<br>kg |
|-------------|------------------|-------------|---------|--------------|
|             | Conductor Ø      | Clamp width | Spacing |              |
| 531.150/362 | 36               | 64          | 400     | 2,20         |
| 531.150/363 | 36               | 64          | 500     | 2,40         |
| 531.150/400 | 50               | 64          | 500     | 2,40         |

Other dimensions on request

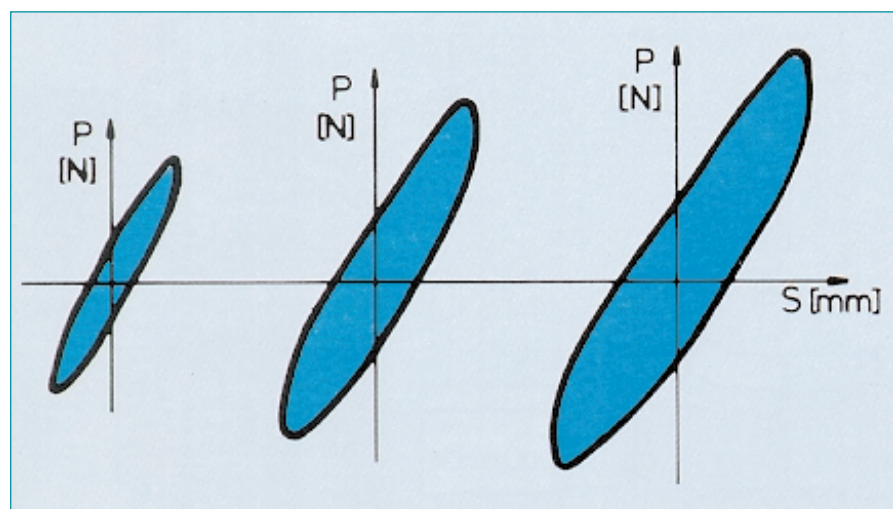


Diagram of hysteresis.

**Flexible Spacers,** with messenger wire and reinforcing sleeve  
for horizontal twin bundle  
for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

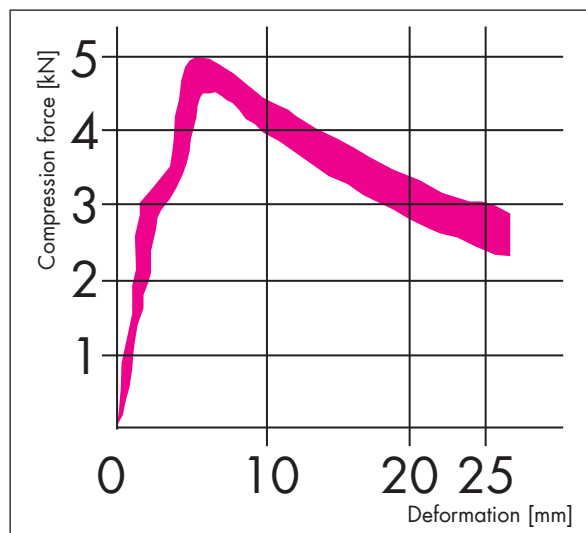
This spacer works because of the special messenger cable which connects the two clamping bodies.

These clamping bodies have a special shape to prevent damage of the conductor. The messenger cable allows a certain flexibility in all directions, which is limited by a longer or shorter sleeve, which is compressed onto the messenger cable.

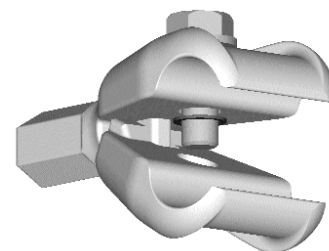


| <b>Material:</b> Clamps: aluminium-alloy, forged<br>Sleeve: aluminium-alloy<br>Messenger wire: alumoweld<br>Bolts: steel, hot dip galvanised |                  |             |         |           |
|----------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------|---------|-----------|
| L-Nr.                                                                                                                                        | Dimensions in mm |             |         | Weight kg |
|                                                                                                                                              | Conductor Ø      | Clamp width | Spacing |           |
| 135-526-021                                                                                                                                  | 22,0–23,5        | 60          | 400     | 0,92      |
| 135-526-035                                                                                                                                  | 25,7–27,7        | 60          | 400     | 0,92      |
| 135-526-095                                                                                                                                  | 29,8–31,8        | 60          | 400     | 0,93      |
| 135-526-020                                                                                                                                  | 31,8–33,8        | 60          | 400     | 0,93      |
| 135-526-029                                                                                                                                  | 35,0–37,5        | 60          | 400     | 0,93      |

Other dimensions and types with stainless steel screws on request.



