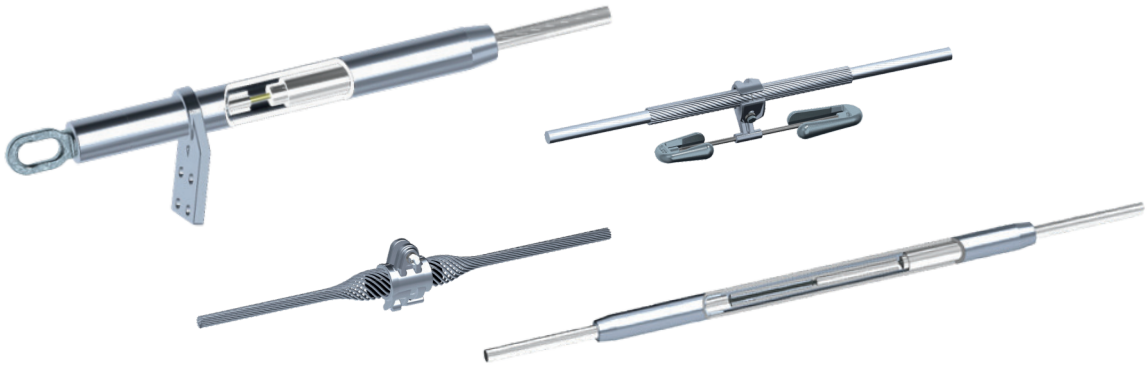
sicame GROUP

EPSILON CABLE
The alternative

2024 EDITION

EPSILON ADVANCED CONDUCTORS ACCESSORIES CATALOG



SICAME Group

SICAME Group is a recognized world leader specializing in the design and manufacturing of components, accessories, equipment's and services for Transmission and Distribution electrical networks.

With decades of background and recognized experience, SICAME Transmission business unit is specialized in designing, manufacturing, and producing a comprehensive ranges of Transmission lines and systems connectors, damping systems, hardware, and has the most advanced substation fitting solutions. These are adapted to the most technical configurations such as 8-bundle Spacer dampers, UHV HVDC connectors or innovative or High Temperature conductor's accessories.

SICAME Transmission relies on world-class brands: Dervaux, Salvi, SBI connectors, SICAME India, SKELT, SEF, and SICAME Energie

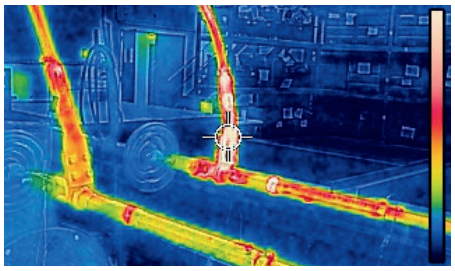
- Renowned and trustworthy in the Transmission realm thanks to its unique know-how
- Giving our customers the best-in-class solutions

High temperature low sag cable line hardware (HTLS)

Since 2001, SICAME Transmission has been working closely with the French electricity grid (RTE: Réseaux de Transport d'Electricité) and other major Utilities, to successfully qualify for the HTLS conductor sets and accessories.

SICAME Transmission has confirmed for many years now, proven its strong technical capacity to design line hardware suitable to the HTLS conductors' characteristics requirements:

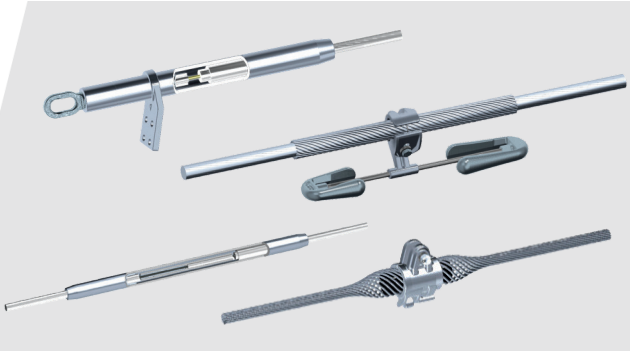
- Maximum operating temperature (up to 482°F)
- Fully annealed aluminum for conductor strands
- Carbon core conductor accessories design expertise



These specific Conductor characteristics require the study and qualification of line hardware that result in safe, durable installations, irespective of whether these are for new or existing lines.

