User Guide

POWERFORMED® Catalogue

SUBLIGN™ and BUSLIGN™ Product Dimensions

Within the Australian POWERFORMED® Substation System Catalogue, PLP has taken the approach of providing only the critical dimensions for each SUBLIGN™ and BUSLIGN™ product. Examples of critical dimensions include: conductor centres for multiple conductor bundles; pitch circle diameters for insulator mountings; and the busbar centerline heights over post insulators. Fully dimensioned Sales Drawings are available for each SUBLIGN™ and BUSLIGN™ item from PLP on request.

SUBLIGN™ and BUSLIGN™ Continuous Current Ratings

Neither the SUBLIGN™ nor BUSLIGN™ catalogue pages list continuous current ratings for each individual item within a product family.

The approach to engineering design for POWERFORMED® products is conservative with continuous current rating limits being determined by factors including current density (cross sectional area and surface area contact), contact force, windspeed, and emissivity. POWERFORMED® continuous current ratings are backed by test data to standards including NEMA CC1, ANSI C119.4, and IEC 61284. Not all POWERFORMED® products have been tested because the diversity of SUBLIGN™ and BUSLIGN™ products is simply too great to achieve 100% type test status. Where products are not tested, the design is verified by tests on similar products where it is possible to extrapolate performance between assemblies. Continuous current ratings are available for all items and listed on the PLP Sales Drawing for each individual item.

SUBLIGN™ and BUSLIGN™ Short Circuit Ratings

In 2008 and 2009 Electropar PLP (New Zealand) embarked upon a programme to mathematically validate and then short circuit test a full size bay width of phase to phase insulated 220kV 200mm OD (4000amp) busbar and interplant connections at 25kA, 31.5kA, 40kA, 50kA and 63kA fault levels. The objectives of the testing were to prove the integrity of PLP's Powerformed fittings designs and to determine whether the existing method of calculation used to determine short circuit performance of substation components is valid (by comparing calculated load and displacement values to actual load and displacement values).

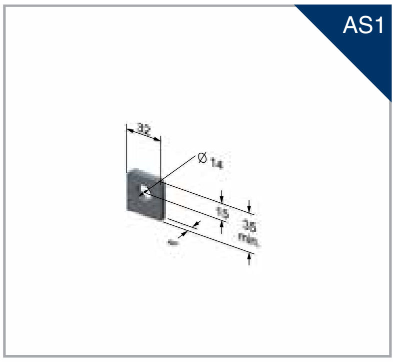
The testing took place at Powertech Lab's in Vancouver, Canada in June 2009 after a global search for laboratories with the capability to complete this scope. Under varying short circuits applied between 25kA/0.3s and 63kA/1sec (including long duration tests at 40kA/3s) measurement of the loads and displacements of the system under varying fault conditions took place. In all, 59 short circuit tests were completed over a 5 day test period with data collected by a combination of high speed cameras, still cameras, video and fibre optic sensors.

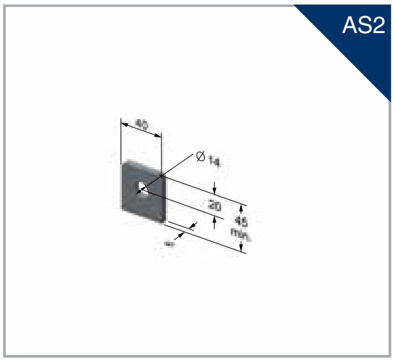
The data obtained from short circuit testing many SUBLIGN™ and BUSLIGN™ products in a real life environment underpins fundamental aspects of POWERFORMED® product designs.

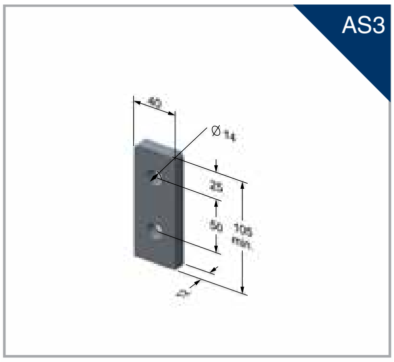
FULL SCALE SHORT CIRCUIT TESTING TO 63 kA/1sec
POWERTECH LABORATORY, VANCOUVER, 2009.

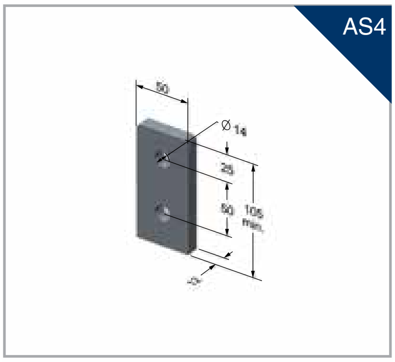
Australian Standard Terminal Palms

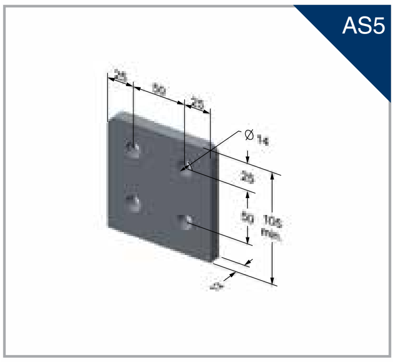
Dimensions and Types - Dimensions in Millimetres

