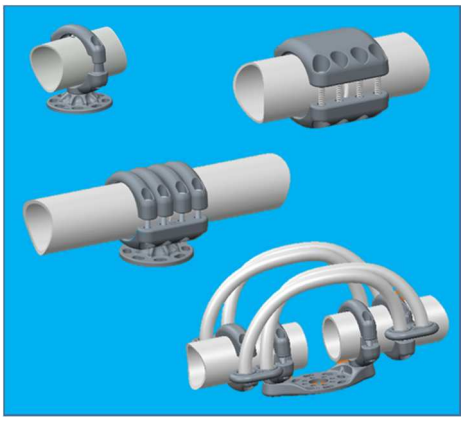
SIMABUS

HIGH VOLTAGE CLAMPS & CONNECTORS FOR SUBSTATION APPLICATIONS

Summary

I. Bus Supports & Junctions

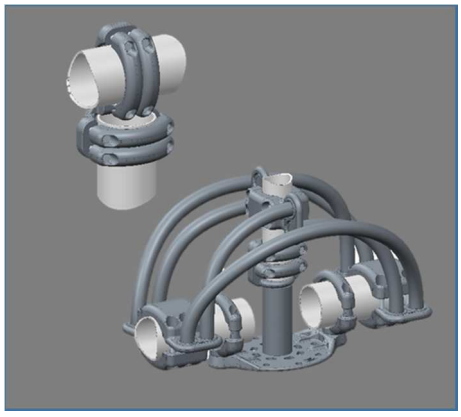


I

II. Bus Accessories

II

III. Derivations



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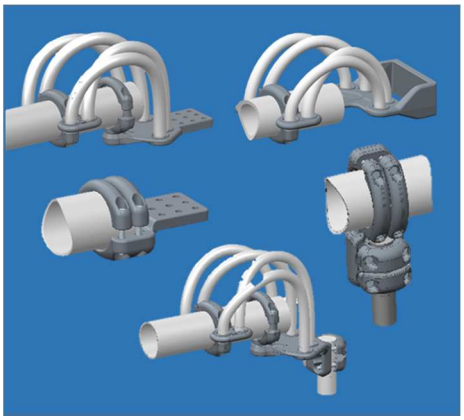


V. Fasteners

Introduction

SUMMARY

Introduction

1 -EXPERIENCE THE FUTURE WITH SIMABUS CONNECTORS

TE Connectivity's (TE) Simel first generation connectors have been created back in 1946. The primarily activity at this time was the development of Power connectors to deliver connectivity solutions to the Transmission Grids over decades from 10kV applications till now 1200kV Ultra high voltage substations.

Today, TE continuously invests in development of new solutions to the Transmission Grids in order to respond to the changing markets trends.

The future of energy delivery relies on a modular approach

It's clear that utilities around the world face a set of unique challenges. Rising energy demands, aging or nonexistent infrastructure, complex financing, political turmoil and extreme environments mean that "one size fits all" energy solutions are not just impractical – in many cases, they are simply impossible.

By 2040, the global demand for electric energy is expected to increase by 37 percent (IEA, 2014), but not all demands are equal. For example, China, the world's top energy consumer, has experienced exponential growth since 1980, with energy demand increasing 500 percent. This has led China to make substantial investments in the transmission and delivery of power. Similarly, India has tripled its energy production over the last two decades.

In many areas, however, expanded capacity hasn't kept pace with the rest of the world. This is especially prevalent in sub-Saharan Africa, where an estimated 620 million people lack access to reliable forms of energy. Conversely, in many parts of the industrialized world, 40 percent of the power plants will need to be replaced by 2040 because transmission lines and substations can no longer handle the electrical loads needed.

If energy demand is going to continue growing at a rapid pace, driving to increase the transfer capacity of the transmission infrastructures, how do utilities know they're choosing a connectivity solution that won't be obsolete within the next decade?

To solve this challenge, utilities should employ a modular approach to the future network expansion that allows for a myriad of partners and product solutions that are ideally suited for their particular project and applications.

A utility's engineering partner should be capable of not just meeting today's demands with a list of ready-stocked products – but should also be prepared to anticipate tomorrow's needs with reliable solutions.

Introduction

This modular approach requires a long-term engineering partner. Before investing in any partnership, utilities should consider the performance of their partner in three key areas:

Range of products and services

Depth of industry experience and knowledge

Global capacity for manufacturing, testing, installation and support

Toward a Universal Solution for Utilities

The first of these areas – products and services – refers to the range of products used to construct new networks and expand existing networks across a range of Extra or eventually Ultra High Voltage levels. High Voltage transmission networks have very different demands than high voltage networks, but it's likely that utilities will need to develop solutions for both. By choosing a partner who handles a full of range of specifications, utilities can maximize their budgets, and ensure they'll have a single source for installation and design support.

The range of products is a critical need in power delivery and transmission applications because the age of infrastructure presents numerous challenges. Retrofitting a substation that is 40 to 50 years old could require numerous connectors to fit various equipment simply based on previous upgrades and the age of original equipment. Finding a single partner to handle the sheer number of options and products needed could have a significant impact not only on a project's budget, but also the timeline to completion.

Of equal importance to utilities should be an engineering partner's depth of industry knowledge. This second consideration is critical to a lasting partnership because energy demands and applications are rapidly changing. Possessing a depth of knowledge and history in power transmission allows partners to develop forward-looking solutions. Understanding the next international standard future requirements ensures, that solutions offer long-term compliance and reliable performance, rather than short term product fixes.

Finally, in selecting a partner to develop innovative solutions, utilities should consider their ability to provide global support, including design, testing and manufacturing as well as training and technical support. Companies with a global footprint are often more equipped to provide outstanding local support than regional partners. The best global partners possess regional manufacturing that can allow products to be delivered to the project site faster, and from shorter distances. In many regions, this makes it easier for utilities to navigate complicated environmental regulations. Distributed capabilities also make it more likely that utilities can receive custom, local installation support and training – which are critical for network reliability and performance. Regardless of a project's size or scope, utilities should seek a partner who can understand and adapt to their unique needs and develop customized solutions that offer proven reliability and meet environmental, structural and network demands.

Introduction

Connecting the future

Staying ahead of energy demand and anticipating new needs requires an innovative approach to the transmission market. It requires new, adaptable products, vast industry knowledge and partners that understand global needs and can provide global support. Power connectivity solutions for substations will continue to become more modular, and as utilities assess current and future needs, they'll favor solutions that adapt to a world that's more connected – and more demanding – than ever before.

Introduction

2-DESCRIPTION

2.1 - Applications

SIMABUS is an Extra high voltage range of clamps and connectors for AC & DC applications up to 500kV (phase-to-phase voltage).

These products are designed to support and connect Ø80 to Ø250mm aluminium bus conductors to Copper or Aluminium Equipment Terminals.

2.2 - Benefits

The main technical benefit of this range is to offer compact connectors with high electrical and mechanical performances obtained by a design with optimized parameters.

Top electrical performances

The resistance of electrical contacts is at the lowest expected level (below 1µΩ). This performance level has been achieved by optimization of the involved performances factors such as, machining of the electrical contact surfaces to get a perfect geometry of the contact grooves of the connectors, specific roughness of the machined surfaces to provide efficient metallic contact points, lubricated bolts with high performance wax to get higher contact pressure.

High mechanical strengths

Each part has been designed with support of FEM (Finite Element Method) calculation to obtain high strength components.

High Quality

Design to manufacturing method has also been applied to the development of this new range to get high quality casting components.

Consistent process

Components submitted to mechanical stress such as mechanical supports and keepers are advantageously die casted.

Fit for applications

The products have been designed to withstand actual mechanical strengths required in EHV Substations considering wing and ice loads as well as short circuit fault current up to 63kA.

No transferred strengths

The design of the products avoids any transfer of torsional moment to the Post Insulators or Terminal Equipment's.

Adaptive solution

The design is adaptive on request to any specific busbar height on the Post Insulator Base to enable extension works to an existing busbar.

Digital advantage

FEM Calculation has been used to meet EHV connector design requirement. Simulation and calculation of electrical field of the connectors enabled our engineers to get high R.I.V (Radio Interference Voltage) and Corona performances before getting confirmation by the test.

Introduction

2.3 - Scope of functions

The SIMABUS product range includes the following functions:

- Mechanical supports of busbars on Post Insulators.
- Junctions on Post Insulators (fix and expansion types).
- Accessories such as, End Caps, Corona Shieldings and Earthing Stirrups, Vibration Dampers…
- Derivations such as Tee connectors (tube to tube).
- Terminations (fix and expansion types) to connect busbars to Terminal Equipment's such as aluminium or copper pads/studs.

2.4 - Power Contacts

The Power of reliability for an extended longevity

The key driver to the power connector's longevity in High Voltage infrastructures is the intrinsic performance of the electrical power contact of the bolted connection. The lowest expected electrical contact resistance value is depending on following two physical parameters:

- Resistivity of the connected materials (connector and conductor)
- Metallic contact areas between the contact surfaces through which the current lines carry-out the power.

Opposite Figure 1 is a given model of power connector's contact where the contact areas are randomly distributed as typically met with connector's contacts obtained raw from casting (no machining of the contact areas).

a) is the area with no contact.

b) is the apparent contact area.

c) is the metallic contact area.

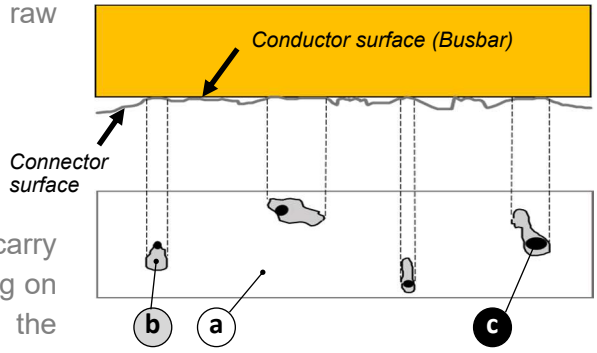


Figure 1

As per the Figure 2, only the metallic contact areas **c**) carry -out the power through the current lines. But depending on the contact areas randomly distributed because of the casting process, then the population of those metallic contact areas is not enough to carry-out the current density or/ and are located in such way that current lines are not consistently distributed across the total contact area (**a**+**b**+**c**).

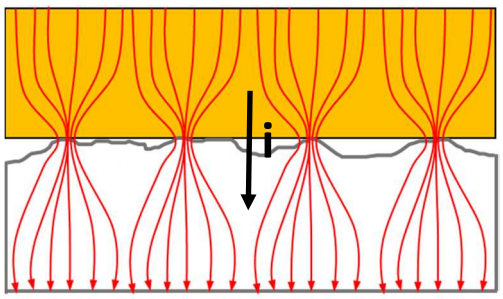


Figure 2

Insufficient or non-uniformly distributed, the metallic contact areas will see important concentration of current flows which have to carry-out the current "**i**". Consequently high current density areas will heat excessively up to melting the contact areas. Then abnormal heating process becomes detrimental to the lifetime of the power contact.

Our extended experience into the power contact and particularly for the bolted technology has enabled us to optimize the electrical performance of our substation connectors. SIMABUS connectors offer an exceptional performance for an extended lifetime in any service condition.

Introduction

As shown on the opposite picture (Figure 3), the cylindrical power contacts of SIMABUS connectors are machined. A specified roughness is provided by a dedicated high speed boring process in order to obtain a regular machined surface with managed contact surface areas.

The contact profile of the connector surface, as shown on the figure 4 provide multiple contact lines with the tubular conductor, uniformly distributed on the contact surface length of the connector.

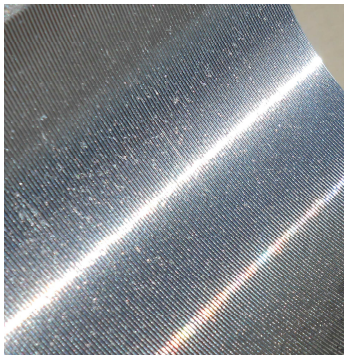


Figure 3

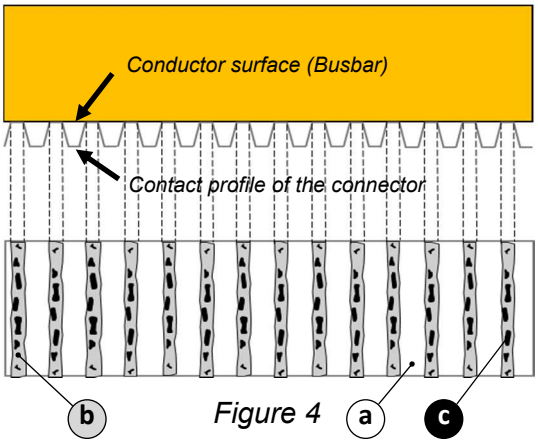


Figure 4

With this obtained model, the managed contact surface **b**) is regularly distributed and multiple metallic contact areas **c**) are created due to the high mechanical pressure provided by the lubricated bolts. The nuts are covered by a specific lubricant which withstands high pressure (Hertz' pressure) in its fillets.

As shown in the Figure 5 the current flow is now made of a numerous current lines uniformly distributed on the contact surface of the connector. In that case, the contact resistance becomes extremely low and is measured within a range of **0.3 to 0.5µΩ**. Consequently the heat of the connector is dramatically reduced and the regular metallic contact areas distribution will avoid getting unpredictable concentration of current flow.

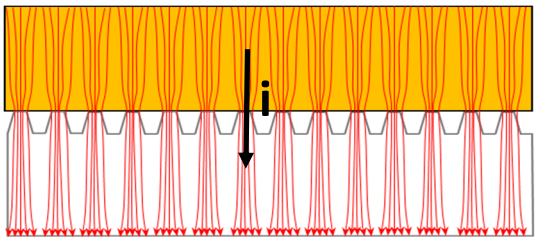


Figure 5

According to the previous model given in Figures 1 and 2, the electrical contact resistances are commonly measured within a range of **1 to 3 µΩ**. Then it is possible to determine by calculation the total metallic contact area of both models by using the Holm's law.

The Holm's law consequently determined from the theory of the "constriction". The electrical constriction is demonstrated by a physical model where is established that current lines can only be carried-out by metallic contact areas as shown in the Figure 6.

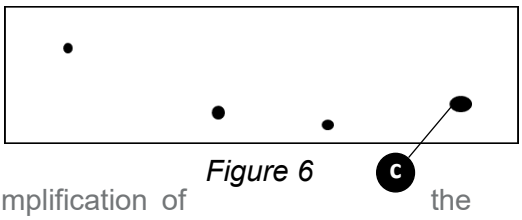
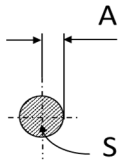


Figure 6

Then the sum of all metallic contact areas **c**) gives the total constriction area "**S**" which will carry-out the current "**i**". By simplification of the model we obtain "**S**" as a circular area having a radius "**A**". The electrical contact resistance "**Rc**" named "constriction resistance" is calculated from the Holm's law as follow, where "**ρ**" is the resistivity of the contact material .

Σc= S



$$Rc = \frac{\rho}{2A}$$

Holm's law

Introduction

By application of the Holm's law we can calculate the total metallic contact area of the first given model in comparison with the SIMABUS model.

Data:

Rc1 = 3μΩ (first given model)

RcS = 0.5μΩ (SIMABUS model)

P = 3.3 μΩ.cm (Resistivity at 20°C of a Silicon aluminium alloy 6060 grade or casting alloy)

A = Radius of the circular constriction area (in cm)

For the first given model: $3 = 3.3/2xA$ —► A = 0.55 cm or A = 5.5mm

Then $S = \pi xA^2$ —► **S = 95mm²**

For the SIMABUS model: $0.5 = 3.3/2xA$ —► A = 3.3 cm or A = 33mm

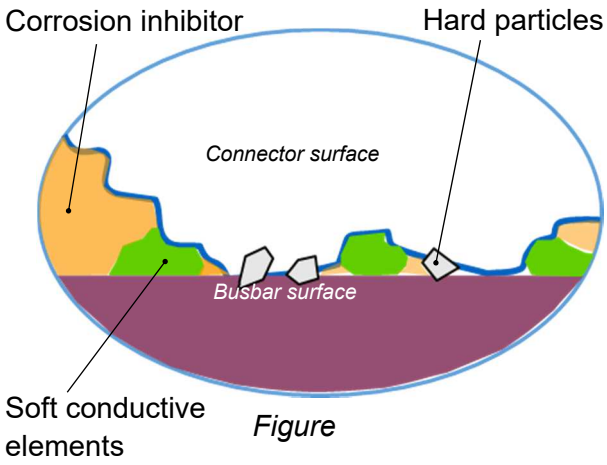
Then $S = \pi xA^2$ —► **S = 3421mm²**

The metallic contact area of the SIMABUS connector is **36 times superior** to the contact area of the first given model which corresponds to a commonly met power contact obtained raw from casting.

Sustainable under any conditions

In order to keep the metallic contact out of external aggression (ie: moisture, pollution…) the overall electrical contact must be kept sealed. Unsealed contact will become inexorably oxidized as it is continuously subjected to temperature changes and environmental constraints.

The opposite figure 7 is a macro view of metallic contacts where the components of the ENERTAL grease are shown. The ENERTAL grease is essential to ensure extended lifetime of the power contact as it's main support is a mineral grease which contains corrosion inhibitor. In addition to its corrosion protection properties, ENERTAL grease also contains soft conductive particles which increase the metallic contact area. Very hard organic particles are also present in the compound in order to create anchorage "micro" points in the contact to improve mechanical tensile strengths.



Figure

ENERTAL grease is a multi-functional compound which will ensure optimized working conditions to the power contacts and for very long time.

Introduction

2.5 – Installation

A detailed installation notice (Instruction Manual ref. 296862-1) is delivered along with our connectors. This manual is providing all recommendations and application methods to install our products for optimal working performances and for an extended lifetime.

The following areas are covered by the manual:

- Preparation of the conductors
- Preparation of the connectors
- Tightening torques
- Clamping operations
- Installation of the busbars
- Maintenance

The contact surfaces, of our connectors are delivered uncoated but our contact grease

« ENERTAL» is supplied along with our connectors for preparation on site.

3 - MATERIAL

TE's connector's components are casted from normalized ingots to guarantee a high alloy quality.

3.1 – Body and keepers

Sand and die cast silicon aluminium alloy: EN AC-42100 SF and EN AC-42200 KF in accordance with EN 1706 (2010) standard.

Mechanical and physical characteristics

Material	Resistivity at 20° C	Electrical conductivity	R_m (MPa*)	$R_{p0.2}$ (MPa*)	A_{50mm} (%)	Hardness (HBS)
EN AC-42100SF	4 µWcm²/cm	> 38 % IACS	140	80	2	50
EN AC-42200KF	4 µWcm²/cm	> 38 % IACS	170	90	4	55

R_m = Minimum tensile strength (*) 1MPa = 1N/mm²

$R_{p0.2}$ = Minimum elasticity conventional limit

A_{50mm} = Minimum elongation

Material cross - Referencing (designation)

French standard (NF EN 1706)	ASTM standard (ASTM B26/B26M)	DIN standard (DIN 1725.2)	BS standard (BS 1490)
EN AC-42100SF	356	G-ALSi7Mg	LM6M
EN AC-42200KF			LM25M

Introduction

3.2 – Aluminium conductors on expansion connectors

In case of expansion type connector, two or more high flexible aluminium stranded conductors are used.
Two cross section sizes of conductor are used:

Designation	Cross section (mm^2)	External diameter (mm)	Stranding (Nos/mm)
SAL 721	610	34.4	53/3.82
SAL 910	791	39.2	53/4.36

The number and the size of the conductors depends of the rated current which has to be carried out.

3.3 – Fasteners

- H type bolts, ISO thread from M10 to M16.
- Screw, washers of A2 type (A4 on request) and hexagonal nut of A4 type stainless steel in accordance with International standard ISO 3506.
- Minimum mechanical strength class 70 (minimum breaking stress = 700 MPa)

The tightening operation and the tightening torque have to be applied in accordance with our Instruction Manual (see 2.5).

