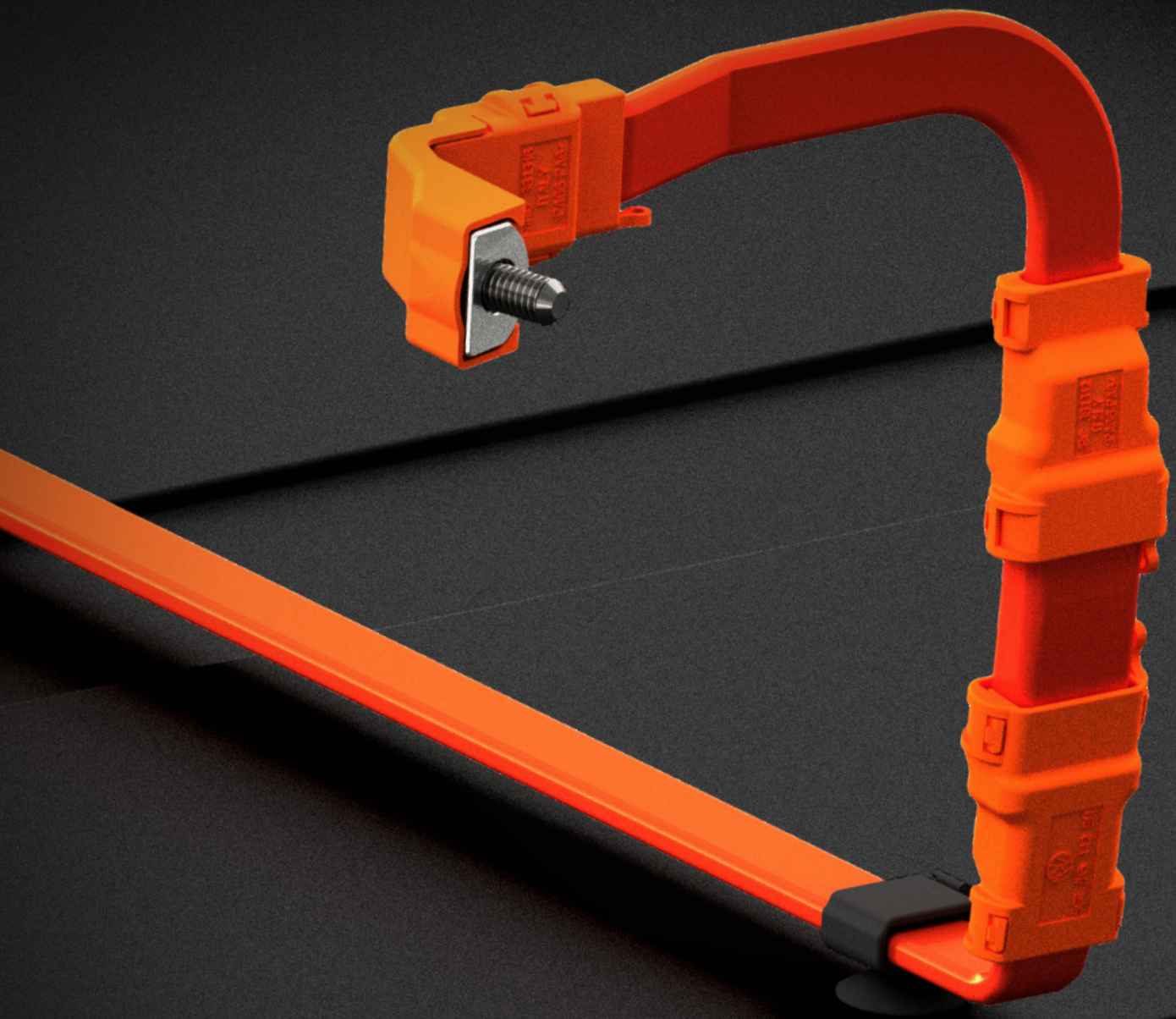


BUSBAR

Product Data Sheet



TECHNICAL DATA SHEET

BUSBAR

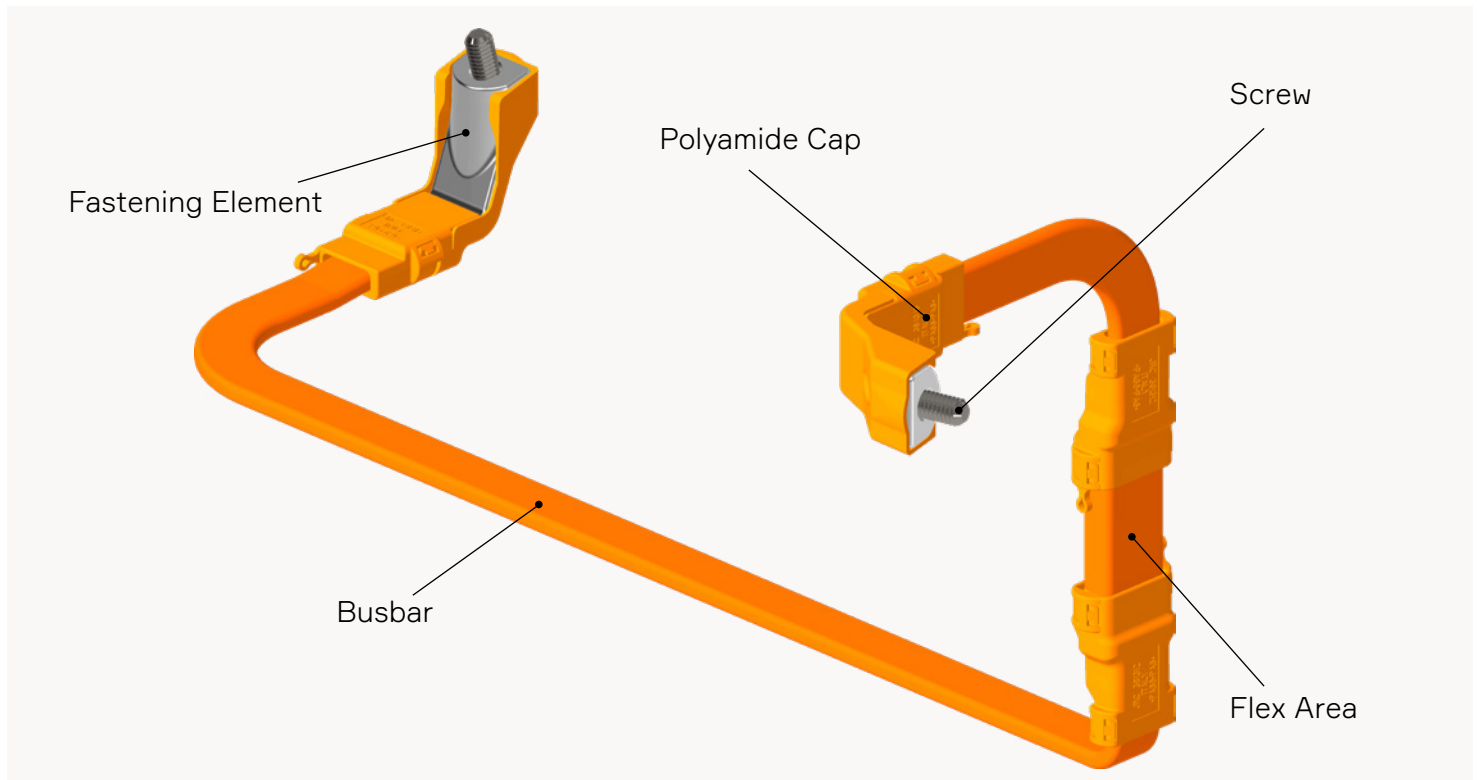


Figure 1 Busbar with different attachments

BUSBAR - For the high-voltage area, in locations where cable connections are unsuitable due to their outer dimensions.

This document provides an overview of Intercable's product line of High Voltage extruded Busbars, the applicable geometry, attachment components as well as a summary of tests conducted per customer product validations.