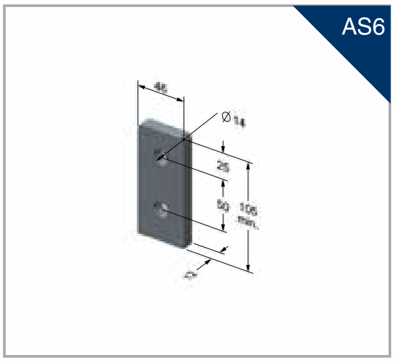

AS1

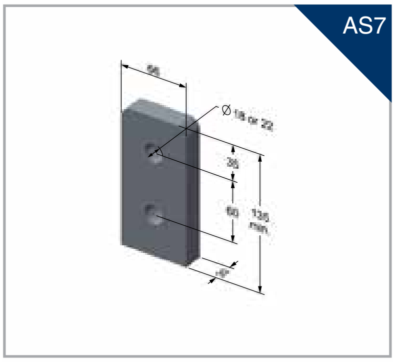

AS2

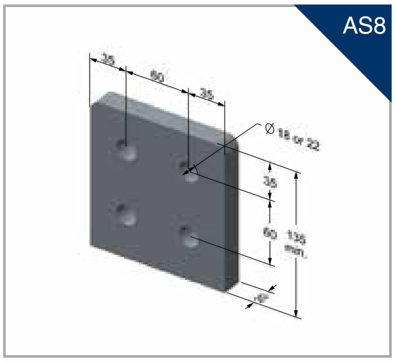

AS3

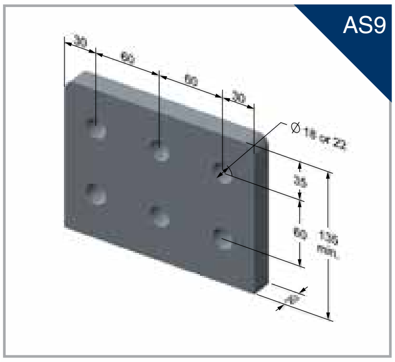

AS4

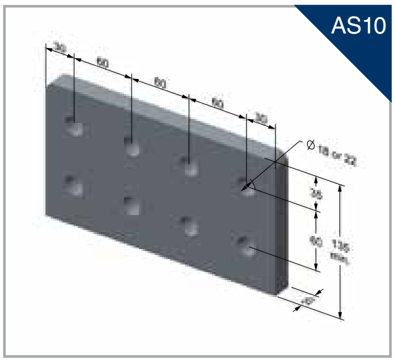

AS5

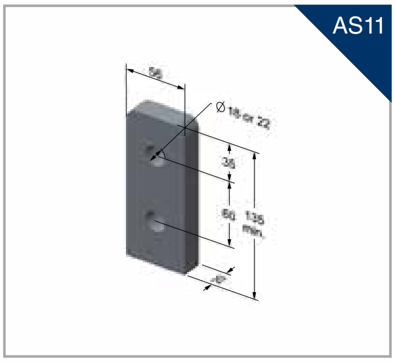

AS6

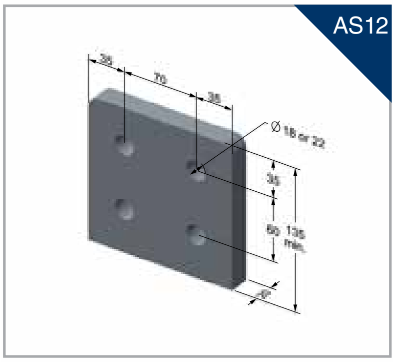

AS7

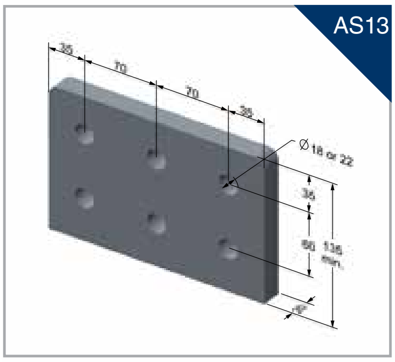

AS8

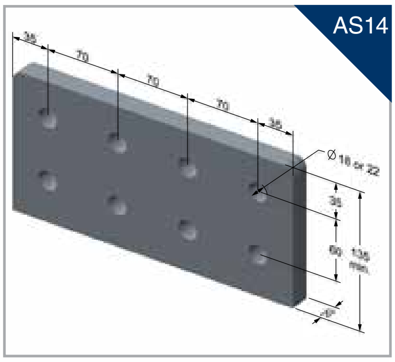

AS9


AS10


AS11


AS12


AS13


AS14

Standard Primary Equipment Stud Sizes

Dimensions, Types and Thread Details

SUBLIGN and BUSLIGN™ IEC
Each BUSLIGN™ and SUBLIGN™ catalogue page within this catalogue that is relevant to primary equipment stud connections lists standard stud diameters in millimetres.

If the stud is threaded, details regarding the stud size (diameter and length), whether the thread is Coarse or fine and the thread pitch will be required. Standard coarse and fine I.S.O metric threads are tabulated below. PLP will supply a special catalogue number and sales drawing to define the BUSLIGN™ and SUBLIGN™ product requirements.

I.S.O Metric Coarse Threads	
Stud Outside Diameter (mm)	Pitch (mm)
10.0	1.50
12.0	1.75
14.0	2.00
16.0	2.00
18.0	2.50
20.0	2.50
22.0	2.50
24.0	3.00
27.0	3.00
30.0	3.50
33.0	3.50
36.0	4.00
39.0	4.00
42.0	4.50
45.0	4.50
48.0	5.00
52.0	5.00
56.0	5.50
60.0	5.50
64.0	6.00
68.0	6.00

Standard I.S.O Metric Fine Threads	
Stud Outside Diameter (mm)	Pitch (mm)
12.0	1.25
16.0	1.50
20.0	1.50
24.0	2.00
30.0	2.00
36.0	3.00
42.0	3.00
48.0	3.00
56.0	4.00
64.0	4.00

Nominal Dimensions and Weights

Metric Aluminium Busbar Tubes

Outside Diameter	Wall Thickness	Cross Sectional Area	Weight
mm	mm	mm^2	kg/m
50.0	4.0	578	1.57
50.0	6.0	829	2.24
63.0	4.0	741	2.01
63.0	6.0	1074	2.91
75.0	4.0	892	2.41
75.0	6.0	1301	3.52
80.0	4.0	955	2.58
80.0	6.0	1395	3.77
80.0	10.0	2199	5.94
100.0	4.0	1206	3.26
100.0	6.0	1772	4.79
100.0	8.0	2312	6.25
100.0	10.0	2827	7.64
120.0	4.0	1458	3.94
120.0	6.0	2149	5.81
120.0	8.0	2815	7.61
120.0	10.0	3456	9.34
125.0	6.0	2243	6.06
125.0	10.0	3613	9.76
140.0	6.0	2526	6.82
140.0	8.0	3318	8.96
140.0	10.0	4084	11.03
150.0	8.0	3569	9.64
150.0	10.0	4398	11.88
150.0	12.0	5202	14.05
160.0	6.0	2903	7.84
160.0	8.0	3820	10.32
160.0	10.0	4712	12.73
160.0	12.0	5579	15.07
200.0	6.0	3657	9.88
200.0	8.0	4825	13.03
200.0	10.0	5969	16.12
200.0	12.0	7087	19.14
250.0	6.0	4599	12.42
250.0	8.0	6082	16.43
250.0	10.0	7540	20.36
250.0	12.0	8972	24.23