Nuts are supplied waxed in order to improve the contact pressure and avoid any gripping issue.

Note: The fasteners used to install connectors on apparatus terminal palms or pillars are not supplied. They are supplied if required.

3.4 –ENERTAL Contact grease

The ENERTAL contact grease contains zinc dust and a corrosion inhibitor.
This grease protects the metal surfaces against the action of atmospheric oxygen and prevents the formation of oxides which increases the contact resistance.
Zinc particles provide a larger contact area to the connectors, so improve the electrical properties. ENERTAL grease is delivered in bags in order to facilitate its application and to reduce waste at site.

ENERTAL bags

Physical characteristics:

* Density at 20° C: 1.8 kg/dm^3
* Drop point: greater than 190° C
* Penetration at 25° C: 245/10 to 280/10.

Introduction

4 - PERFORMANCES - TESTS

4.1 - Electrical performance - HEATING TEST

As a connector must not cause any particular temperature rise in a power circuit, it must not export additional heating to other components like the conductors or apparatus terminals. Instead it must perform as a conductor end and equipment terminal temperature regulator.

· The connectors have a temperature rise less than or equal to the hottest connected conductor for the same current (ANSI/NEMA CC1, § 2.6 and 3.1 - Publication 2009).

· The temperature rise of the connectors, at an ambient air temperature not exceeding 40°C, is less or equal to 50K (IEC 62271-1, §6.5 and 4.4.2 - Publication 2007).

4.2- Electrical performance – HEAT CYCLE TEST

Running on outside circuits the connectors are subjected to many large amplitude thermal shocks (up to 80 °C) at a relatively regular frequency (usually 2 shocks per day). This type of thermal stress can bring significant contact damage if the connectors are not well designed.

For this purpose **heat cycling tests are performed according to the ANSI C119.4 standard (2011), paragraphs 3.2 & 6.**

It consists of subjecting the circuit (including the connectors to be tested) to a current which heats the conductor to 100 °C above air ambient temperature, then cooling the conductors to ambient temperature by forced convection. This process is repeated a certain number of cycles.

The products must be thermally and electrically stable to meet the requirements of the standard. In addition, the test current causing the temperature rise is much higher than the maximum current which the connectors are supposed to carry on site.

4.3- Electrical performance - SHORT-CIRCUIT TEST

The connectors are designed to carry the short-circuit current that may flow through the conductors on which it is set in case of default in the installation.

This short-circuit current must not cause any damage to the connectors.

Neither burn on the contact surfaces nor welding between the parts must occur during the current overload.

The tests are performed in accordance to the paragraph 6.6 of the IEC 62271-1 standard.

The typical values of the fault are 40kA/3s and 63kA/1s.

4.4- Electrical performance - DIELECTRIC HIGH VOLTAGE TESTS

Shapes and design are done to have products able to be used on Phase-to-Phase Rated Voltage up to 550kV.

Introduction

4.4.1 - Corona effect visual test

Neither Positive Corona spark nor light are observed on the surface of the products with naked eyes at the nominal voltage (Phase-to-Ground) equal to 1.1xUr/√3 (Ur = Phase-to-Phase Rated Voltage up to 550kV).

The tests are performed in accordance with the paragraph 6.9.1 of the IEC 62271-1 standard.

4.4.2 - Radio Interference Voltage test

The maximum Radio Interference Voltage level is less than 2500 µV (68dB) at 1.1xUr/√3 (Ur= Rated Voltage up to 550kV) with a 300Ω test circuit impedance.

The tests are performed in accordance with the paragraph 6.9.1 of the IEC 62271-1 standard.

4.5- Mechanical performance - CANTILEVER TEST

The connectors are designed to withstand the mechanical loads which can be applied to the Busbar System.

The minimum cantilever strength of bus support and/or connector is in accordance with ANSI/NEMA CC1 standard (2009 – §2.8-3.4): a transverse load of **8896 N** is applied.

No failure must be observed after the test.

4.6- Mechanical performance – TORQUE STRENGTH TEST

The conductor(s) are assembled in the connector and the bolts tightened uniformly and alternatively in accordance with their instruction manual (TE SIMEL reference: 296862-1), increments until **50% over the nominal torque value is achieved** (in accordance with ANSI/NEMA CC1 - 2009, §3.5).

Introduction

5 – APPLICABLE STANDARDS

- International Standard I.E.C 62271-1 (2007) for heating, resistance, short-circuit and dielectric tests.
- International Standard I.E.C 273 (1990) for base-plate post-insulator interfaces.
- International Standard I.E.C 518 (1975) for stud interfaces.
- International Special Committee (C.I.S.P.R.) publication n° 16 for R.I.V. tests.
- American Standard ANSI/NEMA CC1 (2009) for heating, resistance, tensile and torque strength tests.
- American Standard ANSI C119.4 (2011) for ageing test on tubular conductor products.
- European Standard E.N.C 64-020 (1991) for terminal interface dimensions - palms and studs.
- German Standard DIN 46-206 (1989) for terminal interface dimensions.

6 – SERVICES

Through years of international experience and in the interest of our Customers, TE proposes a choice of technical support services.

6.1 - Fields of expertise

We acquired extended knowledge into the substation applications up to 1200kV over the last 60 years that can be of benefit to our clients such as:

- Innovating solutions that drive to significant savings in the projects. Connection points rationalization, reduction of installation cost by avoiding weldments or bending of the tubes, original solution for retrofit projects of ancient switchyards.
- Mechanical case studies to propose optimized dimensioning and arrangement of busbar systems.
- Dynamic case studies of bus vibration phenomenon to propose adapted damping solution to critical Aeolian applications.
- Electrical field case studies further observed Corona phenomenon in Extra and Ultra High Voltage switchyards in order to propose adapted shielding solutions.

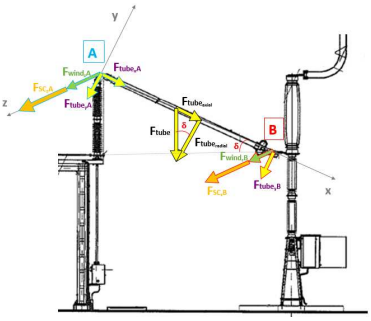
For any challenging application in connection systems, TE has a solution to propose.

Introduction

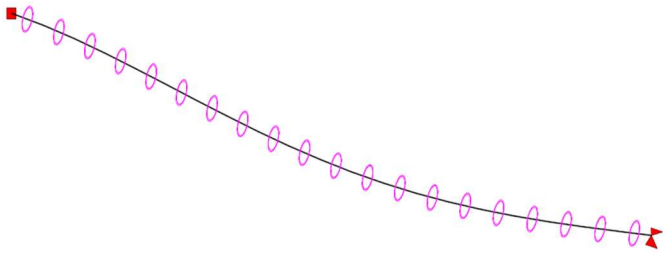
6.2 - Calculation

We offer a wide range of calculation support to our Customers.

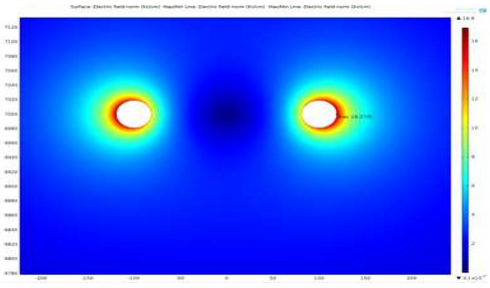
- **Mechanical** calculation of a busbar system by Finite Element Method (FEM). Taking into consideration all external load parameters like short circuit strengths, icing of the tubes, wind pressure… We calculate the strengths in the tubular conductor as well as the strengths at the connection points in order to estimate the transferred loads to the HV equipment's and the adapted size/material grade of the tube.



- Dynamic calculation by FEM of a busbar exposed to **Aeolian vibrations**. We help our Customers to collect the most accurate data from the installed busbar system like span length, dimension/material/ grade of the tube, boundary conditions provided from the installed connectors… We run a dynamic calculation to determine the own frequencies of the system in order to confirm the critically factors of the studied case. We propose a damping system adapted the actual situation and provide all recommendation to install the system.



- **Electrical field** calculation of a connection environment by FEM. Further any observed Corona phenomenon, we collect your connection environment and run a calculation to localize the critical discharges areas in order to propose a shielding system adapted to the environment and easy/fast to install.



- Calculation of the **heating** of the conductors. We take into account all environmental data to calculate the expected temperature rise of the conductor(s) and in consideration of its actual physical characteristics as well as its climatic ageing.

6.3 - Tests laboratory

Our test laboratory, located in France (Gevrey-Chambertin) is Cofrac accredited. This means that our laboratory is considered as independent (third party). It is able to demonstrate its competence and independence to carry out specific assessment tasks (i.e. independent testing of our products).

Introduction

Advantages of accreditation

- Proof of technical expertise
- Qualification, training and experience of the lab team
- Equipment properly calibrated and maintained
- Adequate quality assurance procedures
- Appropriate testing procedures
- Traceability of measurements in line with International Standards
- Validity of the test methods
- Accurate recording & reporting procedures
- Suitable testing equipment and facilities

Our testing laboratory offers a wide choice of tests protocols covered by the accreditation frame (see following tests summary table).

N°	Description of the test	N°	Description of the test
1	Electrical ageing	12	Water tightness strength
2	Temperature rise and short-circuit	13	Crimping capabilities
3	Electrical ageing under mechanical load	14	Low temperature mechanical shock
4	Climatic ageing	15	Electrical ageing under immersion
5	Salt bath corrosion	16	Insulation resistance measurement
6	Dioxide sulfur corrosion	17	Low temperature assembly
7	Soda corrosion	18	Endurance test for LV accessories
8	Dielectric strength	19	Marking strength
9	Dry heat	20	Electrical ageing under water pressure
10	Mechanical tensile strength	21	Mechanical shock at low temperature
11	Screwing and unscrewing measurement		

More specifically to High Voltage connectors, our laboratory can perform electrical temperature rise tests according to the NEMA, EN and ANSI standards, Short circuit tests according to the EN standard and any mechanical test (tensile, bending, cycle…) according to applicable standards and customer's requirements, but also some vibration tests.

Introduction

Some illustrations of our testing capabilities for High Voltage Connectors

Temperature rise test up to 10kA

Cantilever/Bending test up to 5T/Axis

Short-circuit test up to 42kA/2Sec

Tensile test up to 70 T

Vibration test

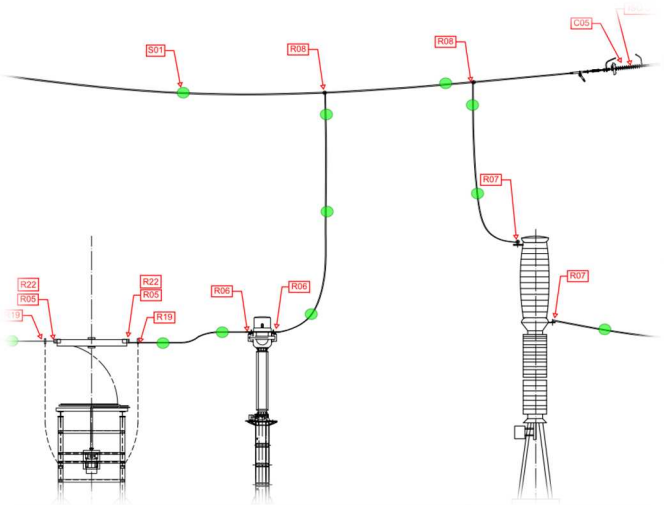
6.4 - Connectors BOQ from switchyard lay-out

As another service, we offer to our customers the definition of the clamps and connectors from the lay-out of the switchyard.

Item numbers of the proposed products are located on the lay-out and the final Bill of Quantity is provided along with our offer.

Fixing bolts can be also proposed in consideration of HV equipment's which will be installed in the switchyard.

Do not hesitate to ask us in case we can support you in making your substation project successful.

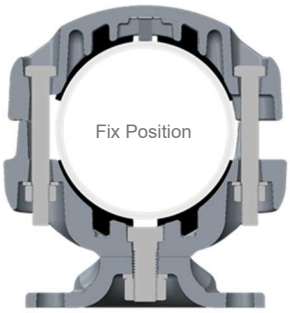


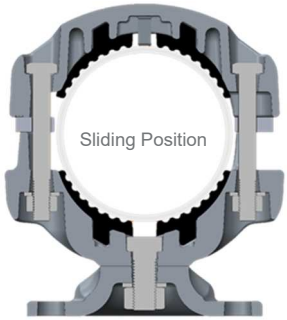
Chapter I

Bus Supports & Junctions

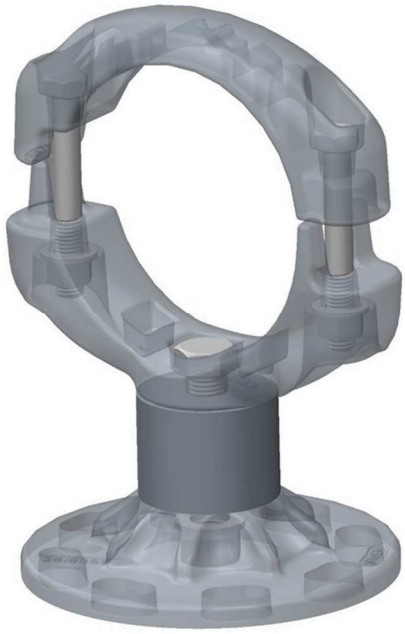
Rubberized Support

- Neoprene rubbers added to the standard supports
- Working temperature up to 120°C
- UV Resistant
- Increased free angular movements of the tube to -/+ 6°
- Self damping characteristics

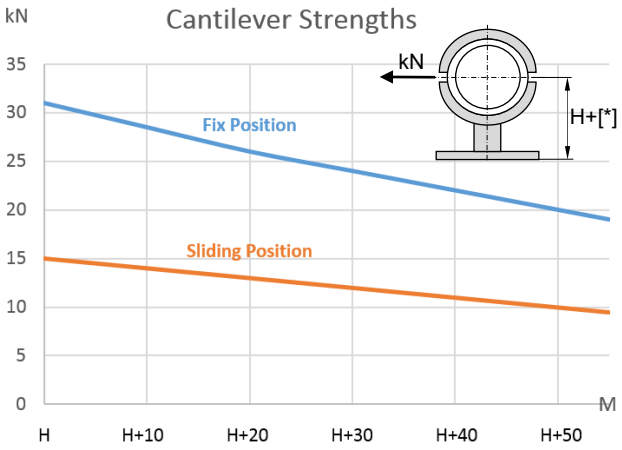




Adjustable Height



- Spacer in Aluminium alloy
- Extended height up to 55mm
- In factory safe assembly
- Alignment of the Bus extension to existing busbar
- No added installation time



"H "Is the standard dimension without spacer (see table page 23)
*: Added spacer from 5 to 55MM
Given cantilever values for indication

5 TSR 82 P_ T_ H_

Rubberized (Optional) — Fixing PCD — T — H (Optional)

Single Bus Supports

Fix/Sliding support for tubular conductors

5 TS 82 P5 T100 H120
Single Bus Support for Al Tube 100 O/D with PCD 5 Fixing and H= 120mm

5 TS 82 P7-P225 T141
Single Bus Support for Al Tube 5'' O/D with PCD 7/225 Fixing (H Std see table below)

CHARACTERISTICS

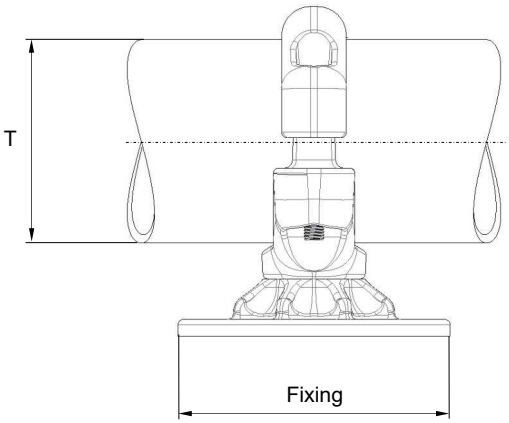
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

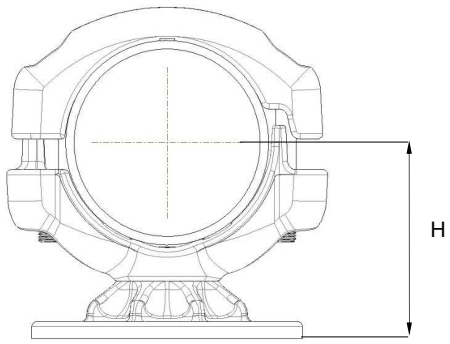
APPLICATIONS

- Main & reserve Busbar
- Mechanical support of Aluminium tubular conductors

ADVANTAGES

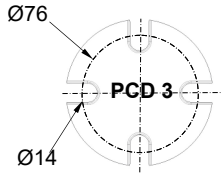
- Fix/Sliding arrangement
- Angular free -/+3° (no transferred torque)
- Metallic equipotential spring
- Corrosion resistant
- Equipotential spring

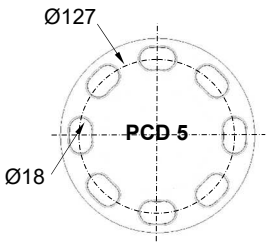


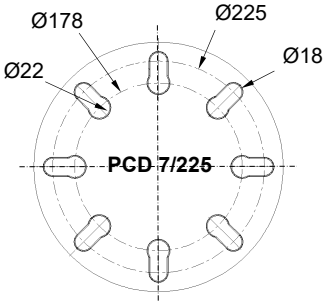


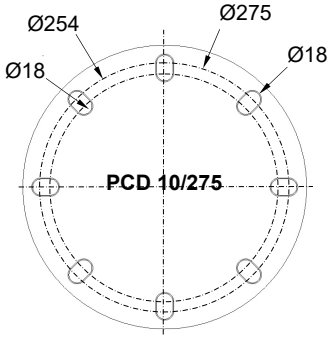
Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
Fixing	PCD 3	●	●	○	○	○										
	PCD 5		●	●	●	●	●	●	●	●	●	●	●	●	●	●
	PCD 7/225		○	○	○	○	●	●	●	●	●	●	●	●	●	●
	PCD 10/275						○	○	○	○	○	○	○	○	○	○

● Standard
○ Option









5 TSRD 82 P_ T_ H_

Rubberized (Optional) — Fixing PCD — T — H (Optional)

Double Bus Supports

Fix/Sliding support for tubular conductors

5 TSD 82 P3-P5 T100 H120

Double Bus Support for Al Tube 100 O/D with PCD 3/5 Fixing and H= 120mm

5 TSD 82 P5/P225 T141

Double Bus Support for Al Tube 5'' O/D with PCD 5/225 Fixing (H Std see table below)

CHARACTERISTICS

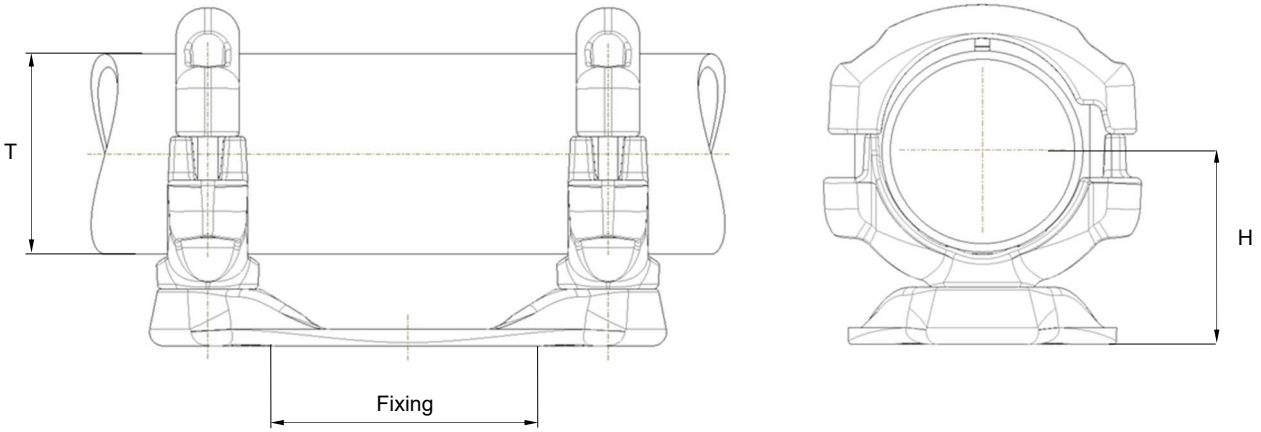
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

