2023 EDITION

sicame
GROUP

EPSILON COMPOSITE CABLE
The alternative

HVCRC® 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 CICAME Energie

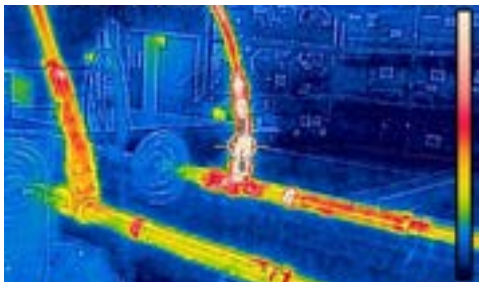
- Renowned and trustworthy in the Transmission realm thanks to its unique know-how
- Giving our customers the best-in-class solutions

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 250°C)
- 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.

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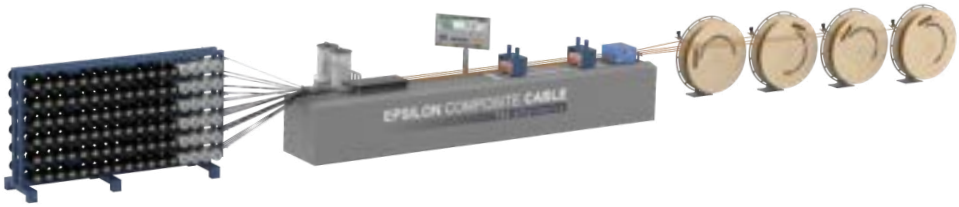
Our mission: create and implement sustainable innovative solutions to modernize power lines worldwide

Since 1987, Epsilon has been a pioneer and world leader in high-performance composite materials thanks to the pultrusion process. This highly efficient technology, combined with the extraordinary properties of carbon fibers makes the perfect solution to manufacture strong durable cores for High-Temperature Low Sag (HTLS) conductors.
In addition to its R&D center and pultrusion facilities in France, Epsilon Composite Cable relies on technical support teams in America, Asia, and Europe, as well as other stranding partners all around the world.



HVCRC ® Technology

HVCRC®, or High Voltage Composite Reinforced Conductors, stands for a complete range of HTLS conductors made up of a carbon-glass epoxy composite core and trapezoidal 1350-O annealed aluminum strands.
Compared with a traditional ACSR conductor, HVCRC® conductors allow to double the ampacity of a line or to decrease line losses by up to 30% while reducing sag.
Several thousands of kilometers of HVCRC® conductors have been installed and energized successfully around the world since 2012, which makes it one of the leading new generation overhead high voltage conductors.

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

ASTM B987

Epsilon Composite Cable works with the most demanding cable manufacturers to help them achieve their ambitious performance and cost targets.

HVCRC ® Accessories and installation

HVCRC® conductors are installed using conventional compression accessories designed by Sicame, unlike some other HTLS solution, this reduces installation costs and complexity. As a result, the training of installation crews is simplified, and there is less risks of line failure due to improper installation.
Different experts from Epsilon, Sicame or the stranding partners always support installation companies providing the up to date, current practices and guidelines to installation crews before and during installation.

