

Technical Report

Report No :

TR-050324E&S

Report Date :

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Subject :

Bolted busbars connections by overlapping means

CAPITAS report ref. :

2005_12009GB

Bibliography :

Copper development association
Le contact électrique « Féchan »

Duration of the study :

1 day

Purpose of the study :

To give a general rule for the dimensioning of bolted contacts on busbars. This rule generally applies for the bars connections left under the responsibility of the panel builder.

However the usage could be different for some Schneider Electric components, but in that case ALL the qualification tests have been performed in accordance with the standard IEC 60439.1 on each and every component.

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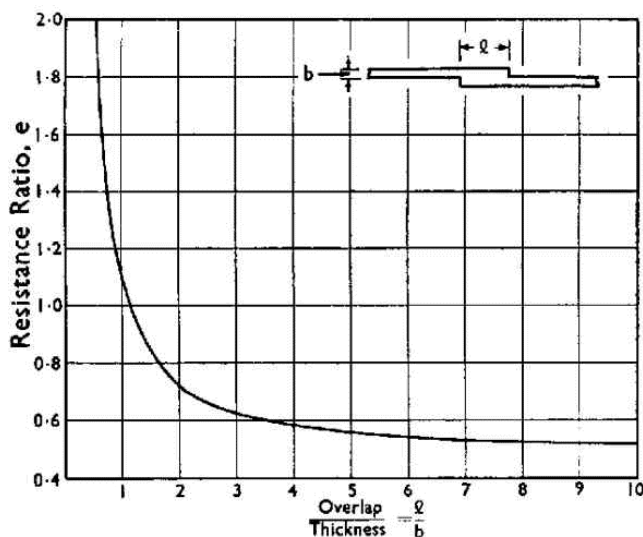
Busbars connection method

In the case of an overlapping joint between two flat copper bars, the current flow is disrupted compared to the flow for a single bar, thus the resistance is increased.

This disrupting effect depends **only** on the ratio of the overlapping length to the thickness of the bars and not to the width, provided that this dimension is the same for both bars.

$$\frac{\text{overlapping_joint}}{\text{thickness}}$$

Current flow efficiency for overlapping joints (Melsom & Booth)



From the graph above it can be observed that the disrupting effect decreases very rapidly for ratios up to 2, and then becomes stable for ratios starting from 5.

This means that in most cases the disrupting effect has very little influence if the overlap ratio is equal or greater than 5.

From that value, it is evident that the efficiency of an overlapping joint does not increase as the length of the overlap is increased and that from a purely electrical point of view no advantage is to be gained by employing an unduly long overlap.

Reminder on contact resistance

Condition of contact surfaces

The condition of the contact surfaces of a joint has an important bearing on its efficiency. The surfaces of the copper should be flat and clean but not polished.

Oxides, sulphides and other surface contaminants have, of course, a higher resistance than the pure copper. However the thin oxide layer present under normal conditions does not influence the resistance : this thin layer (0.01 to 0.02 μ m) has a rough surface and is easily destroyed once the bars are tightened together.

Preparation of the surfaces

Contact surfaces should be flattened by machining if necessary and thoroughly cleaned. A ground or sand-roughened surface is preferable to a smooth one.

Tinning

The tinning of the contact surfaces of a bolted or clamped joint with pure tin or a lead-tin alloy is normally unnecessary.

However it may be recommended in cases where the joints operate under an unusually high temperatures or current densities or when subjected to corrosive atmospheres.

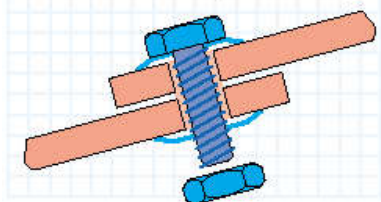
Effect of pressure on contact resistance

It has been proved that the contact resistance depends more on the total applied pressure than on the surface of contact. The more this pressure is high the less is the contact resistance. Moreover a high pressure prevents any ingress of external contaminants.

However this pressure has to remain within the elastic limits of the bar. If not, a temperature rise can occur and lead to a distortion of the copper due to the difference of dilatation characteristics between the steel used for bolt & nut and the copper.