- Main & reserve Busbar
- Suspended Bus configuration
- Mechanical support of Aluminium tubular conductors

ADVANTAGES

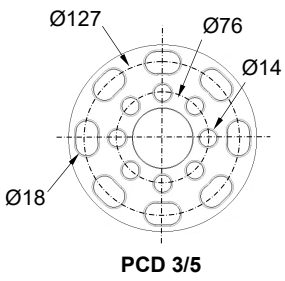
- Fix/Sliding arrangement
- Reinforced mechanical strengths
- Metallic equipotential spring
- Corrosion resistant
- Equipotential spring



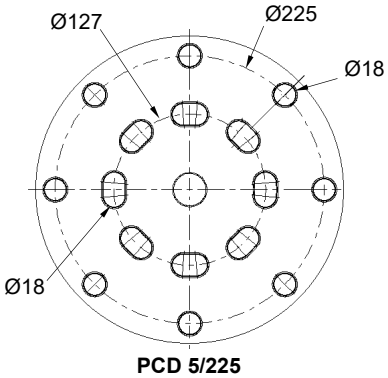
Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
Fixing	PCD 3/5	●	●	●	●	●	●	●	○	○	○	○				
	PCD 5/225			○	○	○	●	●	●	●	●	●	●	●	●	●
	PCD 7/10/275						○	○	●	○	○	○	○	○	●	○

● Standard

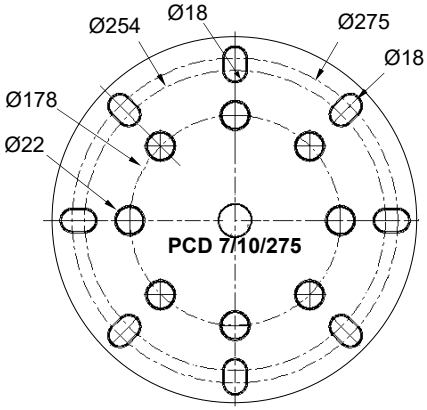
○ Option



PCD 3/5



PCD 5/225



5 TJ 82 P_ T_ H_

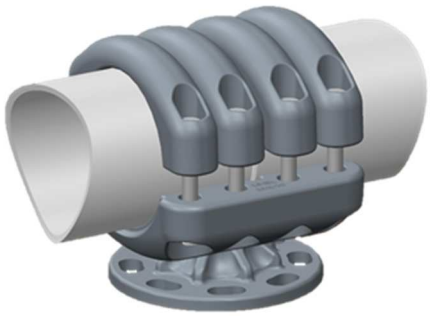
Fixing PCD → T → H (Optional)

Fix Junctions

Fix joint for tubular conductors on Post insulator

5 TJ 82 P3 T80 H120
Fix joint for Al Tube 80 O/D
With PCD 3'' Fixing and H= 120mm

5 TJ 82 P7-P225 T141
Fix joint for Al Tube 5'' O/D with PCD 7/225 Fixing
(H Std see table below)



CHARACTERISTICS

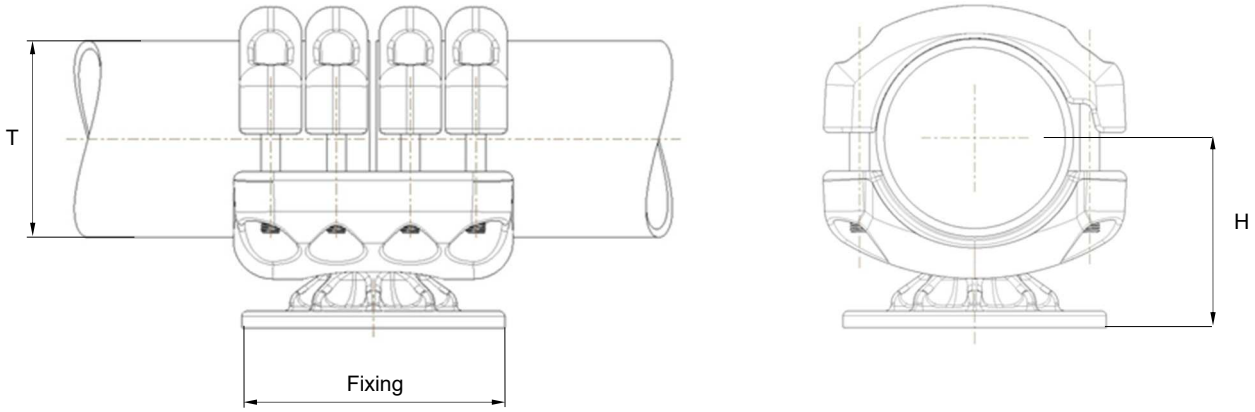
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

- Main & reserve Busbar
- Mechanical support of Aluminium tubular conductors

ADVANTAGES

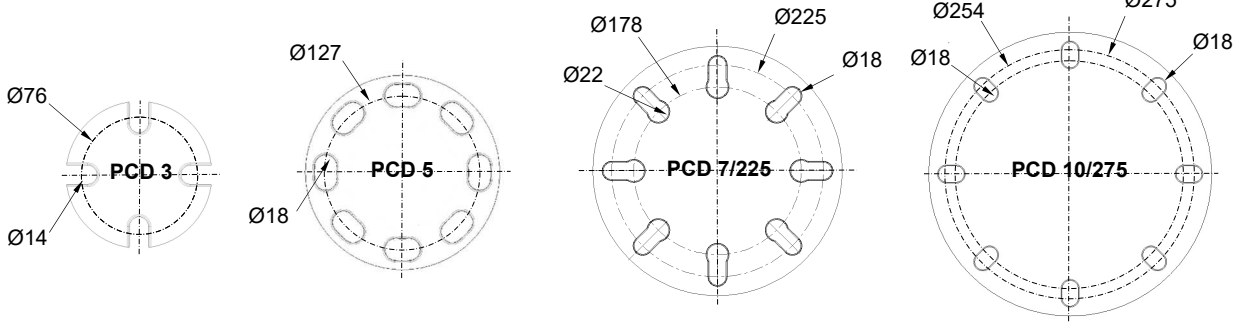
- Economic
- Torque free transfert to Post insulator
- Adjustable Height (see page 8)
- Corrosion resistant



Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
Fixing	PCD 3	●	O	O	O	O										
	PCD 5		O	O	●	O	●	O	O	O	●	●	O	●	O	●
	PCD 7/225		O	O	O	O	●	O	O	O	●	●	O	●	O	●
	PCD 10/275						O	O	O	O	O	O	O	O	O	O

● Standard

O Option



Adjusted to your rating

Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910

- Current bridge adjusted to the rating current (see table below)
- AAC Ultra flexible stranded conductors SAL 721 or 910
- High conductivity
- Short wiring pitch (no “bird cage” effect)
- High flexibility (no transferred strengths)
- Horizontal or vertical arrangement of the bridge

Aluminium Busbar	Metric	80		90	100		120	125	140		150	160		200	220	250
	IPS		3"			3 "1/2				5"			6"			
O/D (mm)		80	88,9	90	100	101.6	120	125	140	141,3	150	160	168,2	200	220	250
I/D (mm)	Maxi	70	77,9	78	90	85.4	104	111	120	128,2	126	148	154,1	184	200	236
	Mini	60	73.7	70	80	90.1	96	105	120	122.3	126	140	146.3	180	200	222

In (min)	A	<1750	2000			3150		4000		
In (max)		2000	3150	4000		5150	4000	6000	4000	8000

Possible flexible conductors arrangement																
Colour code	●●	●●	●●	●●	●●	●●●	●●●	●●●	●●	●●●	●●	●●	●●●	●	●●●●

Ratings guide

The opposite curves gives an .an over-view of the possible conductors heating arrangements.

The heating values are calculated in accordance with IEEE 738 (2006) stand-ard in outdoor and indoor conditions considering the following data:

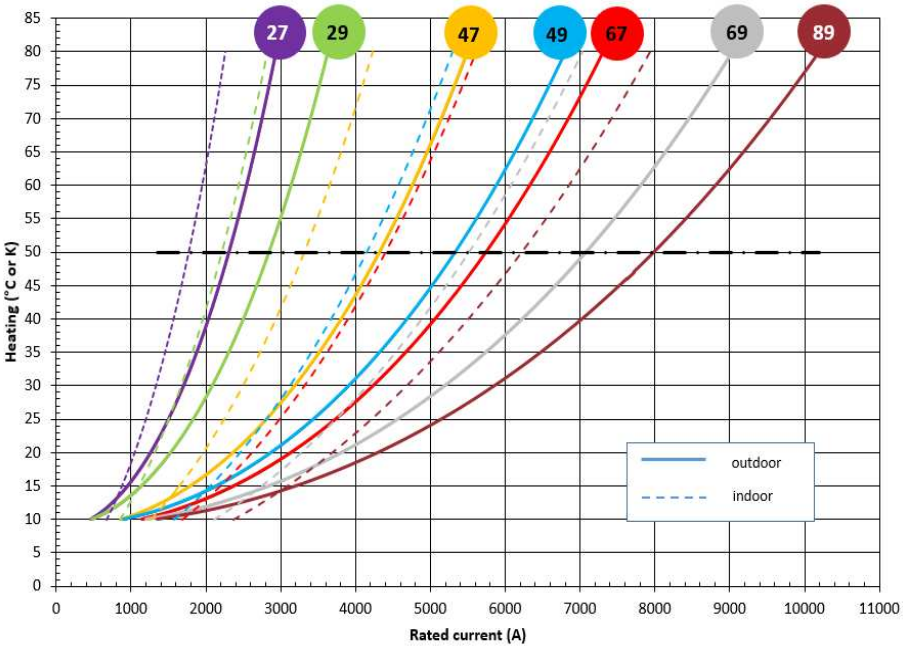
Data	Indoor	Outdoor
Wind speed (m/s)	0	0.61
Emissivity (Coef) *	0.23	0.5
Solar absorption (Coef)	0.3	0.5
Corrected solar Ray (W/m²)	100	1030
Ambiant Temperature (°C)	20	40

* Emissivity factor established on the basis of :

- New conductor with bright surface for indoor conditions.

- Aged conductor with oxidized surface for outdoor conditions

Heating of current bridge configurations (Indoor & Outdoor conditions)



5 TJRL 82 P_ T_ H_ __

Rubberized (Optional) — Fixing PCD — T — H (Optional) — Flex Arrangement

Expansion Junctions

Fix/Sliding joint for tubular conductors on Post insulator

5 TJL 82 P3-P5 T100 H120 29

Fix/Sliding joint for Al Tube 100 O/D with PCD 3/5'' Fixing, H= 100mm and 2x SAL 910 conductor flexible arrangement with H=120

5 TJL 82 P5-P225 T141 47

Fix/Sliding joint for Al Tube 5'' O/D with PCD 5''/225 Fixing and 4x SAL 721 conductor flexible arrangement (H Std see table below)

CHARACTERISTICS

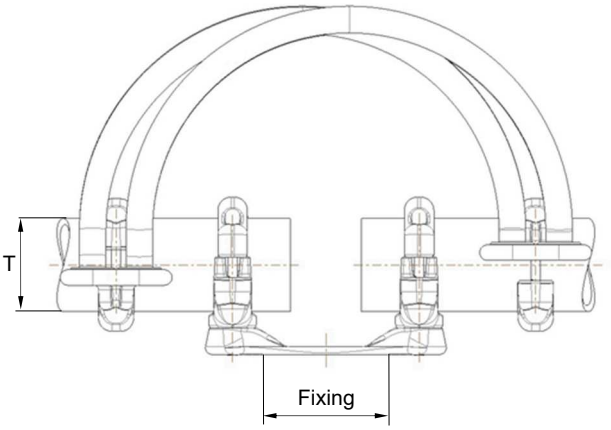
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

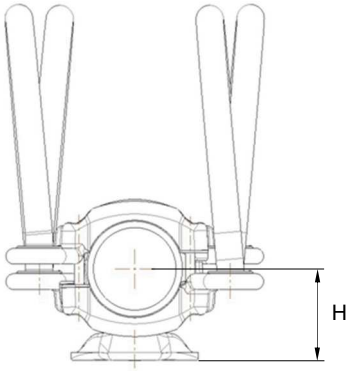
APPLICATIONS

- Main & reserve Busbar
- Mechanical/electrical joint of Aluminium tubular conductors

ADVANTAGES

- Easy to install
- Torque free transfert to Post insulator
- Adjustable Height or/and rubberrized supports (see page 8)
- Corrosion resistant
- Current bridge adjusted to the ratings

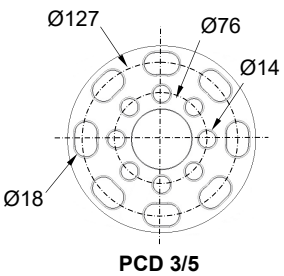




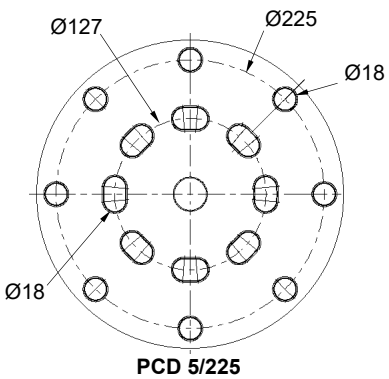
Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
Fixing	PCD 3/5	●	○	○	●	○	●	○	○	○	○	○				
	PCD 5/225			○	○	○	●	○	○	○	●	●	○	●	○	●
	PCD 7/10/275						○	○	○	○	○	○	○	○	○	○

● Standard

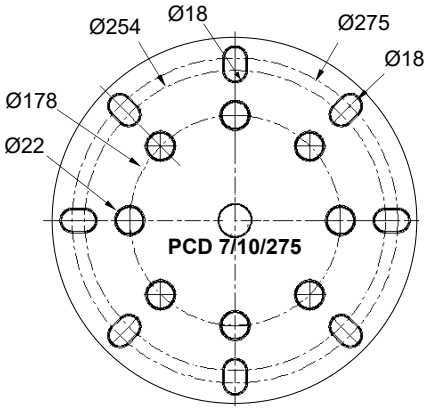
○ Option



PCD 3/5



PCD 5/225



5 TJR 82 T_

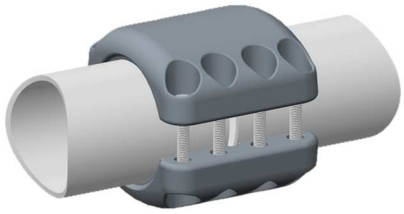
T

Bolted couplers

Bolted joints for tubular conductors

5 TJR 82 T100
Bolted joint for Al Tube 100 O/D

5 TJR 82 T141
Bolted joint for Al Tube 5'' O/D



CHARACTERISTICS

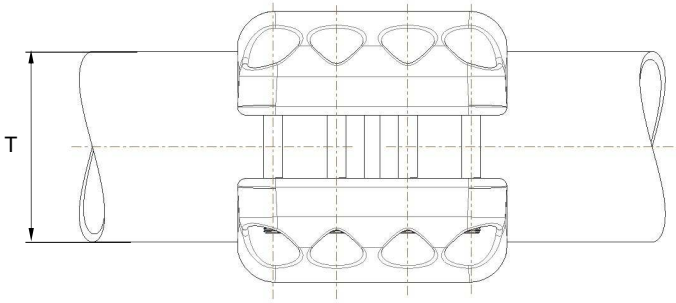
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

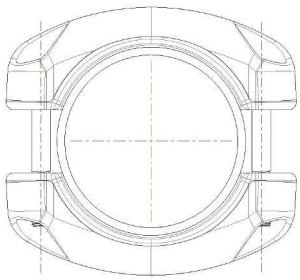
APPLICATIONS

- Main & reserve Busbar
- Mechanical/electrical joint of Aluminium tubular conductors

ADVANTAGES

- Economic solution
- Easy to install (no weldment at site)
- Corrosion resistant





Busbar Size	Metric IPS	80	3"	90	100	3 1/2"	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250

Design guide

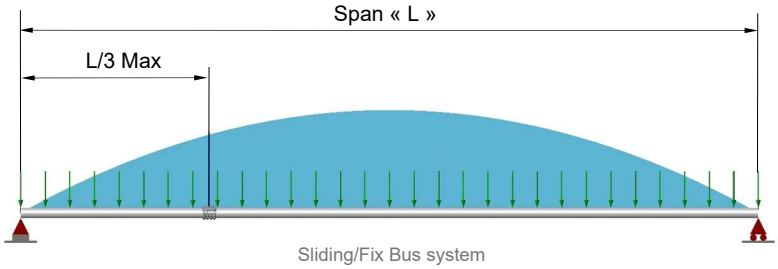
Bolted couplers must be installed at busbar location where the bending moment on the concerned span is null or minor.

The figures in front indicate the two typical bus system configurations depending on the boundary conditions provided by the connection type.

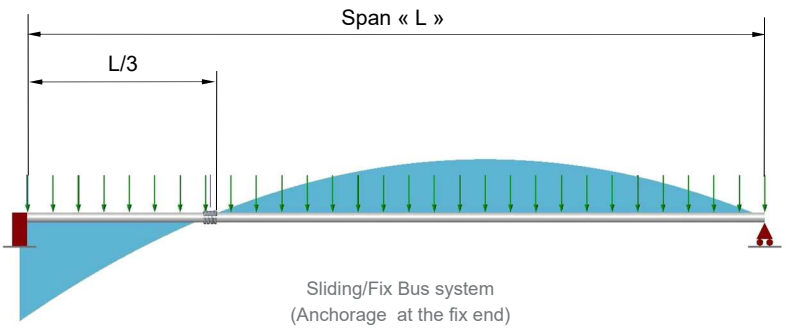
The first figure illustrates a Fix/Sliding bus configuration where the fix connector (or support) allows minor deflection of the tube (due to the applied forces, ie: dead weight, wind, short-circuit...). In that case the coupler will be installed at the closest possible location to the fix connector without exceeding 1/3 of the span length.

The second figure illustrates a Fix/Sliding bus configuration too but here the fix connector is such as it possibly transfers torque to the connected equipment. In that case the coupler must be installed closest as possible to the third length of the tube and at the fix connector side where the bending moment in the tube is null or almost null.

For any other specific bus system configuration, please contact us. Our Engineers can run a calculation in order to recommend the best connections' set configuration.