HTLS accessories

Our offering includes a complete range of suspension, anchoring, and connection accessories for poles.



EPSILON CABLE

Our mission: design and manufacture advanced conductors to modernize power lines worldwide

Since 1987, Epsilon is a pioneer and world leader in high performance composite materials thanks to the pultrusion process. Epsilon Cable is at the forefront of the grid modernization, with a proven track record of several thousands of miles of advanced conductors installed worldwide in the past 2 decades.

With its R&D center and Pultrusion facilities, Epsilon is ISO 9001 certified.

Epsilon Advanced Conductors Technology

Epsilon Cable developed a complete range of advanced conductors (also called High Capacity / High Temperature Low Sag or HTLS conductors) made of carbon-glass fibers epoxy composite cores and trapezoidal conductive strands using annealead aluminium 1350-0 or thermal alloys.
Compared with a traditional ACSR conductor, this composite core conductor allows to double the ampacity of a line, or to decrease line losses by up to 30% while reducing sag. Several thousands of miles of Epsilon composite core conductors have been installed and energized successfully around the world since 2012, which makes it one of the leading advanced conductors.

Epsilon manufactures composite cores by pultrusion, using aerospace grade carbon fibers and a specific matrix to ensure the highest performance and durability. Epsilon Advanced Conductors cores are qualified according to ASTM B987. They include an electrically insulating glass fiber layer to increase the core performance and flexibility, and protect the aluminum strands from galvanic corrosion.

ASTM B987

Epsilon works with the most demanding utilities and cable manufacturers to reach their ambitious performance and cost targets.

Accessories and installation

Epsilon Advanced Conductors are installed using conventional compression accessories designed by Sicame. This technological choice was made to maintain existing practices from the industry, with limited adjustments on the fittings in terms of complexity or cost. It results in simple installation crew training and reduced risks of failures due to improper installation. Our experts support installation teams providing up to date practices and guidelines to installation crews before and during installation.

Damping science mastering

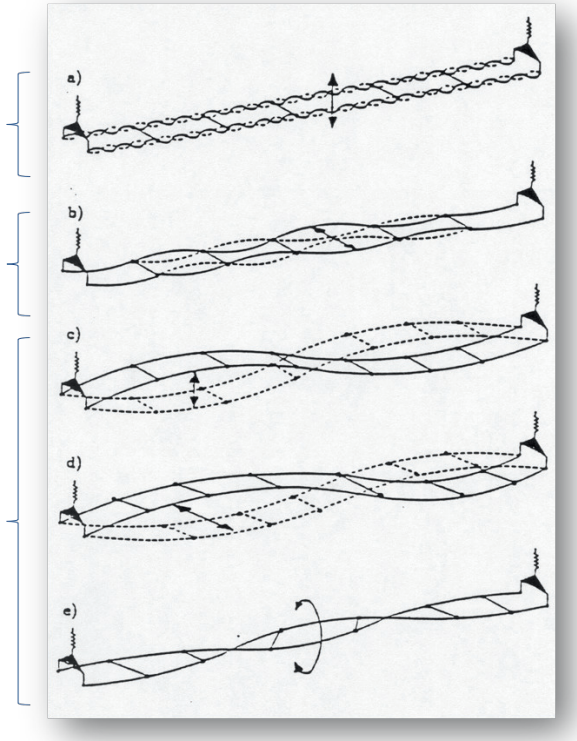
SICAME Group has vast experience on many overhead HTLS lines which have successfully been protected from vibration. SICAME has gained this experience, through advanced research projects including various partnerships with universities, scientific expertise using state of the art vibration simulation, damping techniques, and including various elastomer materials.