Damping science mastering

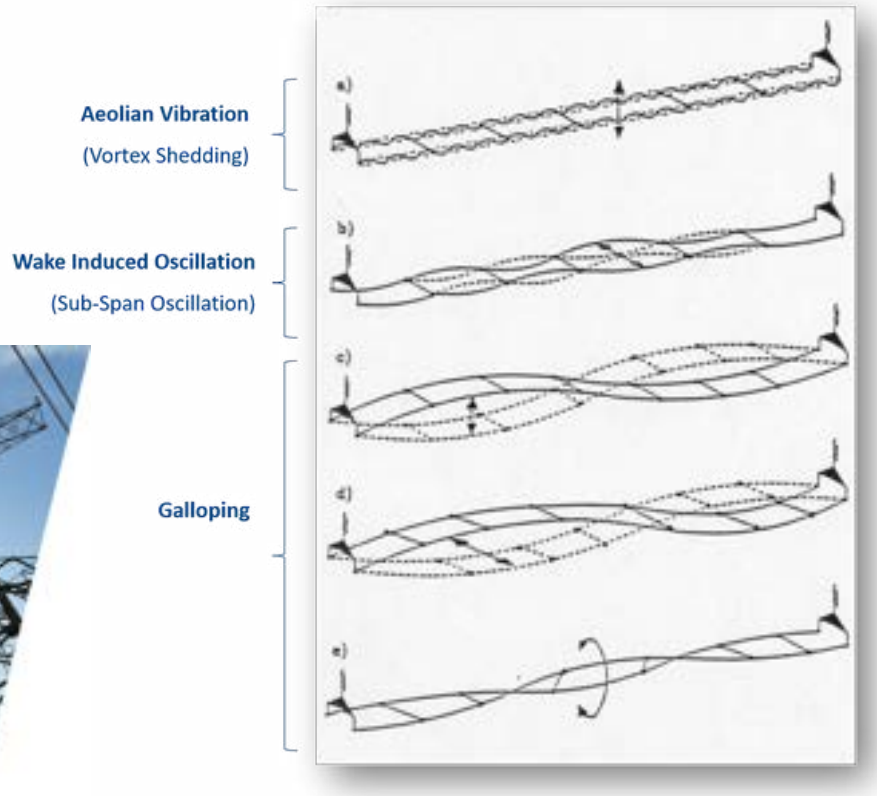
SICAME Group has vast experience on many overhead HTLS lines which have successfully been protected from vibration. SICAME has gained this experience, through advanced research projects including various partnerships with universities, scientific expertise using state of the art vibration simulation,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

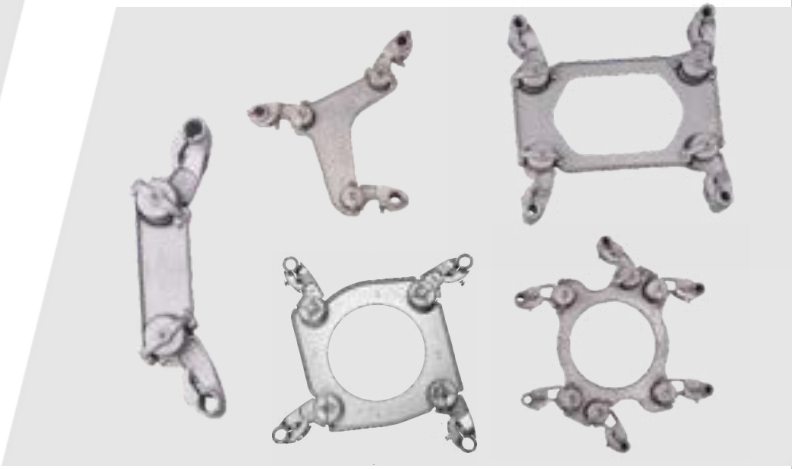


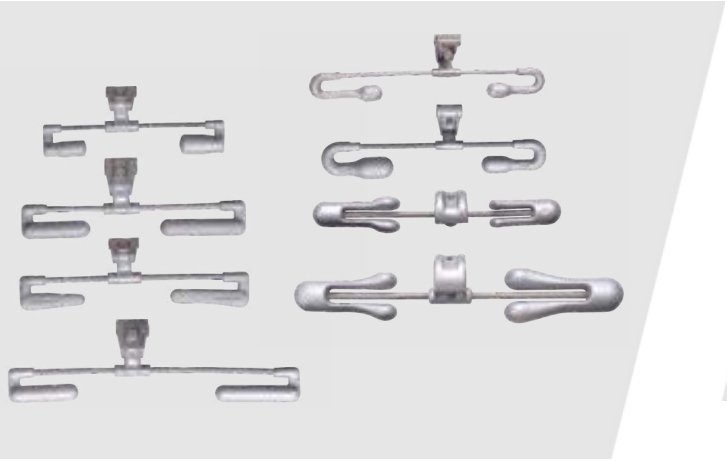
Vibration level are controlled by Sicame using Damping Systems of Spacer Dampers and Vibration Dampers.

