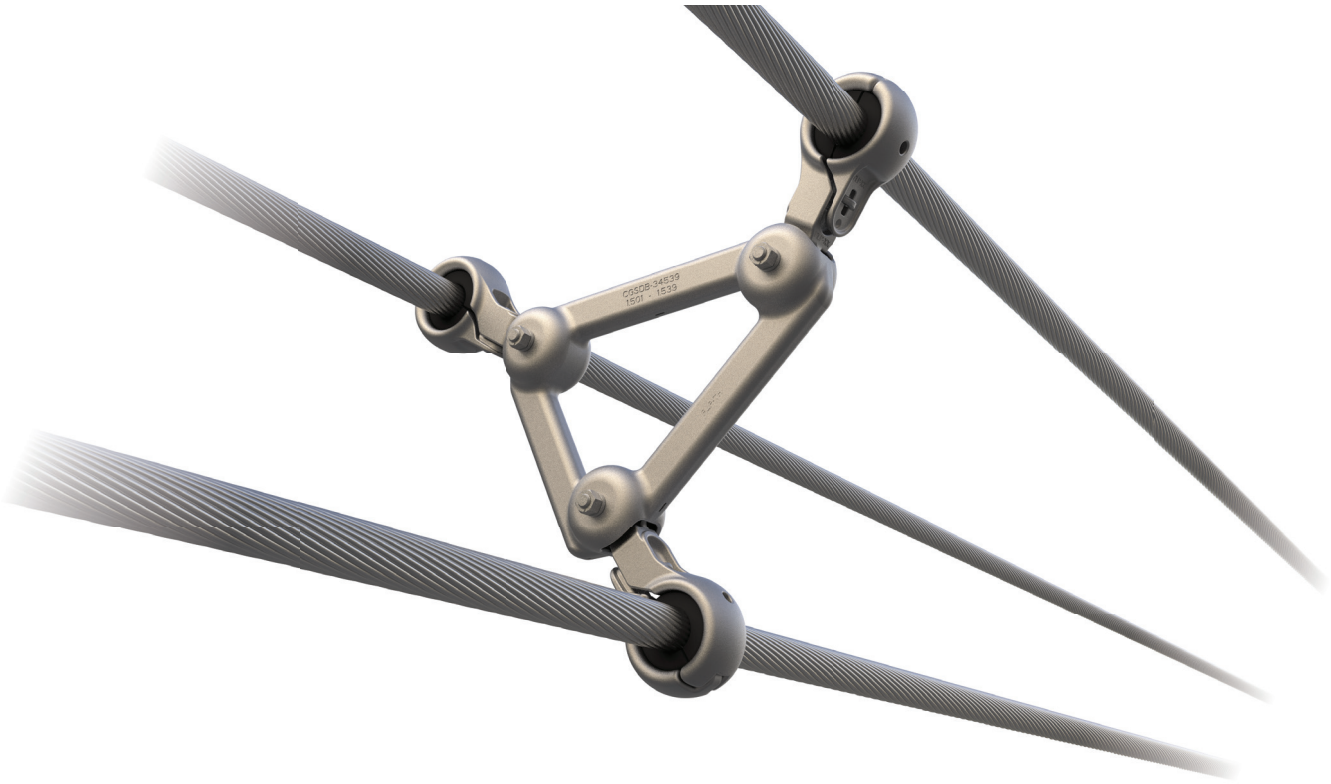
PRODUCT CATALOG



MOTION CONTROL

Aeolian Vibration Damping | Subspan Oscillation Control | Galloping Mitigation

ABOUT PLP

PLP protects the world's most critical connections by creating stronger and more reliable networks. Our precision-engineered solutions are trusted by energy and communications providers worldwide to perform better and last longer. With offices and manufacturing facilities in over 20 countries, PLP works as a united global corporation, delivering high-quality products and unparalleled service to customers around the world.

SALES CONTACTS

ELECTRIC UTILITY
SALES

CUSTOMER SUPPORT

U.S. SUPPORT

Tel: 440.461.5200

Fax: 440.442.8816

Email: info@plp.com

INTERNATIONAL SUPPORT

Tel: 440.473.9294

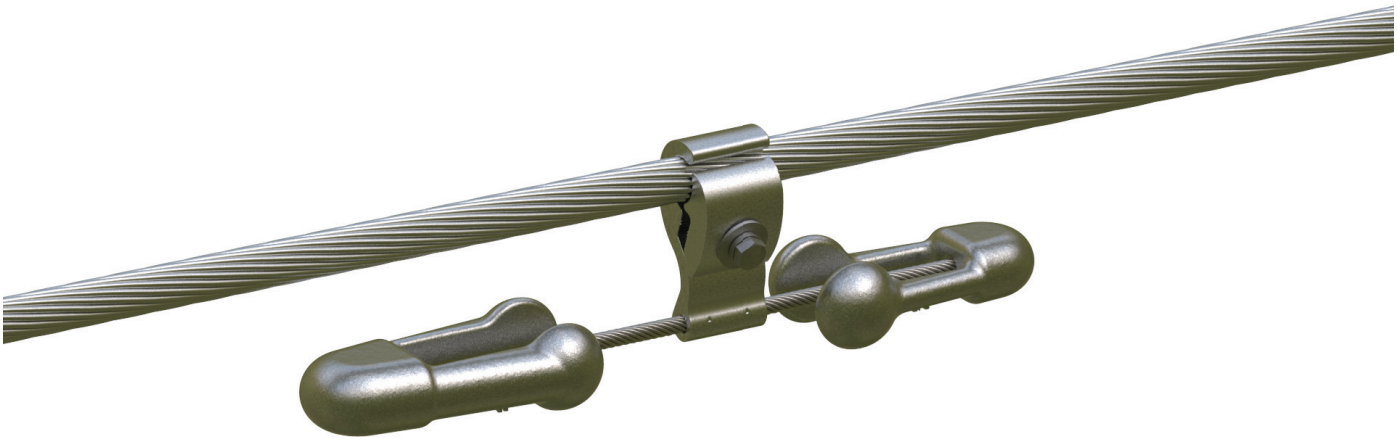
Fax: 440.461.2918

Email: international@plp.com

EN-CA-1033

CONTENTS

MOTION CONTROL



VORTX™ VIBRATION DAMPER

The **VORTX Vibration Damper** responds to wind-induced line vibration that is characterized by high-frequency, low amplitude motion commonly known as aeolian vibration. The large and small weights of the VORTX dampers can achieve greater power dissipation and frequency response performance than "symmetrical weight" Stockbridge damper designs. Wider frequency coverage translates into better span protection as energy is more effectively dissipated over the entire range of span natural frequencies.

FEATURES AND BENEFITS

- Extruded aluminum alloy contoured clamp offers a precision fit to evenly capture the cable and uniformly distribute pressure along its surface
- Meets IEC 61897 and IEEE 664 requirements for Stockbridge dampers
- Precision-manufactured galvanized steel messenger strand efficiently dissipates vibration energy
- Galvanized ductile iron weights
- Dampers can be ordered with a breakaway bolt head designed to shear off when the bolt is tightened to the proper torque value
- Number and placement of dampers in each span is determined by a proprietary, internally-developed online program that utilizes the results of ongoing field and laboratory research
- EHV VORTX Dampers are available for 500 kV applications

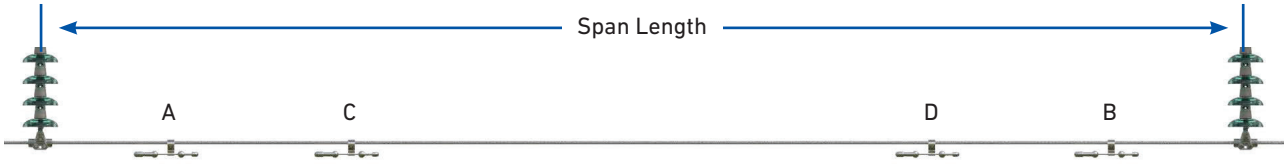
DAMPER SELECTION

Cable Diameter	Damper Type
≤ 0.75" (19 mm)	Spiral Vibration Damper
> 0.75" (19 mm)	VORTX Vibration Damper

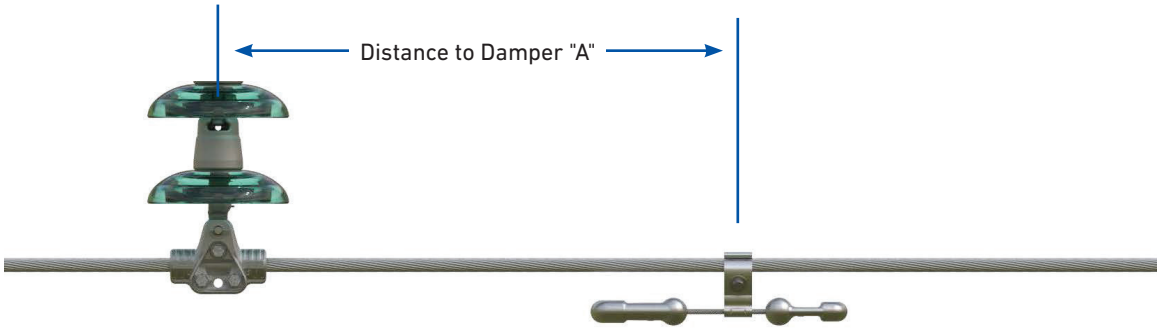
DAMPER QUANTITY & PLACEMENT

- The number of dampers required per span is dependent upon wind energy exposure and the cable's self-damping characteristics
- Longer spans, such as river crossings, need additional protection and may require more than one damper within the span, including dampers that are placed midspan
- Dampers can be installed directly onto ACSR, AAC, AAAC, and ACAR conductors, but cannot be installed directly onto composite core HTLS conductors and must be secured to the protective rods of the attachment hardware or PLP Protector Rods (ordered separately) that are installed on the conductor. Installing VORTX Dampers on suspension rods or Protector Rods is recommended for ACSS, but does not require it.

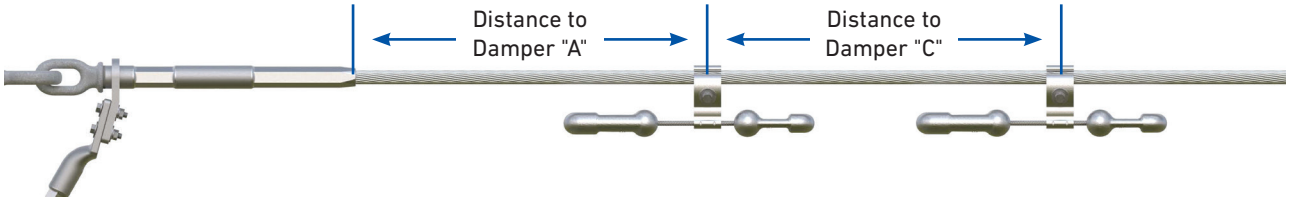
General Placement Sequence



Damper Placement at Tangent Hardware Locations



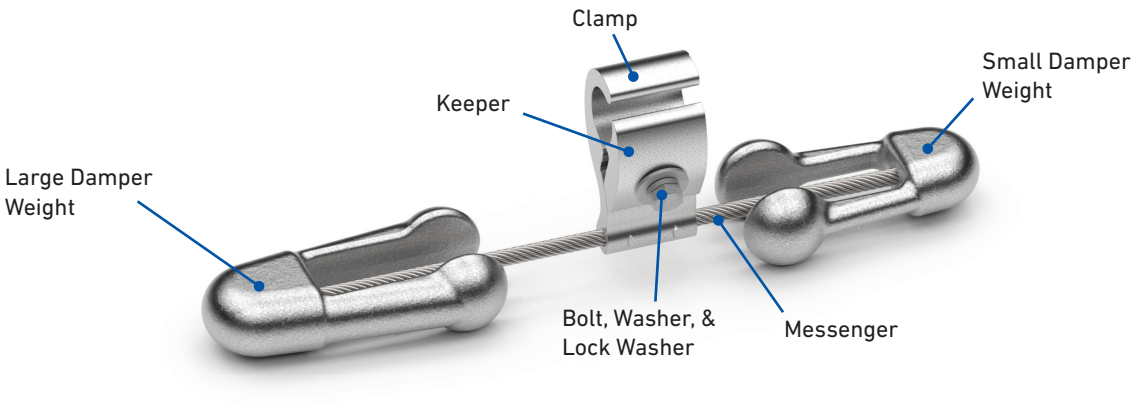
Damper Placement at Dead-End Hardware Locations



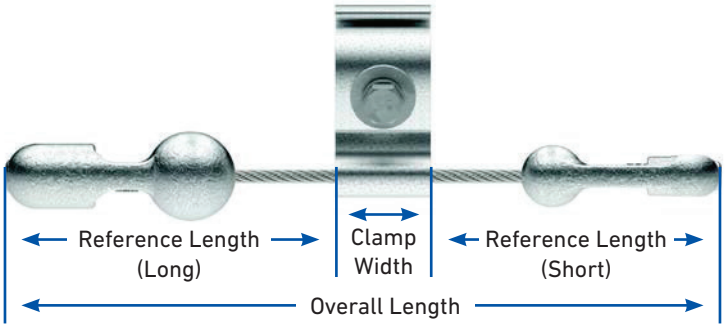
VORTX DAMPER PLACEMENT SOFTWARE

- Based upon PLP's 70+ year knowledge base on vibration to determine the recommended damper model, quantity, and optimal placement location
- Considers many input variables specific to the individual cable, such as its construction, design, and local operating conditions
- Sign up at **plpvortx.com** at no charge to PLP customers. Contact your local representative or PLP Technical Support for more information.