SICAME expertise in R&D, design & test has and continues to assist Engineers, Consultants, and Utilities globally, with new types of spacer dampers or vibration dampers for all types of conductor configurations.

SICAME Damping Systems Vibrations models induced by wind on single and bundled conductors which generate undesirable and dangerous phenomena on the OHTL:

- Aeolian Vibration (Vortex Shedding)
- Wake Induced Oscillation (Sub-Span Oscillation)
- Galloping

Sicame has developed the models which are linked to the tensile conductor loading and the particular evolution of self-damping linked to the use of the HTLS conductor.

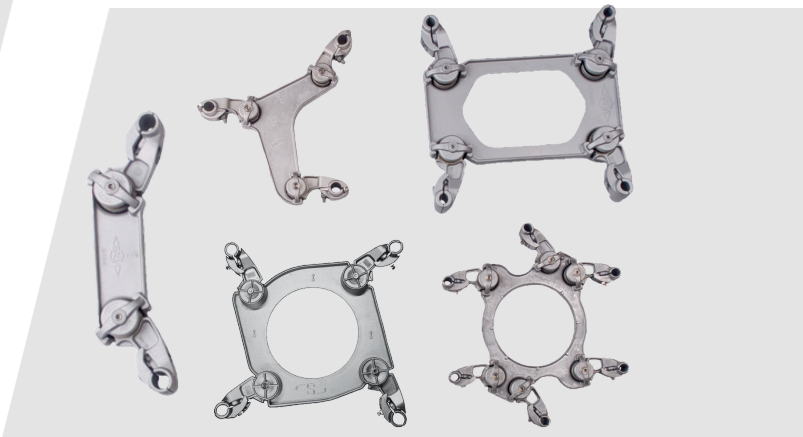


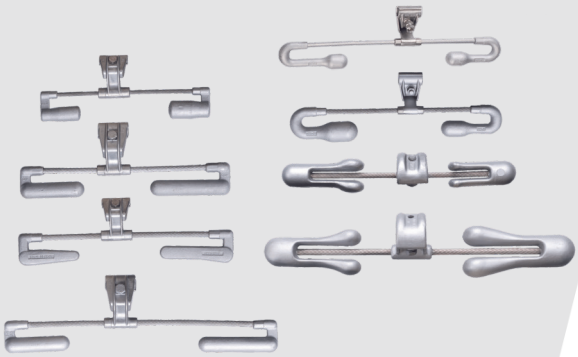
Vibration level are controlled by Sicame using Damping Systems of Spacer Dampers and Vibration Dampers.

Spacer Dampers (SD)

The range of SICAME SD covers all possible applications:

- Voltage up to 1 200 kV
- Bundle Spacing up to 0.047 in
- Any conductor types
- Different clamping solutions





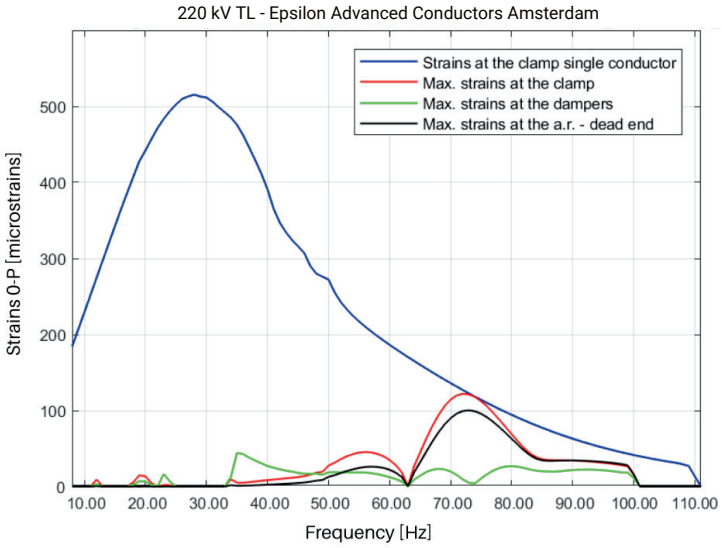
Vibration Dampers (VD)

In order to satisfy the demands of the market, our range of VD is very wide.
It includes models with galvanized steel or Zamac coated masses and models with galvanized steel or stainless-steel messenger cable.