Current Ratings by Temperature

Metric Aluminium Busbar Tubes

0-25°C Ambient, Operating Temperature 90°C maximum

Aluminium Tube			Current Rating					
Outside Diameter	Wall Thickness	Cross Sectional Area	0°C Ambient	5°C Ambient	10°C Ambient	15°C Ambient	20°C Ambient	25°C Ambient
mm	mm	mm²	Amps	Amps	Amps	Amps	Amps	Amps
50.0	4.0	578	1604	1548	1490	1431	1371	1309
50.0	6.0	829	1920	1852	1783	1713	1641	1566
63.0	4.0	741	1958	1889	1819	1747	1673	1598
63.0	6.0	1074	2355	2272	2188	2101	2012	1921
75.0	4.0	892	2275	2195	2113	2030	1944	1856
75.0	6.0	1301	2744	2647	2549	2448	2345	2239
80.0	4.0	955	2405	2320	2234	2146	2055	1962
80.0	6.0	1395	2903	2801	2697	2590	2481	2369
80.0	10.0	2199	3587	3461	3332	3200	3065	2927
100.0	4.0	1206	2913	2811	2706	2599	2490	2377
100.0	6.0	1772	3527	3403	3277	3147	3014	2878
100.0	8.0	2312	4013	3872	3728	3581	3430	3274
100.0	10.0	2827	4384	4230	4073	3912	3747	3577
120.0	4.0	1458	3408	3289	3167	3041	2913	2781
120.0	6.0	2149	4134	3989	3841	3689	3533	3373
120.0	8.0	2815	4713	4547	4378	4205	4028	3845
120.0	10.0	3456	5159	4978	4793	4603	4409	4209
125.0	6.0	2243	4284	4134	3980	3823	3661	3495
125.0	10.0	3613	5350	5162	4970	4774	4572	4365
140.0	6.0	2526	4729	4563	4393	4219	4041	3858
140.0	8.0	3318	5398	5208	5015	4816	4613	4404
140.0	10.0	4084	5917	5709	5497	5279	5057	4828
150.0	8.0	3569	5735	5534	5328	5118	4902	4680
150.0	10.0	4398	6290	6069	5844	5613	5376	5133
150.0	12.0	5202	6709	6474	6233	5986	5734	5474
160.0	6.0	2903	5313	5126	4936	4741	4541	4335
160.0	8.0	3820	6070	5857	5640	5417	5188	4953
160.0	10.0	4712	6661	6427	6188	5943	5693	5435
160.0	12.0	5579	7108	6858	6603	6342	6075	5800
200.0	6.0	3657	6457	6231	5999	5762	5519	5269
200.0	8.0	4825	7388	7129	6864	6592	6314	6028
200.0	10.0	5969	8118	7833	7542	7244	6938	6624
200.0	12.0	7087	8675	8370	8059	7741	7414	7078
250.0	6.0	4599	7854	7579	7297	7008	6713	6409
250.0	8.0	6082	8996	8680	8358	8027	7688	7340
250.0	10.0	7540	9895	9548	9193	8830	8457	8074
250.0	12.0	8972	10586	10214	9835	9446	9047	8638

Basis of Ratings Calculations	
Material	6101 T6 Aluminium Alloy
Resistivity (at 20°C)	0.030µΩm
Wind Velocity	0.6 m/s
Conductor Emissivity	0.5

Current Ratings by Temperature

Metric Aluminium Busbar Tubes

30-50°C Ambient, Operating Temperature 90°C maximum

Aluminium Tube			Current Rating				
Outside Diameter	Wall Thickness	Cross Sectional Area	30°C Ambient	35°C Ambient	40°C Ambient	45°C Ambient	50°C Ambient
mm	mm	mm²	Amps	Amps	Amps	Amps	Amps
50.0	4.0	578	1245	1179	1111	1040	966
50.0	6.0	829	1490	1411	1329	1245	1156
63.0	4.0	741	1520	1439	1356	1270	1179
63.0	6.0	1074	1828	1731	1631	1527	1418
75.0	4.0	892	1766	1672	1575	1475	1370
75.0	6.0	1301	2130	2017	1900	1779	1653
80.0	4.0	955	1866	1767	1665	1559	1448
80.0	6.0	1395	2253	2134	2011	1882	1749
80.0	10.0	2199	2784	2636	2484	2326	2161
100.0	4.0	1206	2261	2141	2018	1889	1755
100.0	6.0	1772	2737	2593	2443	2287	2125
100.0	8.0	2312	3115	2950	2779	2602	2417
100.0	10.0	2827	3403	3223	3036	2843	2641
120.0	4.0	1458	2645	2505	2361	2210	2053
120.0	6.0	2149	3209	3039	2863	2681	2490
120.0	8.0	2815	3658	3464	3264	3056	2839
120.0	10.0	3456	4004	3792	3573	3345	3108
125.0	6.0	2243	3325	3149	2967	2778	2581
125.0	10.0	3613	4152	3932	3705	3469	3223
140.0	6.0	2526	3670	3476	3275	3066	2849
140.0	8.0	3318	4189	3968	3738	3500	3252
140.0	10.0	4084	4592	4349	4098	3836	3564
150.0	8.0	3569	4451	4216	3972	3719	3455
150.0	10.0	4398	4882	4624	4356	4079	3789
150.0	12.0	5202	5207	4932	4646	4350	4041
160.0	6.0	2903	4124	3905	3679	3445	3200
160.0	8.0	3820	4712	4462	4204	3936	3657
160.0	10.0	4712	5170	4896	4613	4319	4012
160.0	12.0	5579	5517	5225	4922	4609	4282
200.0	6.0	3657	5012	4747	4472	4187	3890
200.0	8.0	4825	5734	5431	5117	4791	4451
200.0	10.0	5969	6301	5967	5622	5264	4890
200.0	12.0	7087	6733	6377	6008	5625	5226
250.0	6.0	4599	6096	5773	5440	5093	4731
250.0	8.0	6082	6982	6613	6230	5833	5419
250.0	10.0	7540	7680	7274	6853	6416	5961
250.0	12.0	8972	8216	7781	7331	6864	6377