COMPONENTS



DIMENSIONS



VORTX Vibration Damper Dimensions

Catalog Number	Clamp Range		Overall Length		Reference Length (Long)		Reference Length (Short)		Clamp Width		Bolt Size	Assembled Weight	
	in	mm	in	mm	in	mm	in	mm	in	mm	mm	lb	kg
VSD-2016	0.483 - 0.611	12.3 - 15.4	14.6	370	6.9	175	6.0	153	1.63	41.1	M12 x 50	3.6	1.6
VSD-2020	0.612 - 0.785	15.5 - 19.9	14.9	379	6.9	175	6.0	153	2.00	50.8	M12 x 50	3.9	1.8
VSD-2025	0.786 - 0.982	20.0 - 24.9	14.9	379	6.9	175	6.0	153	2.00	50.8	M12 x 50	4.0	1.8
VSD-2032	0.983 - 1.260	25.0 - 31.9	15.1	384	6.9	175	6.0	153	2.20	55.9	M12 x 70	4.4	2.0
VSD-2040	1.261 - 1.578	32.0 - 40.0	15.3	389	6.9	175	6.0	153	2.38	60.5	M12 x 70	4.6	2.1
VSD-2050	1.579 - 1.970	40.1 - 50.0	15.4	392	6.9	175	6.0	153	2.50	63.5	M12 x 70	4.9	2.2
VSD-2520	0.612 - 0.785	15.5 - 19.9	12.7	322	6.4	161	4.3	110	2.00	50.8	M12 x 50	4.9	2.2
VSD-2525	0.786 - 0.982	20.0 - 24.9	12.7	322	6.4	161	4.3	110	2.00	50.8	M12 x 50	5.0	2.3
VSD-2532	0.983 - 1.260	25.0 - 31.9	12.9	327	6.4	161	4.3	110	2.20	55.9	M12 x 70	5.4	2.5
VSD-2540	1.261 - 1.579	32.0 - 40.0	13.1	332	6.4	161	4.3	110	2.38	60.5	M12 x 70	5.7	2.6
VSD-3525	0.786 - 0.982	40.1 - 50.0	14.7	374	7.0	179	5.7	145	2.00	50.8	M12 x 50	7.3	3.3
VSD-3532	0.983 - 1.260	24.9 - 31.9	14.9	379	7.0	179	5.7	145	2.20	55.9	M12 x 70	7.7	3.5
VSD-3540	1.261 - 1.578	32.0 - 40.0	15.1	384	7.0	179	5.7	145	2.38	60.5	M12 x 70	7.9	3.6
VSD-3550	1.579 - 1.970	40.1 - 50.0	15.2	387	7.0	179	5.7	145	2.50	63.5	M12 x 70	8.2	3.7
VSD-4032	0.983 - 1.260	25.0 - 31.9	20.3	515	10.5	267	5.7	145	2.20	55.9	M12 x 70	10.8	4.9
VSD-4040	1.261 - 1.578	32.0 - 40.0	20.4	519	10.5	267	5.7	145	2.38	60.5	M12 x 70	11.1	5.0
VSD-4050	1.579 - 1.970	40.1 - 50.0	20.6	523	10.5	267	5.7	145	2.50	63.5	M12 x 70	11.4	5.2
VSD-4061	1.971 - 2.422	50.1 - 61.5	21.1	535	10.5	267	5.7	145	3.00	76.2	M12 x 75	12.1	5.5
VSD-5240	1.261 - 1.578	32.0 - 40.0	23.9	606	12.1	307	5.7	145	2.38	60.5	M12 x 75	13.5	6.1
VSD-5250	1.579 - 1.970	40.1 - 50.0	24.0	609	12.1	307	5.7	145	2.50	63.5	M12 x 75	13.8	6.3
VSD-5261	1.971 - 2.422	50.1 - 61.5	24.5	622	12.1	307	5.7	145	3.00	76.2	M12 x 75	14.5	6.6
VSD-5543EHV	1.500 - 1.700	38.1 - 43.2	19.4	493	10.1	257	6.8	173	2.63	66.8	M12 x 50	18.3	8.3
VSD-5549EHV	1.701 - 1.950	43.2 - 49.5	21.8	552	11.3	286	7.8	197	2.75	69.9	M12 x 50	18.5	8.4
VSD-5561EHV	1.951 - 2.422	49.5 - 61.5	21.8	553	11.1	291	7.6	193	3.13	79.4	M12 x 100	18.5	8.4

ORDERING INFORMATION

- Complete the catalog number by selecting the appropriate suffix codes from the tables below
- In order to select the proper clamp suffix code, use the following equation to determine the overall diameter for the section of the span on which the damper will be installed: **Cable Diameter + (2 x Protector Rod Diameter)**
- For twin bundle 500 kV applications, please reference the EHV VORTX Vibration Damper section

VORTX Vibration Damper Catalog Number

VSD-__X____X____X____
(Section 1) (Section 2) (Section 3)

Catalog Number Example: VSD-4050B
Includes (1) VORTX Vibration Damper with weights for cable diameter range 0.984" - 1.345", clamp for overall diameter range 1.579" - 1.970", and Break-away Bolt

Section 1

Weight Suffix Code	ACSR, AAC, AAAC, and ACAR Diameter Range		Galvanized Steel and Aluminum-Clad Diameter Range		OPGW Diameter Range	
	in	mm	in	mm	in	mm
20	0.473 - 0.720	12.0 - 18.2	0.401 - 0.486	10.2 - 12.3	0.465 - 0.720	11.8 - 18.2
25	0.721 - 0.858	18.3 - 21.8	0.487 - 0.650	12.4 - 16.5	0.612 - 1.260	15.5 - 32.0
35	0.859 - 0.983	21.9 - 24.9	-	-	0.721 - 1.260	18.3 - 32.0
40	0.984 - 1.345	25.0 - 33.9				
52	1.346 - 1.602	32.1 - 40.7				

Section 2

Clamp Suffix Code	Clamp Range	
	in	mm
16	0.483 - 0.612	12.3 - 15.5
20	0.612 - 0.786	15.5 - 20.0
25	0.786 - 0.983	20.0 - 25.0
32	0.983 - 1.261	25.0 - 32.0
40	1.261 - 1.579	32.0 - 40.1
50	1.579 - 1.970	40.1 - 50.0
61	1.970 - 2.422	50.0 - 61.5

Section 3

Bolt Suffix Code	Bolt Type
Leave Blank	Standard
B	Break-away

ORDERING INFORMATION

VORTX Vibration Dampers for EHV

- EHV dampers are specially designed to meet the higher electrical corona/RIV noise requirements at voltages of 500 kV and higher. The EHV damper utilizes special weight and clamp designs to meet these requirements.
- Complete the catalog number by selecting the appropriate suffix codes from the tables below
- In order to select the proper clamp suffix code, use the following equation to determine the overall diameter for the selection of the span on which the diameter will be installed: **Cable Diameter + (2 x Protector Rod Diameter)**

VORTX Vibration Damper for EHV Catalog Number

VSD- **X** **X** **X**
(Section 1) (Section 2) (Section 3)

Catalog Number Example: VSD-5561EHVB
Includes (1) EHV VORTX Vibration Damper with weights for cable diameter range 1.602" - 1.929", clamp for overall diameter range 1.951" - 2.422", and Break-away Bolt

Section 1

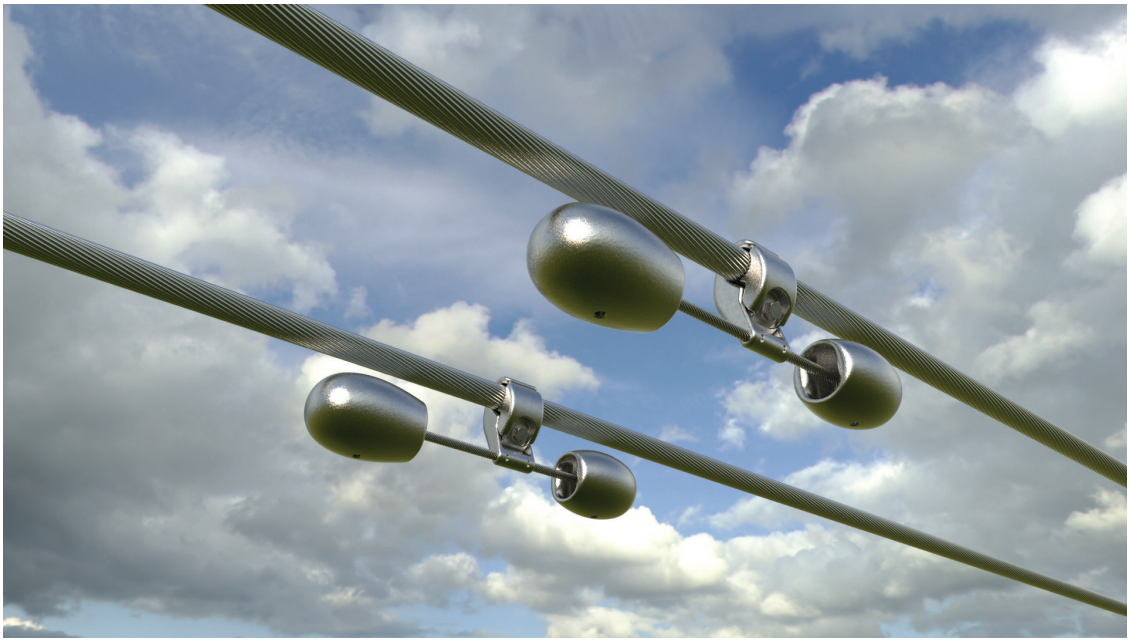
Weight Suffix Code	ACSR, AAC, AAAC, and ACAR Diameter Range	
	in	mm
55	1.602 - 1.929	40.7 - 49.0

Section 2

Clamp Suffix Code	Clamp Range	
	in	mm
43EHV	1.500 - 1.700	38.1 - 43.2
49EHV	1.700 - 1.950	43.2 - 49.5
61EHV	1.951 - 2.422	49.5 - 61.5