Analytical Evaluation

Damping Systems design

An optimum Damping Systems is designed to evaluate the two vibration phenomena
(Aeolian vibration and Sub-Conductor oscillation) on the OHTL, by means of a damping study, performed with validated software, issued by a collaboration with Politecnico di Milano.
Due to thousands of hours of tests, we have acquired a good understanding of the dedicated self-damping profile linked to HTLS conductor and their different types.



Damping Systems validation

The validation of a Damping System is carried out with measurements performed by SICAME equipment and personnel on the site ie (FIELD TEST). Such tests verify the real level of vibrations compared with evaluation at the design stage with the analytical method ie (DAMPING STUDY).

SICAME Transmission: Laboratories & Testing

The Laboratory is vital in assisting both design activities and product verification. During the design stage, it supports the Technical Department in its activity of Research and Development while in the product verification stage all Quality Control mechanical verifications and tests are carried out to include batch acceptance tests.

A testing laboratory able to characterize and qualify HTLS conductors & accessories

SICAME Transmission has state of the art resources among the best in the world which means that low sag / high ampacity conductors and accessories can be fine-tuned and qualified. The studies and trials are performed in accordance to the power, environmental, and configuration parameters of the line to be fitted. All tests comply with the requirements of the international reference standards or/and with the technical specifications of each country.

ISO 17025 certified laboratories

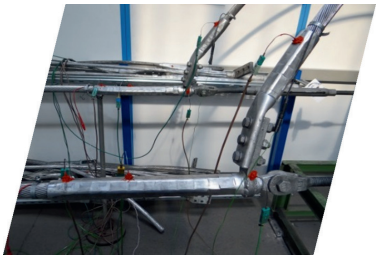
- DERVAUX Lab. In Saint-Etienne (FRANCE)
- SICAME INDIA Laboratory in Chennai (INDIA)

University partnerships: Politecnico of Milano
Barcelona university

NABL
ISO / IEC 17025
Accredited

cofrac
ESSAIS

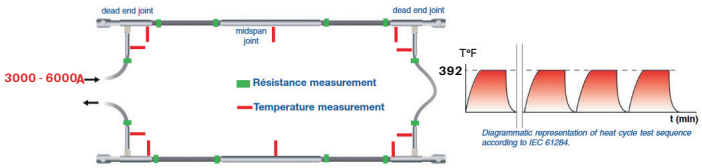
Mechanical tests



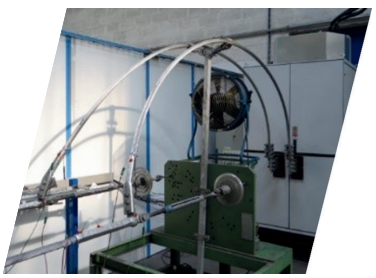
Category	Equipment	Tests	Standards
Tensile tests	179.84 kipf tensile test bench. Length : 68.89 ft Program with stress and displacement instructions	Tensile tests on dead end and mid span joint	IEC 61284
		Mechanical fatigue test	IEC 61284
		Vertical tests on suspension clamp	IEC 61284
		Stress train tests	EN 50182
Slip tests	179.84 kipf tensile test bench. Length : 68.89 ft Program with stress and displacement instructions	On suspension clamp	IEC 61284
		On vibration dampers	IEC 61897
		On spacer dampers	IEC 61854
Creep test	Experimental span of 65.61 ft to 164.04 ft Ambient temperature regulation system : max 32.36°F/hour Thermal sensor, laser displacement sensor, load sensor	Mechanical fatigue test	IEC 61284