Basis of Ratings Calculations	
Material	6101 T6 Aluminium Alloy
Resistivity (at 20°C)	0.030μΩm
Wind Velocity	0.6 m/s
Conductor Emissivity	0.5

Short Circuit Ratings

Metric Aluminium Busbar Tubes

Aluminium Tube			Current Rating	
Outside Diameter	Wall Thickness	Cross Sectional Area	3 Second Short Circuit Duration	1 Second Short Circuit Duration
mm	mm	mm²	kA	kA
50.0	4.0	578	31.7	54.9
50.0	6.0	829	45.5	78.8
63.0	4.0	741	40.7	70.4
63.0	6.0	1074	58.9	102.1
75.0	4.0	892	48.9	84.8
75.0	6.0	1301	71.3	123.6
80.0	4.0	955	52.4	90.7
80.0	6.0	1395	76.5	132.5
80.0	10.0	2199	120.6	208.9
100.0	4.0	1206	66.2	114.6
100.0	6.0	1772	97.2	168.3
100.0	8.0	2312	126.8	219.7
100.0	10.0	2827	155.1	268.6
120.0	4.0	1458	80.0	138.5
120.0	6.0	2149	117.9	204.1
120.0	8.0	2815	154.4	267.4
120.0	10.0	3456	189.5	328.3
125.0	6.0	2243	123.0	213.1
125.0	10.0	3613	198.2	343.2
140.0	6.0	2526	138.5	240.0
140.0	8.0	3318	182.0	315.2
140.0	10.0	4084	224.0	388.0
150.0	8.0	3569	195.7	339.0
150.0	10.0	4398	241.2	417.8
150.0	12.0	5202	285.3	494.2
160.0	6.0	2903	159.2	275.8
160.0	8.0	3820	209.5	362.9
160.0	10.0	4712	258.5	447.7
160.0	12.0	5579	306.0	530.0
200.0	6.0	3657	200.6	347.4
200.0	8.0	4825	264.7	458.4
200.0	10.0	5969	327.4	567.1
200.0	12.0	7087	388.7	673.3
250.0	6.0	4599	252.3	436.9
250.0	8.0	6082	333.6	577.8
250.0	10.0	7540	413.5	716.3
250.0	12.0	8972	492.1	852.4

Basis of Ratings Calculations	
Ambient Temperature	20°C
Conductor Temperature - Continuous	70°C
Conductor Temperature - Short Time	250°C

Thermal Expansion

Metric Aluminium Busbar Tubes

10-50°C Temperature Change

Length	Change in Length				
	10°C temperature change	20°C temperature change	30°C temperature change	40°C temperature change	50°C temperature change
m	mm	mm	mm	mm	mm
3.05	0.7	1.4	2.1	2.8	3.5
6.1	1.4	2.8	4.2	5.6	7.0
9.14	2.1	4.2	6.3	8.4	10.5
12.19	2.8	5.6	8.4	11.2	14.0
15.24	3.5	7.0	10.5	14.0	17.5
18.29	4.2	8.4	12.6	16.8	21.0
21.34	4.9	9.8	14.7	19.6	24.5
24.38	5.6	11.2	16.8	22.4	28.0
27.43	6.3	12.6	18.9	25.2	31.5
30.48	7.0	14.0	21.0	28.0	35.0

60-100°C Temperature Change

Length	Change in Length				
	60°C temperature change	70°C temperature change	80°C temperature change	90°C temperature change	100°C temperature change
m	mm	mm	mm	mm	mm
3.05	4.2	4.9	5.6	6.3	7.0
6.10	8.4	9.8	11.2	12.6	14.0
9.14	12.6	14.7	16.8	18.9	21.0
12.19	16.8	19.6	22.4	25.2	28.0
15.24	21.0	24.5	28.0	31.5	35.1
18.29	25.2	29.4	33.7	37.8	42.1
21.34	29.4	34.3	39.3	44.2	49.1
24.38	33.7	39.3	44.9	50.5	56.1
27.43	37.8	44.2	50.5	56.8	63.1
30.48	42.1	49.1	56.1	63.1	70.1