FEATURES & BENEFITS

Busbars are used for high-voltage current transmission, in locations where cable connections are unsuitable due to their outer dimensions. The solid flat conductor used permits a smaller cross-section while preserving conductivity.

SPECIFICATIONS

The busbars can be delivered in different sizes. A flexible area is used in the relevant locations to compensate for tolerances and prevent vibration damage.

Holes are punched in the ends or mounting elements, which are protected from corrosion through surface coating, are welded on to permit simple mounting on the poles with screws. Plastic caps are used to pre-fix the screws, as well as to ensure protection against contact. They serve as protection against loss at the same time. Figure 1 shows the schematic of such a bus bar with different attachments.

TECHNICAL DETAILS

- Materials
- Bar structure
- Bending Geometry
- Derating

COMPATIBLE COMPONENTS

- Contacting: Flex or Rigid
- Fastening
- Attachments

TECHNICAL DETAILS

1. Cross Sections

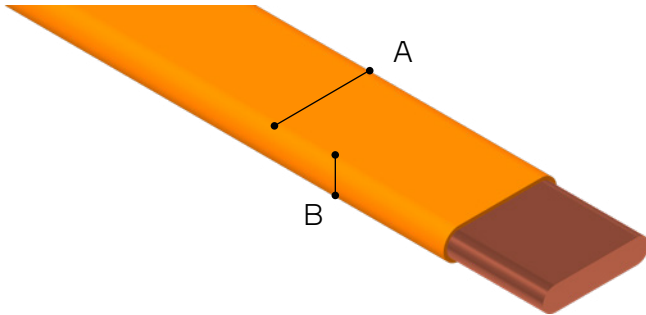


Figure 2 Busbar insulated with a polyamide layer

Cross-section	Dimensions (AxB)	
	A	B
25mm ²	13	3.2
32mm ²	17	3
35mm ²	13	4
50mm ²	16.5	4.5
70mm ²	18	5.5
90mm ²	20.5	6
100mm ²	22.5	6
120mm ²	25	5
150mm ²	26	7.5

The insulation thickness is 0.5 mm for all cross sections.

2. Bar Structure

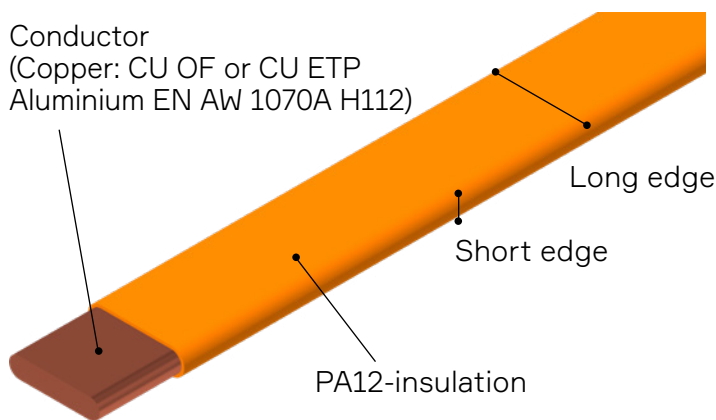


Figure 3 Buildup of the busbar

The busbar is made of highly conductive copper (Cu OF or Cu ETP) or aluminium (EN AW 1070A H112), which is insulated by a PA12-layer. The insulation is extruded onto the flat conductor in

order to maintain adhesion even after twisting and bending. The busbar is stripped at the contact points by a special laser process, enabling proper contacting. The longer one of the two edges is usually called the long edge (or high edge), the shorter one the short edge. The busbars can be designed in different cross-sections (see Figure 2). Figure 3 shows the schematic structure.

Compared to cables, busbars are particularly suitable for use with sharp bends due to their low height. Busbars can be twisted as well as bent. The twisting and bending is performed by a special bending machine. More details on twisting and bending capabilities can be taken from Figure 4, 5 and 6.

3. Insulation

3.1 PA12

PA12 is the standard insulation material for battery busbars with long-term temperature requirements up to 105°C.