Electrical tests

Heat cycle test at 392°F



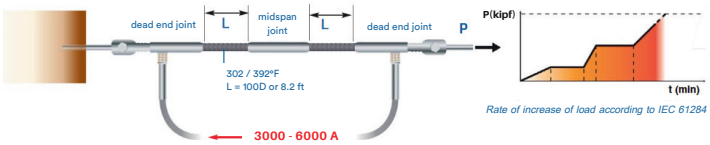
Category	Equipment	Tests	Standards
Heat cycle	Generator; 6000A-40V; 21 thermal sensors Generator; 3000A-40V; 21 thermal sensor	Dead end, mid span joint, jumper terminal, connectors ...	IEC 61284
High Voltage	HV generator up to 56.20 kipf phase-ground (equivalent to 96.66 kipf phase to phase)	On suspension clamp	IEC 61284
Simulated short circuit	Test bench for spacers (x2, x3, x4)	Compression and tension	IEC 61854

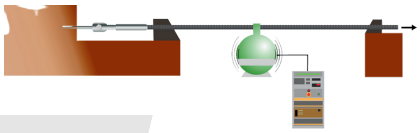


Combined mechanical and electrical tests

Category	Equipment	Tests	Standards
Heat cycle	179.84 kipf tensile tests bench Current generator 50Hz; 6000A-40V; 21 thermal sensors	High temperature tensile test	IEC 61284
High Voltage	179.84 kipf tensile tests bench Current generator 50Hz; 6000A-40V;21 thermal sensors Thermocouples, laser displacement sensor, load sensor	CTE on all conductors	CIGRE TB426
Simulated short circuit	Slipping test area. Lenght: 65.61 ft Regulated tensile machine, sensor: 56.20 kipf, 44.96 kipf, 11.24 kipf Current generator 50Hz; 6000A-40V;21 thermal sensors	Slip tests on all conductors	IEC 61284

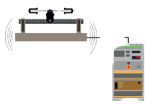
High temperature tensile bench test

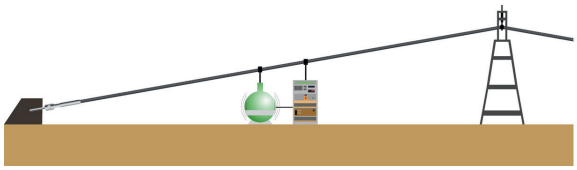




Vibratory test

Category	Equipment	Tests	Standards
Self damping test	Span length : 167.32 ft. Force excitation with shakers Regulated room temperature Minimum energy dissipation at ends	On conductor	IEC 62567
Damping effectiveness	Span length : 167.32 ft. Force excitation with shakers Regulated room temperature Strain and antinode measurement methods	On spacers/vibration dampers, jumpers, spiral ...	IEC 61897
Fatigue test	Span length : 167.32 ft or 2 spans of 98.42 ft (crossing length) Force excitation with shakers Can be performed with high temperature and tension	Span fatigue, suspension clamp ...	IEC 62568
	Shaker and 50 span	On vibration dampers, different methods : sweep, resonance R4 and 4 resonances	IEC 61897
	Dedicated test bench and Shaker	On spacers dampers, sub-span oscillation, aeolian vibration, conical and horizontal fatigue	IEC 61854
Environnemental test	Shakers	Sweep ageing	IEC 60068





Others tests

Category	Equipment	Tests	Standards
Salt spray	Combo climatic chamber: T° range -76°F to +356°F Coupling with shaker Dry & wet heat	Corrosion test on every type of fittings	ISO 9227-2007

Full-Scale Mechanical Tests:
We are also capable of carrying out full-scale mechanical tests in independent and accredited laboratories to verify the actual mechanical behaviour of the full strings.

Electrical tests on complete strings:
RIV and Corona, Power Arc, and Short Circuit are conducted out in independent and accredited laboratories according to International Standards and prescriptions of Project Technical Specifications

Compression fittings

The compression fittings are co-developed and designed in collaboration with Epsilon Cable. Solution uses specific protective sleeve to protect the carbon core and brings high controlled crimping rate.