Basis of Calculations	
Coefficient of Thermal Expansion	0.000023 in/in.°C

Deflection Values

Metric Aluminium Busbar Tubes

5.0-13.0m Spans

Tube Size		Span Length (m)								
OD (mm)	WT (mm)	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
50.0	4.0	11.6	24.1	44.6						
50.0	6.0	12.6	26.0	48.2						
63.0	4.0	7.1	14.7	27.2	46.4					
63.0	6.0	7.5	15.6	29.0	49.4					
75.0	4.0	4.9	10.2	18.8	32.1	51.4				
75.0	6.0	5.2	10.7	19.8	33.8	54.2				
80.0	4.0	4.3	8.9	16.4	28.0	44.9				
80.0	6.0	4.5	9.3	17.3	29.4	47.2				
80.0	10.0	5.0	10.3	19.0	32.5	52.0				
100.0	4.0	2.7	5.6	10.3	17.6	28.2	42.9	62.8		
100.0	6.0	2.8	5.8	10.7	18.3	29.3	44.7	65.4		
100.0	8.0	2.9	6.0	11.2	19.0	30.5	46.5	68.0		
100.0	10.0	3.0	6.3	11.6	19.8	31.7	48.3	70.7		
120.0	4.0	1.8	3.8	7.1	12.0	19.3	29.4	43.1	61.0	
120.0	6.0	1.9	3.9	7.3	12.5	19.9	30.4	44.5	63.0	
120.0	8.0	2.0	4.1	7.5	12.9	20.6	31.4	46.0	65.2	
120.0	10.0	2.0	4.2	7.8	13.3	21.3	32.5	47.5	67.3	
125.0	6.0	1.7	3.6	6.7	11.4	18.3	27.9	40.9	57.9	
125.0	10.0	1.9	3.9	7.1	12.2	19.5	29.7	43.5	61.7	
140.0	6.0	1.4	2.9	5.3	9.0	14.4	22.0	32.2	45.7	62.9
140.0	8.0	1.4	2.9	5.4	9.3	14.9	22.7	33.2	47.0	64.7
140.0	10.0	1.5	3.0	5.6	9.5	15.3	23.3	34.1	48.3	66.6
150.0	8.0	1.2	2.5	4.7	8.0	12.9	19.6	28.7	40.6	55.9
150.0	10.0	1.3	2.6	4.8	8.2	13.2	20.1	29.4	41.7	57.4
150.0	12.0	1.3	2.7	5.0	8.5	13.5	20.6	30.2	42.8	59.0
160.0	6.0	1.0	2.2	4.0	6.8	10.9	16.7	24.4	34.6	47.6
160.0	8.0	1.1	2.2	4.1	7.0	11.2	17.1	25.0	35.5	48.8
160.0	10.0	1.1	2.3	4.2	7.2	11.5	17.5	25.7	36.4	50.1
160.0	12.0	1.1	2.3	4.3	7.4	11.8	18.0	26.3	37.3	51.3
200.0	6.0	0.7	1.4	2.5	4.3	6.9	10.5	15.4	21.8	30.0
200.0	8.0	0.7	1.4	2.6	4.4	7.0	10.7	15.7	22.2	30.6
200.0	10.0	0.7	1.4	2.6	4.5	7.2	10.9	16.0	22.7	31.3
200.0	12.0	0.7	1.4	2.7	4.6	7.3	11.2	16.3	23.2	31.9
250.0	6.0	0.4	0.9	1.6	2.7	4.4	6.7	9.7	13.8	19.0
250.0	8.0	0.4	0.9	1.6	2.8	4.4	6.8	9.9	14.0	19.3
250.0	10.0	0.4	0.9	1.6	2.8	4.5	6.9	10.1	14.2	19.6
250.0	12.0	0.4	0.9	1.7	2.9	4.6	7.0	10.2	14.5	19.9

(Continued)

Deflection Values

Metric Aluminium Busbar Tubes

14.0-21.0m Spans

Tube Size		Span Length (m)							
OD (mm)	WT (mm)	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0
140.0	6.0	84.6							
140.0	8.0	87.0							
140.0	10.0	89.5							
150.0	8.0	75.2							
150.0	10.0	77.3							
150.0	12.0	79.3							
160.0	6.0	64.1	84.4						
160.0	8.0	65.7	86.6						
160.0	10.0	67.3	88.8						
160.0	12.0	69.0	91.0						
200.0	6.0	40.4	53.2	68.9	87.8	110.4			
200.0	8.0	41.2	54.3	70.3	89.6	112.6			
200.0	10.0	42.0	55.4	71.7	91.4	114.9			
200.0	12.0	42.9	56.5	73.2	93.2	117.2			
250.0	6.0	25.6	33.7	43.6	55.5	69.8	86.7	106.4	129.3
250.0	8.0	26.0	34.2	44.3	56.4	70.9	88.1	108.1	131.4
250.0	10.0	26.4	34.8	45.0	57.4	72.1	89.5	109.9	133.5
250.0	12.0	26.8	35.3	45.7	58.3	73.2	90.9	111.6	135.7

Basis of Calculations
Maximum deflections shown here are calculated assuming a simply supported beam
Maximum deflections of beams fixed at both ends is approxiametly 1/5 of the values shown here
See Deflection and Stress Formulae page for equations

Standards

Busbar Tube and Flexible Conductor Fittings, Design, Testing and Manufacture

The following standards are used by PLP for the design and supply of POWERFORMED® Products and Systems.

Design Standards		
AS 62271.301	High voltage switchgear 301: Dimensional standardization of terminals	2005
BS 159	Specification for high voltage busbars and busbar connections	1992
NEMA CC 1	Electrical Power Connections for Substations	2009
AS1154.1	Insulator and Conductor fittings for overhead power lines. Performance, material, general requirements and dimensions	2009
AS1154.3	Insulator and Conductor fittings for overhead power lines. Performance and General requirements for helical fittings	2009
IEC 60865	Short circuit currents - Calculation of effects Part 1 Definitions and calculation methods	2011
IEEE 605	IEEE Guide for bus design in air insulated substations	2008
Testing Standards		
IEC 61238-1 2nd Edition	Compression and mechanical connectors for power cables with copper or aluminium conductors - Part 1: Test methods and requirements	2nd Edition (2003)
IEC 61284	Overhead lines - Requirements and tests for fittings	1997
ANSI C119.4	Connectors for use between aluminium to aluminium and aluminium to cooper conductors designed for normal operation at or below 93 degree C and copper to copper conductors designed for normal operation at or below 100 degree C	2011
Material Standards		
AS/NZS 1531	Conductors - Bare overhead - Aluminium and Alu-minium Alloy	1991
BS 2898	Specification for wrought aluminium and aluminium alloys for electrical purposes - bars, extruded round tubes and sections	1970
AS 1866	Aluminium and Aluminium alloys - Extruded rod, bar, solid and hollow shapes	1997
AS 2848.1	Aluminium and Aluminium alloys - Compositions and designations - Wrought products	1998
AS 3607	Conductors - Bare overhead, aluminium and alu-minium alloy - Steel reinforced	1989
BS EN 755-2	Aluminium and aluminium alloys - extruded rod/bar, tube and profiles. Mechanical properties	2008
BS EN 1706	Aluminium and aluminium alloys - Castings. Chemical composition and mechanical properties	2010
ADC Handbook	Australian Aluminium Council Specifications	1994
Manufacturing Standards		
AS 1665	Welding of Aluminium structures	2004
Miscellaneous Standards		
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated fer-rous articles	2006
IEC 17025	General requirements for the competence of testing and calibration laboratories	2005