PA12 is one of the most commonly used insulation materials on extruded flat power busbars. Unfilled PA12 has ideal properties for extrusion on busbars. The elasticity of the material allows to use small bending radii without crack formation on the outer side of the bendings, whereas the good adhesion to copper and aluminium avoids detachment of the insulation and formation of wrinkles.

3.2 PA12 HP

PA12 HP is the high performance solution for battery busbars with long-term temperature requirements up to 130°C.

The High Performance (HP) PA12 is a special amorphous PA12 grade. This material combines a higher temperature resistance than PA12 and exceptional insulation properties even at high temperatures with good elasticity and adhesion on copper and aluminium. The color stability and hydrolysis resistance is comparable to PA12. PA12 HP has CTI 600 like PA12 and this allows to use low creepage distances.

3.3 PPS

PPS is the standard insulation material for applications with higher temperature requirements.

PPS is characterized by exceptional thermal and chemical stability, which makes it the ideal solution for charging busbars that are exposed to a harsh chemical environment and high temperatures during charging.

The electrical insulation properties are maintained over a high temperature range and the PPS benefits from its intrinsic flame retardancy.

The high flexibility and good ductility of this unfilled PPS allows good extrudability and bending behavior on copper and aluminium busbars.

4. Bending Geometry

For process-related reasons, bending radii are limited to the values displayed in the chart below. Minimum distances between the bends must be maintained for structural integrity, as well for process-related reasons.

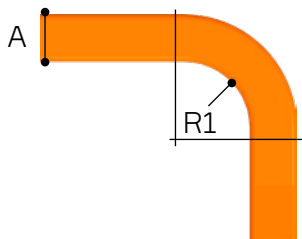


Figure 4 Bending radii – long edge

Bending radii - long edge	
25mm ²	R1 = 13mm
32mm ²	R1 = 20mm
35mm ²	R1 = 13mm
50mm ²	R1 = 15mm
70mm ²	R1 = 18mm
90mm ²	R1 = 20mm
100mm ²	R1 = 30mm
120mm ²	R1 = 25 mm
150mm ²	R1 = 25 mm

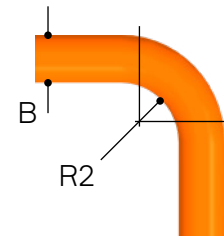


Figure 5 Bending radii – short edge

Bending radii - short edge	
25mm ²	R2 = 3mm
32mm ²	R2 = 3mm
35mm ²	R2 = 4mm
50mm ²	R2 = 4mm
70mm ²	R2 = 4mm
90mm ²	R2 = 4mm
100mm ²	R2 = 6mm
120mm ²	R2 = 5mm
150mm ²	R2 = 7mm

Busbars can be twisted as well as bent. More Details on twisting can be taken from Figure 6:

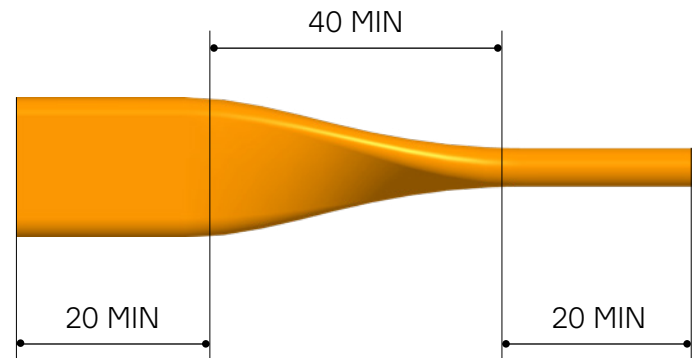


Figure 6 Minimum distances for twisting

5. Derating

Following charts show the max. permissible current load capacity for individual busbar cross sections, under which the max. permissible temperature of the busbar (105 °C for standard PA12 insulation, 130°C for high performance PA12 insulation) will be reached at a given ambient temperature.

The graphs represent corrected curves where the current has been multiplied by a correction factor of 0.8. These corrected curves are the desired derating curves showing the current carrying capacities according to the reference standard for the respective cross-sections and conductor materials.

