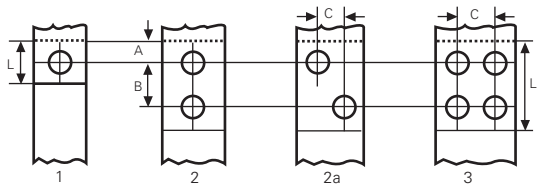
Recommendations for Bolted Joints

In order to obtain an efficient electrical contact between busbars, it is necessary to penetrate the surface film of oxides, sulphides and other contaminants that may be present when the metal has been freely exposed to air. The contact is therefore more easily achieved when the surface is rugged, has extrusion lines or has been knurled. The naturally occurring extrusion lines in Cuponal therefore help achieve a good electrical contact.

Copper oxide has a much lower electrical resistance than aluminium oxide, and a negative temperature coefficient of resistance. Therefore, as the temperature rises, the conductivity of a joint between two oxidised copper surfaces tends to increase. Because of the copper cladding, Cuponal has the same excellent contact properties as copper. Hence, in bolted joints, Cuponal busbars can be used in exactly the same way as copper busbars.

The contact between two surfaces is initially limited to the peaks on each surface, which are therefore subjected to a much higher pressure than the average joint pressure, and will therefore deform during the jointing process. Within a completed joint, the actual contact area is much smaller than the total surface area of the joint. The effective contact area is usually confined to the region in which the pressure is applied, ie near the bolts. A sufficient overlap is therefore required in order to allow for this and also the "streamline effect" - the distortion of lines of current flow through the overlap joint.

Bolting arrangements (DIN 43 673)



Bar	Shape 1		Shape 2 & 2a				Shape 3				Bolt	Hole
width	L	A	L	A	B	C	L	A	B	C	size	DIA
12	12	6									M5	5.5
15	15	7.5									M6	6.6
20	20	10									M8	9
25	25	12.5	55	12.5	30						M10	11
30	30	15	60	15	30						M10	11
40	40	20	80	20	40						M12	13.5
50	50	25	80	20	40						M12	13.5
60			80	20	40						M12	13.5
60			60	17	26	26					M12	13.5
80							80	20	40	40	M12	13.5
100							80	20	40	50	M12	13.5
120							80	20	40	60	M12	13.5

Contact surfaces should be flat, clean and uniformly roughened. Perfectly flat joint faces are not necessary since very good results will be obtained merely by ensuring that the joint is clean and tight. A slight improvement may be gained by preventing reoxidation of the surfaces after cleaning by coating the surfaces with petroleum jelly. If the joint surfaces are pressed together without removing the jelly, any excess is squeezed out, and that which remains will help to seal the joint and protect it from deterioration.

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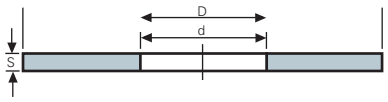
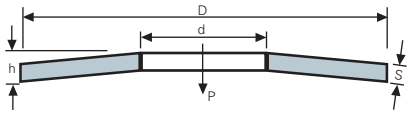
Bolt tightening torque and washer dimensions:





Bolt size	Torque Nm to DIN 43673		Plain washer to DIN 7349			Spring disc washer to DIN 6796				
	Indoors[1]	In/Outdoors[1]	D mm	d mm	S mm	D mm	d mm	S mm	h mm	P kN
M5	2.5	3	15	5.3	2	11	5.3	1.2	1.45	5.5
M6	4.5	5.5	17	6.4	3	14	6.4	1.5	1.85	8.6
M8	10	15	21	8.4	4	18	8.4	2	2.42	14.9
M10	20	30	25	10.5	4	23	10.5	3.0	3	22.1
M12	40	60	30	13	6.0	29	13.0	3.5	3.69	34.1

[1]Oil or grease lubricant [2]MoS_2 based lubricant (molybdenum disulphide)

For a given contact pressure, a copper surface has a contact resistance 20 to 50 times less than an aluminium surface. Joint resistance falls rapidly with increasing pressure, but the improvement above a pressure of about 20N/mm² is minimal. It is important that the proof stress of the busbar material is not exceeded, and therefore a contact pressure of 20N/mm² is the recommended maximum. DIN 43 673 recommends bolting arrangements that result in average contact pressures of between 7 and 20 N/mm². The creep characteristics of Cuponal are between that of copper and aluminium.

Bolts may be of various grades of steel, brass or bronze. From the point of view of availability, steel bolts are recommended. These should be of high strength (8.8 or higher) and should be suitably protected, eg hot dip galvanised. The contact pressure should be distributed by the use of oversize washers. Spring washers help maintain a constant pressure during thermal cycling, allow for any differential expansion between the bolts and the bar, and compensate for any eventual relaxation of the metal.

Cuponal can be tin or silver plated.

Effect of pressure on contact resistance