Busbar Tube Aluminium Alloys

Mechanical and Electrical Properties

Bus Alloys: Comparison Of Properties

Alloy and Temper	Thermal Conductivity At 25°C (W/m.k)	Electrical Conductivity At 20°C % IACS Equal Volume	Electrical Resistivity at 20°C (μΩ.m)	Average Coefficient of Thermal Expansion Per °C	Melting Range Approx (°C)	Ultimate Tensile Strength (MPa) Min	Yeild Tensile Strength (MPa) Min
6060 T5	209	55	0.031	23.4	615-650	150	110
6060 T6	201	54	0.032	23.4	615-650	205	170
6061 T6	167	43	0.040	23.4	580-650	260	240
6063 T5	209	55	0.031	23.4	615-650	120	110
6063 T6	201	53	0.033	23.4	615-650	205	170
6101 T5	218	57	0.030	23.4	615-650	150	110
6101 T6	218	57	0.030	23.4	615-650	205	170

Alloys For Compression Fitting Barrels: Comparison Of Properties

Alloy and Temper	Thermal Conductivity At 25°C (W/m.k)	Electrical Conductivity At 20°C % IACS Equal Volume	Electrical Resistivity at 20°C (μΩ.m)	Average Coefficient of Thermal Expansion Per °C	Melting Range Approx (°C)	Ultimate Tensile Strength (MPa) Min	Yeild Tensile Strength (MPa) Min
1350 - F	234	61	0.028	23.8	645-655	60	30
1200 - F	222	60	0.029	24.0	645-655	90	35

Temper Designation Table			
U.K/EN	U.S.A. or CANADA	ISO Temper	Description of Designation
O	O	O	Annealed
F	F	F	As fabricated, as manufactured or as cast
T3	T3	TD	Solution heat treated, cold worked and naturally aged
T4	T4	TB	Solution heat treated, naturally aged and amenable to artificial ageing
T5	T5	TE	Artificially aged or precipitation heat treated
T6	T6	TF	Solution heat treated and precipitation heat treated

Sources:
Aluminium Development Council of Australia handbook
BSEN 755-2 : 1997 Aluminium and aluminium alloys – Extruded rod/bar, tube and profilesw

Busbar Tube Aluminium Alloys

Mechanical and Electrical Properties

Actual Temper Designations

Temper designations occur as a suffix at the end of the alloy's numeric designation, an example would be 6061-T6, the "T6" is the temper designation.

F	means the alloy is "as fabricated", no special control over strain hardening is noted
O	means that is has been annealed only, the alloy has been recrystallized, this is the softest temper
H1	means that it has strain hardened only
H2	means that it has been strain hardened and partially annealed
H3	means that it has been strain hardened and thermally stabilized
W	means that is has been solution heat treated
T1	means that it has been partially solution heat treated (cooled from an elevated-temperature shaping process such as extrusion), and naturally aged
T2	means that it has been cooled from an elevated-temperature shaping process, (casting), cold worked, and naturally aged
T3	means that it has been solution heat treated, then cold worked and naturally aged
T4	means that it has been solution heat treated, and naturally aged, it applies to alloys not cold worked after solution treatment, or where the effect of cold working may not be recognized in applicable specifications
T5	means that it has been partially solution heat treated and artificially aged, the temper is produced after an elevated temperature, rapid cool fabrication process, (like extrusion)
T6	means that it has been solution heat treated and then artificially aged, without cold working
T7	means that it has been solution heat treated and stabilized to control characteristics such as grain growth, distortion, or residual stresses
T8	means that it has been solution heat treated, then cold worked, and artificially aged
T9	means that it has been solution heat treated, artificially aged, and then cold worked
T10	means that it has been partially solution treated (cooled from an elevated shaping process, such as extrusion), cold worked, then artificially aged

Deflection and Stress Formulae

For Standard Pipe Size (SPS) and Metric Aluminium Busbar Tubes

			Continuous Beam	
	Simply Supported Beam	Beam Fixed At Both Ends	2 Spans	More Than 2 Spans
Maximum Deflection	$D = \frac{5wL^4}{384EI}$	$D = \frac{wL^4}{384EI}$	$D = \frac{5wL^4}{185EI}$	①
Maximum Moment	$M = \frac{wL^2}{8}$ ②	$M = \frac{wL}{12}$ ③	$M = \frac{wL^2}{8}$ ④	$M = 0.107wL^2$ ④
Fiber Stress	$f^1 = \frac{wL^2}{8S}$ ②	$f^1 = \frac{wL^2}{12S}$ ③	$f^1 = \frac{wL^2}{8S}$ ④	$f^1 = \frac{0.107wL^2}{S}$ ④
Maximum Load	$W = \frac{8fS}{l}$	$W = \frac{12fS}{L}$	$W = \frac{8fS}{L}$	$W = \frac{fS}{0.1071}$
Maximum Span	$L = \sqrt{\frac{8fS}{w}}$	$L = \sqrt{\frac{12fS}{w}}$	$L = \sqrt{\frac{8fS}{w}}$	$L = \sqrt{\frac{fS}{0.107w}}$

Symbols:	**Units:**
D = deflection	in
w = load	lb/in
W = total uniform load	lb
L = span	in
E = modulus of elasticity	lb/in²
I = second moment of area ④	in
M = bending moment	lb.in
S = section modulus ②	in
f^1 = fiber stress	lb/in²
f = maximum allowable fiber stress	lb/in²

Notes:

① Maximum deflection occurs in the end spans and is only slightly more than that for a continuous beam of 2 spans.

② Maximum moment and fiber stress for simple beams occur at the center of the span.

③ Maximum moment and fiber stress for beams fixed at both ends occur at the points of support.

④ Maximum moment and fiber stress for continous beams occur at the second support from each end.