Compression characteristic of a spacer with reinforcing sleeve.



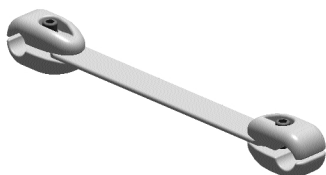


**Flexible spacers** patented, with straps  
for horizontal and vertical twin bundles  
for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

This type of spacer connects the two clamp bodies by means of a strap and a connecting bolt this allows a possible displacement in the longitudinal direction.

The bore holes in the straps are fitted with stainless steel bushings thus limiting the abrasion.

The shape of the distance strap can be round or flat.



| <b>Material:</b> Clamps: aluminium-alloy, forged<br>Strap: aluminium-alloy, forged<br>Bolts: stainless steel |                  |             |         |               |           |
|--------------------------------------------------------------------------------------------------------------|------------------|-------------|---------|---------------|-----------|
| L.-Nr.                                                                                                       | Dimensions in mm |             |         | Type of strap | Weight kg |
|                                                                                                              | Conductor Ø      | Clamp width | Spacing |               |           |
| 531.65/381                                                                                                   | 18,8–19,9        | 45          | 400     | flat          | 0,90      |
| 531.65/3                                                                                                     | 21,7–22,5        | 45          | 400     | flat          | 1,00      |
| 531.65/709                                                                                                   | 26,1–27,5        | 50          | 400     | round         | 1,10      |

Other dimensions on request.

**Flexible Spacers** with al-straps  
for horizontal and vertical twin bundles  
for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

### Serial-Nr. 9437

This type connects the two clamp bodies by means of a strap and a connecting bolt also this allows a possible displacement in the longitudinal direction.

To reduce possible noise caused by the link and connecting bolts (rattle) the bore holes are finished by reaming.



### Serial-Nr. 9438

Similar to Serial-Nr. 9437 but with neoprene-bushings.

| <b>Material:</b> Clamps: aluminium-alloy, forged<br>Strap: aluminium-alloy, forged<br>Bolts: steel, hot dip galvanised<br>Hingebolt: stainless steel |                  |             |         |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------|---------|-----------|
| Serial-Nr.                                                                                                                                           | Dimensions in mm |             |         | Weight kg |
|                                                                                                                                                      | Conductor Ø      | Clamp width | Spacing |           |
| 9437                                                                                                                                                 | 21,0 – 32,8      | 45          | 200–400 | 1,00      |
| 9438                                                                                                                                                 | 21,0 – 36,0      | 45          | 200–400 | 1,00      |

Other dimensions and types with stainless steel bolts on request.



## Semi-flexible Spacers

for horizontal and vertical twin bundles

for aluminium-, al-alloy-, ACSR-, AACSR- and alumoweld conductors

Semi-flexible spacers consist of two clamp halves with a semi-conducting neoprene-insert, which is solidly connected between the clamp halves. There are no movable components, which means that there will be no damage caused by abrasion. Movements within the conductor bundle will be absorbed by the neoprene-inserts. They also act as protection for the conductor.

The design of the connection guarantees easy and cost-effective installation.



**Material:** Clamp-body: cast aluminium-alloy

Insert: neoprene

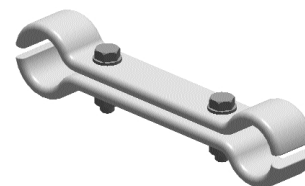
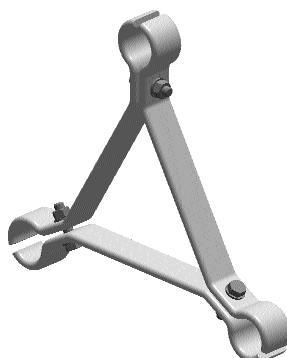
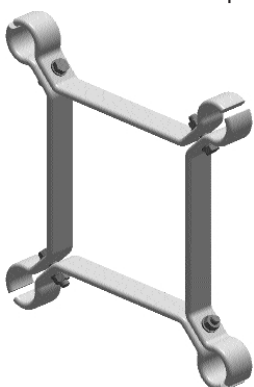
Bolts: steel, hot dip galvanized

Serial-Nr. 4974...

L.-Nr. on request.

## Rigid spacers for jumper connections

dimensions on request.



## PHASE SPACERS

dimensions on request.