To avoid the temperature rise problem it is necessary to use elastic contact washers and respect the tightening torque recommended by Schneider Electric.

Assemblies should be tightened using class 8-8 corrosion-resistant steel nuts and bolts, fitted with a contact washer on either side. If they are unscrewed, the contact washers must be replaced.



For a moving contact, such as a switch blade moving between spring loaded contacts, If the total applied pressure remains constant the total contact resistance remains practically constant.

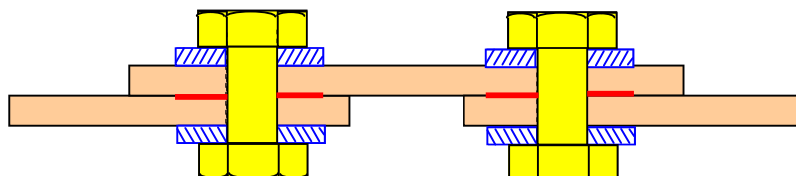
Number of screws

In practice, the real surface of contact is limited to the areas on which the pressure is applied in an effective way. In a joint by overlap, such as a bolted joint, these areas consist of the zones bordering the bolts.

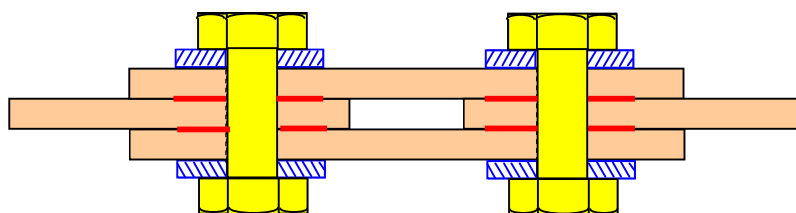
In this case, the "effective" section of contact corresponds to the surface of the contact washer (less the hole for the passage of the screw).

Thus the effective surface of contact or pressure surface should be as close as possible to the copper overlapping surface.

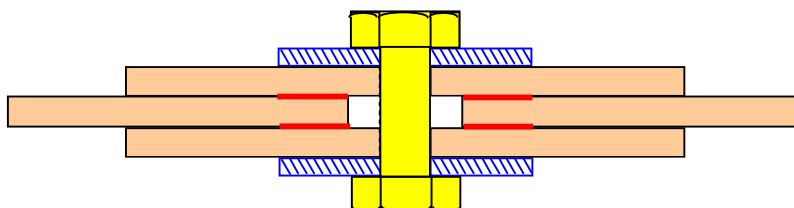
Connection 1 (Prisma/Prisma Plus)



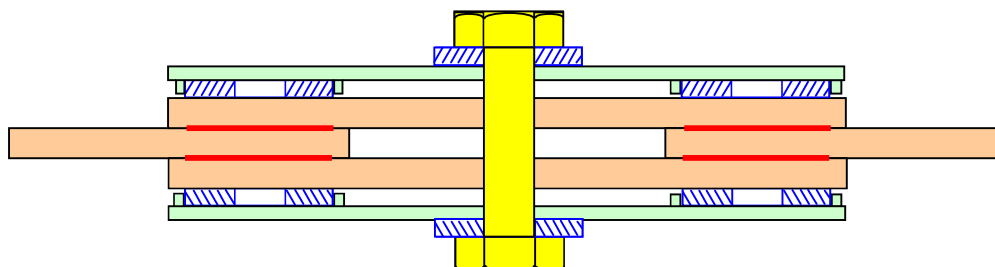
Connection 2



Connection 3 (Busduct-Prisma Plus)



Connection 4 (Canalis)



Some precautions must be taken to ensure that the contact pressure is not unduly high, since it is important that the maximum stress level of the conductor material or its bolts and clamps is not exceeded.

As a bar heats up under load the contact pressure in a joint made of steel bolts tends to increase because of the difference in expansion coefficients between copper and the steel. It is therefore essential that the initial contact pressure is kept to a level for which the contact pressure is not excessive when at operating temperature. If the elastic limit of the bar is exceeded the joint will have a reduced contact pressure when it returns to its cold state due to the joint materials having deformed or stretched.

The effect of pressure on the contact resistance of a joint between two copper conductors is given in the table below.