Aluminium Casting Alloys

Specification, Designations, Compositions and Properties

Specification Designations

Aluminium Association (AA)	Aluminium Development Council of Australia (ADC)	British Standard (BS)	France NF A57-702 NF A57-703	Germany DIN 1725	Italy U.N.I.
A413	CC401	LM6	A-S13	G-AlSi12	4514
A356	CC601	LM25	AS7G	-	3599

Aluminium Association (AA)	Japan JIS	Spain UNE	Sweden SIS	ISO
A413	AC3A	L-2520	144261	Al-Si 12
A356	AC4C	L-2651	144244	Al-Si7Mg

Chemical Composition Of Aluminium Castings (BS1490:1988)

Alloy	Silicon (Si)	Iron (Fe)	Copper (Cu)	Manganese (Mn)	Magnesium (Mg)	Nickel (Ni)
LM6	10.0 - 13.0	0.6*	0.1*	0.5*	0.1*	0.1*
LM25	6.5 - 7.5	0.5*	0.2*	0.3*	0.2 - 0.6	0.1*

Alloy	Zinc (Zn)	Tin (Sn)	Lead (Pb)	Titanium (Ti)	Other Elements	Aluminium (Al)
LM6	0.1*	0.05*	0.1*	0.2*	0.2*	Remainder
LM25	0.1*	0.05*	0.1*	0.2*	0.2*	Remainder

*Maximum Value

Typical Properties Of Aluminium Castings

Alloy and Temper	Casting Method	Thermal Conductivity At 25°C (W/m.K)	Electrical Conductivity At 20°C (%IACS Equal Volume)	Density (kg/m³)
CC401 F1	Sand	142	37	2650
	Permanent Mould	142	37	2650
CC601 T5	Sand	151	39	2680
	Permanent Mould	151	40	2680

Damping Conductors

Application in All Busbar Tubes

When the calculated resonant frequency of a length of busbar tube is less than 2.75 Hz in accordance with IEC 60865-1, damping is normally required to minimise aeolian vibration.

PLP recommend damping a busbar tube by installing a flexible conductor (AAC, ACSR or AAAC) inside the busbar tube fixed to the tube at one end. Damping conductors can be fixed into the tube by spot welding or by using a damping conductor type flat end cap or corona end cap.

Normally the flexible conductor mass per unit length should be between 10% and 15% of the mass per unit length of the busbar. In addition, the flexible conductor should be no less than two thirds the length of the busbar.

Examples (Metric Aluminium Tubes)

Tube Outside Diameter (OD)	Tube Wall Thickness (WT)	Tube Mass / Unit Length kg/m	Damping Conductor Type	Damping Conductor Mass / Unit Length kg/m	Mass Per Unit Length Ratio
200.0 mm	6.0 mm	9.88	Cicada	1.73	17.5%
160.0 mm	10.0 mm	12.73	Venus	1.86	14.6%
120.0 mm	8.0 mm	7.61	Centipede	1.15	15.0%

Expansion Supports and Connectors

All Busbar Tubes

Within substations, thermal expansion and contraction of busbar tubes occurs as a result of variations in busbar temperature. Busbar temperatures increase when there is a higher electrical load or if, given a constant load, the ambient temperature increases (summer). This will cause the busbar to expand. Busbar temperatures decrease when there is a lighter electrical load or if, given a constant load, the ambient temperature decreases (winter). This will cause the busbar to contract.

Elsewhere in the General Information section of this catalogue, PLP lists values for the thermal expansion Metric aluminium busbar tubes. The thermal expansion tables list the change in length of Metric aluminium busbar tubes based on changes in temperature over given busbar tube lengths.

The values for expansion and contraction of busbar tubes are not dependent on the busbar tube outside diameter or wall thickness i.e. for the same span length, every size of busbar tube will expand and contract the same amount in the axial direction based on identical temperature changes.

BUSLIGN™ expansion fittings for busbar tubes are applied when busbars are being connected to primary equipment (e.g. an HV disconnector) or located on top of post insulators. The expansion supports eliminate the possibility of the busbar tube applying a mechanical load to the substation primary equipment or post insulators. Mechanical load applied to substation primary equipment can potentially damage the equipment or pre-load the equipment connections so that in the event of a short circuit the mechanical forces applied to the equipment are intensified.

POWERFORMED® expansion type BUSLIGN™ fittings are designed, when installed correctly, to account for a busbar tube operational temperature range of -20°C to 90°C continuous. For example, if a BUSLIGN™ expansion type primary equipment connector is installed on the end of a 15.3 metre busbar which is at 20°C (equal to ambient), the assembly can account for at least 24.5mm of expansion which will occur when the busbar reaches an operating temperature of 90°C. It can also account for a contraction of at least 14.0mm which will occur when the busbar reaches an operating temperature of -20°C.

Busbar temperature = -20°C

Busbar temperature = 20°C
(As Installed)

Busbar temperature = 90°C

Principles of Electrical Jointing

For Aluminium and Copper Conductors

CORROSION OF CONNECTORS

Two factors are associated with corrosion:
1. Atmospheric action
2. Galvanic action

For atmospheric action to result in corrosion, there must be moisture and oxygen. Galvanic action results in corrosion when two dissimilar metals in the electrolytic series, for example, aluminium and copper, are in physical contact. In this case, moisture acts as an electrolyte. In such an instance, the copper becomes a cathode and receives a positive charge; the aluminium becomes the anode and receives a negative charge.

The resultant current flow attacks the aluminium leaving the copper unharmed. Both factors described above are influenced by environmental conditions -the chemical attack of airborne pollutants. This occurs in rural areas to a lesser extent than in urban centres and more so in heavy industry locations such as steelworks, chemical plants, refineries, etc.

The problem of the mechanical jointing of two dissimilar metals in physical contact with each other, such as aluminium and copper, stems from their difference in electrical potential.

The column of metals listed here shows their relative positions in the Electrolytic Series, with the more anodic metals in the higher positions and the more cathodic in the lower.

The extent, or severity, of the corrosive action is proportional to the distance of separation of the metals in the list. i.e. the magnitude of the difference in electrolytic potential of the two metals, aluminium and copper, is quite considerable.

Aluminium to Aluminium Connections
No problem exists in the jointing of these conductors as electrolytic action is nonexistent. Nevertheless, care must be taken to prevent crevice corrosion and to select an aluminium alloy connector body not liable to stress corrosion cracking.