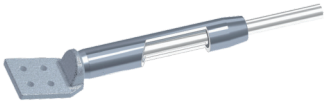
The dedicated design allows a simple on-site installation, workers can use the same installation process and tools as a conventional ACSR conductor.
Our connecting pads, aluminum sections, crimping length, and grease inhibitor are specifically designed to support the unique high transit capacity provided by Epsilon Advanced Conductors ® cable

Scan to watch installation procedures

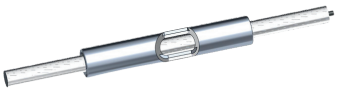
Dead-end clamp

Mid-span joint

Jumper terminal



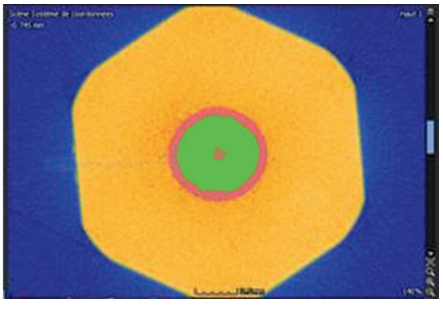
Repair sleeve



Compression rate sizing

For more than 20 years we have developed our knowledge related to the innovative technologies of composite cables. Based on this experience, we have fundamentally changed our designs of compressed fittings to adapt them to traditional crimping methods. We thus seek to guarantee perfect safety in the use of sleeves, by offering the possibility of using a technique proven on innovative products.

Our products respond perfectly to use in all circumstances and withstand without any problem accepting the highest transits associated with the use of these high temperature conductors throughout their life.
The compression ratios have been defined to guarantee electrical continuity and ensure the mechanical resistance of the core, while optimizing the compression lengths, in order to obtain a compact, reliable and robust fitting, which are easy to install on site.