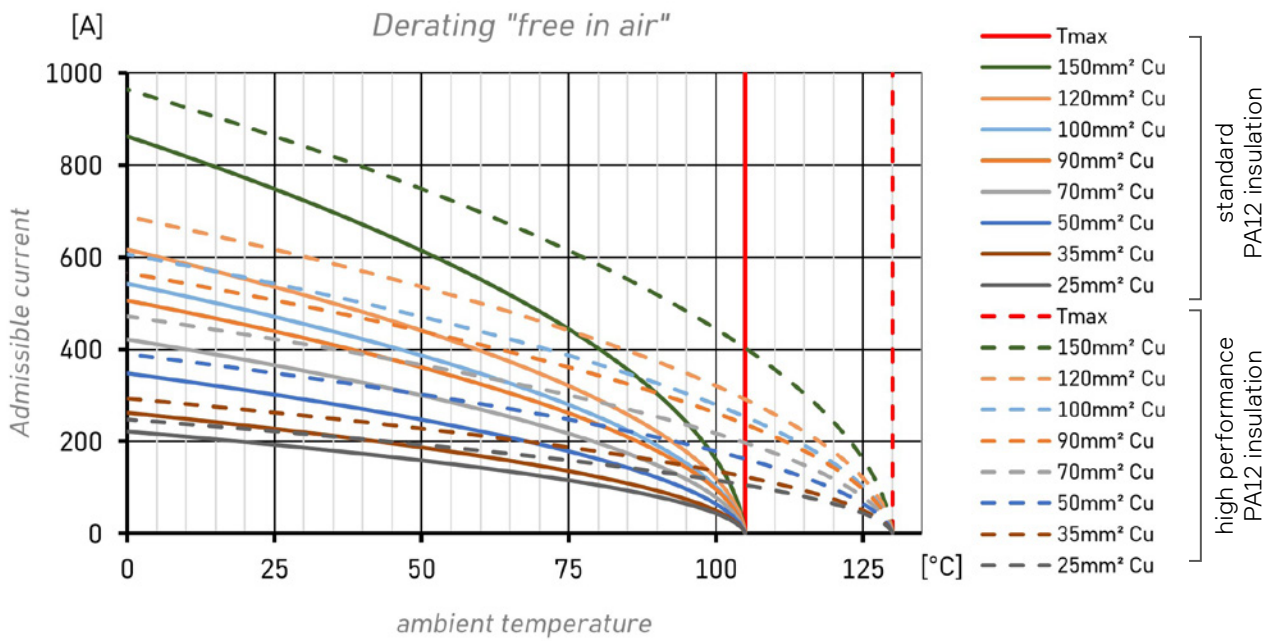


Figure 7 Derating curves for copper with standard PA12 insulation and high performance PA12 insulation