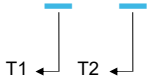


Sliding/Fix Bus system
(Torque free at the fix end)



Sliding/Fix Bus system
(Anchorage at the fix end)

5 UATFR _/R_ 5B



Adjustable Elbow

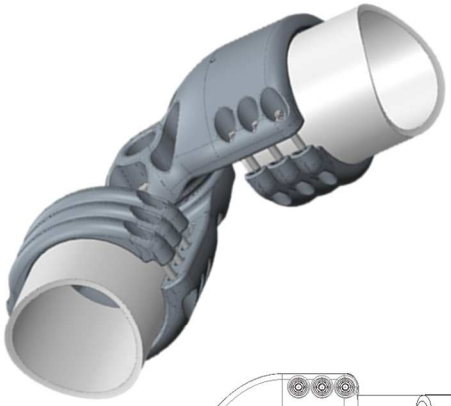
Bolted and adjustable angular joint

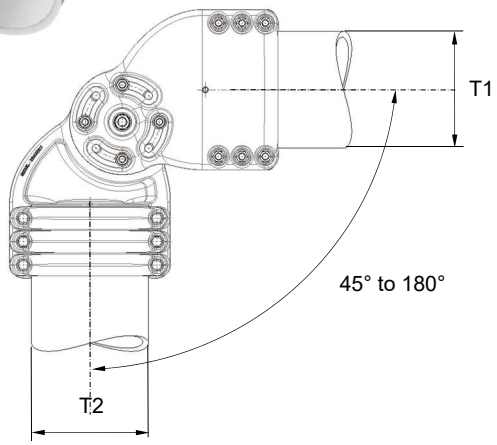
5 UATFR160/R160 5B

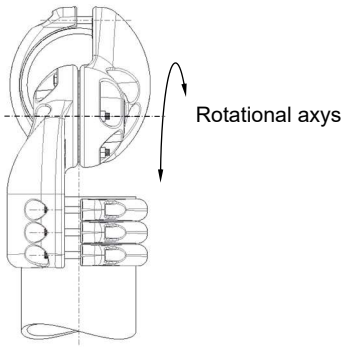
Adjustable Elbow for Al Tubes 160 O/D

5 UATFR160/R120 5B

Adjustable Elbow for Al Tube 160 O/D to 120 O/D







CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners
- Internal multi-contacts contact tin plated

APPLICATIONS

- Main & reserve Busbar—Coupling section—HVDC converters

ADVANTAGES

- Save significant installation cost
- Avoid welding or bending operation at site
- Fully adjustable in any direction
- TE SIMEL single bolt contact technology proven by 15 years field experience
- Corrosion resistant

Busbar Size	Metric IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T1	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
T2	80	O			O		O									
	88.9		O			O				O						
	90			O					O							
	100				O		O	O			O					
	101.6					O				O			O			
	120						O				O	O		O		O
	125							O			O					
	140								O					O		O
	141.3									O			O			
	150										O					
	160											O		O		O
	168.2												O			
	200													O		O
	220														O	
	250															O

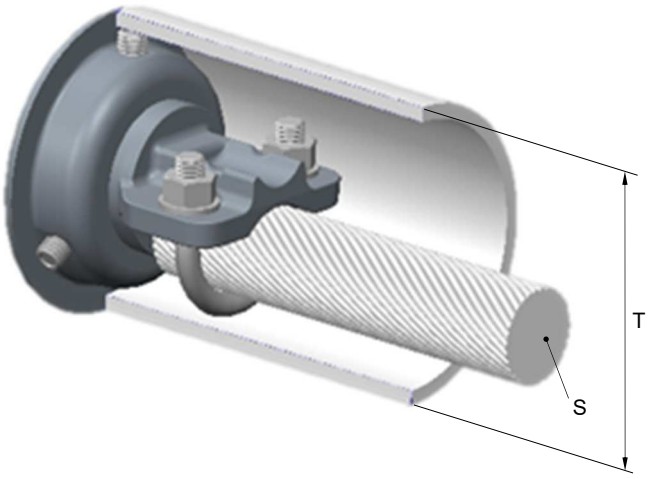
● Standard

O Option

Chapter II

Bus Accessories

Vibration Attenuation



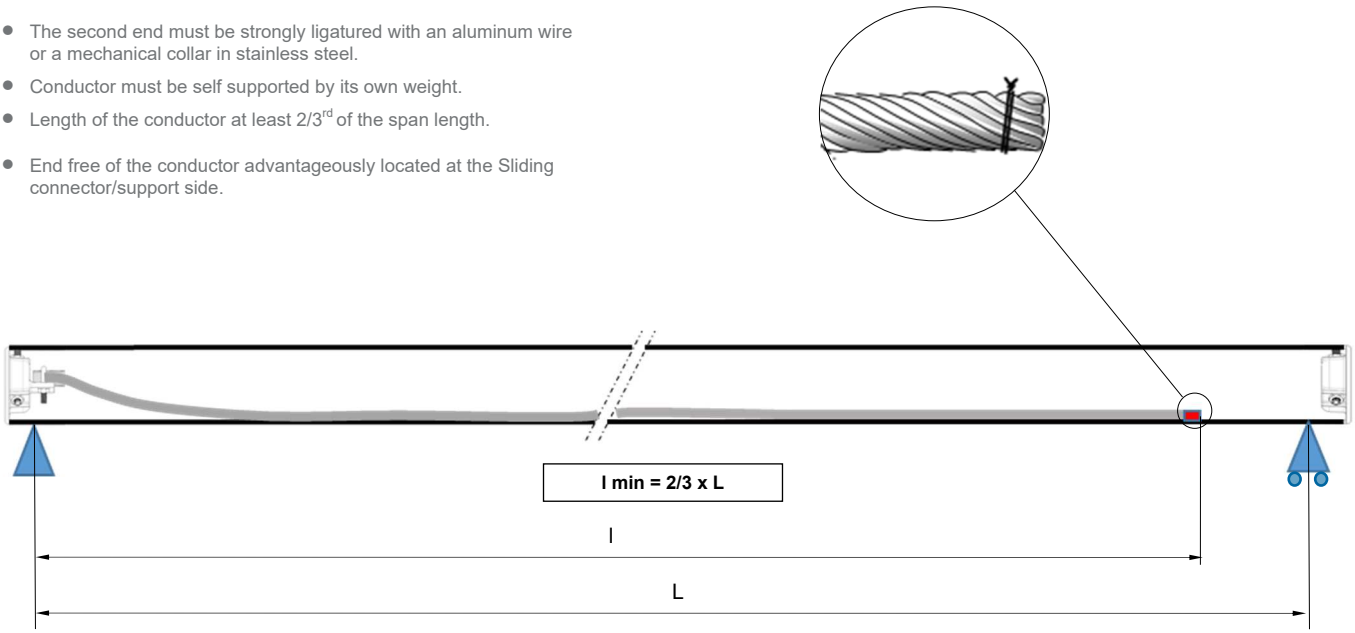
- Internal conductor size must be defined on the basis of the busbar dimension (see table below)
- Conductor type must be AAC or AAAC types (ACSR to be avoided) due to their snacking behavior inside the tube)
- Damping a busbar with an inside conductor is an empirical method which cannot be modelized by calculation. Some extreme vibration conditions cannot be solved by a damping conductor system (See page 37 Damper for busbar)

Busbar Size	Metric IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
S min (*)	(mm²)	220	200	250	280	280	400	360	400	300	520	470	350	600	530	900
S Maxi (*)	(mm²)	390	475	522	500	500	600	1150	1150	900	1030	960	1150	1150	1150	1150

(*) Min and Max conductors cross sections defined as per IEEE Std 605-2008 (IEE Guide for Bus Design in Air Insulated Substations)

Installation Recommendation

- Conductor must be fixed at one at its end only.
- The second end must be strongly ligatured with an aluminum wire or a mechanical collar in stainless steel.
- Conductor must be self supported by its own weight.
- Length of the conductor at least 2/3rd of the span length.
- End free of the conductor advantageously located at the Sliding connector/support side.



5 TABPC 82 T_ _/_

With Cable holder (Optional)

T

Cmin Cmax

End Caps

End Caps with/without damping cable holder

5 TABP 82 T80

End Cap for Al Tube 80 O/D w/o cable holder

5 TABPC 82 T120 18/35

End Cap for Al Tube 80 O/D with cable holder 16 to 26 O/D

CHARACTERISTICS

- From 60kV to 220kV
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

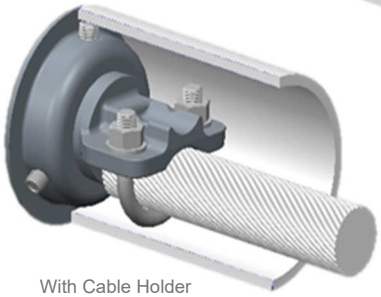
- Main & reserve Busbar - Equipment's Bus connections

ADVANTAGES

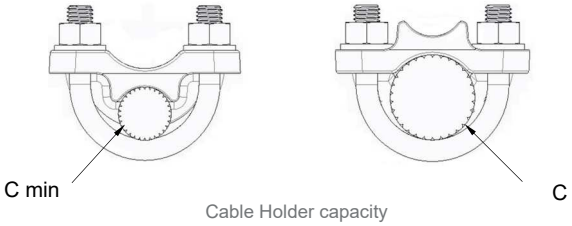
- Avoid birds, small animals intrusion.
- Range taking per O/D tube sizes
- Wide damping conductors range taking
- Corrosion resistant

Size 80 to 90

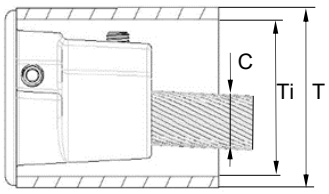
Without Cable Holder (size 100 to 250)



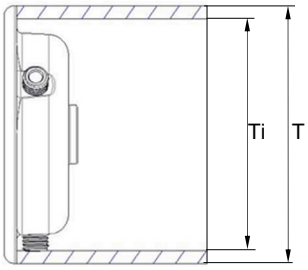
With Cable Holder (size 100 to 250)



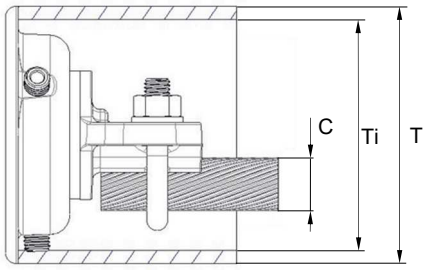
Cable Holder capacity (size 100 to 250)



With & w/o Cable Holder (Size 80 to 90)



Without Cable Holder (size 100 to 250)



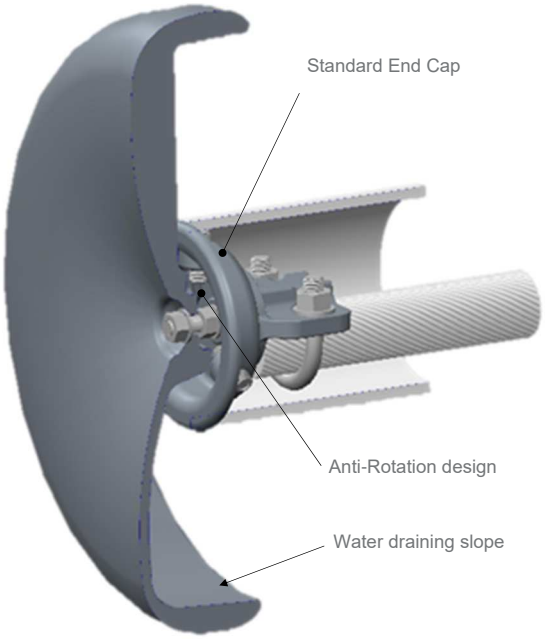
With Cable Holder

Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Ti min	(mm)	60	73.7	70	80	85.4	96	105	120	122.3	126	140	146.3	180	200	222
Ti Maxi	(mm)	70	77.9	78	90	90.1	110	111	121	128.2	126	148	154.1	184	204	240
C min - C Maxi	16-26 (mm)	●	○	○												
	18-35 (mm)				●	●	●	○	●	●	●	●	○	●	○	
	35- 44.5 (mm)							○	●	●	●	●	○	●	○	●

● Standard

○ Option

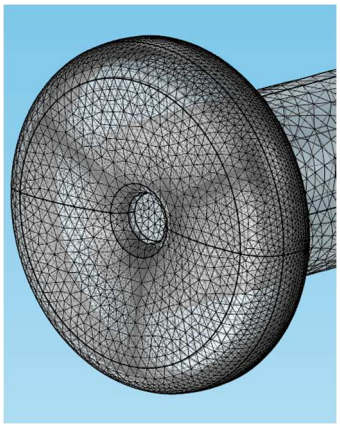
Design Experience



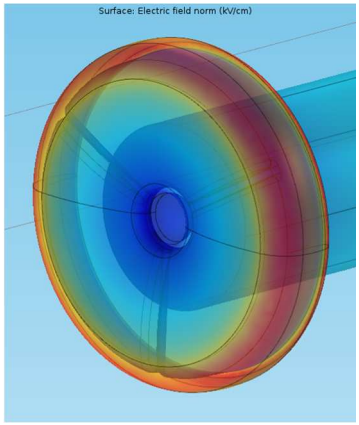
- TE has almost 70 years experience in HV and UHV substation connectors supporting research & development of optimized solutions.
- A unique size of Corona shield end fitting for any conductor size up -to 250 O/D operating up-to 550kV.
- The Corona shield is locked in rotation to withstand wind pressure during its service life.
- Design of the shielding avoid water retention which is an additional stress factor to the Corona phenomenon.
- The shield is adapted to our standard range of end caps (see page 33).

Design Expertise

- TE SIMEL acquired a solid experience through HV R.I.V and Corona tests over the last 60 years.
- Our Engineers optimize the design of the HV and UHV products with the support of FEM calculation software.
- Correlations between the test results and calculation models have been carried-out to obtain accurate and reliable UHV design solutions without repeating tests.
- End free of the conductor advantageously located at the Sliding connector/support side.



Meshing of the exposed surfaces
of electrical stress



FEM Analysis of
electrical stress fields

5 TAPAC 82 T_ _/_

With Cable holder (Optional)

T Cmin Cmax

End Shieldings

End caps Corona Shields

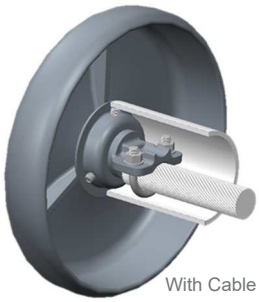
5 TAPA 82 T120

End Shielding for Al Tube 120 O/D w/o cable holder

5 TABPC 82 T160 18/35

End Shielding for Al Tube 160 O/D with cable holder 18 to 35 O/D

Without Cable



With Cable

CHARACTERISTICS

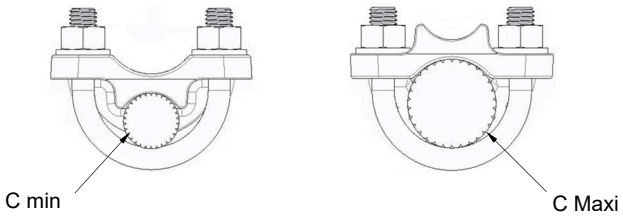
- From 220kV to 550kV
- Aluminium Alloy & Stainless steel fasteners
- Corona free

APPLICATIONS

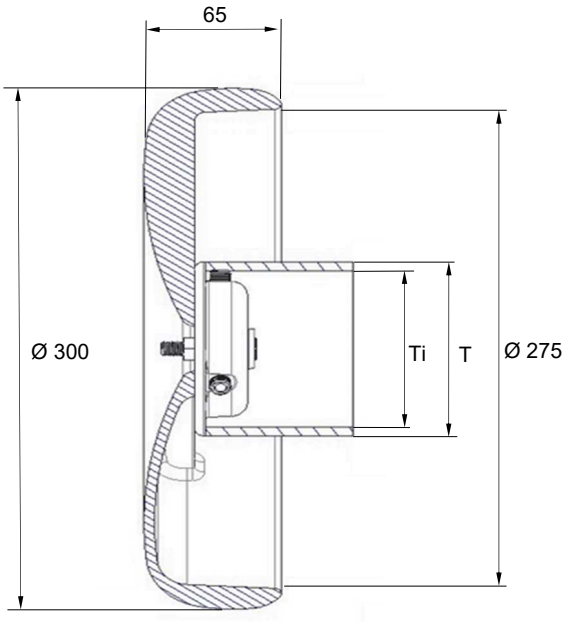
- Main & reserve Busbar

ADVANTAGES

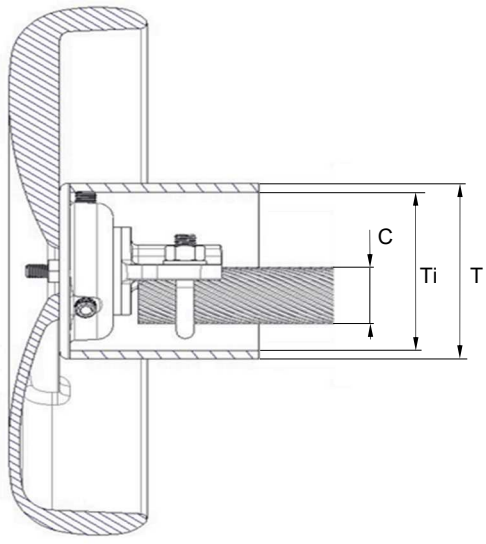
- Range taking per O/D tube sizes
- Wide damping conductors range taking
- One size shield up to 250O/D tube
- Adaptable to the range of end caps
- Corrosion resistant



Cable Holder capacity



Without Cable Holder

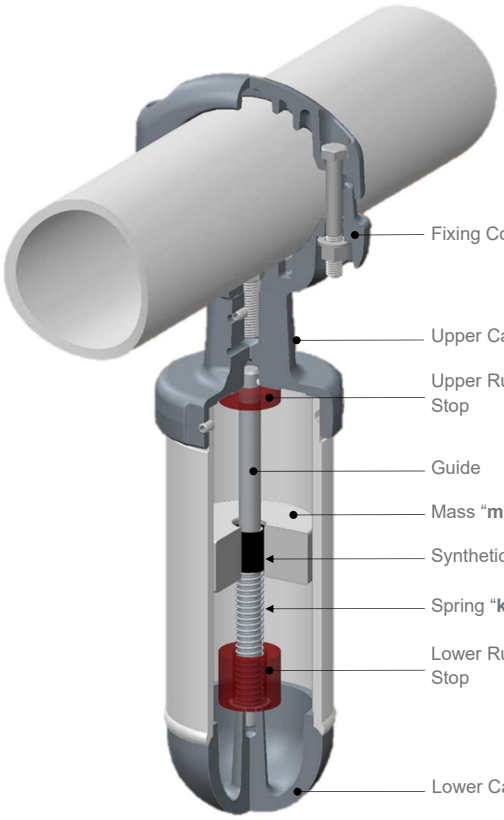


With Cable Holder

Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Ti min	(mm)	60	73.7	70	80	85.4	96	105	120	122.3	126	140	146.3	180	200	222
Ti Maxi	(mm)	70	77.9	78	90	90.1	110	111	121	128.2	126	148	154.1	184	204	240
C min - C Maxi	18-35 (mm)						●	O	O	O	●	●	O	O	O	
	35- 44.5 (mm)						O	O	O	O	●	●	O	●	O	●

● Standard

O Option



AMORSIM Damper

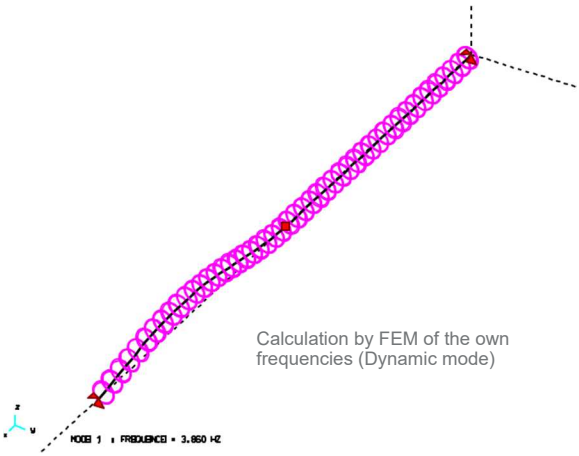
Did You Know?

- Critical busbar vibration is one of the first root cause of connector's failure in Air Insulated Substations
- There are critical cases where damping cable systems are inefficient (own frequency below 4Hz).
- Low own frequencies of a busbar system depends on combination of several factors as, long span, large size of tubes, inappropriate busbar connectors, topographic situation of the switchyard, low and continuous wind speed...
- Audible noise can be generated by the damping stranded conductor inside the tube which may be not acceptable in some location (urbanized areas, wildlife disturbance…) .
- AMORSIM damper by TE is an efficient damping product adapted to critical vibration situations. AMORSIM damper is a proven solution with now more than 20 years experience on the field.

$$f(Hz) = \frac{\sqrt{k/m}}{2\pi}$$ ⟺ Weight (**m**) & Spring (**k**) adjusted in factory at the calculated frequency

Design to Customer

- We collect the data of the actual busbar systems configurations (Span length, tube characteristics, boundary conditions….).
- We run a calculation by FEM in a dynamic mode to calculate the first own frequencies of each configuration to confirm if of the studied cases are critical.
- Own frequencies of a busbar from 2 to 4Hz can be critical and below 2Hz are considered as highly critical.
- We defined the damping characteristics and parameters of the AMORSIM dampers (mass and spring stiffness)
- We indicate the most appropriate position of the AMORSIM damper on each span (where the vibration amplitude is the largest).
- End free of the conductor advantageously located at the Sliding connector/ support side.