Spacer Dampers (SD)

The range of SICAME SD covers all possible applications:

- Voltage up to 1.200kV
- Bundle Spacing up to 1.200mm
- Any conductor types
- Different clamping solutions





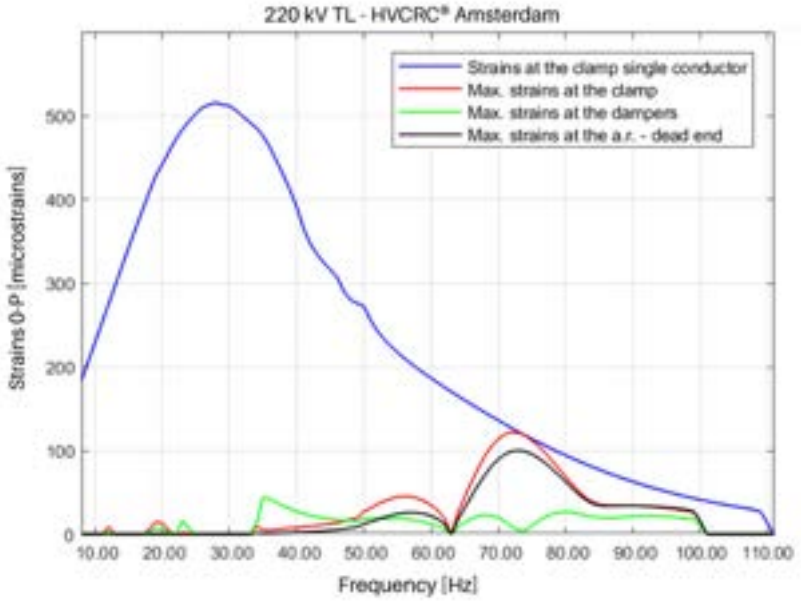
Vibration Dampers (VD)

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.

6 laboratories worldwide

2 Certified laboratories:

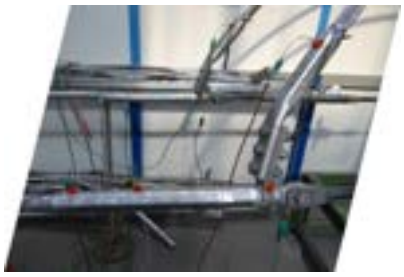
- DERVAUX Lab. In Saint-Etienne (FRANCE)
- SICAME INDIA Laboratory in Chennai (INDIA)

University partnership (Politecnico of Milano and Barcelona university)

COFRAC ACCREDITATION ST-ETIENNE LABORATORY

Mechanical and electrical tests

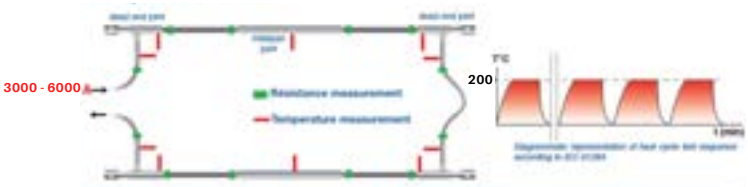
Mechanical tests



Category	Equipment	Tests	Standards
Tensile tests	800 kN tensile test bench. Length : 21m 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	800 kN tensile test bench. Length : 21m 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 20m to 50m Ambient temperature regulation system : max 0.2°C/hour Thermal sensor, laser displacement sensor, load sensor	Mechanical fatigue test	IEC 61284