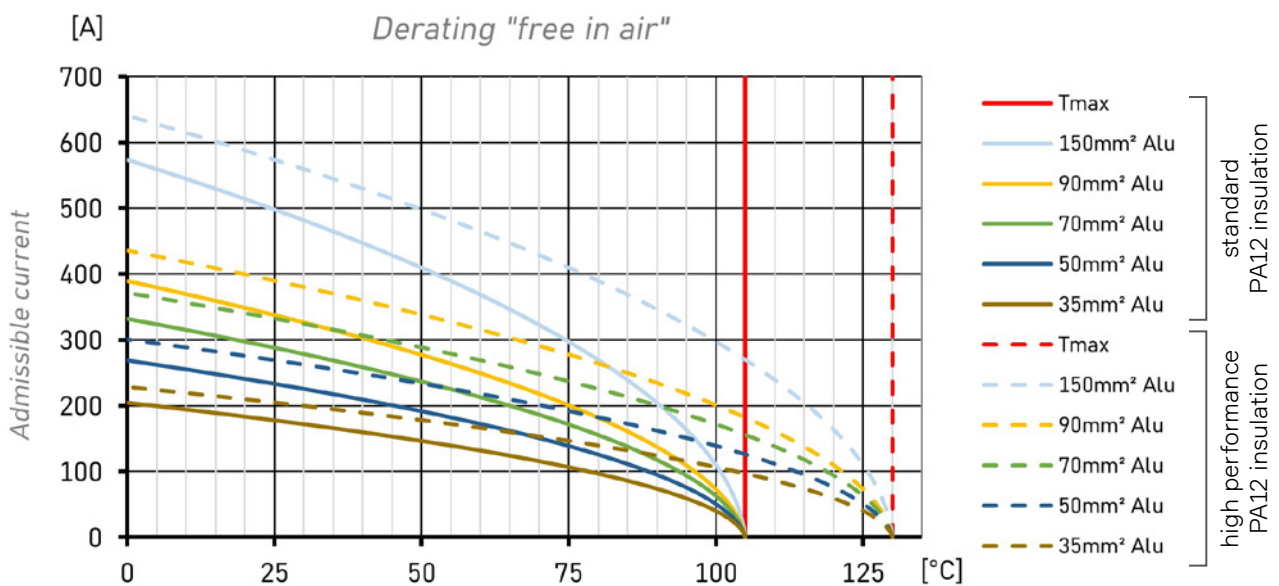


Figure 8 Derating curves for aluminium with standard PA12 insulation and high performance PA12 insulation

Material	Cross-section	Permissible continuous current at 80°C ambient	
		Standard PA12 insulation	High Performance PA12 insulation
Copper	25mm ²	105 A	151 A
Copper	35mm ²	123 A	178 A
Copper	50mm ²	161 A	235 A
Copper	70mm ²	196 A	285 A
Copper	90mm ²	237 A	343 A
Copper	100mm ²	253 A	367 A
Copper	120mm ²	291 A	419 A
Copper	150mm ²	322 A	467 A
Aluminium	35mm ²	97 A	139 A
Aluminium	50mm ²	126 A	182 A
Aluminium	70mm ²	156 A	225 A
Aluminium	90mm ²	182 A	264 A
Aluminium	150mm ²	270 A	389 A

6. Temperature rise curve

The curves in the following diagram represent the self-heating of the busbars at the respective current load.

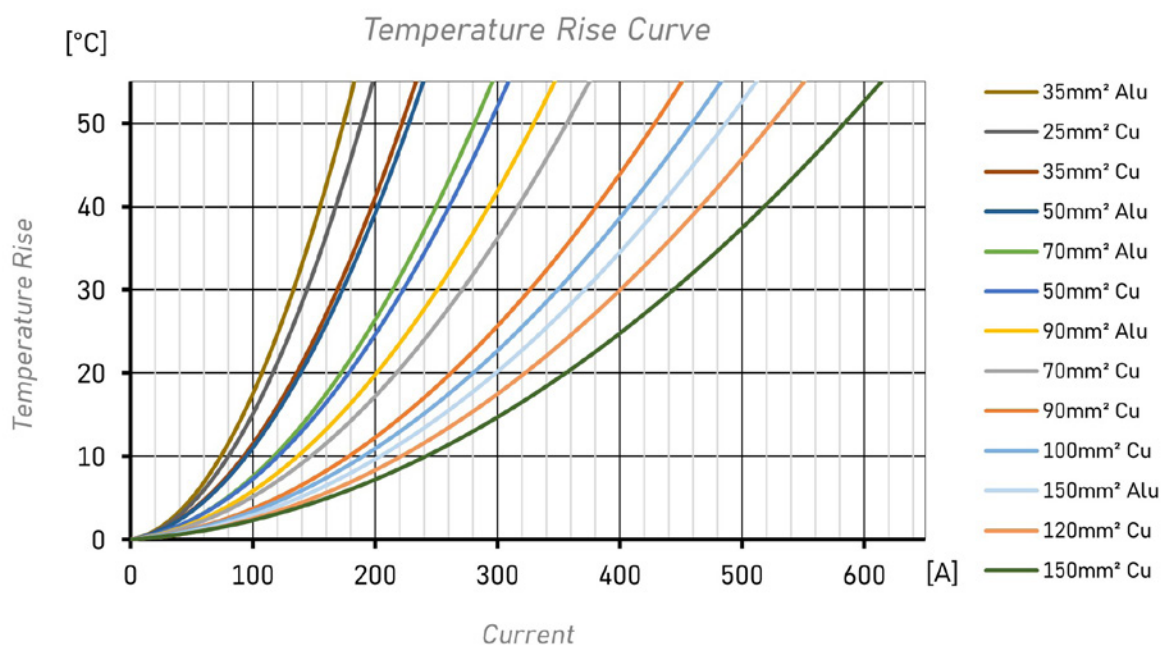
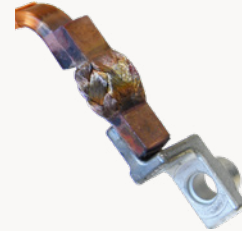