Calculation by FEM of the own frequencies (Dynamic mode)

Span N°	Busbar system configuration (Initial)	Own Frequencies	Maximum amplitude location at f1
1	18m, Anchorage, 62kg, Sliding	**f1 = 1,83 Hz** f2 = 5,75 Hz f3 = 12,75 Hz	13,5m, Amorsim
2	5m, Anchorage, 62kg, Sliding	**f1 = 1,96 Hz** f2 = 5,83 Hz f3 = 11,9 Hz	13,5m, Amorsim
3	11,5m, Fix, 62kg, Sliding	**f1 = 1,11 Hz** f2 = 5,12 Hz f3 = 10,5 Hz	11,5m, Amorsim
4	Fix, Sliding	**f1 = 1,28 Hz** f2 = 5,14 Hz f3 = 11,55 Hz	11,5m, Amorsim

Dead weight (Pantograph connector)

Output calculation summary sheet

5 AM 82 T_ F_

T ← → Frequency

5 AM 82 T250 F210

Damper suitable for Al Tube 250 O/D adjusted at 2.10Hz Frequency

AMORSIM Damper

Damper

Damper for Busbar Systems

CHARACTERISTICS

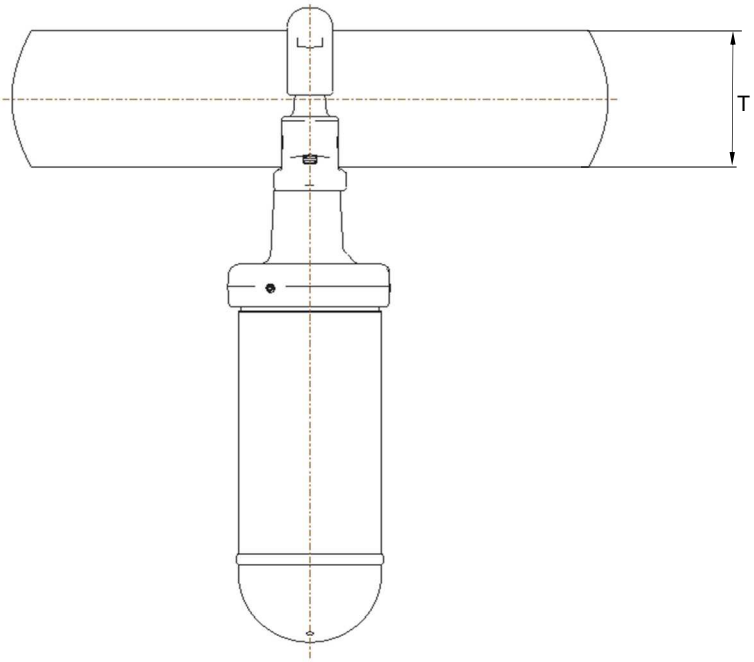
- From 60kV to 550kV
- Aluminium Alloy & Stainless steel fasteners
- Internal organs corrosion resistant (see left page)

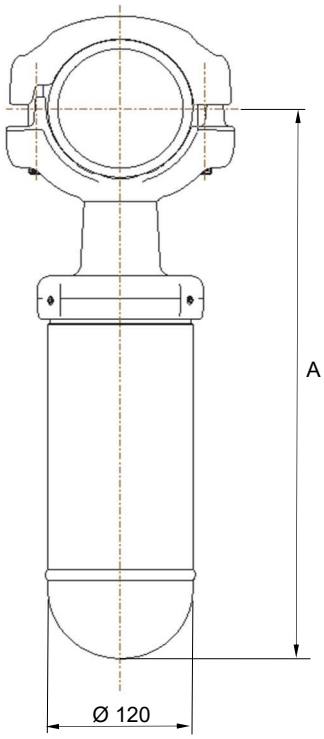
APPLICATIONS

- Main & reserve Busbar - Equipment's Bus connections

ADVANTAGES

- Guaranteed damping characteristics where damping cable system is inefficient.
- Damping frequency adjusted to each customer's case study
- Silent
- Corrosion resistant
- Equipotential





Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
A	(mm)	495	500	500	505	506	515	518	525	526	530	535	539	555	565	580
Standard/Option	●/○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

5 TAMALTF 82 T_

Axial (Optional)

T

Earthing Stirrups

Trapeze Type Earthing stirrups

5 TAMALT 82 T120

Perpendicular Trapeze type Earthing stirrup for tube 120 O/D

5 TAMALTF 82 T141

Axial Trapeze type Earthing stirrup for tube 5'' O/D

Perpendicular

Axial

CHARACTERISTICS

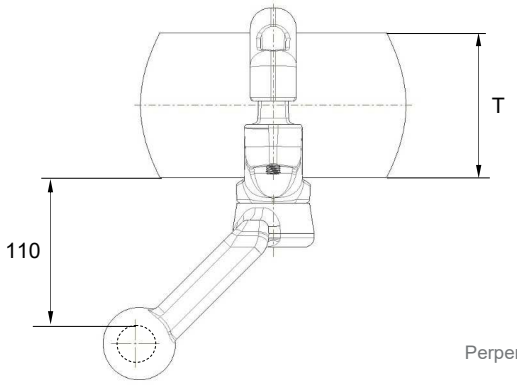
- From 60kV to 400kV
- Up-to 63kA/1sec
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

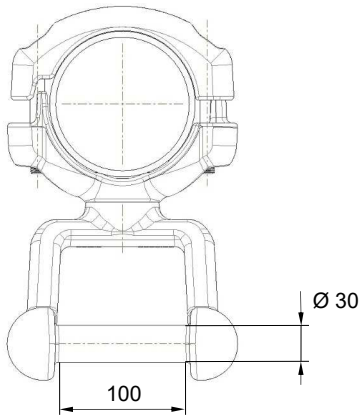
- Main & reserve Busbar - Equipment's Bus connections

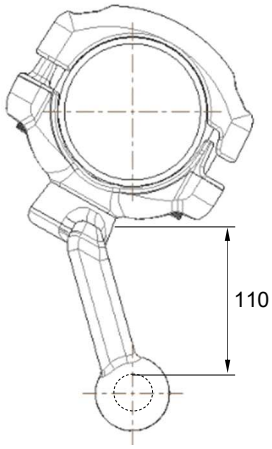
ADVANTAGES

- Multi-position stirrup
- Wide access to earthing clamp
- Corrosion resistant

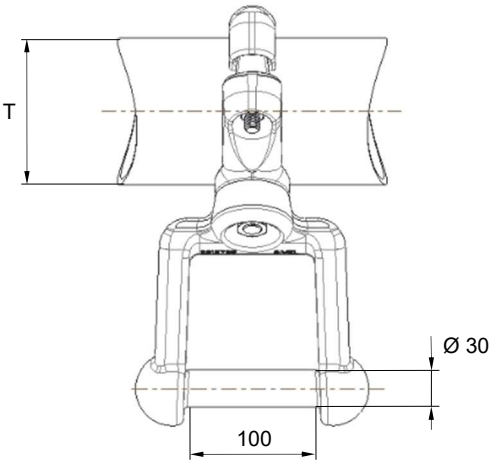


Perpendicular Position





Axial position



Busbar Size	Metric IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Standard/Option	●/○	●	○	○	●	○	●	○	○	○	●	●	○	●	○	●

5 TAMALTFD 82 T_

T

Double Earthing Stirrups

Double Axial Earthing stirrups

5 TAMALTFD 82 T120
Double Axial Earthing stirrup for tube 120 O/D

5 TAMALTFD 82 T141
Double Axial Earthing stirrup for tube 5'' O/D

CHARACTERISTICS

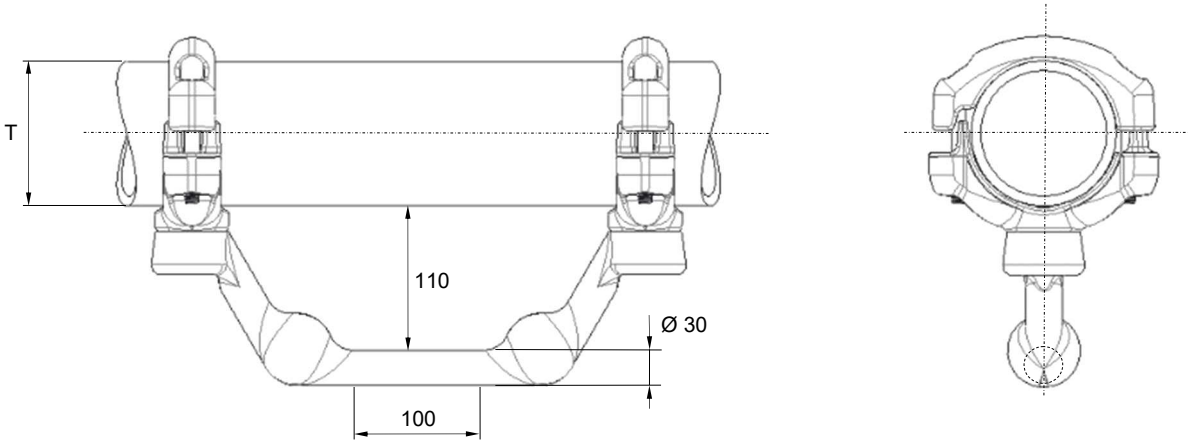
- From 132kV to 550kV
- Up-to 50kA/3sec and 63kA/1sec
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

- Main & reserve Busbar - Equipment's Bus connections

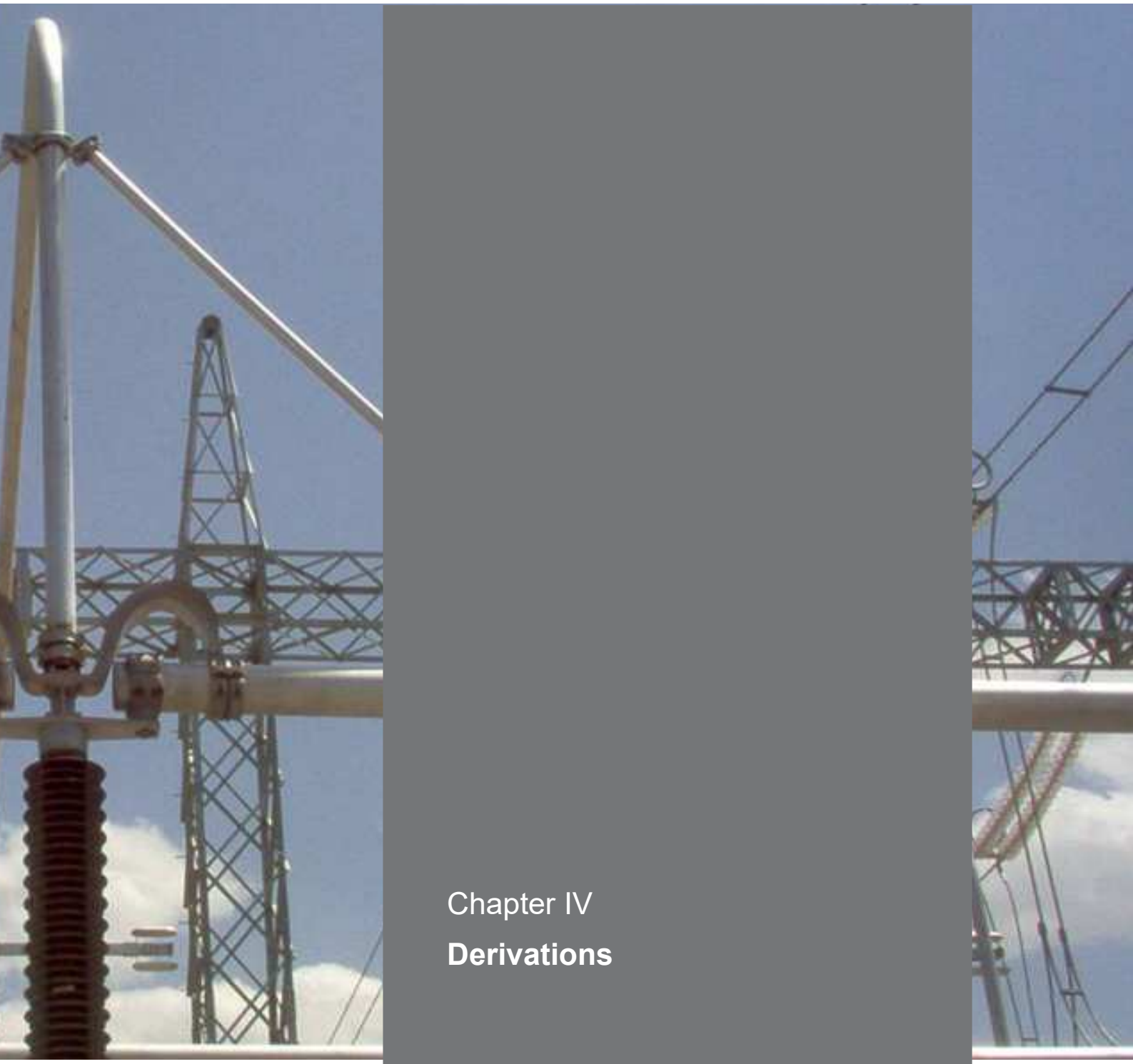
ADVANTAGES

- Easy to install
- Reinforced design for high default
- Corona free up-to 550kV
- Wide access to earthing clamp
- Corrosion resistant



Axial position

Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Standard/Option	●/○	○	○	○	○	○	●	○	○	○	●	●	○	●	○	●



Chapter IV
Derivations

5 TD 82 T_ T_

T1 (Main) ← → T2 (Tap– Optional)

Tee Connectors

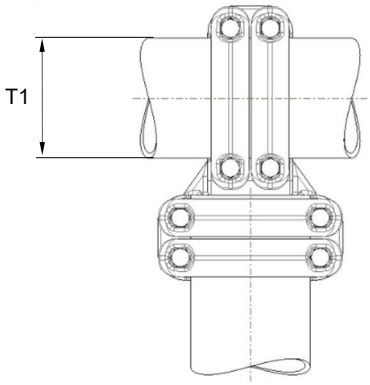
Bolted Fixed Tee Busbar Connectors

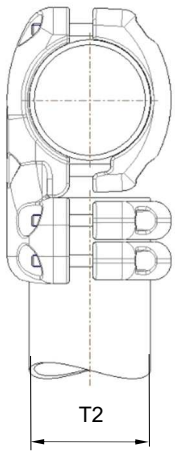
5 TD 82 T100

Tee Connector for Al Tube 100 O/D (Main & Tap)

5 TD 82 T141 T89

Tee Connector for Al Main Tube 5'' O/D and Tap 3'' O/D





CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

- Main & reserve Busbar—Coupling section

ADVANTAGES

- High mechanical strengths
- Corrosion resistant

Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T1	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
T2	80	●			○		○									
	88.9		○			○				○						
	90			○					○							
	100				●		○	○			○					
	101.6					○				○						
	120						●					○		○		
	125							○			○					
	140								○						○	
	141.3									○			○			
	150										●					
	160											●				
	168.2												○			
	200													○		
	220														○	
	250															○

● Standard

○ Option

5 TDL 82 T_ T_ __

T2 (Tap– Optional)

T1 (Main)

Flex Arrangement

Expansion Tee Connectors

Bolted Expansion Tee Busbar Connectors

5 TDL 82 T100 27
Expansion tee Connector for
Al Tube 100 O/D with 2x SAL 721
conductor flexible arrangement

5 TDL 82 T141 T89 49
Tee Connector for Al Tube Main 5'' O/D
to Tap 3'' O/D with 4x SAL 910 Conductor flexible arrangement

CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

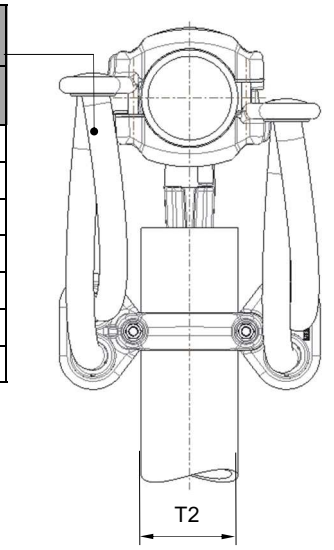
APPLICATIONS

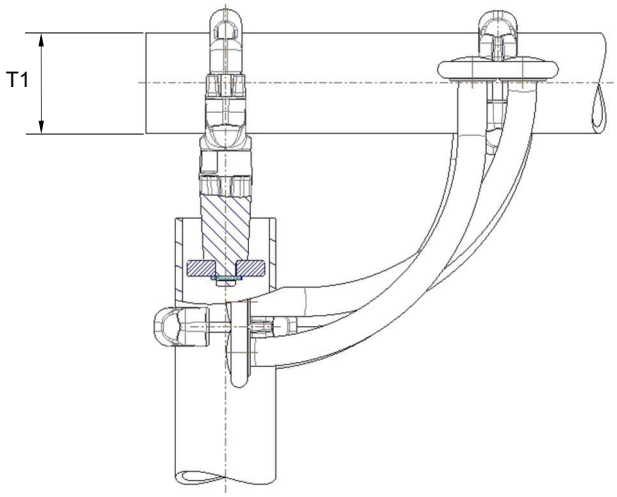
- Suspended Busbar connection to Bus section

ADVANTAGES

- Easy to install
- Flexible connection
- Current bridge adjusted to the ratings (see page 26)
- Corrosion resistant

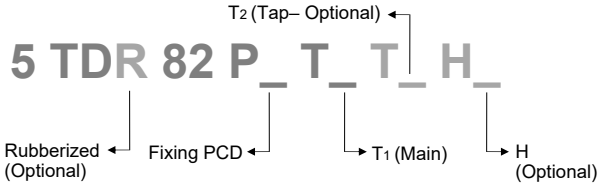
Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910





Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T1	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
T2	80	●			○		○									
	88.9		○			○				○						
	90			●					○							
	100				●		○	○			○					
	101.6					○				○						
	120						●					○		○		
	125							○			○					
	140								○						○	
	141.3									○			○			
	150										●					
	160											●				
	168.2												○			
	200													●		
	220														○	
	250															●
Flex arrangement	Colour Code	●●	●●	●●	●●	●●	●●●	●●●	●●●	●●	●●●	●●	●●	●●●	●	●●●●

● Standard
○ Option

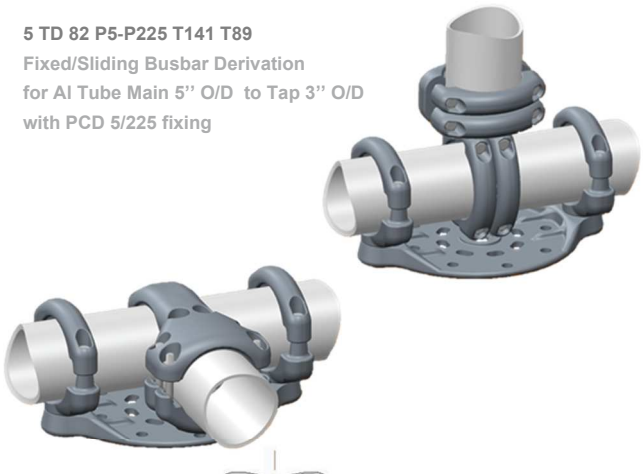


Fixed/Sliding Bubar Derivation

Bolted Fixed/Sliding joint Busbar Connectors with Tubular Conductor Derivation

5 TDR 82 P5-P225 T100 H120
Fixed/Sliding Rubberized Busbar Derivation for Al Tube 100 O/D with PCD 5/225 fixing and H= 120 mm