Section 3

Bolt Suffix Code	Bolt Type
Leave Blank	Standard
B	Break-away

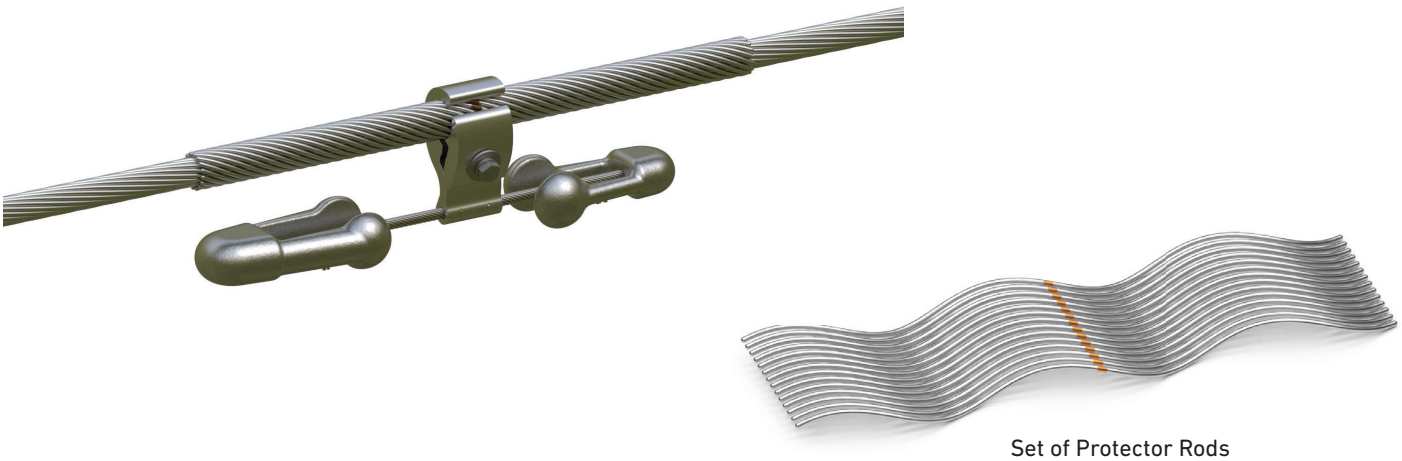


ORDERING INFORMATION

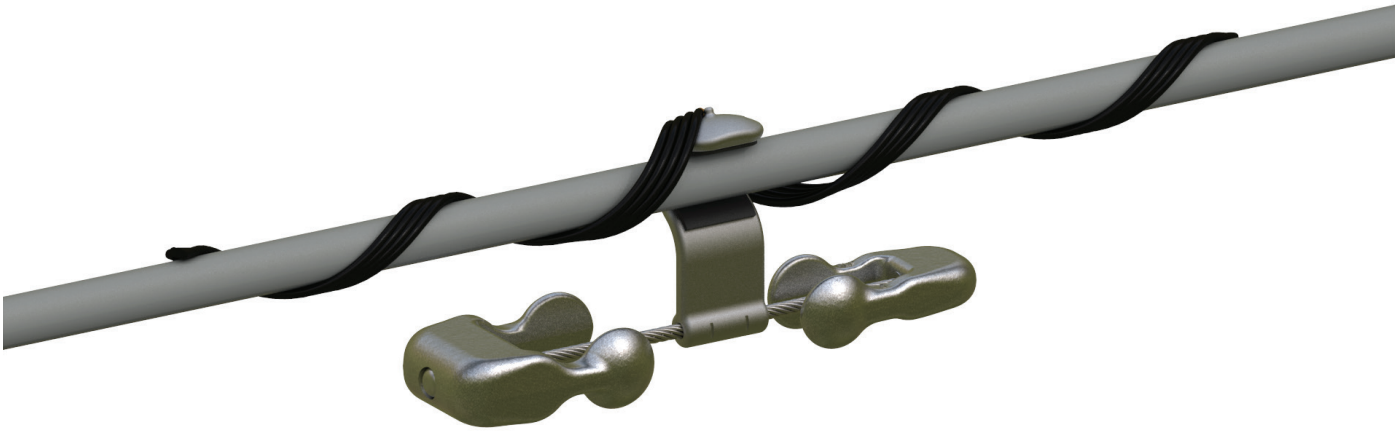
Protector Rods

- Must be ordered for locations that require the damper to be placed beyond the protective rods of the attachment hardware on composite core HTLS conductors. Protector rods are optional but recommended on ACSS.
- Select the appropriate catalog number from the table below using the cable diameter
- For EHV applications, add "E" to the end of the part number (**EXAMPLE:** PR-0156E)

Catalog Number	Cable Diameter		Rod Length		Rod Diameter		Rods per Set	Color Code	Units per Carton	Weights per Carton	
	in	mm	in	mm	in	mm				lb	kg
PR-0135	0.378 - 0.423	9.6 - 10.7	12	304	0.121	3.1	11	Yellow	50	10	4.5
PR-0137	0.424 - 0.475	10.8 - 12.1	12	304	0.121	3.1	12	Brown	50	10	4.5
PR-0139	0.476 - 0.533	12.1 - 13.5	16	406	0.121	3.1	13	Blue	50	14	6.4
PR-0141	0.534 - 0.585	13.6 - 14.8	16	406	0.121	3.1	14	Green	50	14	6.4
PR-0142	0.586 - 0.618	14.9 - 15.6	16	406	0.146	3.7	13	Orange	50	21	9.5
PR-0144	0.619 - 0.667	15.7 - 16.9	16	406	0.146	3.7	14	Purple	50	21	9.5
PR-0146	0.668 - 0.722	17.0 - 18.3	20	508	0.146	3.7	15	Red	50	29	13.1
PR-0148	0.723 - 0.816	18.4 - 20.3	20	508	0.146	3.7	16	Black	50	29	13.1
PR-0150	0.817 - 0.898	20.8 - 22.7	20	508	0.146	3.7	17	White	50	31	14.1
PR-0151	0.899 - 0.954	22.8 - 24.2	24	610	0.167	4.2	17	Yellow	50	47	21.3
PR-0152	0.955 - 1.019	24.3 - 25.8	24	610	0.182	4.6	16	Brown	25	29	13.1
PR-0152E	0.955 - 1.019	24.3 - 25.8	24	610	0.250		16	Brown	25	29	13.1
PR-0154	1.020 - 1.064	25.9 - 27.0	24	610	0.182	4.6	17	Blue	25	29	16.1
PR-0155	1.065 - 1.098	27.1- 27.8	26	660	0.204	5.2	16	Green	25	36	16.3
PR-0156	1.099 - 1.181	27.9 - 29.9	26	660	0.250	6.4	14	Orange	25	48	21.7
PR-0158	1.182 - 1.298	30.0 - 32.9	26	660	0.250	6.4	15	Purple	25	51	23.1
PR-0160	1.299 - 1.415	33.0 - 35.9	26	660	0.250	6.4	16	Blue	20	44	19.9
PR-0162	1.416 - 1.543	36.0 - 39.2	26	660	0.250	6.4	17	Yellow	20	48	21.7
PR-0163	1.544 - 1.685	39.2 - 42.8	26	660	0.250	6.4	19	Brown	15	40	18.1
PR-0164	1.686 - 1.840	42.8 - 46.7	26	660	0.250	6.4	20	Blue	15	42	19.0



Set of Protector Rods



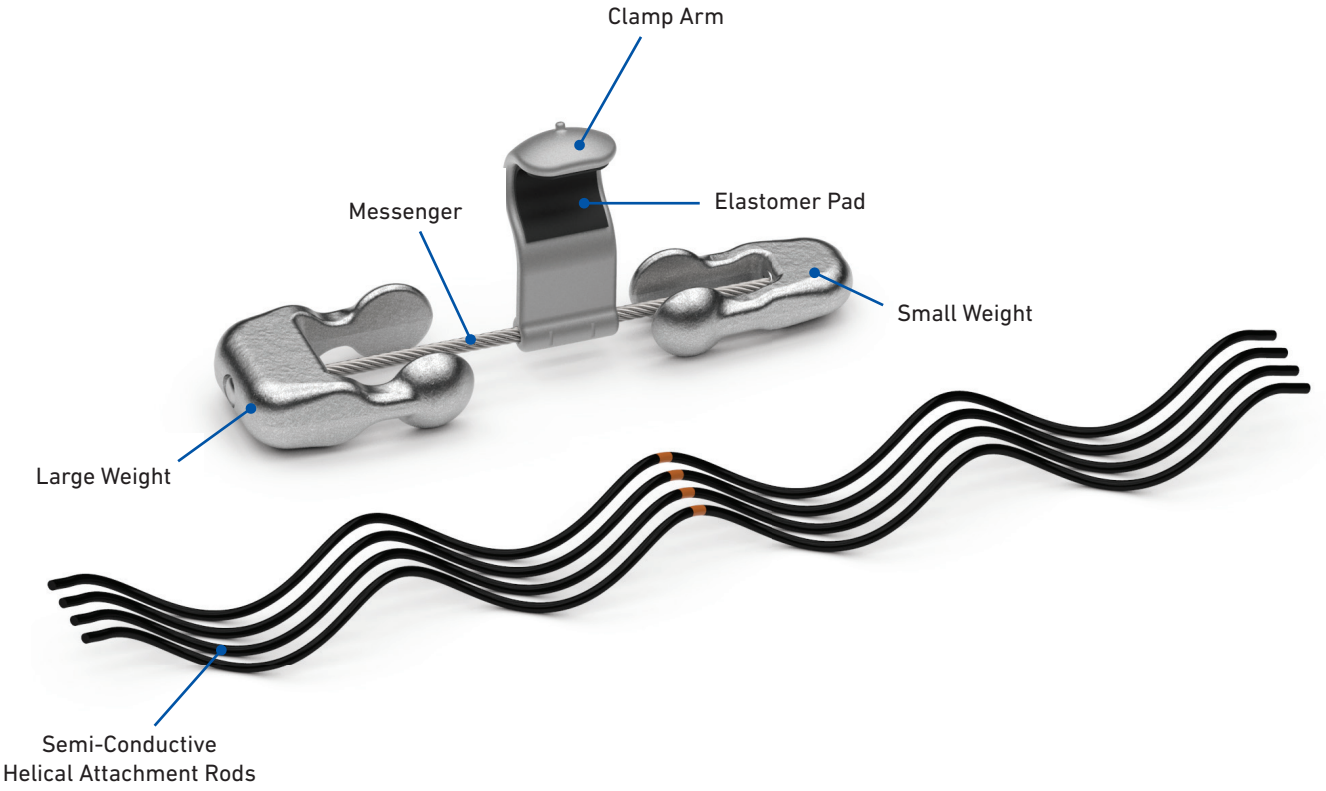
VORTX™ DAMPER FOR COVERED CONDUCTOR

PLP's **VORTX Damper for Covered Conductor** responds to wind-induced line vibration characterized by high-frequency, low amplitude motion commonly known as aeolian vibration. To protect the soft polyethylene outer layer of covered conductors, the damper for Covered Conductor features semi-conductive elastomer lined clamps and engineered helical coated attachment rods to distribute clamping forces. Developed in conjunction with utilities that experience considerable wildfire activity, the damping system is V-0 flammability tested to withstand the high heat associated with wildfires.

FEATURES AND BENEFITS

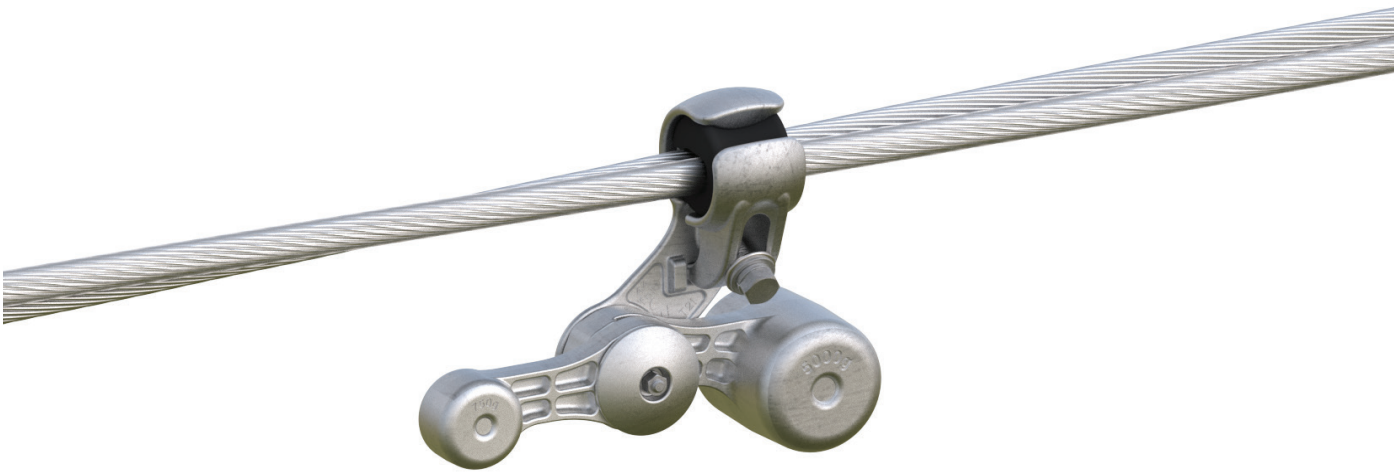
- Four-response Stockbridge design provides effective damping for wide range of frequencies
- Novel V-0 tested, semi-conductive attachment method protects the conductor jacket
- VORTX Dampers are tested in accordance with IEC 61897: Overhead Lines - Requirements and Tests for Stockbridge-Type Aeolian Vibration Dampers

COMPONENTS



ORDERING INFORMATION

- VORTX Damper for Covered Conductor design, selection, and placement is project-specific and requires analysis by PLP
- Contact your local representative or PLP Technical Support for details on design and placements that will minimize the motion of the covered conductor



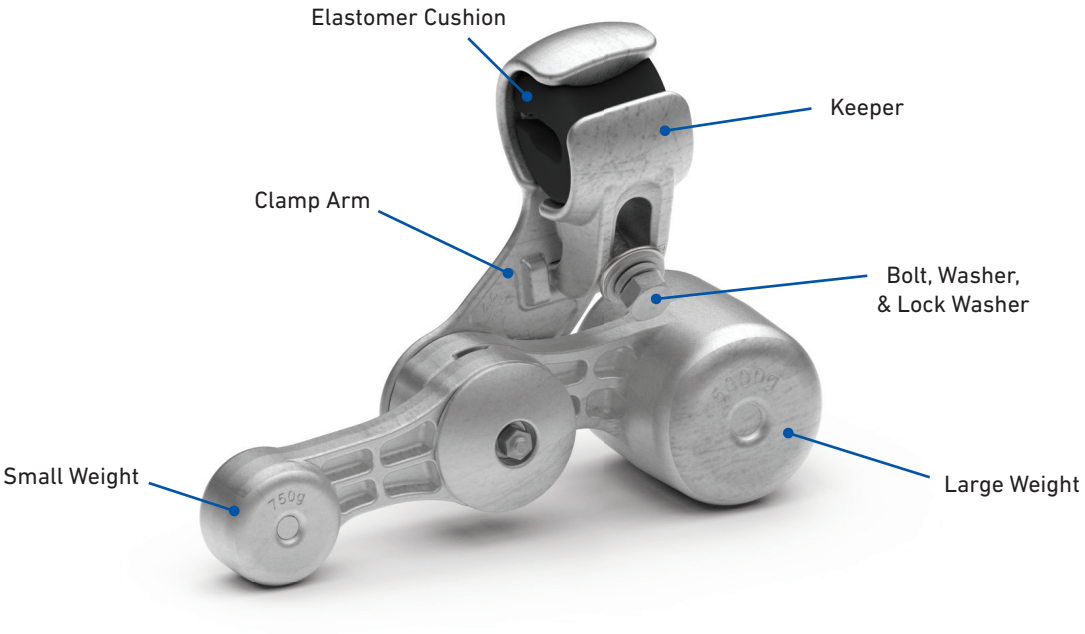
TWISTED PAIR VIBRATION DAMPER

PLP's **Twisted Pair Vibration Damper** is designed to withstand the high dynamic stresses of twisted pair conductor autorotation, while mitigating aeolian vibration. Autorotation is a torsional instability under wind flow that can cause rotational oscillation about the span axis, causing high stresses at conductor connections. Autorotation has been observed to damage Stockbridge style dampers for twisted pair conductor. The Twisted Pair Vibration Damper utilizes an elastomer damping element, and elastomer lined clamp, to withstand autorotation and provide sufficient aeolian vibration damping.