Figure 9 Temperature Rise Curve copper and aluminium

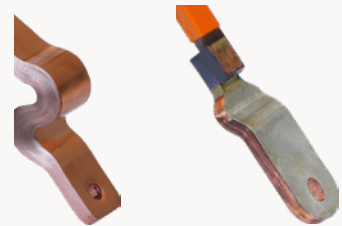
COMPATIBLE COMPONENTS

1. Flex Area

Copper or aluminium braids can be integrated into busbars as flexible sections to compensate for tolerances and prevent vibration damage.



Flexible laminated copper connectors are another way of flexibly designing busbars and thus ensuring tolerance compensation. These connectors can also be coated with the desired coating on the contact surface.



Flexible Braid

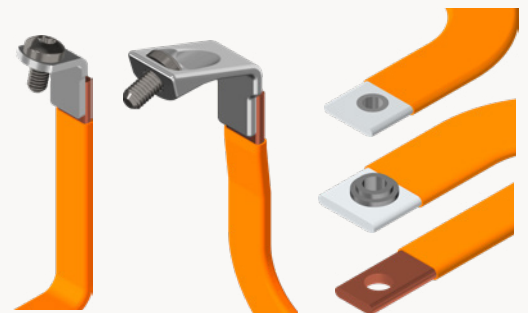
Cross-section	Dimensions (AxB)	
	A	B
25mm ²	12	4.5
30mm ²	18	4
35mm ²	13	5.5
50mm ²	16	6.5
70mm ²	19	7
90mm ²	24	7
100mm ²	24	7.5
120mm ²	26	9
150mm ²	55	5.3

2. Fastening Parts



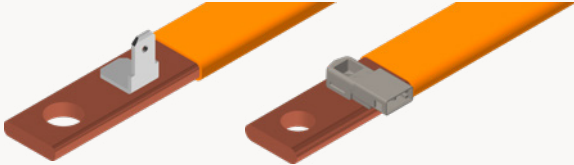
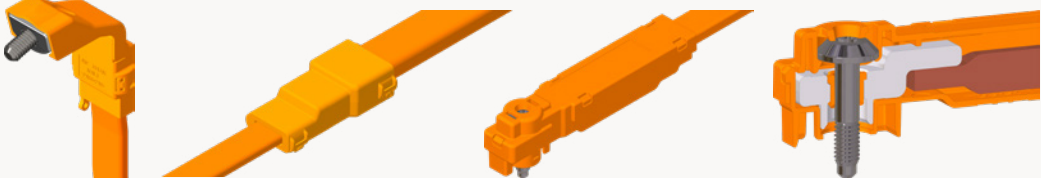
Fastening elements serve to fasten the busbar to the counterpart.

For Copper busbars, this is either done using punched or forged terminals of surface coated copper that are welded to the ends of the busbars in any outlet direction, or simply by riveting a surface coated washer into the busbar.

For aluminium busbars, this is done with ultrasonic welded copper inserts or punched terminals. These inserts and terminals can be plated with nickel or silver.