Compression fittings references

EPSILON ADVANCED CONDUCTORS				FITTINGS						
Reference	Internationnal Size	ASTM Size	Ø (in)	Dead-End	Mid-span joint	Jumper terminal	Hexagonal dies		Repair sleeve	Repair sleeve
							steel eye bolt	ext. alu. tube		
130-28	SILVASSA	-	0.565	V2XRFFK	JXFFK	CDAXRSFK	H20R	H37U	R155K	H23.5U
160-28	HELSINKI	PASADENA	0.616	V2XRFFK	JXFFK	CDAXRSFK	H20R	H38.5U	R170K	H32U
180-40	ZADAR	-	0.673	V2XRFFK	JXFFK	CDAXRSFK	H24.5R	H44U	R185K	H32U
190-28	ROVINJ	-	0.673	V2XRFFK	JXFFK	CDAXRSFK	H20R	H41.5U	R185K	H31U
230-28	COPENHAGEN	LINNET	0.72	V2XRFFK	JXFFK	CDAXRSFK	H20R	H38U	R210K	H35U
230-40	REYKJAVIK	ORIOLE	0.741	V2XRFFK	JXFFK	CDAXRSFK	H23R	H45.5U	R210K	H35U
230-87	MONTE CARLO	-	0.818	V2XRFFK	JXFFK	CDAXRSFK	H28.5R	H50.5U	R235K	H40.5U
240-47	GLASGOW	WACO	0.77	V2XRFFK	JXFFK	CDAXRSFK	H24.5R	H47U	R210K	H36U
250-28	GDANSK	-	0.756	V2XRFFK	JXFFK	CDAXRSFK	H20R	H38U	R210K	H35U
280-40	CASABLANCA	LAREDO	0.807	V2XRFFK	JXFFK	CDAXRSFK	H24.5R	H46U	R235K	H40U
320-60	OSLO	IRVING	0.882	V2XRFFK	JXFFK	CDAXRSFK	H27R	H46.5U	R235K	H43U
320-40	LISBON	HAWK	0.858	V2XRFFK	JXFFK	CDAXRSFK	H24.5R	H46U	R235K	H40.5U
370-47	AMSTERDAM	DOVE	0.927	V2XRFFK	JXFFK	CDAXRSFK	H24.5R	H46U	R255K	H43U
410-47	CORDOBA	-	0.962	V2XRFFK	JXFFK	CDAXRSFK	H24.5R	H46U	R280K	H45U
430-52	BRUSSELS	GROSBEAK	0.989	V2XRFFK	JXFFK	CDAXRSFK	H27R	H46.5U	R280K	H45.5U
470-60	STOCKHOLM	LUBBOCK	1.039	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	H27R	H55U	R280K	H46.5U
520-60	WARSAW	CUCKOO	1.091	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	H27R	H53.5U	R301K	H45.5U
530-71	DUBLIN	DRAKE	1.109	T3XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	H27R	H54U	R323K	H46.5U
560-60	HAMBURG	PLANO	1.127	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	H27R	H57U	R323K	H47U
580-60	MILAN	CORPUS CHRISTI	1.146	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	H27R	H56.5U	R323K	H47U
600-71	ROME	ARLINGTON	1.176	T3XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	H27R	H49U	R323K	H47.5U
640-60	VIENNA	CARDINAL	1.198	V2XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H27R	H50.5U	R340K	H48U
700-60	PRAGUE	EL PASO	1.252	V2XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H27R	H52U	R340K	H49U
740-71	MUNICH	BEAUMONT	1.294	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H27R	H53U	R350K	H50.5U
750-87	WARWICK	-	1.315	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H28.5R	H55.5U	R350K	H51.5U
770-75	LONDON	SAN ANTONIO	1.316	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H30R		R390K	
820-60	PARIS	BITTERN	1.346	T2XWPL6T16FFK	JXK	CDAXSWPL6T16FK	H27R	H55U	R390K	H55U
950-75	ANTWERP	DALLAS	1.453	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H30R		R400K	
1020-75	MADRID	LAPWING	1.503	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	H30R	H67U	R400K	H58U
1160-79	CHUKAR	CHUKAR	1.604	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK			R440K	

When you communicate the accessories references for compression fittings to Sicame, please add the international size to the conductor reference.
For example :

- Dead end for Epsilon Advanced Conductors Lisbon is : V2XRFFK Epsilon Advanced Conductors LISBON
- Jumper terminal for Epsilon Advanced Conductors Amsterdam is : CDAXRSFK Epsilon Advanced Conductors AMSTERDAM

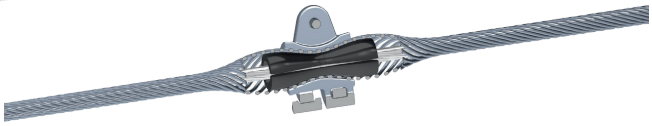
Suspension clamp and vibration damper

Suspension clamps

The armor grip design gives soft retention of the conductor without an inflection point, to avoid vibration fatigue, and stress on carbon core. Armor rod sets reduce the local temperature of a conductor by decreasing the joule effect and increasing the thermal dissipation.

The lining of the suspension clamps have been specially designed and tested to guarantee the protection of the conductor in contact with the suspension clamp, by integrating the constraints of the external environment (UV, bad weather, etc.) associated with the high operating temperature requirements of the Epsilon Advanced Conductors cable.

Scan to watch installation procedures



Vibration damper

Installed on armor rods sets to protect the soft aluminum and reduce the local temperature of the conductor.
4 frequency response for larger damping spectrum.
Dedicated clamp/attachment design to use on armor rod set.
Space dampers can also be supplied in case of multiple bundles.