FEATURES AND BENEFITS

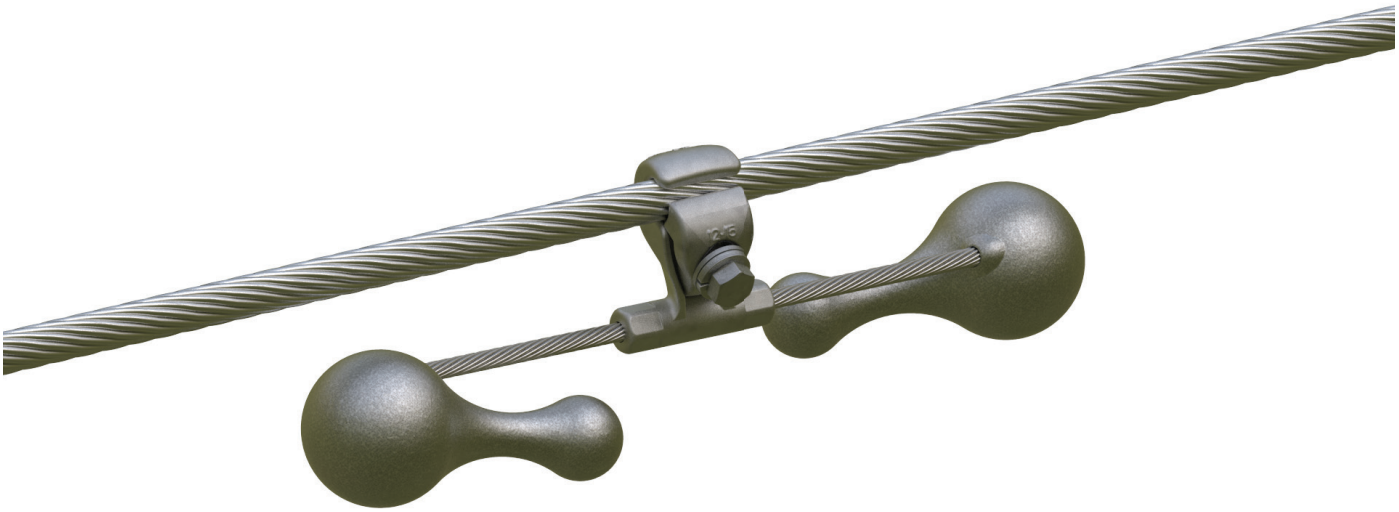
- Elastomer damping element designed to withstand the stresses associated with autorotation better than a Stockbridge damper for twisted pair conductor
- Specially designed elastomer-lined clamp reduces static and dynamic stresses on the conductor
- Elastomer damping system was initially developed in conjunction with Hydro-Québec for severe environment applications
- Corona-free up to 345 kV

COMPONENTS



ORDERING INFORMATION

- Twisted Pair Vibration Damper selection and placement is project-specific and requires analysis by PLP
- Contact your local representative or PLP Technical Support for details on design and placements



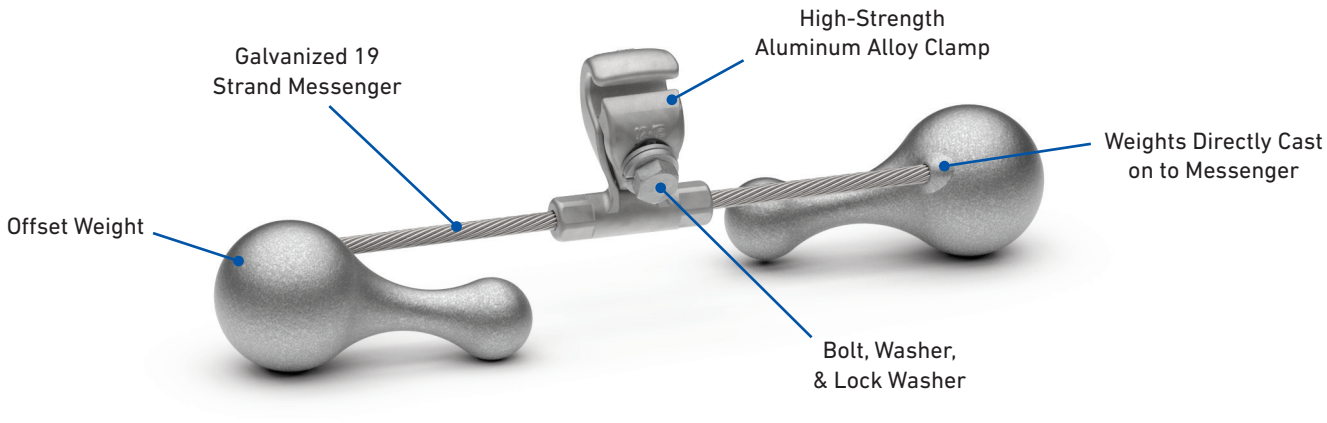
DOGBONE® VIBRATION DAMPER

The **DOGBONE Vibration Damper** is designed to eliminate overhead shield wire fatigue damage and line maintenance costs by effectively diminishing aeolian vibration. The messenger cable and unique "dog bone" shape of the weights are designed to achieve optimal energy dissipation for minimal cable movement. The DOGBONE Vibration Damper may be used as an alternate to the Spiral Vibration Damper for customers whom prefer a tuned damper option.

FEATURES AND BENEFITS

- Offset DOGBONE shaped weights introduce a torsional mode of vibration damping not present in conventional Stockbridge type dampers
- The 19 strand messenger cable provides greater energy dissipation at small amplitudes of cable motion
- The damper attachment clamp provides adequate slip strength without imposing excessive clamping pressure on the conductor
- Capable of being installed by hand or using live line installation techniques without the need to disassemble the clamp

COMPONENTS



ORDERING INFORMATION

- PLP uses an internally-developed program that utilizes the results of ongoing field and laboratory research to determine the required number and placement of DOGBONE Dampers in each cable span
- Please contact PLP to calculate optimal damper placements and quantities

DOGBONE Damper

DOGBONE Damper Weight and Clamp Sizes						
Product Code	1. Select Weight Code from Cable Diameter			2. Select Clamp Code from Applied Diameter		
	Weight Code (wc)	Steel & AL-Clad Shield Wire Range		Clamp Code (cc)	Clamp Range	
		in	mm		in	mm
DB	05	0.250 - 0.386	6.25 - 9.81	06	0.250 - 0.370	6.4 - 9.3
				09	0.371 - 0.490	9.4 - 12.4
				12	0.491 - 0.600	12.5 - 15.2
				15	0.601 - 0.710	15.3 - 18.0
	1	0.387 - 0.550	9.82 - 14.0	09	0.371 - 0.490	9.4 - 12.4
				12	0.491 - 0.600	12.5 - 15.2
				15	0.601 - 0.710	15.3 - 18.0

DOGBONE Damper Dimensions										
3. Confirm Damper Catalog Number and Properties										
Damper Catalog Number	Clamp Width		Bolt Size	Install Torque		Assembled Weight		Damper Length		Quantity per Box
DB wc-cc	in	mm	in	ft-lb	Nm	lb	kg	in	mm	ea
DB 05-06	1.50	38.1	7/16 x 1-3/4	20	27	2.7	1.2	13.8	351	15
DB 05-09	1.50	38.1	7/16 x 1-3/4	20	27	2.7	1.2	13.8	351	15
DB 05-12	1.55	39.4	1/2 x 2-1/4	25	34	2.9	1.3	13.8	351	15
DB 05-15	1.55	39.4	1/2 x 2-1/4	25	34	2.9	1.3	13.8	351	15
DB 1-09	1.50	38.1	7/16 x 1-3/4	20	27	5.1	2.3	16.3	414	10
DB 1-12	1.55	39.4	1/2 x 2-1/4	25	34	5.1	2.3	16.3	414	10
DB 1-15	1.55	39.4	1/2 x 2-1/4	25	34	5.1	2.3	16.3	414	10

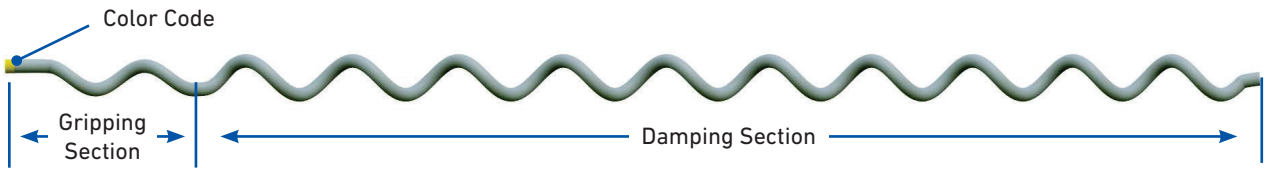
SPIRAL VIBRATION DAMPER

The **Spiral Vibration Damper (SVD)** is a motion control product used to dissipate aeolian vibration that may occur on cable spans. Using the recommended number of Spiral Vibration Dampers minimizes bending strain, protecting the cable from long-term fatigue due to aeolian vibration.

FEATURES AND BENEFITS

- Not placement sensitive - can be installed anywhere on the cable away from other attachments
- Helically-formed PVC-based rod makes impact with the cable to disrupt the aeolian vibration standing wave
- Gripping section of the damper gently holds the cable, preventing damage from clamping forces
- Effective over a broad range of frequencies
- Easily installed by hand
- Can be nested (subsetted), allowing easier installation
- Proven through extensive field and laboratory testing
- Thermal rating of 125°C for continuous operation
- Hi-Mass version provides the effectiveness of two standard SVDs
- Recommended aeolian vibration solution for all cables 0.75" in diameter and below

COMPONENTS



ORDERING INFORMATION

- Select the appropriate Spiral Vibration Damper catalog number from the table below using the cable diameter
- Refer to the Basic Recommendations table below to determine the number of Spiral Vibration Dampers required per span

Standard Spiral Vibration Damper

Catalog Number	Cable Diameter Range		Length		Per Carton	
	in	mm	in	mm	Units	Weight/lb
5050102	0.174 - 0.249	4.4 - 6.3	46	1.17	50	29
5050103	0.250 - 0.326	6.3 - 8.3	49	1.25	50	49
5050104	0.327 - 0.461	8.3 - 11.6	51	1.30	50	34
5050105	0.462 - 0.563	11.7 - 14.2	53	1.35	50	36
5050106	0.564 - 0.760	14.3 - 19.3	65	1.65	25	50

Basic Recommendations

Total Number of Standard SVDs Recommended per Span			
Span Length (ft)	Standard Application	Typical Application with Final Tensions > 20% of RBS/UTS OR Crossing Span Application	Crossing Span Application with Final Tensions > 20% of RBS/UTS
0 - 800	2	4	6
801 - 1600	4	6	10
1601 - 2400	6	10	16

NOTE: For spans over 2400 ft, contact PLP.