3. Attachments

Attachment Clip	
Spacers	
Voltage pick-ups or connections for sensors (e.g. temperature sensors)	
Touch protection for terminals	

CUSTOMER VALIDATION

Intercable Automotive Solutions S.r.l. has carried out different validations according to international and customer standards. Most of the validation tests are carried out in accordance to ISO 6722-1 (2011-10) and ISO 19642-2 (2023-08). As there is no specific standard or amendmend for busbars some adaptions and deviations have to be considered to cover the typical busbar applications and to respect the characteristics of this kind of product. An example of deviation from the standard is as follows: Instead of bending the test specimens around a mandrel, the specimens are bent around their critical radius before the test is initiated.

The validation consists of the following tests.

Test	Requirements	Result
Visual inspection	No defects such as cracks, inclusions, blisters, or any other conspicuous imperfections should be present in the insulation. Additionally, the color should be similar to RAL 2003.	OK
Bending test - critical radii	In the bent area, any material bulges or „wrinkles“ in the insulation, as well as bare copper spots, are prohibited. However, fine cracks or imprints resulting from the bending tool, which do not compromise the functionality of the component, are permissible.	OK
Conductor geometry	According technical drawing	OK
Insulation thickness	PA12 0,5 -0,1/+0,3mm PPS 1 -0,1/+0,3mm PPS 1,5 -0,1/+0,3mm	OK
Withstand voltage	Following a 4h immersion in a 3% NaCl saltwater bath, the specimen must withstand 30 minutes of testing at 1 kV (AC) and 5 minutes of testing at 5 kV (AC) without electrical breakdown.	OK
Conductor resistance	See table 5 acc. to ISO 6722-1 (2011-10)	OK
Pressure test at high temperature	After a 16h pressure test at T_{Max} with a load of $F = 6.3N$, the specimen must withstand 1 minute of testing at 1 kV (AC) without electrical breakdown.	OK
Long term heat ageing, 3000 h	After a 3000h long-term heat aging test at T_{Max} , the specimen must withstand 1 minute of testing at 1 kV (AC) without electrical breakdown.	OK
Short term heat ageing, 240 h	After a 240h short-term heat aging test at $T_{Max} + 25^{\circ}C$, the specimen must withstand 1 minute of testing at 1 kV (AC) without electrical breakdown.	OK

Test	Requirements	Result
Thermal overload	After a 6h thermal overload test at $T_{Max} + 50^{\circ}C$, the specimen must withstand 1 minute of testing at 1 kV (AC) without electrical breakdown	OK
Cold impact	After 16h cold storage at $-15^{\circ}C$ and immediately impact of 400g weight from 100mm high, the specimen must withstand 1 minute of testing at 1 kV (AC) without electrical breakdown.	OK
Scrape abrasion (needle)	The insulation must not shrink more than 2mm from either end.	OK
Temperature and humidity cycling	Following 320h of temperature and humidity cycling, the specimen must endure 1 minute of testing at 1 kV (AC) without electrical breakdown.	OK
Shrinkage by heat	The insulation must not shrink more than 2mm from either end.	OK
Resistance to ozone	Following 192h of storage in an ozone chamber, the specimen must not exhibit any cracks or noticeable defects.	OK
Insulation volume resistivity	The insulation's volume resistivity must be equal to or greater than $10^9 \Omega mm$.	OK
Hot water resistance (in a 1% salt water bath)	The insulation's volume resistivity must be equal to or greater than $10^9 \Omega mm$. Following hot water resistance testing, the insulation must remain free of cracks and withstand 1 minute of testing at 1 kV (AC) without electrical breakdown.	Test can be passed with selected insulation materials
Fluid compatibility (test method 1 and 2)	Test Method 1: Following fluid storage, the specimen must endure 1 minute of testing at 1 kV (AC) without electrical breakdown. Test Method 2: After fluid storage, the height and width of the busbar should not change by more than 15% - 30%, and the specimen must withstand 1 minute of testing at 1 kV (AC) without electrical breakdown.	Material PA12: not recommended for battery acid, not recommended for 5%-NaCl-solution Material PA12 HP: not recommended for battery acid Material PPS: not recommended for battery acid
Durability of busbar marking	The markings must remain legible throughout the testing process.	OK
Flammability acc. UL 94 (2023-02)	The entire busbar must meet the classification of V0 according to UL 94.	OK

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