Suspension clamp and vibration damper references

Reference	Internationnal Size	ASTM Size	Ø (in)	Suspension clamp	Stockbridge damper + AR
130-28	SILVASSA	-	0.565	SAR140-145 HTZ	VD2332JB + AAR140-145
160-28	HELSINKI	PASADENA	0.616	SAR 154-159 HTZ	VD2332JB + AAR154-159
180-40	ZADAR	-	0.673	SAR 166-172 HTZ	VD2332CD + AAR166-172
190-28	ROVINJ	-	0.673	SAR 166-172 HTZ	VD2332CD + AAR166-172
230-28	COPENHAGEN	LINNET	0.72	SAR178-183 HTZ	VD2332CD + AAR178-183
230-40	REYKJAVIK	ORIOLE	0.741	SAR188-195 HTZ	VD2332CD + AAR188-195
230-87	MONTE CARLO	-	0.818	SAR206-213 HTZ	VD3242CD + AAR206-213
240-47	GLASGOW	WACO	0.77	SAR195-199 HTZ	VD3242CD + AAR195-199
250-28	GDANSK	-	0.756	SAR188-195 HTZ	VD2332CD + AAR195-199
280-40	CASABLANCA	LAREDO	0.807	SAR200-206 HTZ	VD3242CD + AAR200-206
320-60	OSLO	IRVING	0.882	SAR219-226 HTZ	VD3242CD + AAR219-226
320-40	LISBON	HAWK	0.858	SAR219-226 HTZ	VD3242CD + AAR219-226
370-47	AMSTERDAM	DOVE	0.927	SAR230-236 HTZ	VD3242CD + AAR230-236
410-47	CORDOBA	-	0.962	SAR240-248 HTZ	VD3242CD + AAR240-248
430-52	BRUSSELS	GROSBEAK	0.989	SAR248-253 HTZ	VD3242N + AAR248-253
470-60	STOCKHOLM	LUBBOCK	1.039	SAR263-270 HTZ	VD4252N + AAR263-270
520-60	WARSAW	CUCKOO	1.091	SAR270-279 HTZ	VD4252N + AAR270-279
530-71	DUBLIN	DRAKE	1.109	SAR279-289 HTZ	VD4252N + AAR279-289
560-60	HAMBURG	PLANO	1.127	SAR279-289 HTZ	VD4252N +AAR279-289
580-60	MILAN	CORPUS CHRISTI	1.146	SAR289-295 HTZ	VD4252N + AAR289-295
600-71	ROME	ARLINGTON	1.176	SAR295-301 HTZ	VD4252N + AAR295-301
640-60	VIENNA	CARDINAL	1.198	SAR301-306 HTZ	VD4252N + AAR301-306
700-60	PRAGUE	EL PASO	1.252	SAR312-319 HTZ	VD4252P + AAR312-319
740-71	MUNICH	BEAUMONT	1.294	SAR327-333 HTZ	VD4252P +AAR327-333
750-87	WARWICK	-	1.315	SAR334-344 HTZ	VD4252P + AAR334-344
770-75	LONDON	SAN ANTONIO	1.316	SAR334-344 HTZ	VD4252P + AAR334-344
820-60	PARIS	BITTERN	1.346	SAR334-344 HTZ	VD4252P + AAR334-344
950-75	ANTWERP	DALLAS	1.453	SAR360-374 HTZ	VD5262P + AAR360-374
1020-75	MADRID	LAPWING	1.503	SAR375-384 HTZ	VD5262P + AAR375-384
1160-79	CHUKAR	CHUKAR	1.604	SAR384-411 HTZ	VD5262P + AAR384-411

www.sicame.com

www.epsilon-cable.com

EPSILON COMPOSITE SAS | 5 Route de Hourtin - 33340 Gaillan-en-Médoc - FRANCE
Phone: +33 (0)556 734 774 | E-mail: contact@epsilon-cable.com

Dervaux SA - Sicame Group | Z.I. Le Bec - Allée Ampère - B.P. 49 - 42501 Le Chambon Feugerolles - FRANCE
Phone: +33 (0)477 401 740 | E-mail: info@dervaux.fr