Hi-Mass Spiral Vibration Damper

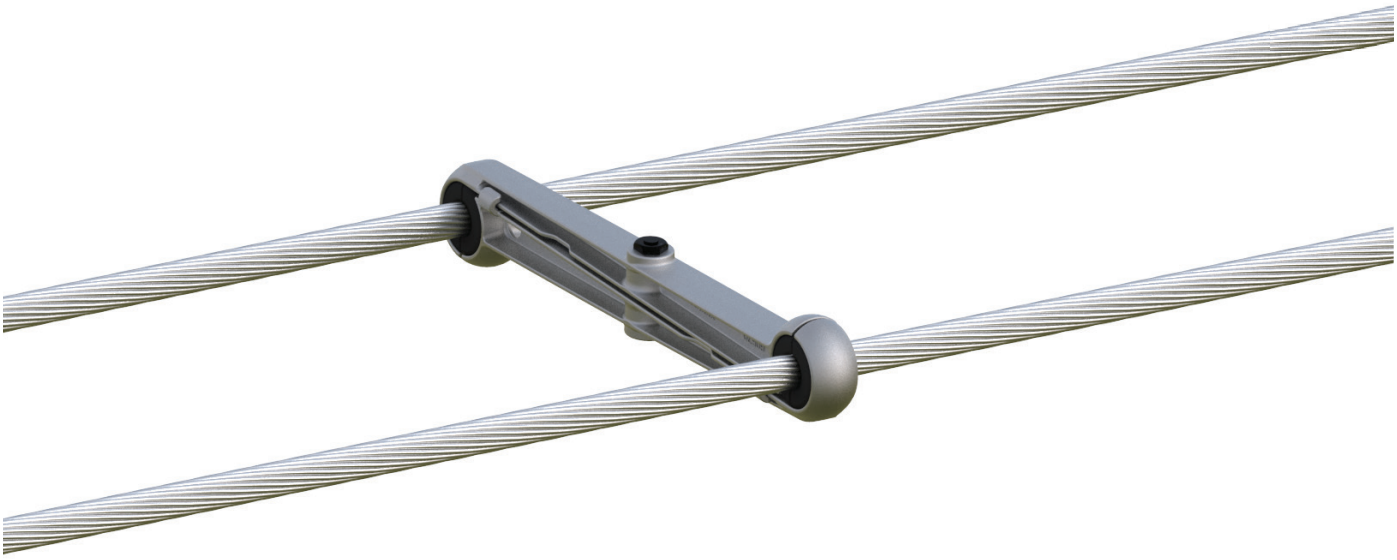
Catalog Number	Cable Diameter Range		Length		Per Carton	
	in	mm	in	mm	Units	Weight/lb
5050200	0.250 - 0.326	6.3 - 8.3	87	2.21	50	55
5050201	0.327 - 0.461	8.3 - 11.6	91	2.31	50	60
5050202	0.462 - 0.563	11.7 - 14.2	94	2.39	50	65
5050203	0.564 - 0.760	14.3 - 19.3	97	2.46	15	55

NOTE: Hi-Mass Spiral Vibration Dampers are longer in length and heavier than standard SVDs. The benefit is that they reduce the number of installations in half. Hi-Mass SVDs are recommended for longer span applications.

Basic Recommendations

Total Number of Hi-Mass SVDs Recommended per Span			
Span Length (ft)	Standard Application	Typical Application with Final Tensions > 20% of RBS/UTS OR Crossing Span Application	Crossing Span Application with Final Tensions > 20% of RBS/UTS
0 - 800	1	2	3
801 - 1600	2	3	5
1601 - 2400	3	5	8

NOTE: For spans over 2400 ft, contact PLP.



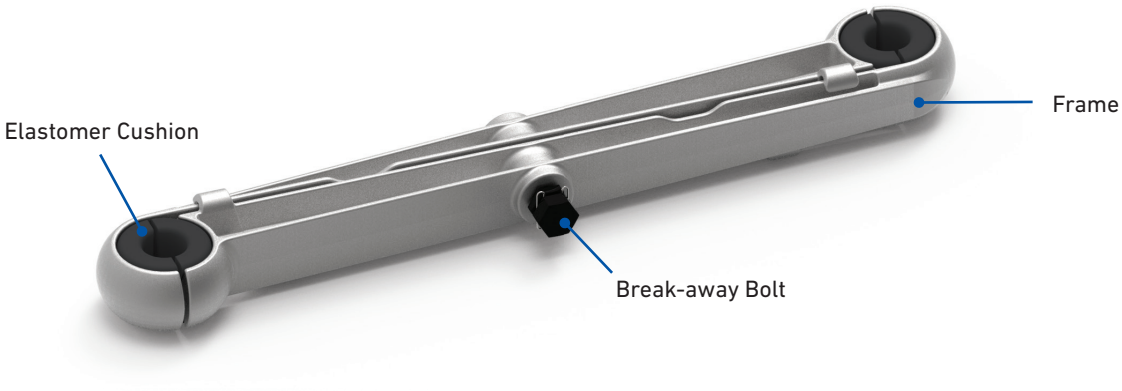
CUSHION-GRIP® TWIN SPACER

The **CUSHION-GRIP Twin Spacer** is used to maintain the conductor spacing in horizontal twin-bundle applications to maintain nominal sub-connector spacing. The secure elastomer cushions protect the conductors from bending stresses associated with sub-span oscillation and aeolian vibration.

FEATURES AND BENEFITS

- Field-proven elastomer cushions protect conductors from dynamic stresses
- Laboratory-tested against both mechanical and electrical requirements of IEC Specification IEC 61854
- High-strength aluminum alloy sliding frame uses a single break-away bolt to apply proper closing forces and facilitates installation
- Working holes facilitate easy hot-stick installation
- No loose parts - ships fully assembled
- 18" spacing is standard; contact PLP for other spacing options
- Designs for twisted pair conductor available
- Standard version available for up to 125° C continuous operation and High-Temperature version (HT) available for up to 250° C continuous operation

COMPONENTS



CUSHION-GRIP® TWIN SPACER PLACEMENT SOFTWARE

- Based upon data gathered from laboratory testing, field studies, as well as the recommendations outlined in the CIGRE report, "State of the Art Survey on Spacers and Spacer Dampers"
- Considers many input variables specific to the individual line, such as its construction, design, and local operating conditions
- Determines the recommended spacer quantity and optimal placement location within the span to counter potential damage to the line system
- Available for registration at no charge to PLP customers at **plpvortx.com**. Contact your local representative or PLP Technical Support for additional information.

ORDERING INFORMATION

• Complete the catalog number by selecting the appropriate suffix codes from the tables below

CUSHION-GRIP® Twin Spacer Catalog Number

CGTS- **X** (Section 1) **X** (Section 2) **X** (Section 3)

Catalog Number Example: CGTS-0112HT
Includes (1) CUSHION-GRIP® Twin Spacer, cable diameter range 1.107" - 1.146", high-temperature cushions, and bolt for robotic installation

Section 1

Single Conductors		
Diameter Suffix Code	Conductor Diameter Range	
	in	mm
0101	0.673 – 0.713	17.1 – 18.1
0102	0.714 - 0.752	18.1 - 19.1
0103	0.753 - 0.791	19.1 - 20.1
0104	0.792 - 0.831	20.1 - 21.1
0105	0.832 - 0.870	21.1 - 22.1
0106	0.871 - 0.909	22.1 - 23.1
0107	0.910 - 0.949	23.1 - 24.1
0108	0.950 - 0.988	24.1 - 25.1
0109	0.989 - 1.028	25.1 - 26.1
0110	1.029 - 1.067	26.1 - 27.1
0111	1.068 - 1.106	27.1 - 28.1
0112	1.107 - 1.146	28.1 - 29.1
0113	1.147 - 1.185	29.1 - 30.1
0114	1.186 - 1.224	30.1 - 31.1
0115	1.225 - 1.264	31.1 - 32.1
0116	1.265 - 1.303	32.1 - 33.1
0117	1.304 - 1.345	33.1 - 34.1

Section 1

Single Conductors		
Diameter Suffix Code	Conductor Diameter Range	
	in	mm
0118	1.346 - 1.382	34.1 - 35.1
0119	1.383 - 1.421	35.1 - 36.1
0120	1.422 - 1.461	36.1 - 37.1
0121	1.462 - 1.500	37.1 - 38.1
0122	1.501 - 1.539	38.1 - 39.1
0123	1.540 - 1.579	39.1 - 40.1
0124	1.580 - 1.618	40.1 - 41.1
0125	1.619 - 1.657	41.1 - 42.1
0126	1.658 - 1.697	42.1 - 43.1
0127	1.698 - 1.736	43.1 - 44.1
0128	1.737 - 1.776	44.1 - 45.1
0129	1.777 - 1.821	45.1 - 46.3

Section 1

Twisted Pair Conductors	
Diameter Suffix Code	Conductor Size
T2266	Partridge
T2336	Linnet
T2397	Ibis
T2477	Hawk
T2556	Grosbeak

Section 2

Temperature Suffix Code	Continuous	2-Hour Emergency
Leave Blank	125°C	150°C
HT	250°C	-

Section 3

Bolt Suffix Code	Bolt Type
Leave Blank	Standard Bolt
R	Robot Bolt

TWIN-SPACER ROBOTIC INSTALLATIONS

CSR-Twin™ Robot

Offered in partnership with FulcrumAir, installations of PLP's CUSHION-GRIP® Twin Spacers utilizing the CSR-Twin robot provide utilities with dramatic improvements in workplace safety, project efficiency, and product application. Using proprietary systems developed by PLP and FulcrumAir, the CSR-Twin robot automatically and accurately installs twin-conductor spacers at any present distance to within a five-centimeter tolerance. The spacers are positioned at precise right angles to the conductor the ensure optimal performance, and the specially designed bolt is torqued to PLP's exact specification. This sequence happens automatically while also logging important quality control data, such as torque values and spacer locations, enabling easy reference for future inspection and maintenance needs.

Improved Workplace Safety

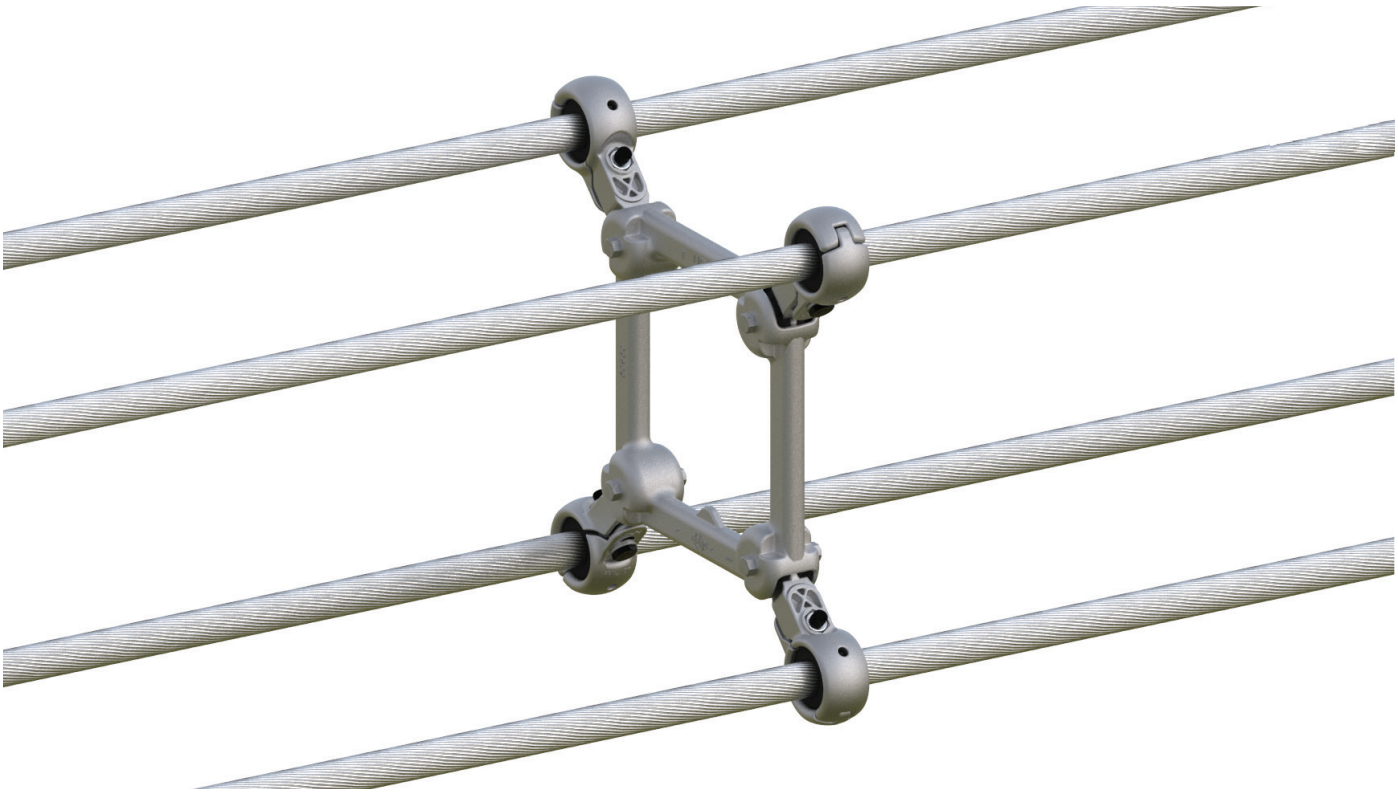
- Reduces lineworker exposure to safety hazards
- Eliminates the need for conductor carts