Electrical tests

Heat cycle test at 200 °C

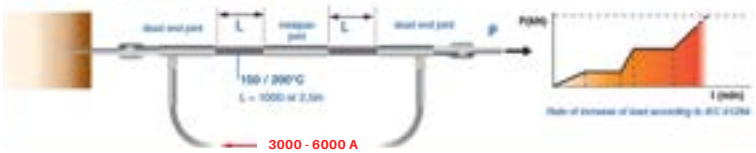


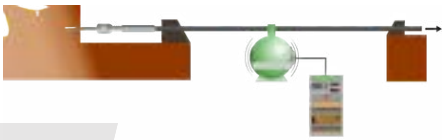
Category	Equipment	Tests	Standards
Heat cycle	Generator; 6000A-40V;21 thermal sensors Generator; 3000A-40V;21 thermal sensor	Dead end, mid span joint, jumper terminal, connectors ...	IEC 61284
High Voltage	HV generator up to 250 kV phase-ground (equivalent to 430 kV phase to phase)	On suspension clamp	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	800 kN tensile tests bench Current generator 50Hz; 6000A-40V; 21 thermal sensors	High temperature tensile test	IEC 61284
High Voltage	800 kN 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: 20m Regulated tensile machine, sensor: 250kN, 200kN, 50kN Current generator 50Hz; 6000A-40V;21 thermal sensors	Slip tests on all conductors	IEC 61284

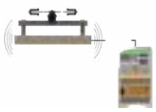
High temperature tensile bench test

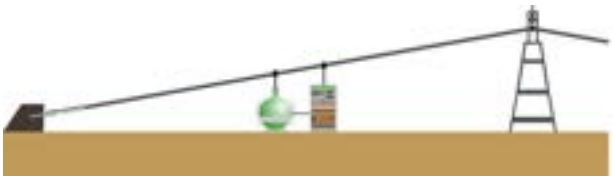




Vibratory test

Category	Equipment	Tests	Standards
Self damping test	Span length : 51m. Force excitation with shakers Regulated room temperature Minimum energy dissipation at ends	On conductor	IEC 62567
Damping effectiveness	Span length : 51m. Force excitation with shakers Regulated room temperature Strain and antinode measurement methods	On spacers/vibration dampers, jumpers, spiral ...	IEC 61897
Fatigue test	Span length : 51m or 2 spans of 30m (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 -60°C to +180°C 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 Composite 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 HVCRC ® cable

Dead-end clamp

The following QR codes give you access to the installations procedures

Mid-span joint

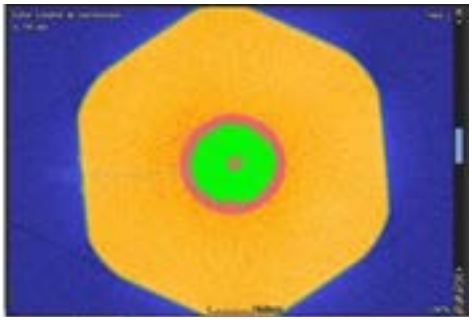
Jumper terminal

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 rod, while optimizing the compression lengths, in order to obtain a compact, reliable and robust fitting, which are easy to install on site.