5 TD 82 P5-P225 T141 T89
Fixed/Sliding Busbar Derivation for Al Tube Main 5'' O/D to Tap 3'' O/D with PCD 5/225 fixing



CHARACTERISTICS

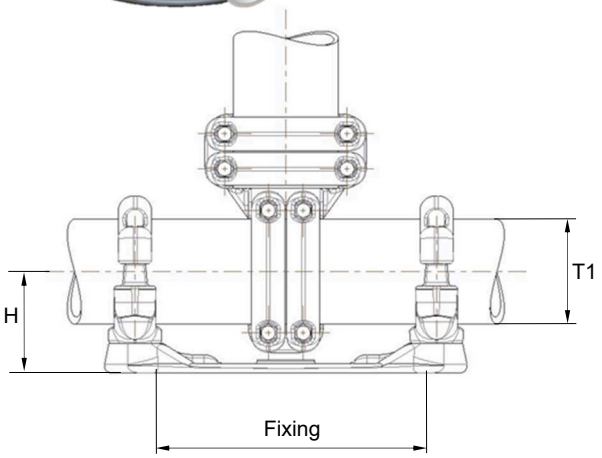
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminium Alloy & Stainless steel fasteners

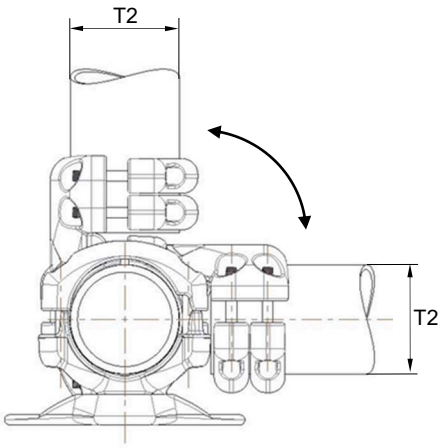
APPLICATIONS

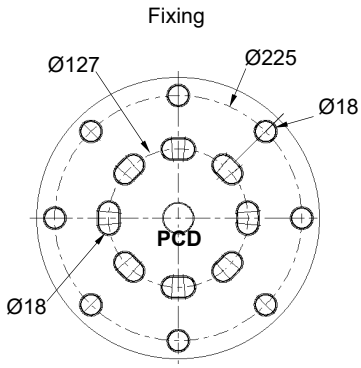
- Coupling section/Bus transfer

ADVANTAGES

- Easy to install
- Dual connector functions (Support & Derivation)
- Fix or Sliding configuration
- Adjustable Height or/and rubberized supports (see page 22)
- High mechanical strengths
- Corrosion resistant

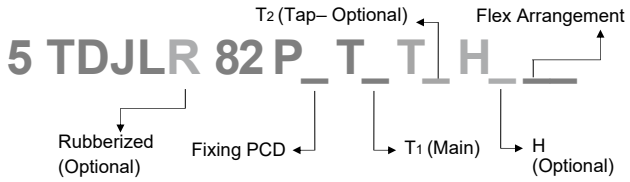






Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T1	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
T2	80	●			○		○									
	88.9		○			○				○						
	90			○					○							
	100				●		○	○			○					
	101.6					○				○						
	120						●					○		○		
	125							○			○					
	140								○						○	
	141.3									○			○			
	150										○					
	160											●				
	168.2												○			
	200													○		
	220														○	
	250															○

● Standard ○ Option



Expansion Busbar Derivation

Bolted Expansion joint Busbar Connectors with Tubular Conductor Derivation

5 TDJL 82 P5-P225 T100 H120 27
Expansion Busbar Derivation for Al Tube 100 O/D with PCD 5/225 fixing, H= 120 mm and 2x SAL 721 conductor flexible arrangement

5 TDJL 82 P5-P225 T141 T89 49
Expansion Busbar Derivation for Al Tube Main 5'' O/D to Tap 3'' O/D with PCD 5/225 fixing and 4xSAL 910 conductor flexible arrangement

CHARACTERISTICS

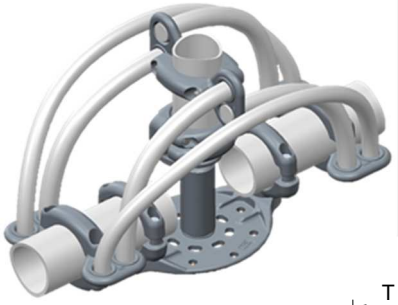
- From 60kV to 550kV
- EN & NMEA compliant
- Aluminium Alloy & Stainless steel fasteners

APPLICATIONS

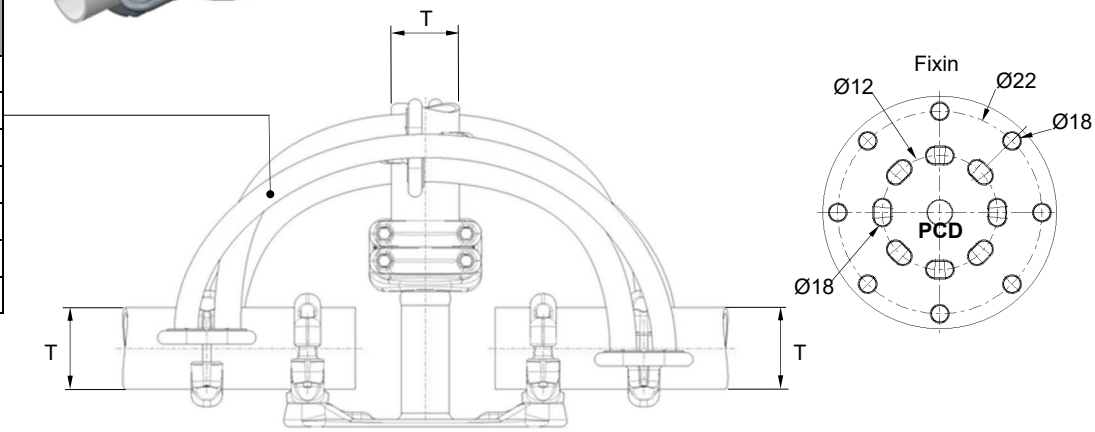
- Coupling section

ADVANTAGES

- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Dual connector functions (joint & derivation)
- Fix or Sliding configuration
- High mechanical strengths
- Corrosion resistant

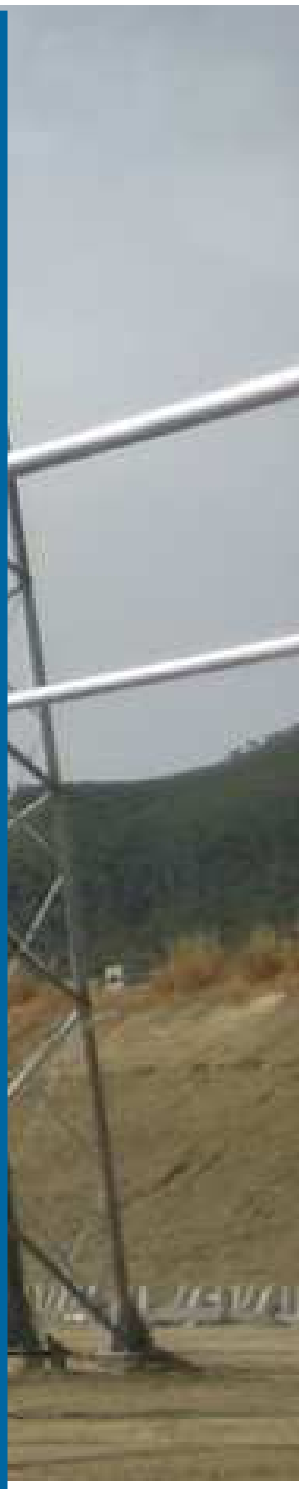


Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910



Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T1	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
T2	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
	80	O			O		O									
	88.9		O			O				O						
	90			O					O							
	100				O		O	O			O					
	101.6					O				O						
	120						O					O		O		
	125							O			O					
	140								O						O	
	141.3									O			O			
	150										O					
	160											O				
	168.2												O			
	200													O		
	220														O	
	250															O
Flex arrangement	Colour Code	●●	●●	●●	●●	●●	●●●	●●●	●●●	●●	●●●	●●	●●	●●●	●	●●●●

● Standard O Option



Chapter III

Terminal connectors

Drilling (Optional)

5 TTPD 82 T_ _

T

Palm

Rigid Horizontal Flat Terminal

Straight Bolted Fixed Terminal Connectors Bus to Flat

5 TTPD 82 T100 80 C278

Rigid Horizontal Flat Terminal for
Al Tube 100 O/D with 80x80x16 palm
and 4 holes 14,5 dia- □40x40 (Page 56)

5 TTPD 82 T141 125

Rigid Horizontal Flat Terminal for Al Tube 5'' O/D with
125x125x25 palm undrilled

CHARACTERISTICS

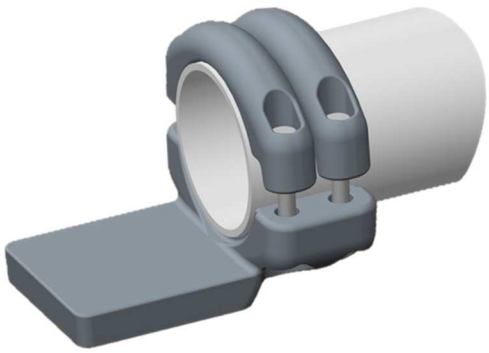
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

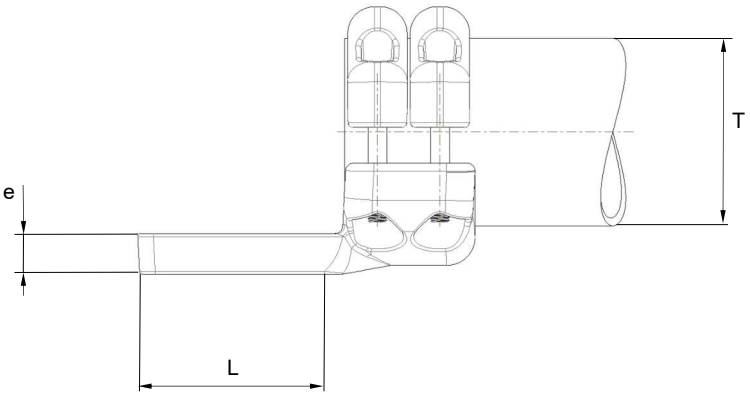
APPLICATIONS

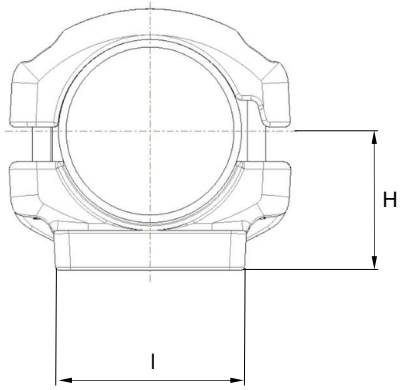
- Substation bays
- Rigid type terminal equipment connection

ADVANTAGES

- Easy to install
- High mechanical strengths
- Corrosion resistant





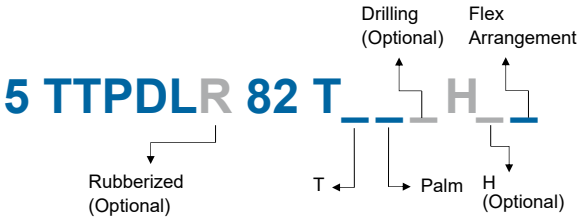


Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
Palm (LxIxe)	80x80x16	●														
	100x100x16	●	○	○	●	○	●	○				○				
	100x100x25						○					○				
	125x125x16		○	○	●	○	●					○	○			
	125x125x25				○	○	○	○	○	○	○	○	○			
	100x200x20						○	○	○	○	○	○	○	○	○	○

Standard Drillings See Page 56

● Standard

○ Option



Expansion Horizontal Flat terminal

Straight Bolted Expansion Terminal Connectors Bus to Flat

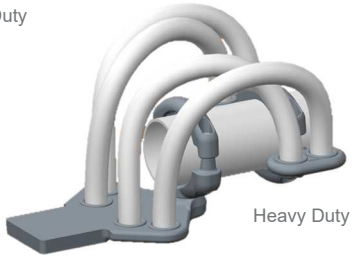
5 TTPDL 82 T100 80 C278 H120 27

Expansion Horizontal Flat Terminal for Al Tube 100 O/D with 80x80x16 palm and 4 holes 14,5 dia ☐ 40x40 (see page 56) H= 120mm and 2x SAL 721 conductor flexible arrangement

5 TTPDL 82 T141 100 49

Expansion Horizontal Flat Terminal for Al Tube 5'' O/D with 125x125x25 undrilled palm and 4x SAL 910 conductor flexible arrangement

Low Duty



Heavy Duty

CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

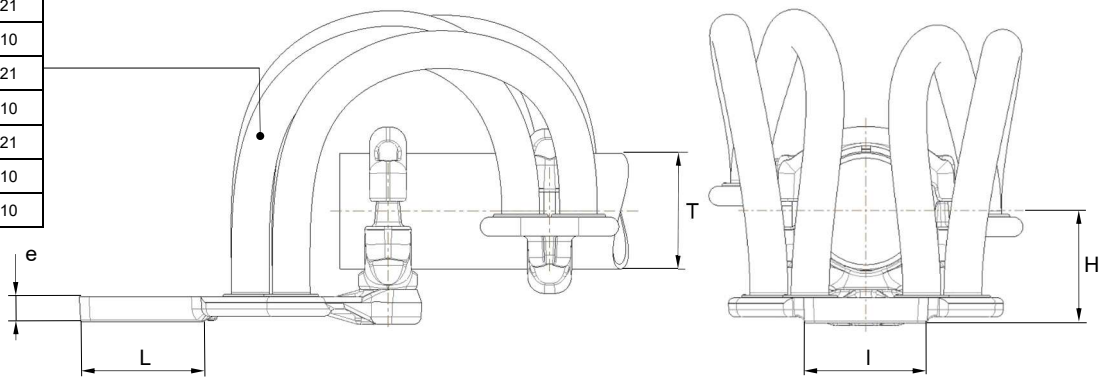
APPLICATIONS

- Substation bays
- Expansion terminal equipment connection
- Semi-flexible terminal connection

ADVANTAGES

- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Can be rubberized to make the terminal semi-flexible
- Self corona protected
- High mechanical strengths
- Corrosion resistant

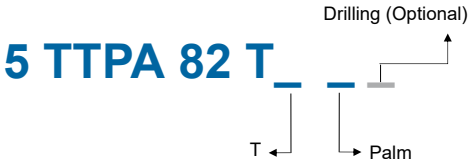
Possible Flexible Conductors Arrangement		
Co-lour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910



Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	95	99.5	100	105	105.8	115	117.5	125	125.7	130	135	139.1	155	165	180
Palm (LxlxE)	80x80x16	●	○	○												
	100x100x16	●●	○○	○○	●●	○○	●●	○○	○○	○○	○○	○○	○○			
	100x100x25						○	○	○	○	○	○	○			
	125x125x16		○	○	●	○	●	○	○	○	○	○	○			
	125x125x25			○	●	○	●●	○○	○○	○○	●●	●●	○○			
	100x200x20						●	○	○	○	●	●	○	○○○	○○○	○○○○

Standard Drillings See Page 56

● Standard
○ Option



5 TTPA 82 T_ _ _

Rigid Axial Flat Terminal

Axial Bolted Fixed Terminal Connectors Bus to Flat

5 TTPA 82 T100 80 C278

Rigid Axial Flat Terminal for
Al Tube 100 O/D with 80x80x16 palm
and 4 holes 14,5 dia- □40x40 (see page 56)

5 TTPA 82 T141 125

Rigid Axial Flat Terminal for Al Tube 5'' O/D with 125x125x25 palm undrilled

CHARACTERISTICS

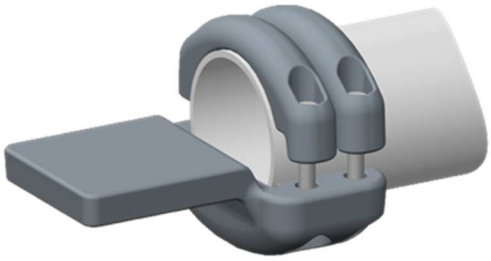
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

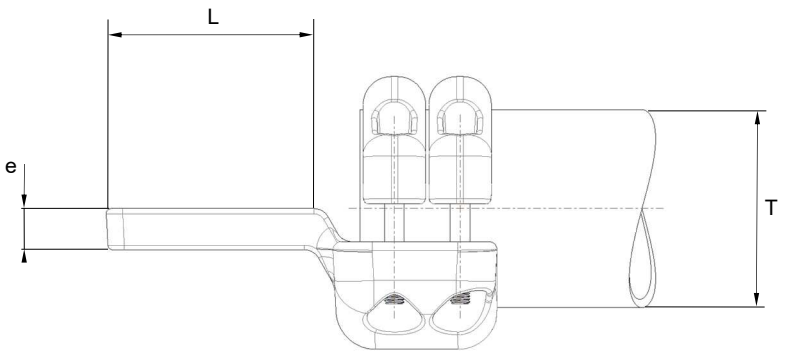
APPLICATIONS

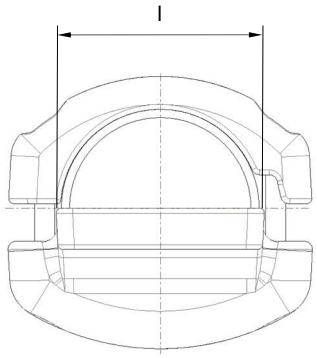
- Substation bays
- Rigid type terminal equipment connection

ADVANTAGES

- Easy to install
- High mechanical strengths
- Corrosion resistant



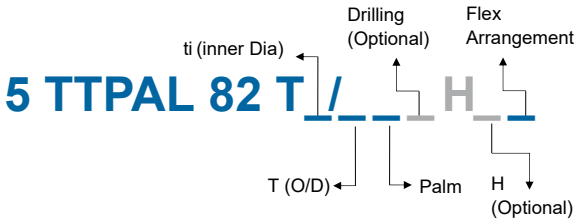




Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Palm (LxlxE)	80x80x16	●	O	O	●	O										
	100x100x16	●	O	O	●	O	●	O				O				
	100x100x25				O	O	O	O				O				
	125x125x16		O	O	●	O	●					O	O			
	125x125x25				O	O	O	O	●	O	O	O	O			
	100x200x20						●	O	O	O	O	O	O	O	O	O

Standard Drillings See Page 56

● Standard
O Option



Expansion Axial Flat terminal

Axial Bolted Expansion Terminal Connectors Bus to Flat

5 TTPAL 82 T90/100 80 C278 H120 27

Expansion Axial Flat Terminal for Al Tube 100 O/D
with 80x80x16 palm and 4 holes 14,5 dia ☐ 40x40 (see page 56),
H= 120mm and 2x SAL 721 conductor flexible arrangement

5 TTPAL 82 T128/141 100 49

Expansion Axial Flat Terminal for Al Tube 5" O/D
with 125x125x25 undrilled palm and 4x SAL 910 conductor flexible arrangement

CHARACTERISTICS

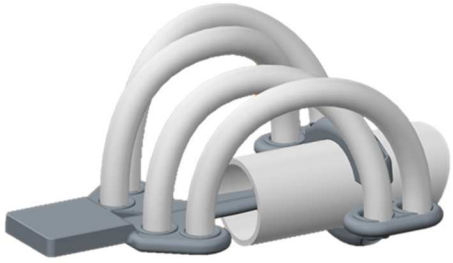
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

APPLICATIONS

- Substation bays
- Expansion terminal equipment connection
- Semi-flexible terminal connection