Increased Project Efficiency

- Dramatically decreases installation time
- Multiple robots deployed from one set-up location
- Installs spacers along multiple spans in minutes

Precision Product Installations

- Installs spacers at precise right angles, ensuring optimal performance
- Accurately torques bolt to exact specifications
- Automatically logs placement data for future inspection/maintenance needs



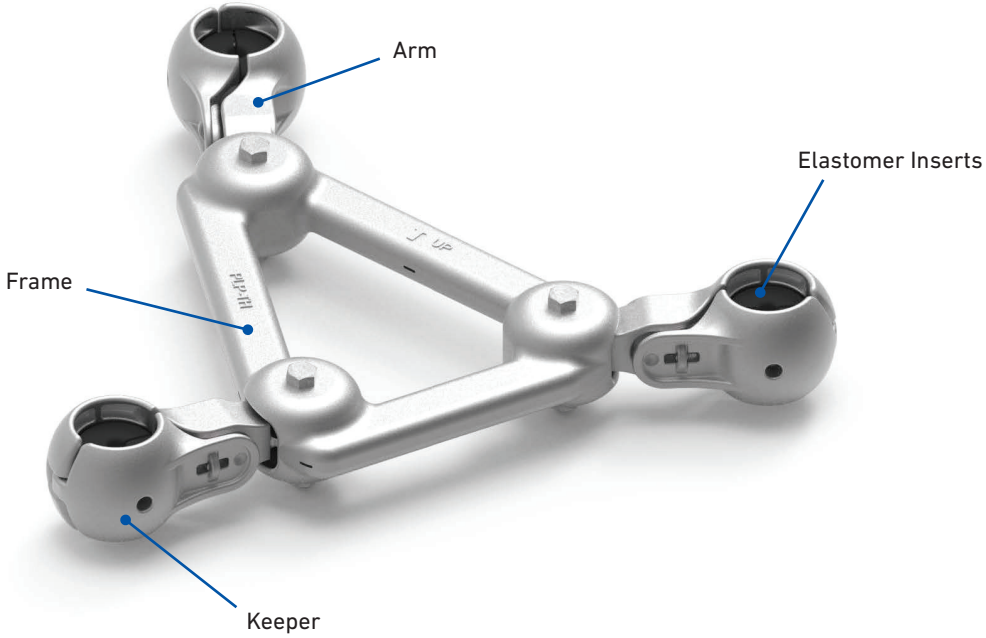
CUSHION-GRIP® SPACER DAMPER

CUSHION-GRIP Spacer Dampers for Tri, Quad, and Hex Bundles feature elastomer damping elements engineered to absorb maximum energy. This design provides resistance to conductor fatigue by eliminating the need for additional vibration dampers. Both the Type "B" and Type "C" designs employ unique damping elements which are captured in a way which assures the elastomer damping material is always in compression, providing maximum service life. The secure elastomer cushions protect the conductors from bending stresses associated with subspan oscillation and aeolian vibration.

FEATURES AND BENEFITS

- The Type B standard design meets the demanding requirements of IEC 61854 while maintaining a light overall weight and effective performance
- The Type C design features a more robust frame and damping elements, suited for application in rugged areas where traditional spacer dampers have experienced premature performance problems or failures
- Offered with three different arm closure systems: quarter turn fastener, break-away bolt, and standard bolt
- Standard version is designed for up to 125°C continuous conductor temperature (150°C two-hour emergency) and High-Temperature version (HT) is rated for up to 250°C
- For custom bundle spacing, contact PLP for details

COMPONENTS



Quarter Turn Fastener

Breakaway Bolt

Standard Bolt

SPACER DAMPER QUANTITY & PLACEMENT

- The number of spacer dampers required per span is dependent upon wind energy exposure and the cable's characteristics such as self-damping determined by the cable construction and the amount of applied tension
- A maximum sub-span length is determined, and spacer damper quantity and placements are recommended accordingly utilizing asymmetrical placement criteria

SPACER DAMPER PLACEMENT SOFTWARE

- Based upon data gathered from laboratory testing, field studies, as well as the recommendations outlined in the CIGRE report, "State of the Art Survey on Spacers and Spacer Dampers"
- Considers many input variables specific to the individual line, such as its construction, design, and local operating conditions
- Determines the recommended spacer damper quantity and optimal placement locations within the span to counter potential damage to the line system
- Available for registration at no charge to PLP customers at **plpvortx.com**. Contact your local representative or PLP Technical Support for more information.

ORDERING INFORMATION

• Complete the catalog number by selecting the appropriate suffix codes from the tables below

CUSHION-GRIP® Spacer Damper Catalog Number

CGSD- X (Section 1) X (Section 2) X (Section 3) X (Section 4) X (Section 5) X (Section 6)

Catalog Number Example: CGSDB-34534HT
CGSDB-34534HT is a Type "B" Spacer Damper for Tri Bundle application, with conductors having a diameter range of 1.304 - 1.345" (33 - 34 mm) and an 18" x 18" x 18" conductor configuration, utilizing a quarter turn fastener and high-temperature cushions.

Section 1

Frame Type Suffix Code	Frame
B	B Type
C	C Type

Section 2

Bundle Suffix Code	Bundle
3	Tri
4	Quad
6	Hex

Section 3

Conductor Spacing Suffix Code	Conductor Spacing A x B x B
45	18" x 18" x 18"
64	25.5" x 18" x 18"

Section 4

Clamp Suffix Code	Clamp Range	
	in	mm
18	0.673 - 0.713	17 - 18
19	0.714 - 0.752	18 - 19
20	0.753 - 0.791	19 - 20
21	0.792 - 0.831	20 - 21
22	0.832 - 0.870	21 - 22
23	0.871 - 0.909	22 - 23
24	0.910 - 0.949	23 - 24
25	0.950 - 0.988	24 - 25
26	0.989 - 1.028	25 - 26
27	1.029 - 1.067	26 - 27
28	1.068 - 1.106	27 - 28
29	1.107 - 1.146	28 - 29
30	1.147 - 1.185	29 - 30
31	1.186 - 1.224	30 - 31
32	1.225 - 1.264	31 - 32
33	1.265 - 1.303	32 - 33
34	1.304 - 1.345	33 - 34
35	1.346 - 1.382	34 - 35
36	1.383 - 1.421	35 - 36
37	1.422 - 1.461	36 - 37
38	1.462 - 1.500	37 - 38
39	1.501 - 1.539	38 - 39
40	1.540 - 1.579	39 - 40
41	1.580 - 1.618	40 - 41
42	1.619 - 1.657	41 - 42
43	1.658 - 1.697	42 - 43
44	1.698 - 1.736	43 - 44
45	1.737 - 1.776	44 - 45
46	1.777 - 1.821	45 - 46

Section 5

Arm Type Suffix Code	Arm Type
Leave Blank	Quarter Turn
B	Bolt
EB	Breakaway Bolt

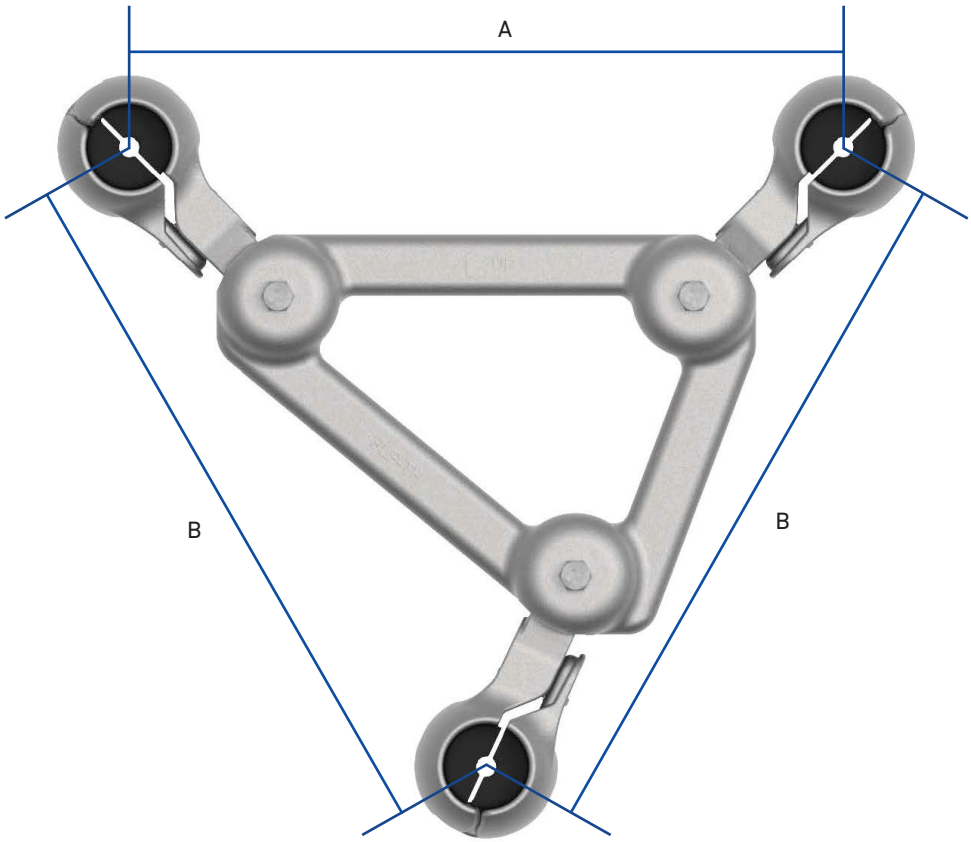
Section 6

Cushion Type Suffix Code	Cushion
Leave Blank	Standard
HT	High-Temperature

ORDERING INFORMATION

A x B x B

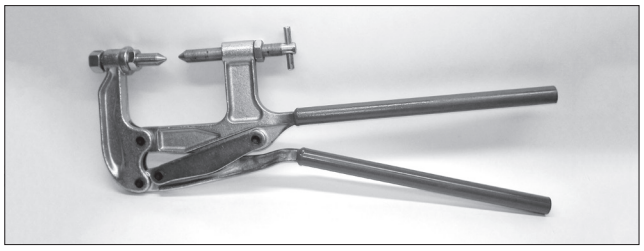
• The conductor spacing is denoted by the following configuration.



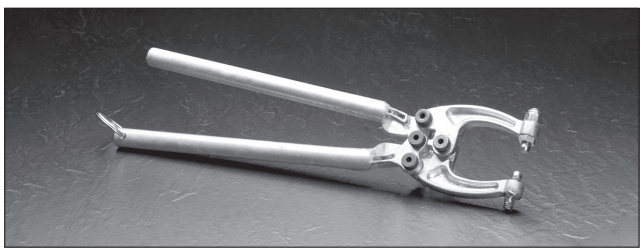
Tools

Catalog Number	Description
00071004	90-Degree CUSHION-GRIP Spacer Damper Installation Tool
00071033	Parallel CUSHION-GRIP Spacer Damper Installation Tool

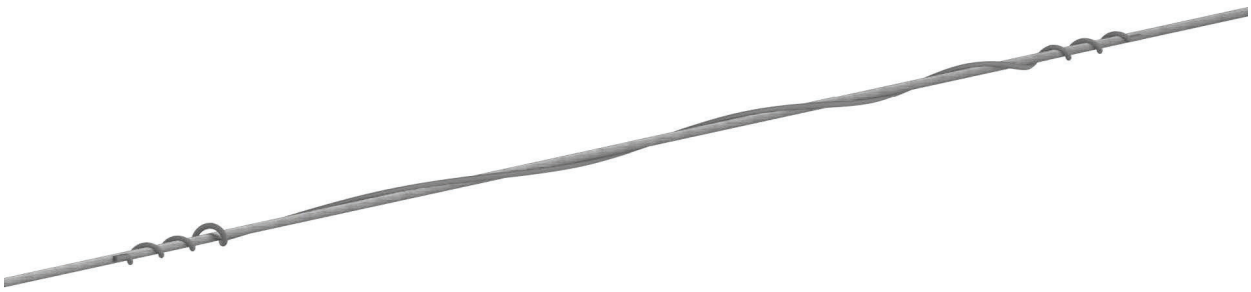
NOTE: PLP offers tools to assist in the closing of the quarter turn. Two different versions are available for versatility.