References compression fittings

Reference	Internationnal Size	ASTM	Ø (mm)	Dead-End	Mid-span joint	Jumper terminal	Repair sleeve
HVCRC®130-28	SILVASSA	-	14.35	V2XRFFK	JXFFK	CDAXRSFK	R150K
HVCRC®160-28	HELSINKI	PASADENA	15.65	V2XRFFK	JXFFK	CDAXRSFK	R170K
HVCRC®160-47	JAIPUR	-	16.51	V2XRFFK	JXFFK	CDAXRSFK	R185K
HVCRC®160-18	BERN	-	15.50	V2XRFFK	JXFFK	CDAXRSFK	R170K
HVCRC® 180-40	ZADAR	-	17.09	V2XRFFK	JXFFK	CDAXRSFK	R185K
HVCRC®190-28	ROVINJ	-	17.09	V2XRFFK	JXFFK	CDAXRSFK	R185K
HVCRC®230-28	COPENHAGEN	LINNET	18.29	V2XRFFK	JXFFK	CDAXRSFK	R210K
HVCRC® 230-40	REYKJAVIK	ORIOLE	18.82	V2XRFFK	JXFFK	CDAXRSFK	R210K
HVCRC® 230-87	MONTE CARLO	-	20.78	V2XRFFK	JXFFK	CDAXRSFK	R235K
HVCRC®240-47	GLASGOW	WACO	19.55	V2XRFFK	JXFFK	CDAXRSFK	R210K
HVCRC®250-28	GDANSK	-	19.21	V2XRFFK	JXFFK	CDAXRSFK	R210K
HVCRC®280-40	CASABLANCA	LAREDO	20.51	V2XRFFK	JXFFK	CDAXRSFK	R235K
HVCRC®320-47	OSLO	IRVING	22.40	V2XRFFK	JXFFK	CDAXRSFK	R235K
HVCRC®320-40	LISBON	HAWK	21.79	V2XRFFK	JXFFK	CDAXRSFK	R235K
HVCRC®370-47	AMSTERDAM	DOVE	23.55	V2XRFFK	JXFFK	CDAXRSFK	R255K
HVCRC®410-47	CORDOBA	-	24.43	V2XRFFK	JXFFK	CDAXRSFK	R255K
HVCRC®430-52	BRUSSELS	GROSBEAK	25.13	V2XRFFK	JXFFK	CDAXRSFK	R280K
HVCRC®470-60	STOCKHOLM	LUBBOCK	26.40	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	R280K
HVCRC®520-60	WARSAW	CUCKOO	27.72	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	R301K
HVCRC®530-71	DUBLIN	DRAKE	28.17	T3XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	R323K
HVCRC®560-60	HAMBURG	PLANO	28.62	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	R323K
HVCRC®580-60	MILAN	CORPUS CHRISTI	29.10	V2XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	R323K
HVCRC®600-71	ROME	ARLINGTON	29.87	T3XRWPL4T16FFK	JXFFK	CDAXRSWPL4T16FK	R323K
HVCRC®640-60	VIENNA	CARDINAL	30.42	V2XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R323K
HVCRC®680-71	BUDAPEST	FORT WORTH	31.49	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R350K
HVCRC®700-60	PRAGUE	EL PASO	31.80	V2XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R350K
HVCRC®740-71	MUNICH	BEAUMONT	32.87	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R350K
HVCRC®770-75	LONDON	SAN ANTONIO	33.42	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R390K
HVCRC®820-60	PARIS	BITTERN	34.20	T2XWPL6T16FFK	JXK	CDAXSWPL6T16FK	R390K
HVCRC® 880-87	BORDEAUX	-	35.76	T3XWPL6T16FFK	JXK	CDAXSWPL6T16FK	R390K
HVCRC®950-75	ANTWERP	DALLAS	36.90	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R400K
HVCRC®1020-75	MADRID	LAPWING	38.18	T3XWPL6T16FFK	JXFFK	CDAXSWPL6T16FK	R400K
HVCRC®1160-79	CHUKAR	CHUKAR	40.74	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 HVCRC Lisbon is : V2XRFFK HVCRC LISBON
- Jumper terminal for HVCRC Amsterdam is : CDAXRSFK HVCRC 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 HVCRC cable.

The following QR codes give you access to the installations 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.