ADVANTAGES

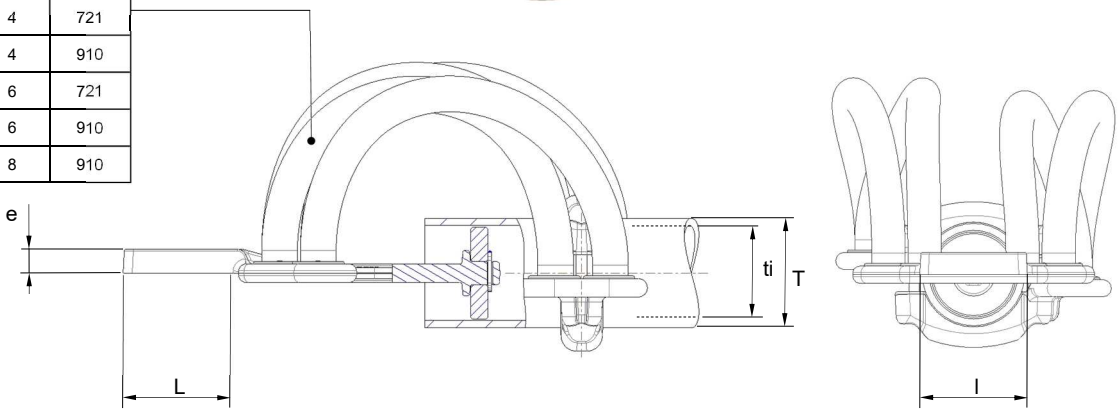
- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Self corona protected
- High mechanical strengths
- Corrosion resistant



Heavy Duty

Low Duty

Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910



Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Palm (LxIxe)	80x80x16	●	○	○												
	100x100x16	●●	○○	○○	●●	○○	○○	○○	○○	○○	○○	○○	○○			
	100x100x25						○	○	○	○	○	○	○			
	125x125x16		○	○	●	○	○	○	○	○	○	○	○			
	125x125x25			●	●	○	○○	○○	○○	○○	○○	○○	○○			
	100x200x20						○	○	○	○	○	○	○	○○○	○○○	○○○○

Standard Drillings See Page 56

● Standard
○ Option

Drilling (Optional)

5 TTPE 82 T_ _

T

Palm

Rigid Vertical Flat Terminal

90° Bolted Fixed Terminal Connectors Bus to Flat

5 TTPE 82 T100 80 C278

Rigid Vertical Flat Terminal for
Al Tube 100 O/D with 80x80x16 palm
and 4 holes 14,5 dia- □40x40 (see page 56)

5 TTPE 82 T141 125

Rigid Vertical Flat Terminal for Al Tube 5'' O/D with 125x125x25 palm undrilled

CHARACTERISTICS

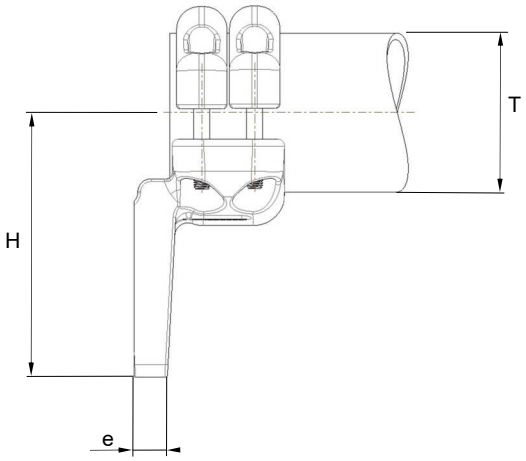
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

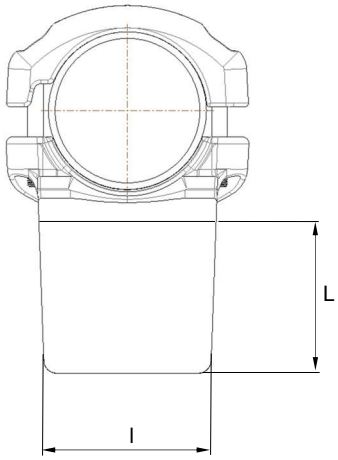
APPLICATIONS

- Substation bays
- Rigid type terminal equipment connection

ADVANTAGES

- Easy to install
- High mechanical strengths
- Corrosion resistant



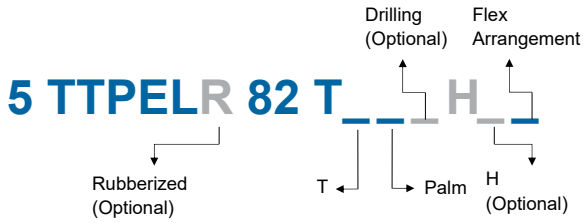


Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	140	144.5	145	150	151	160	162.5	170	170.7	175	180	184.1	200	210	225
Palm (LxIxe)	80x80x16	●														
	100x100x16	●	○	○	○	○	●	○				○				
	100x100x25						○					○				
	125x125x16		○	○	○	○	●					○	○			
	125x125x25				○	○	○	○	○	○	○	○	○			
	100x200x20						●	○	○	○	○	○	○	○	○	○

Standard Drillings See Page 56

● Standard

○ Option



Expansion Vertical Flat terminal

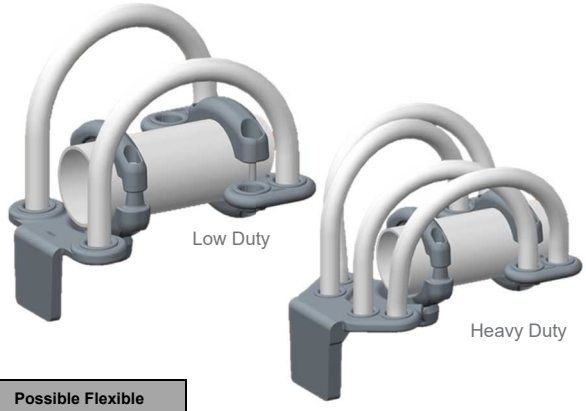
90° Bolted Expansion Terminal Connectors Bus to Flat

5 TTPEL 82 T100 80 C278 H120 27

Expansion Vertical Flat Terminal for Al Tube 100 O/D
with 80x80x16 palm and 4 holes 14,5 dia □ 40x40 (see page 56),
H= 120mm and 2x SAL 721 conductor flexible arrangement

5 TTPEL 82 T141 100 49

Expansion Vertical Flat Terminal for Al Tube 5'' O/D
with 125x125x25 undrilled palm and 4x SAL 910 conductor
flexible arrangement



CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

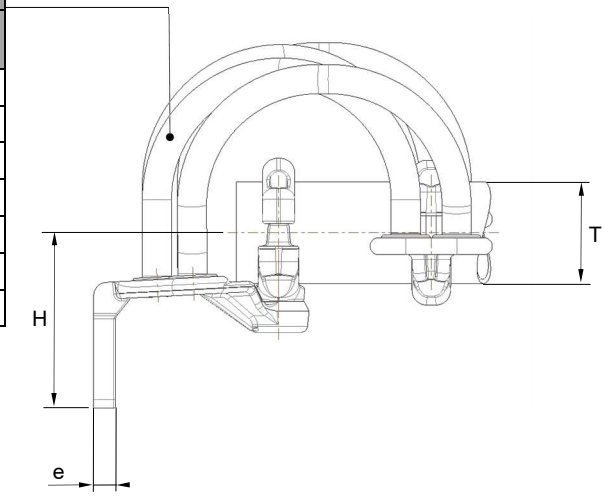
APPLICATIONS

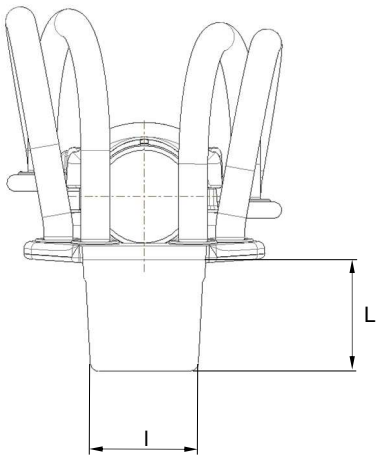
- Substation bays
- Expansion terminal equipment connection
- Semi-flexible terminal connection

ADVANTAGES

- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Can be rubberized to make the terminal semi-flexible
- Self corona protected
- High mechanical strengths
- Corrosion resistant

Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910





Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	140	144.5	145	150	151	160	162.5	170	170.7	175	180	184.1	200	210	225
Palm (LxlxE)	80x80x16	●	○	○												
	100x100x16	●●	○○	○○	●●	○○	●●	○○	○○	○○	○○	○○	○○			
	100x100x25						○	○	○	○	○	○	○			
	125x125x16		○	○	●	○	●	○	○	○	○	○	○			
	125x125x25			○	●	○	●●	○○	○○	○○	●●	●●	○○			
	100x200x20						●	○	○	○	●	●	○	●○○	○○○	○○○○

Standard Drillings See Page 56

● Standard
○ Option

Drilling (Optional)

5 TTPH 82 T_ _

T ◄ ► Palm

Rigid Vertical Axial Flat Terminal

90° Axial Bolted Fixed Terminal Connectors Bus to Flat

5 TTPH 82 T100 100x200 R90

Rigid Vertical Axial Flat Terminal for Al Tube 100 O/D with 100x200x20 palm and 8 holes 14,5 dia- □50x50 (see page 56)

5 TTPH 82 T141 100x200

Rigid Vertical Axial Flat Terminal for Al Tube 5'' O/D with 100x200x20 palm undrilled

CHARACTERISTICS

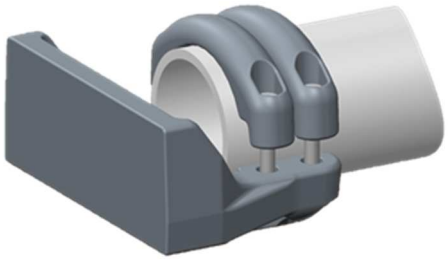
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

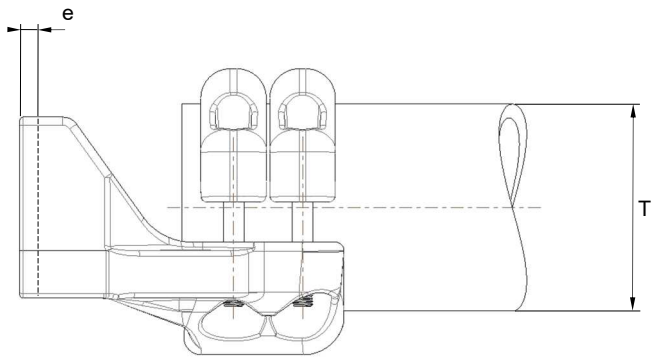
APPLICATIONS

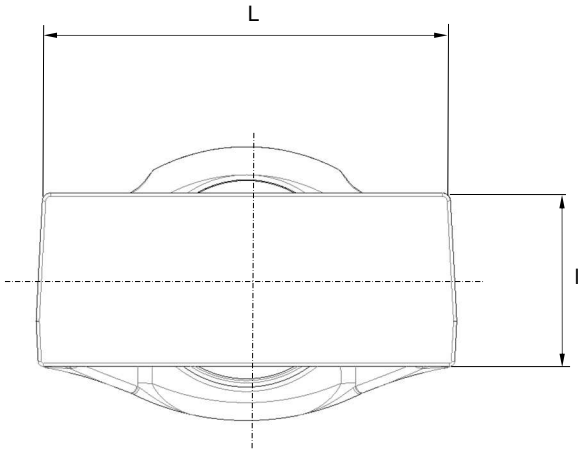
- Substation bays

ADVANTAGES

- Easy to install
- Center line of the palm in the axis of the tube
- High mechanical strengths
- Corrosion resistant



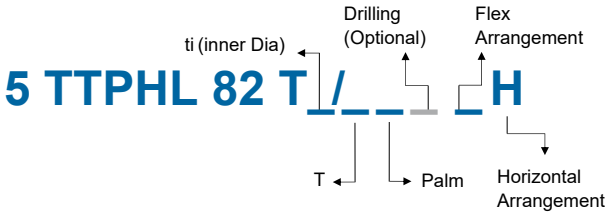




Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Palm (LxIxe)	100x200x20	O	O	O	●	O	●	O	O	O	●	O	O	●	O	●

Standard Drillings See Page 56

● Standard
O Option



Expansion Vertical Axial Flat Terminal

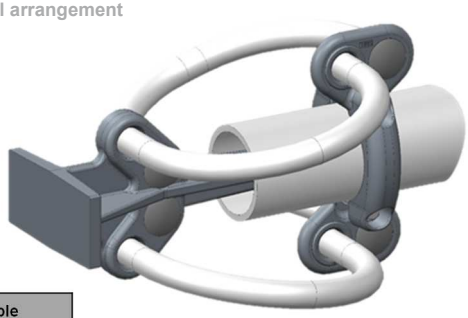
90° Axial Bolted Expansion Terminal Connectors Bus to Flat

5 TTPHL 82 T90/100 100x200 R90 27 H

Expansion Vertical Axial Flat Terminal for Al Tube 100 O/D with 100x200x20 palm and 8holes 14.5 dia ☐ 50x50 (see page 56), and 2x SAL 721 conductor flexible Horizontal arrangement

5 TTPHL 82 T128/141 100x200 49 H

Expansion Vertical Axial Flat Terminal for Al Tube 5'' O/D with 100x200x20 undrilled palm and 4x SAL 910 conductor flexible Horizontal arrangement



CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

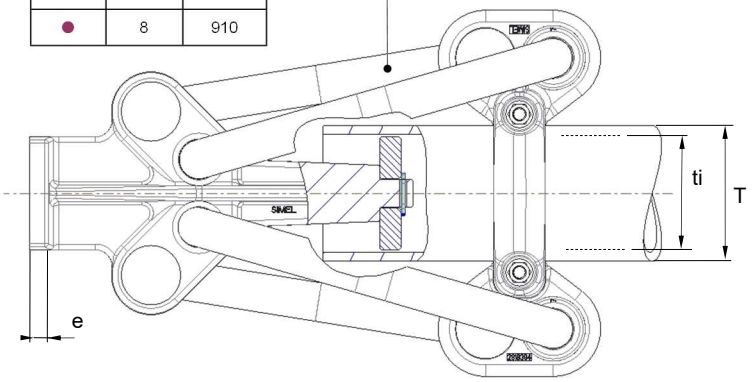
APPLICATIONS

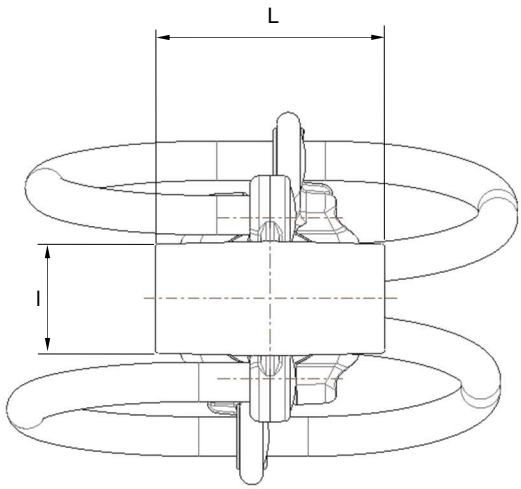
- Substation bays
- Expansion connection to pantograph disconnector
- Semi-flexible terminal connection

ADVANTAGES

- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Center line of the palm in the axis of the tube
- Self corona protected
- High mechanical strengths
- Corrosion resistant

Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910





Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Palm (LxIxe)	100x200x20						○	○	●	○	○	○	○	●○○	○○○	●○○○

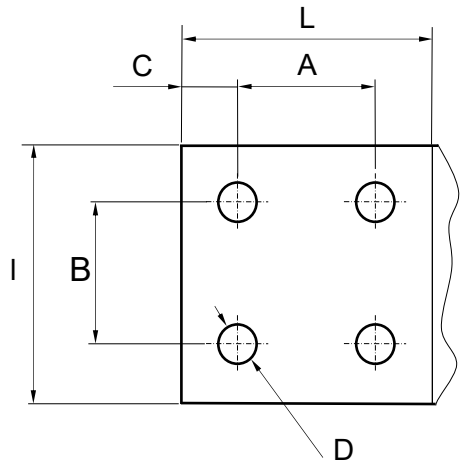
Standard Drillings See Page 56

● Standard
○ Option

Standard drillings of palms

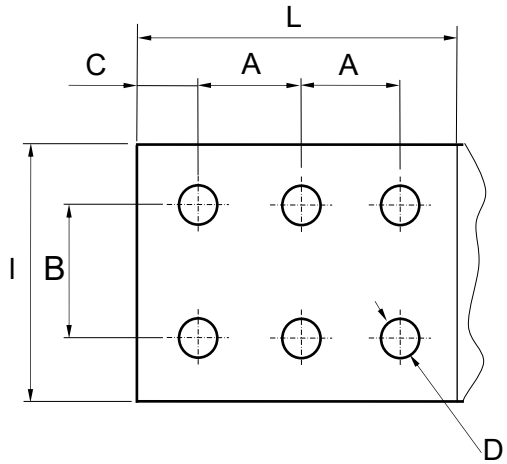
Dimensional standards of bolt holes for terminal connectors

4 Holes Standard palms

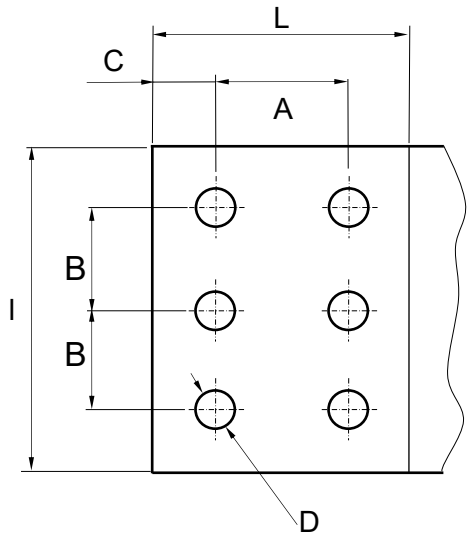


Standard	Drilling Code	L	I	A	B	C	D
IEC	C21	80	80	40	40	20	14.5
NEMA	C294	80 (3")	80 (3")	44.4 (1.75")	44.4 (1.75")	15.3 (0.6")	14.3 (0.56")
DIN	C35	80	80	50	50	15	14.5
French	C124 (PL4)	80	80	45	45	16.5	16
IEC	C336	100	100	40	40	30	14.5
NEMA	C290	100 (4")	100 (4")	44.4 (1.75")	44.4 (1.75")	27.8 (1.1")	14.3 (0.56")
DIN	C257	100	100	50	50	25	14.5

6 Holes Standard palms



Standard	Drilling Code	L	I	A	B	C	D
French	R11 (PL6)	125	80	45	45	16.5	16
IEC	R168	125	80	40	40	22.5	14.5

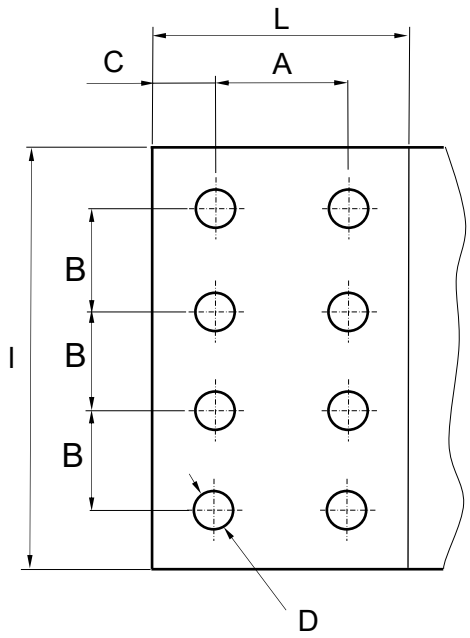


Standard	Drilling Code	L	I	A	B	C	D
IEC	R284	100	125	40	40	30	14.5
NEMA	R285	100 (4")	125 (5")	44.4 (1.75")	44.4 (1.75")	27.8 (1.1")	14.3 (0.56")

Standard drillings of palms

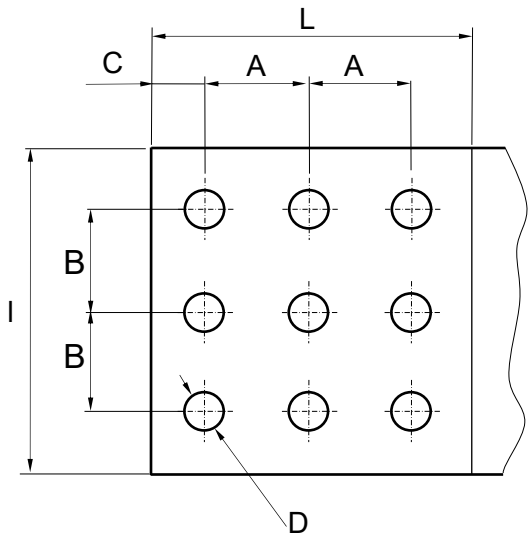
Dimensional standards of bolt holes for terminal connectors