00071033



00071004



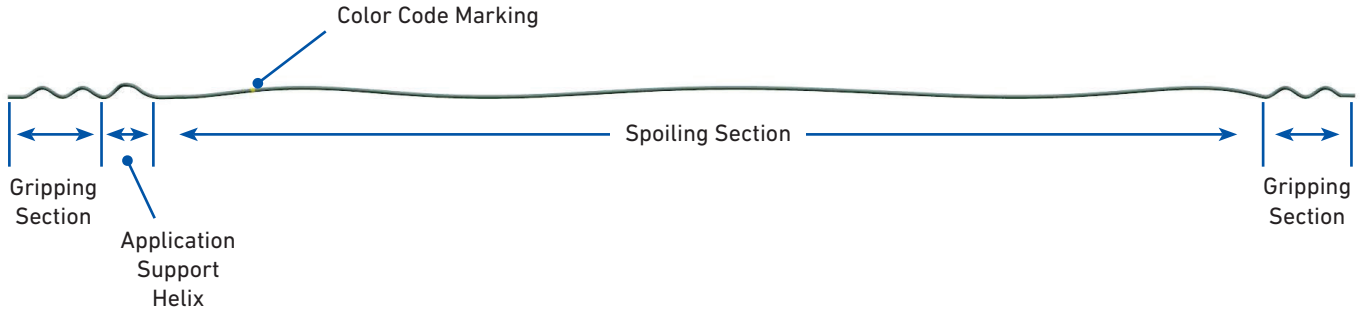
AIR FLOW SPOILER

The **Air Flow Spoiler** is a motion control product used to control galloping of cable spans. Galloping can rapidly cause severe damage to cable systems if left unmitigated. Using the recommended quantity and placement of Air Flow Spoilers can suppress galloping and increase cable longevity.

FEATURES AND BENEFITS

- Central spoiling section suppresses galloping by providing a constantly changing aerodynamic profile, disrupting lift
- Helical gripping sections on both ends grip the cable securely without excess clamping forces
- Number and placement of Air Flow Spoilers in each cable span are determined by an internally-developed program based on the results of field and laboratory research
- AFS's are made of durable, UV-rated PVC
- Standard version available for up to 230 kV and EHV available for up to 345 kV
- Air Flow Spoilers for EHV applications have a co-extruded semi-conductive material layer that resists the surface effects of high electrical gradients and minimizes the possible generation of radio interference (RI)

CHARACTERISTICS



Feature	Description
Gripping Section	Gently grips the cable
Application Support Helix	Supports the Air Flow Spoiler as the gripping sections are installed
Spoiling Section	Provides a change in the aerodynamic profile of the cable to mitigate galloping
Color Code Marking	Identifies the product's cable diameter range

ORDERING INFORMATION

• Select the appropriate catalog number from the tables below using the cable's diameter

Air Flow Spoiler

Catalog Number	EHV Catalog Number	Cable Diameter Range		Length		Weight/Unit	Color Code
		in	mm	ft	m	lb	
5058100		0.25 - 0.326	6.3 - 8.3	13-1/2	4.11	1.0	Red
5058101		0.327 - 0.461	8.31 - 11.7	13-1/2	4.11	1.0	White
5058102		0.462 - 0.563	11.8 - 14.3	14	4.27	2.3	Orange
5058103		0.564 - 0.760	14.4 - 19.3	14-1/2	4.42	2.4	Yellow
5058104		0.761 - 0.926	19.4 - 23.5	15	4.57	4.3	Blue
5058105	5058200	0.927 - 1.019	23.6 - 25.9	15-1/4	4.65	4.5	Black
5058106	5058201	1.02 - 1.165	26.0 - 29.6	15-3/4	4.8	5.5	Purple
5058107	5058202	1.166 - 1.469	29.7 - 37.3	16	4.88	5.8	Brown
5058108	5058203	1.47 - 1.602	37.4 - 40.7	17	5.18	9.5	Green
5058109	5058204	1.603 - 1.762	40.8 - 44.8	17-1/2	5.33	9.8	Pink
5058110	5058205	1.763 - 1.922	44.9 - 48.8	18	5.49	10.5	Red

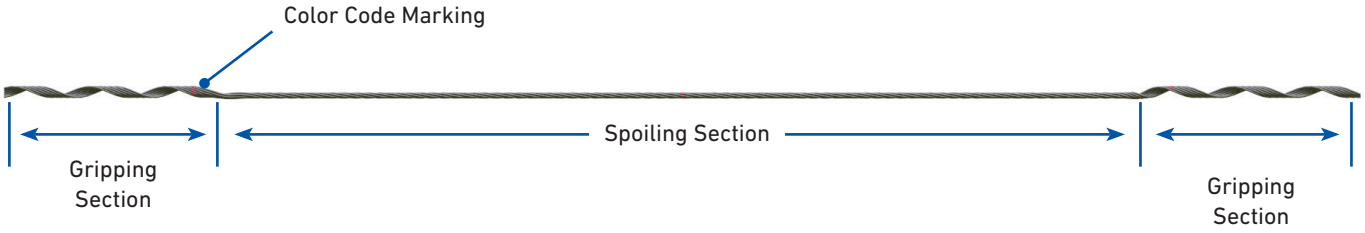
HIGH-TEMPERATURE AIR FLOW SPOILER

The **High-Temperature Air Flow Spoiler** is constructed of aluminum alloy rods that enable the device to withstand conductor temperatures up to 250°C. By subsetting multiple helical rods and cabling (twisting) the center section, the high-temperature Air Flow Spoiler functions in the same manner as the standard Air Flow Spoiler.

FEATURES AND BENEFITS

- Central spoiling section suppresses galloping by providing a constantly changing aerodynamic profile, disrupting lift
- Helical gripping sections on both ends grips the cable securely without excess clamping forces
- Number and placement of Air Flow Spoilers in each cable span are determined by an internally-developed program based on the results of extensive field and laboratory research
- Contact PLP for details regarding High-Temperature Air Flow Spoiler applications above 230 kV

CHARACTERISTICS



Feature	Description
Gripping Section	Gently grips the cable
Spoiling Section	Provides a change in the aerodynamic profile of the cable to mitigate galloping
Color Code Marking	Identifies the product's cable diameter range
Application Support Tool	Supports the High-Temperature Air Flow Spoiler while the gripping section on the opposite end is applied

Application Support Tool

ORDERING INFORMATION

• Select the appropriate catalog number from the tables below using the cable's diameter

High-Temperature Air Flow Spoiler

Catalog Number	Cable Diameter Range		Length		Weight/Unit	Color Code
	in	mm	ft	m	lb	
5059017	0.761 - 0.808	19.3 - 20.5	15-1/2	4.72	5.7	Brown
5059018	0.809 - 0.856	20.6 - 21.7	16	4.88	5.8	Purple
5059019	0.857- 0.907	21.8 - 23.0	16	4.88	5.8	Orange
5059020	0.908 - 0.962	23.1 - 24.4	16	4.88	5.9	Black
5059021	0.963 - 1.019	24.5 - 25.9	16	4.88	5.9	Red
5059022	1.02 - 1.078	26.0 - 27.4	16-3/4	5.11	10.9	Blue
5059023	1.079 - 1.138	27.5 - 28.9	16-3/4	5.11	11.0	Yellow
5059024	1.139 - 1.199	29.0 - 30.5	16-3/4	5.11	11.3	Green
5059025	1.2 - 1.263	30.6 - 32.1	17-1/2	5.33	11.5	Pink
5050926	1.264 - 1.33	32.2 - 33.8	17-3/4	5.41	11.7	Brown
5059027	1.331 - 1.399	33.9 - 35.5	18-1/2	5.64	12.2	Purple
5059028	1.4 - 1.469	35.6 - 37.3	19-1/4	5.87	12.6	Orange
5059029	1.47 - 1.549	37.4 - 39.3	21-1/2	6.55	20.2	Black
5059030	1.55 - 1.629	39.4 - 41.1	22	6.71	20.9	Red
5059031	1.63 - 1.714	41.5 - 43.5	22-1/2	6.86	21.2	Blue
5059032	1.715 - 1.805	43.6 - 45.9	23-1/2	7.16	22.0	Yellow

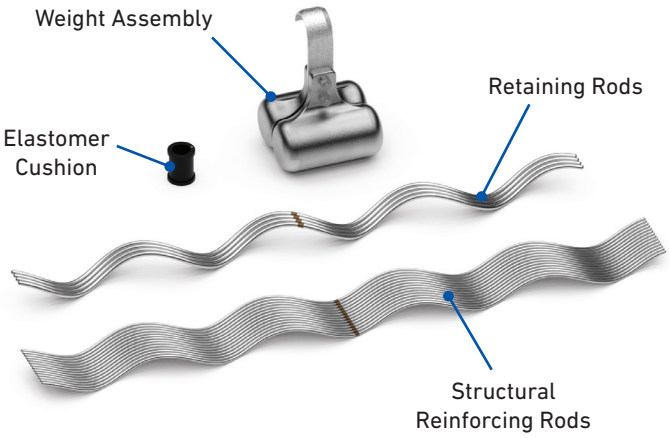
DETUNING PENDULUM

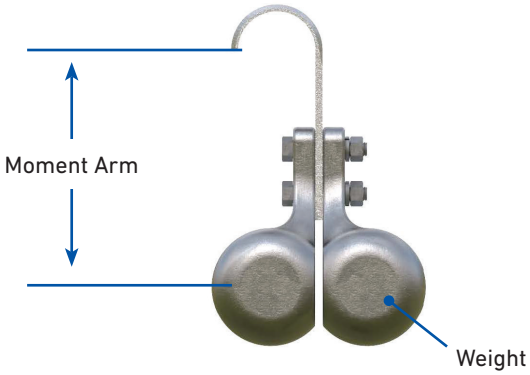
The **Detuning Pendulum** is a motion control product designed to minimize the amplitude of vertical conductor motion during galloping events. Galloping can rapidly cause severe damage to the cable system. Applying the recommended quantity and placements of Detuning Pendulums can suppress galloping, minimize conductor clashing, and increase cable longevity.

FEATURES AND BENEFITS

- Detuning Pendulums are project-specific, and are designed and analyzed specifically for the line configuration
- Can be configured for single or bundled conductors
- Structural reinforcing rods are applied over the conductor before Detuning Pendulum application to protect the outer aluminum conductor strands from damage at the attachment location
- Rubber sleeve provides an added layer of protection to the structural reinforcing rods where the Detuning Pendulum is placed
- Helical rods are used to attach the Detuning Pendulum to the conductor to help reduce compression forces and the level of strain on the underlying conductor
- Rated for 250°C continuous operation
- Pendulum weight varies depending on specific application
- Can be applied to a de-energized or live line through helicopter or bucket truck installation

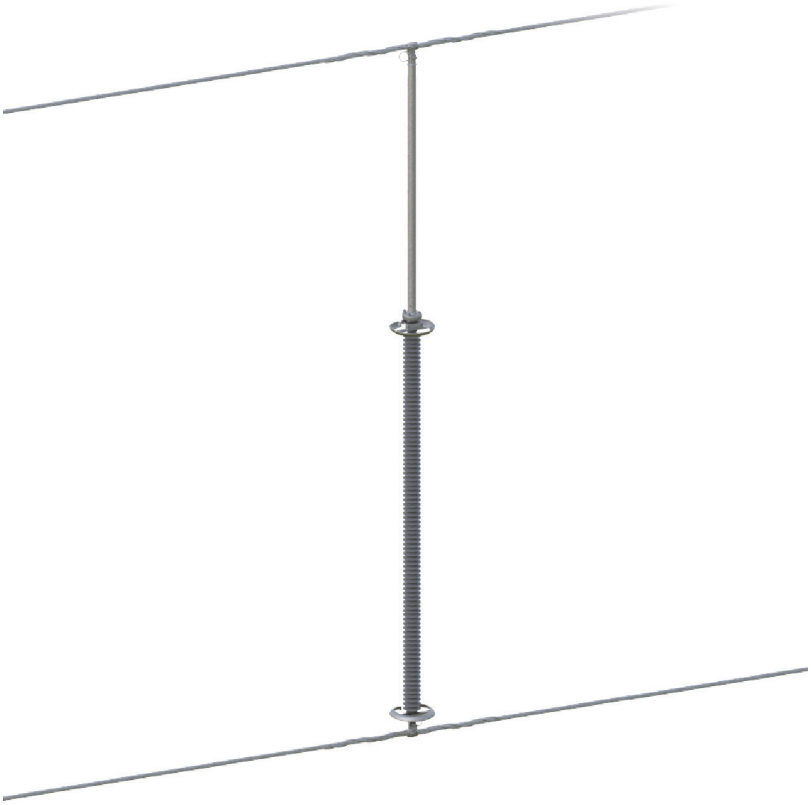
COMPONENTS





ORDERING INFORMATION

- Detuning Pendulum design and placement is project-specific and requires analysis by PLP. Span and tension information, tower dimensions, and icing levels, among other factors, will influence pendulum design and placements.
- PLP's extensive experience with laboratory and field testing allows us to provide customers with placement and design recommendations that will minimize the motion of the conductor bundles due to galloping events and maximize the longevity of the line
- Please contact PLP for details on Detuning Pendulum design and placements