References suspension clamp and vibration damper

Reference	Internationnal Size	ASTM	Ø (mm)	Suspension clamp	Stockbridge damper + AR
HVCRC®130-28	SILVASSA	-	14.35	SAR140-145 HTZ	VD2332JB + AAR140-145
HVCRC®160-28	HELSINKI	PASADENA	15.65	SAR 154-159 HTZ	VD2332JB + AAR154-159
HVCRC®160-47	JAIPUR	-	16.51	SAR 164-166 HTZ	VD2332JB + AAR164-166
HVCRC®160-18	BERN	-	15.50	SAR 154-159 HTZ	VD2332JB + AAR154-159
HVCRC® 180-40	ZADAR	-	17.09	SAR 166-172 HTZ	VD2332CD + AAR166-172
HVCRC®190-28	ROVINJ	-	17.09	SAR 166-172 HTZ	VD2332CD + AAR166-172
HVCRC®230-28	COPENHAGEN	LINNET	18.29	SAR178-183 HTZ	VD2332CD + AAR178-183
HVCRC® 230-40	REYKJAVIK	ORIOLE	18.82	SAR188-195 HTZ	VD2332CD + AAR188-195
HVCRC® 230-87	MONTE CARLO	-	20.78	SAR206-213 HTZ	VD3242CD + AAR206-213
HVCRC®240-47	GLASGOW	WACO	19.55	SAR195-199 HTZ	VD3242CD + AAR195-199
HVCRC®250-28	GDANSK	-	19.21	SAR188-195 HTZ	VD2332CD + AAR195-199
HVCRC®280-40	CASABLANCA	LAREDO	20.51	SAR200-206 HTZ	VD3242CD + AAR200-206
HVCRC®320-47	OSLO	IRVING	22.40	SAR219-226 HTZ	VD3242CD + AAR219-226
HVCRC®320-40	LISBON	HAWK	21.79	SAR219-226 HTZ	VD3242CD + AAR219-226
HVCRC®370-47	AMSTERDAM	DOVE	23.55	SAR230-236 HTZ	VD3242CD + AAR230-236
HVCRC®410-47	CORDOBA	-	24.43	SAR240-248 HTZ	VD3242CD + AAR240-248
HVCRC®430-52	BRUSSELS	GROSBEAK	25.13	SAR248-253 HTZ	VD3242N + AAR248-253
HVCRC®470-60	STOCKHOLM	LUBBOCK	26.40	SAR263-270 HTZ	VD4252N + AAR263-270
HVCRC®520-60	WARSAW	CUCKOO	27.72	SAR270-279 HTZ	VD4252N + AAR270-279
HVCRC®530-71	DUBLIN	DRAKE	28.17	SAR279-289 HTZ	VD4252N + AAR279-289
HVCRC®560-60	HAMBURG	PLANO	28.62	SAR279-289 HTZ	VD4252N +AAR279-289
HVCRC®580-60	MILAN	CORPUS CHRISTI	29.10	SAR289-295 HTZ	VD4252N + AAR289-295
HVCRC®600-71	ROME	ARLINGTON	29.87	SAR295-301 HTZ	VD4252N + AAR295-301
HVCRC®640-60	VIENNA	CARDINAL	30.42	SAR301-306 HTZ	VD4252N + AAR301-306
HVCRC®680-71	BUDAPEST	FORT WORTH	31.49	SAR312-319 HTZ	VD4252N + AAR312-319
HVCRC®700-60	PRAGUE	EL PASO	31.80	SAR312-319 HTZ	VD4252P + AAR312-319
HVCRC®740-71	MUNICH	BEAUMONT	32.87	SAR327-333 HTZ	VD4252P +AAR327-333
HVCRC®770-75	LONDON	SAN ANTONIO	33.42	SAR334-344 HTZ	VD4252P + AAR334-344
HVCRC®820-60	PARIS	BITTERN	34.20	SAR334-344 HTZ	VD4252P + AAR334-344
HVCRC® 880-87	BORDEAUX	-	35.76	SAR354-360 HTZ	VD4252P + AAR354-360
HVCRC®950-75	ANTWERP	DALLAS	36.90	SAR360-374 HTZ	VD5262P + AAR360-374
HVCRC®1020-75	MADRID	LAPWING	38.18	SAR375-384 HTZ	VD5262P + AAR375-384
HVCRC®1160-79	CHUKAR	CHUKAR	40.74	SAR384-411 HTZ	VD5262P + AAR384-411

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