8 Holes Standard palms



Standard	Drilling Code	L	I	A	B	C	D
DIN	R90	100	200	50	50	25	14.5

9 Holes Standard palms



Standard	Drilling Code	L	I	A	B	C	D
IEC	C258	125	125	40	40	22.5	14.5
French 1	C41 (PL9)	125	125	45	45	16.5	16
French 2	C292	125	125	45	45	16.5	14

For any other requirement please contact us

5 TTBA 82 T_ B_

T → Stud

Rigid Axial Stud Terminal

Axial Bolted fixed Connectors Bus to Stud

5 TTBA 82 T100 B30
Rigid Axial Stud Terminal for Al Tube 100 O/D to 30 mm Stud

5 TTBA 82 T141 B40
Rigid Axial Stud Terminal for Al Tube 5'' O/D to 40 mm Stud

CHARACTERISTICS

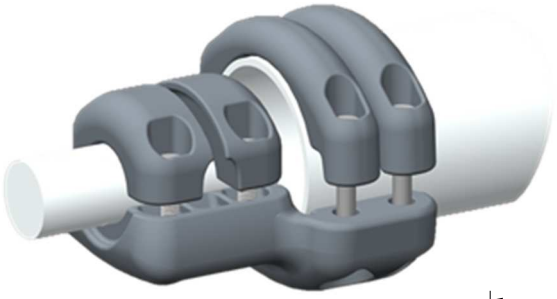
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

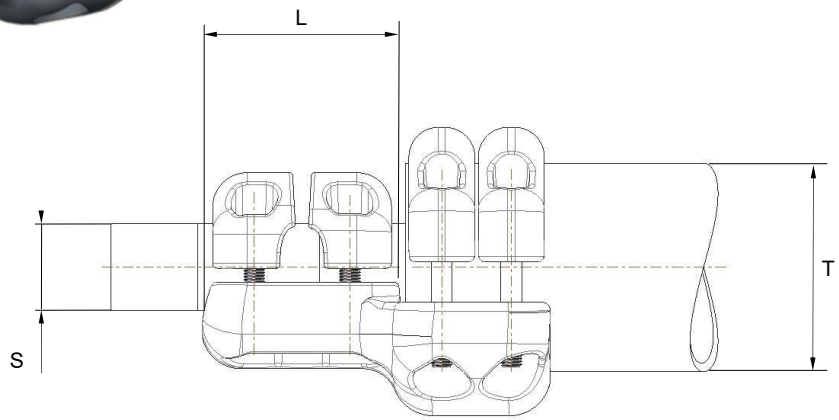
APPLICATIONS

- Substation bays
- Rigid type terminal equipment connection

ADVANTAGES

- Easy to install
- High mechanical strengths
- Corrosion resistant





Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Stud (SxL)	30x100	O	O	O	O	O	O	O	O	O		O				
	40x100	O	O	O	O	O	O	O	O	O		O				
	40x110		O	O	O	O	O	O	O	O	O	O	O			
	50x110				O	O	O	O	O	O	O	O	O	O	O	O
	60x110						O	O	O	O	O	O	O	O	O	O

● Standard
O Option

ti (inner Dia) ← | → Flex Arrangement

5 TTBAL 82 T_/_ B_ _

T ← | → Stud

Expansion Axial Stud terminal

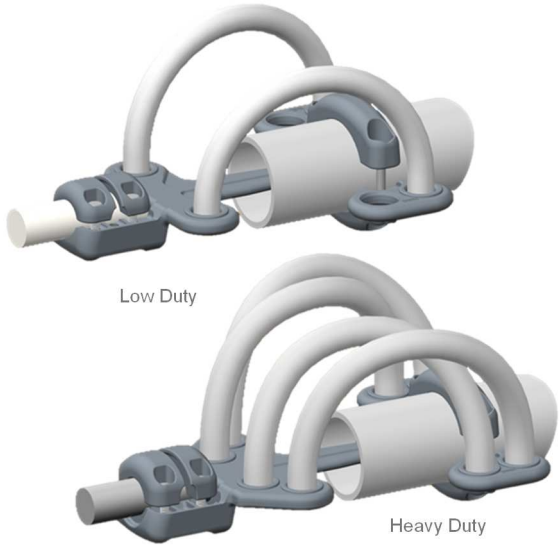
Axial Bolted Expansion Connectors Bus to Stud

5 TTBAL 82 T90/100 B30 27

Expansion Axial Stud Terminal for Al Tube 100 O/D
to 30 mm Stud with 2x SAL 721 conductor flexible arrangement

5 TTBAL 82 T128/141 B40 49

Expansion Axial Stud Terminal for Al Tube 5'' O/D
to 40 mm Stud with 4x SAL 910 conductor flexible arrangement



CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

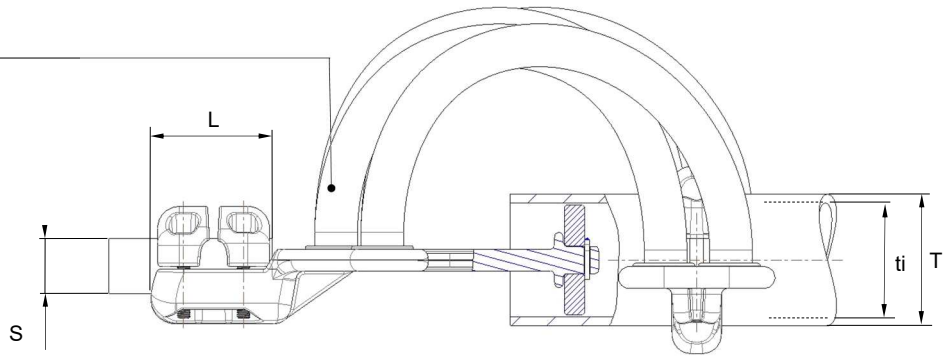
APPLICATIONS

- Substation bays
- Expansion terminal equipment connection
- Semi-flexible terminal connection

ADVANTAGES

- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Can be rubberized to make the terminal semi-flexible
- Self corona protected
- High mechanical strengths
- Corrosion resistant

Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910



Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
Stud (SxL)	30x100	○	○	○●	○●	○●	○●	○●	○●	○●		○●				
	40x100	○●	○●	○●	○●	○●	○●	○●	○●	○●		○●				
	40x110		○●	○●	○●	○●	○●	○●	○●	○●	○●	○●	○●			
	50x110				○●	○●	○●	○●	○●	○●	○●	○●	○●	○●	○●	○●
	60x110						○●	○●	○●	○●	○●	○●	○●	○●	○●	○●

● Standard
○ Option

5 TTBF 82 T_ B_

T → Stud

Rigid Vertical Stud Terminal

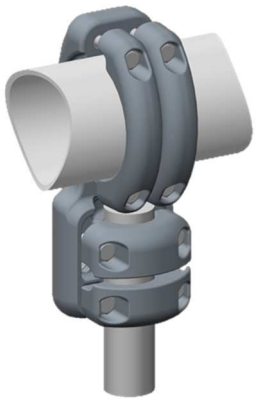
90° Bolted fixed Connectors Bus to Stud

5 TTBF 82 T100 B30

Rigid Vertical Stud Terminal for Al Tube 100 O/D to 30 mm Stud

5 TTBF 82 T141 B40

Rigid Vertical Stud Terminal for Al Tube 5'' O/D to 40 mm Stud



CHARACTERISTICS

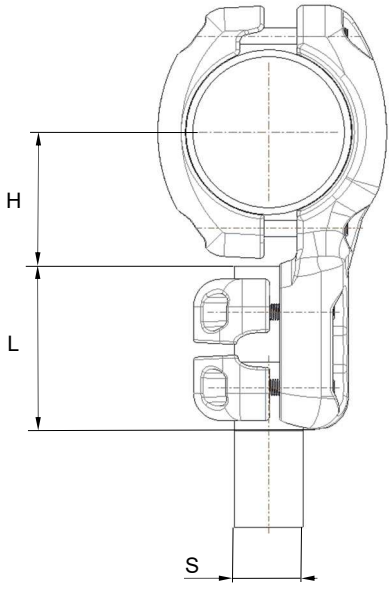
- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

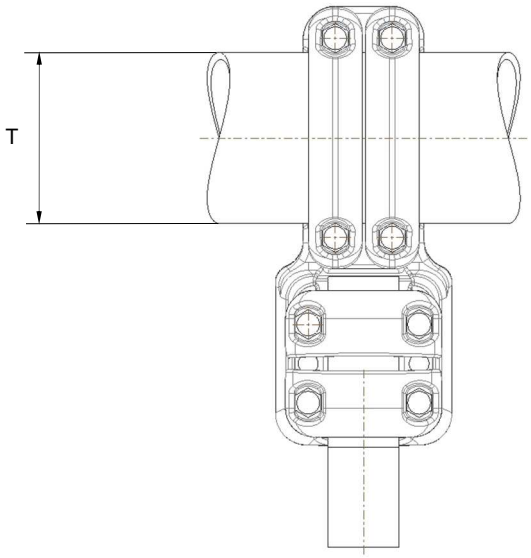
APPLICATIONS

- Substation bays
- Rigid type terminal equipment connection

ADVANTAGES

- Easy to install
- High mechanical strengths
- Corrosion resistant





Busbar Size	Metric IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	88	92,5	93	98	98,8	108	110,5	118	119	123	128	132,1	148	158	173
Stud (SxL)	30x90	O	O	O	O	O	O	O	O	O	O					
	40x90	O	O	O	O	O	O	O	O	O	O	O	O			
	40x100				O	O	O	O	O	O	O	O	O	O	O	O
	50x100				O	O	O	O	O	O	O	O	O	O	O	O
	60x100				O	O	O	O	O	O	O	O	O	O	O	O

● Standard

O Option

Flex Arrangement

5 TTBFLR 82 T_ B_ H_ _

Rubberized (Optional) — T Stud — H (Optional)

Expansion Vertical Stud Terminal

90° Bolted Expansion Connectors Bus to Stud

5 TTBFL 82 T100 B30 H120 27

Expansion Axial Stud Terminal for Al Tube 100 O/D to 30 mm Stud with H=120 and 2x SAL 721 conductor flexible arrangement

5 TTBFL 82 T141 B40 49

Expansion Axial Stud Terminal for Al Tube 5'' O/D to 40 mm Stud with 4x SAL 910 conductor flexible arrangement

CHARACTERISTICS

- From 60kV to 550kV
- EN & NEMA compliant
- Aluminum Alloy & Stainless steel fasteners

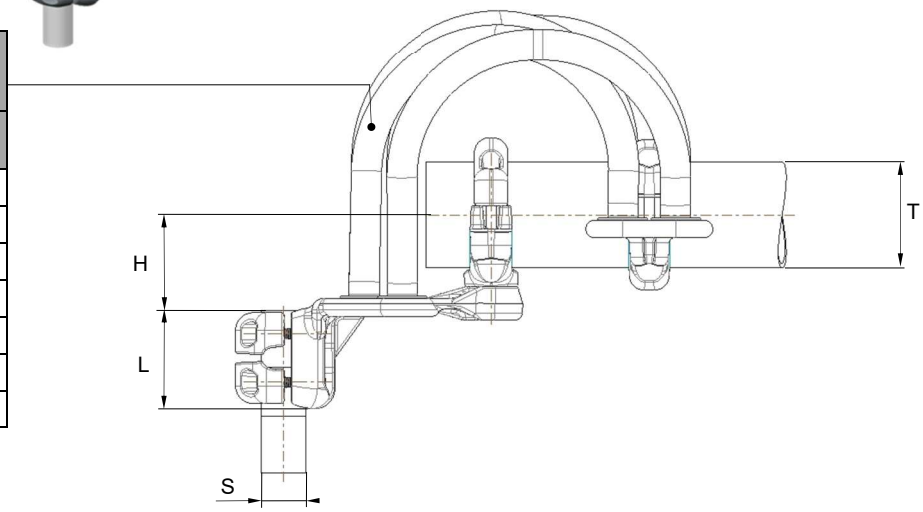
APPLICATIONS

- Substation bays
- Expansion terminal equipment connection
- Semi-flexible terminal connection

ADVANTAGES

- Easy to install
- Current bridge adjusted to the ratings (see page 26)
- Can be rubberized to make the terminal semi-flexible
- Self corona protected
- High mechanical strengths
- Corrosion resistant

Possible Flexible Conductors Arrangement		
Colour Code	N° Cond	SAL Cond
●	2	721
●	2	910
●	4	721
●	4	910
●	6	721
●	6	910
●	8	910



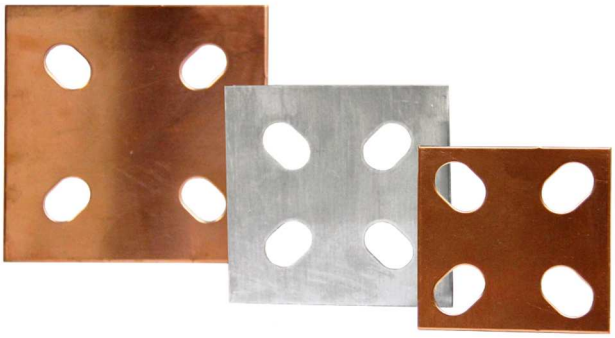
Busbar Size	Metric / IPS	80	3"	90	100	3 "1/2	120	125	140	5"	150	160	6"	200	220	250
T	(mm)	80	88.9	90	100	101.6	120	125	140	141.3	150	160	168.2	200	220	250
H	(mm)	88	92,5	93	98	98,8	108	110,5	118	119	123	128	132,1	148	158	173
Stud (SxL)	30x90	○	○	○○	○○	○○	○○	○○								
	40x90	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○			
	40x100				○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○
	50x100				○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○
	60x100				○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○	○○

● Standard
○ Option

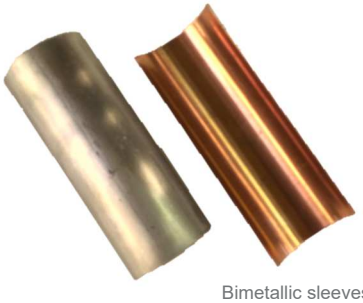
Chapter IV
Fasteners

Bimetallic Plates & Sleeves

Aluminum-Copper/Bimetallic strip plates and Sleeves



Bimetallic plates



Bimetallic sleeves

CHARACTERISTICS

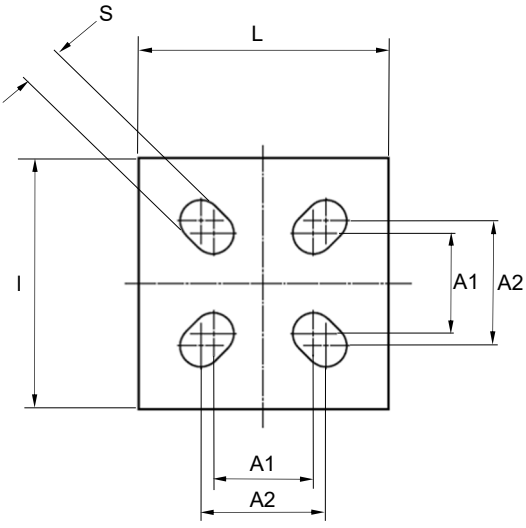
- From 60kV to 550kV
- IEC; NEMA & NF drilling compliant
- Aluminum (99.5%) & Copper

APPLICATIONS

- Corrosive atmospheres
- Bimetallic terminal connection
- Recommended for connection of aluminum connector terminal to : Copper/Al - Silver plate/Al - Stainless steel

ADVANTAGES

- Easy to install
- Cancel galvanic corrosion
- High conductivity material
- Multi drilling standard plates (4 slots)
- Composite material (Al/Co) obtained by roll cladding
- Corrosion resistant



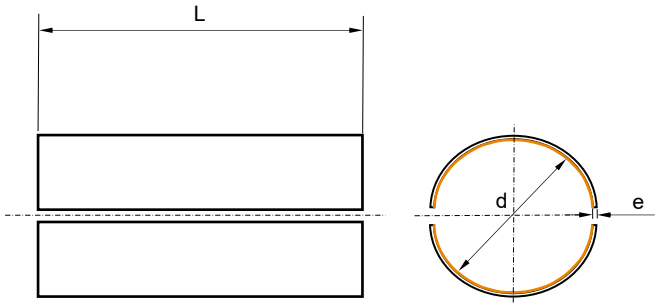


Plate size (Lxl)	(mm)	80 x 80	100 x 100	125 x 125
A1	(mm)	40	40	60
A2	(mm)	50	50	70
S	(mm)	16.5	16.5	16.5
e	(mm)	2	2	2

Stud Dia (d)	(mm)	30	40	40	50	60
L	(mm)	90	90	100	100	100
e	(mm)	1	1	1	1	1

Fixing Bolts

HDG Steel and Stainless Seel / Kits of fixing bolts

CHARACTERISTICS

- Kits of 4 bolts or screws
- Stainless steel or Hot Dip Galvanized Steel
- Metric sizes from M8 to M16

APPLICATIONS

- Terminal connection to High Voltage equipements
- Fixing of Busbar Clamps and connectors to PI

ADVANTAGES

- Ready to install kits of 4 bolts
- Flat washers and nut included
- Pre-defined lengths to cover any applications (see below table)

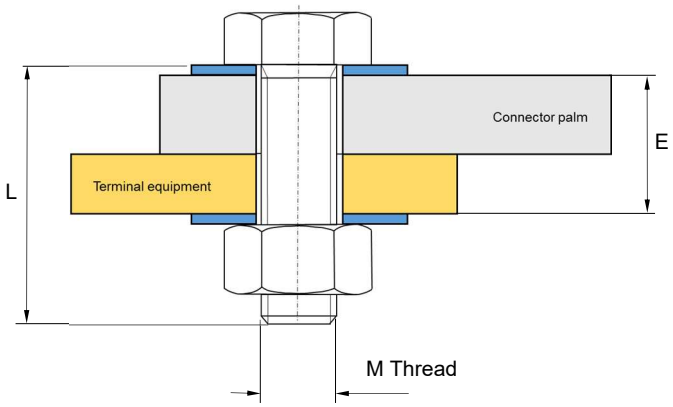


Fig 1

Terminal connector fixing

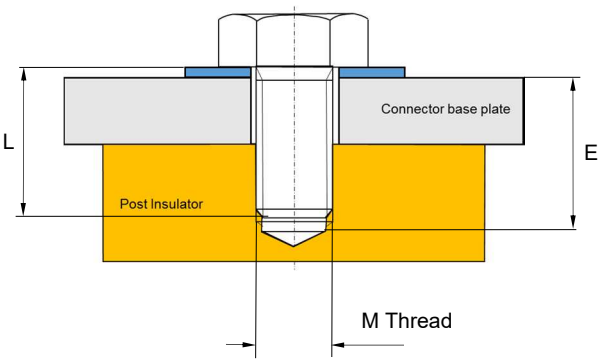


Fig 2

Bus support fixing

Bolt Size	Thread	M8	M10		M12					M14		M16			
	L (mm)	40	50	60	25	40	60	70	80	60	80	30	60	70	90
Figure	Fig N°	Fig1	Fig1	Fig1	Fig 2	Fig1	Fig1	Fig1	Fig1	Fig1	Fig1	Fig 2	Fig1	Fig1	Fig1
E Mini	(mm)	12	16	36	10	12	23	43	53	20	41	16	20	38	38
E Maxi	(mm)	30	36	46	22	23	43	53	63	41	61	27	38	48	68
Material	* SS/HDG	SS	SS	SS	HDG	SS	SS	SS	SS	SS	SS	HDG	SS	HDG	SS

* SS = Stainless Steel Bolts

HDG = Hot Dip Galvanized Steel Bolts

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