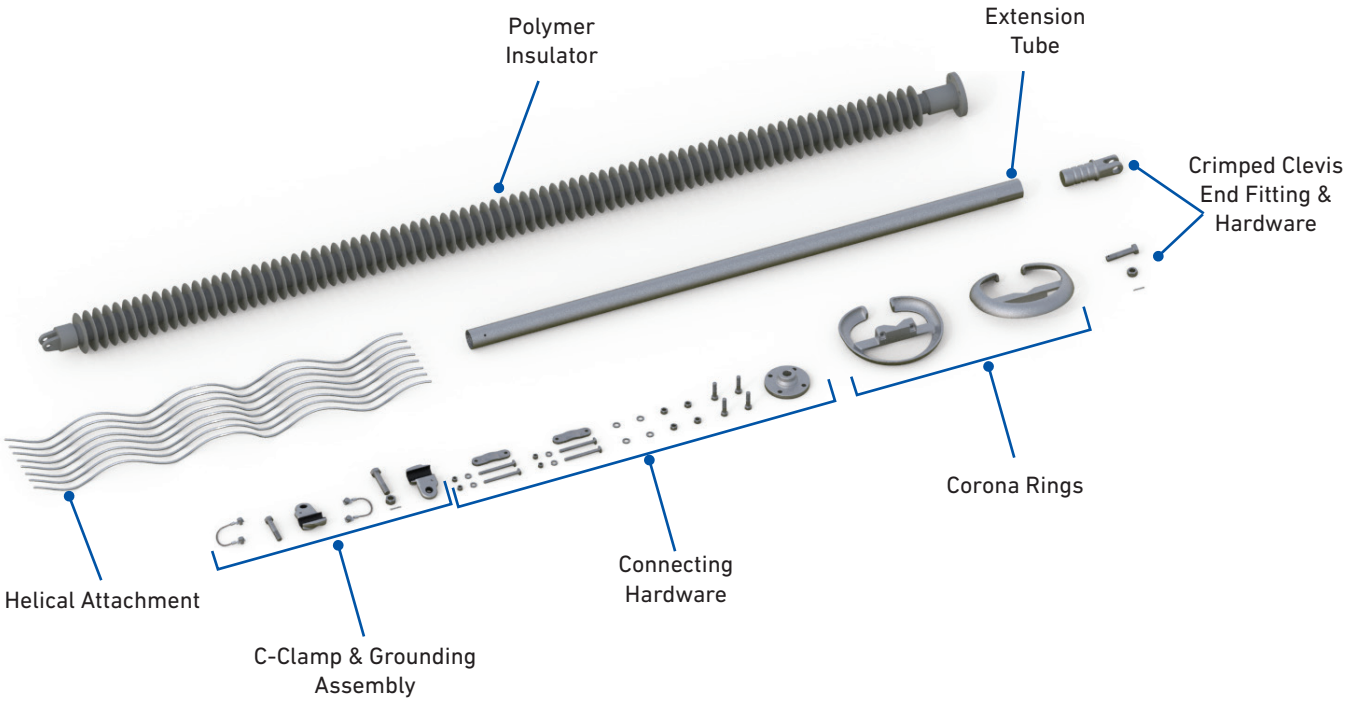
INTERPHASE SPACER

The **Interphase Spacer** is a motion control device designed to minimize the amplitude of conductor motion during galloping events. Galloping can rapidly cause severe damage to the cable system. Interphase Spacers protect valuable transmission equipment by reducing the oscillation amplitudes induced by galloping or ice shedding, maintaining critical phase spacing to avoid flashovers, to help withstand dynamic loads in both tension and compression.

FEATURES AND BENEFITS

- Can be configured to specific project requirements
- Clamping systems, electrical characteristics, and material properties can be modified on-demand
- Spacer length can be field-adjusted
- Designed and tested to withstand compressive loads induced by galloping and ice shedding oscillations

COMPONENTS



ORDERING INFORMATION

- Interphase Spacer design and placement is project-specific and requires analysis by PLP. Tower design, phase spacing, span length, and line tension are among factors that impact Interphase Spacer design and placements.
- PLP's extensive experience with laboratory and field testing allows us to provide customers with placement and design recommendations that will minimize the motion of the conductor bundles due to galloping events, and maximize the longevity of the line
- Contact your local representative or PLP Technical Support for details on design and placements

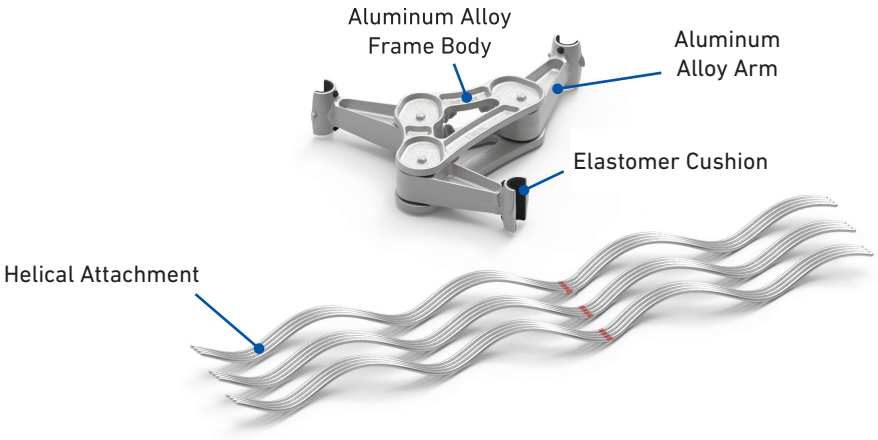
PLP/HYDRO-QUÉBEC SPACER DAMPER

The **PLP/Hydro-Québec Spacer Damper** provides wind-induced motion control and endurance to dynamic loads in extreme environments. The functionality of this advanced spacer damper was validated by comprehensive laboratory testing and field trials.

FEATURES AND BENEFITS

- Helical attachment and elastomer cushion reduces conductor stress on the conductor and eliminates the possibility of clamp loosening
- Articulation point designed to subject elastomer damping elements to compressive forces, improving fatigue endurance
- Rugged frame specially designed for heavy ice, wind loads, and severe weather conditions
- Available in twin, triple, and quad bundle configurations
- High-temperature version capable of 230° C continuous operating temperatures available upon request

COMPONENTS



ORDERING INFORMATION

- Select the appropriate catalog number for the PLP/Hydro-Québec Spacer Damper from the table below using the conductor diameter
- PLP/Hydro-Québec Spacer Dampers utilize a different asymmetric placement scheme from standard CUSHION-GRIP® Spacer Dampers. Please reach out to PLP Product Support for placement and quantity recommendations.

PLP/Hydro-Québec Spacer Damper

Sub-conductor Diameter		Sub-conductor Spacing					
		Twin			Triple	Quad	
in	mm	16" (406 mm)	18" (457 mm)	20" (500 mm)	18" (457 mm)	18" (457 mm)	20" (500 mm)
0.835 - 0.873	21.2 - 22.1	EAT2-406-221	EAT2-457-221	EAT2-500-221	EAT3-457-221	EAT4-457-221	EAT4-500-221
0.874 - 0.921	22.2 - 23.3	EAT2-406-233	EAT2-457-233	EAT2-500-233	EAT3-457-233	EAT4-457-233	EAT4-500-233
0.922 - 0.960	23.4 - 24.3	EAT2-406-243	EAT2-457-243	EAT2-500-243	EAT3-457-243	EAT4-457-243	EAT4-500-243
0.961 - 0.999	24.4 - 25.3	EAT2-406-253	EAT2-457-253	EAT2-500-253	EAT3-457-253	EAT4-457-253	EAT4-500-253
1.000 - 1.039	25.4 - 26.3	EAT2-406-263	EAT2-457-263	EAT2-500-263	EAT3-457-263	EAT4-457-263	EAT4-500-263
1.040 - 1.062	26.4 - 26.9	EAT2-406-269	EAT2-457-269	EAT2-500-269	EAT3-457-269	EAT4-457-269	EAT4-500-269
1.063 - 1.102	27.0 - 27.9	EAT2-406-279	EAT2-457-279	EAT2-500-279	EAT3-457-279	EAT4-457-279	EAT4-500-279
1.102 - 1.141	28.0 - 28.9	EAT2-406-289	EAT2-457-289	EAT2-500-289	EAT3-457-289	EAT4-457-289	EAT4-500-289
1.142 - 1.169	29.0 - 29.6	EAT2-406-296	EAT2-457-296	EAT2-500-296	EAT3-457-296	EAT4-457-296	EAT4-500-296
1.170 - 1.208	29.7 - 30.6	EAT2-406-306	EAT2-457-306	EAT2-500-306	EAT3-457-306	EAT4-457-306	EAT4-500-306
1.207 - 1.247	30.7 - 31.6	EAT2-406-316	EAT2-457-316	EAT2-500-316	EAT3-457-316	EAT4-457-316	EAT4-500-316
1.248 - 1.287	31.7 - 32.6	EAT2-406-326	EAT2-457-326	EAT2-500-326	EAT3-457-326	EAT4-457-326	EAT4-500-326
1.288 - 1.326	32.7 - 33.6	EAT2-406-336	EAT2-457-336	EAT2-500-336	EAT3-457-336	EAT4-457-336	EAT4-500-336
1.303 - 1.339	33.1 - 34.0	EAT2-406-340	EAT2-457-340	EAT2-500-340	EAT3-457-340	EAT4-457-340	EAT4-500-340
1.327 - 1.365	33.7 - 34.6	EAT2-406-346	EAT2-457-346	EAT2-500-346	EAT3-457-346	EAT4-457-346	EAT4-500-346
1.366 - 1.405	34.7 - 35.6	EAT2-406-356	EAT2-457-356	EAT2-500-356	EAT3-457-356	EAT4-457-356	EAT4-500-356
1.406 - 1.444	35.7 - 36.6	EAT2-406-366	EAT2-457-366	EAT2-500-366	EAT3-457-366	EAT4-457-366	EAT4-500-366
1.445 - 1.483	36.7 - 37.6	EAT2-406-376	EAT2-457-376	EAT2-500-376	EAT3-457-376	EAT4-457-376	EAT4-500-376
1.484 - 1.523	37.7 - 38.6	EAT2-406-386	EAT2-457-386	EAT2-500-386	EAT3-457-386	EAT4-457-386	EAT4-500-386
1.524 - 1.562	38.7 - 39.6	EAT2-406-390	EAT2-457-390	EAT2-500-390	EAT3-457-390	EAT4-457-390	EAT4-500-390
1.563 - 1.602	39.7 - 40.6	EAT2-406-406	EAT2-457-406	EAT2-500-406	EAT3-457-406	EAT4-457-406	EAT4-500-406
1.603 - 1.641	40.7 - 41.6	EAT2-406-416	EAT2-457-416	EAT2-500-416	EAT3-457-416	EAT4-457-416	EAT4-500-416

NOTE: For high-temperature applications, add suffix HT.

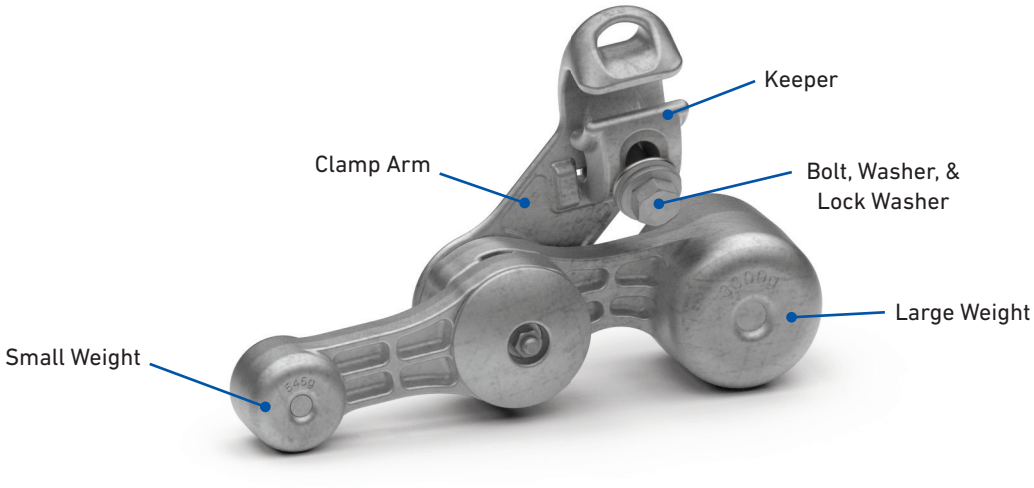
PLP/HYDRO-QUÉBEC VIBRATION DAMPER

The **PLP/Hydro-Québec Vibration Damper** has been developed to increase durability while providing a damping performance equivalent to the best Stockbridge dampers available on the market. It was developed by redesigning the spacer damper's articulated structure to create a new damping mechanism.

FEATURES AND BENEFITS

- Ideal for use in areas with known icing and galloping activities
- Superior fatigue endurance increases service life of conductors and tower components
- Particularly suited to applications in areas where dependability and long life are important and where high corrosion resistance is required, such as coastal areas and river or fjord crossings. Elimination of the messenger strand greatly improves the corrosion resistance and durability of the damper.
- Elastomer damping mechanism works primarily in compression, greatly improving damper service life

COMPONENTS



ORDERING INFORMATION

- Contact your local representative or PLP Technical Support for assistance with Vibration Damper catalog number recommendations and placements

NOTES:

NOTES:

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