Aluminium to Copper Connections
The best choice is an aluminium bodied connector since it is not subject to the galvanic attack of the more vulnerable element - the aluminium conductor. It is essential to use a jointing compound on the aluminium connector body and brushed into the strands of the aluminium conductor. Wherever possible, install the aluminium conductor above the copper to prevent pitting from the galvanic action of copper salts washing over the aluminium connector and conductor when in a lower position.

Copper to Copper Connections
No problem exists in the jointing of these conductors as electrolytic action is non-existent.

Torque Settings

THE ELECTROLYTIC SERIES

ANODIC
(Corroded End)

Magnesium
Aluminium
Duralumin
Zinc
Cadmium
Iron
Chromium Iron (active)
Chromium-Nickel-Iron (active)
Soft solder
Tin
Lead
Nickel
Brasses
Bronze
Monel
Copper
Chromium Iron (passive)
Chromium-Nickel-Iron (passive)
Silver solder
Silver
Gold
Platinum

CATHODIC
(Protected End)

Principles of Electrical Jointing

Contact Sealant
Various sealant formulations have been developed to provide improved electrical and mechanical performance as well as environmental protection to the contact area. The use of sealants is recommended for aluminium to aluminium or aluminium to copper connections. Sealants are also recommended for copper to copper joints which are subject to severe corrosive environments. Non-gritted sealants are recommended for flat connections and as a groove sealant in bolted connectors such as parallel groove clamps. Our gritted sealant is primarily used in compression connectors. The sharp metallic grit particles provide multi-contact current carrying bridges through remaining oxide films to ensure superior electrical conductivity.

Tightening Torque
The tightening torque for either stainless or galvanised fasteners should be as recommended by AS62271.301. These values are 45Nm for M12 nuts/bolts and 90Nm for M16. Fasteners should be tightened alternatively to achieve this value.

Product Name	Description	Recommended Applications	
Alvania ALV300	A mineral oil based corrosion inhibitor with added lithium. Drop point 180°C	Bolted Connections - Alum to Alum - Alum to Copper - Copper to Copper	Palm to Palm - Copper to Copper
Alminox ALM325G	A mineral oil based corrosion inhibitor with added zinc grit. Drop point 188°C. Provides excellent outdoor weathering protection.	Compression Joints Bolted Connections - Alum to Alum - Alum to Copper	

Jointing Guideline For Substation Fittings

To ensure satisfactory bolted joints in substation equipment, the correct bolt torque and joint preparation is needed. In making the following recommendations, direction has been taken from the ADC book Aluminiumin Electrical Engineering, AS 62271.304-2005 as well as jointing standards by several Australian Power Authorities. The following guidelines are not however intended to supersede any Authoritys own construction manuals or safety standards.

Aluminium To Aluminium Joints
Aluminium as soon as it is exposed to the air forms an invisible oxide film which does not conduct electricity. Before making an electrical bolted joint it is necessary to remove this film and ensure that oxide cannot reform during the life of the joint. To ensure this the following method should be used.

The contact face is to be cleaned with a stainless steel wire brush or a scotchbrite pad, dusted to remove any loose dirt or grit and then coated immediately with a thin coating of Alminox aluminium jointing compound. The prepared joint is then protected while the other face is made ready in a similar manner. The joint is assembled, the bolts torqued down and any excess compound squeezed from the joint wiped off.

Tinned Aluminium Or Copper Fitting
Oxide formation on tinned parts is not as rapid, nor as severe as with aluminium so the tinned surface may not need any preparation if the surface has been protected. If there is evidence of a weathered surface, then a similar procedure to that described above may be used but extreme care must be taken to ensure that the surface of the tinned component is not damaged or a galvanic situation may occur. Jointing compound application and assembly should be carried out in the same manner as for aluminium to aluminium joints.

Metric Fastenings

Torque Settings

Recommended Tightening Torque For Galvanised Steel Bolts With Lubricant Coating

Bolt Diameter	Torque	
	ft lbs	Nm
M12	33	45
M16	66	90

Recommended Tightening Torque For Galvanised Steel High Tensile Bolts With Lubricant Coating

Bolt Diameter	Torque	
	ft lbs	Nm
M12	33	45
M16	66	90

Recommended Tightening Torque For Aluminium Bolts With Lubricant Coating

Bolt Diameter	Torque	
	ft lbs	Nm
M12	25	34
M16	40	54

Recommended Tightening Torque For Stainless Steel

Bolt Diameter	Torque	
	ft lbs	Nm
M12	33	45
M16	66	90

Bolted Aluminium Joints

Installation Instructions

FASTENER SET ARRANGEMENTS

i. Typical fastener set arrangements are shown in Figures A, B, C and D below.

ii. Tools needed for installation (Fig 1) – Flat file, torque wrench, socket, spanner, stainless steel wire brush, Emery paper, Uni-Seal jointing compound.

CONSTRUCTING THE JOINT

1. Remove the protective covering from the bolted joint palms. Inspect the contact surfaces and use a flat file to remove any raised imperfections (Fig 2).

2. Using a stainless steel wire brush, scouring pad or Emery paper, clean the contact surfaces of the palms (Fig 3). Apply Uni-Seal jointing compound to both contact surfaces immediately (Fig 4).

   DO NOT USE THE SAME ABRASIVE TOOLS FOR COPPER AND ALUMINIUM AS THIS MAY CAUSE GALVANIC CORROSION.

3. Join the contact surfaces together and apply fasteners according to the correct arrangement illustrated in Figures A, B, C or D. Ensure the threads of the bolts are lubricated using a non-gritted compound or Uni-Seal jointing compound. Using a torque wrench, tighten the nut to the specified torque according to the bolt size (Fig 5).

   For double nut arrangements (Fig B), apply the second nut and tighten against the first nut to the specified torque.

4. Wipe away any excess Uni-Seal jointing compound from the completed bolted aluminum electrical joint.


FIG 1


FIG 2


FIG 3


FIG 4


FIG 5

Fig A S/S OR HDG BOLTS AND NUTS WITH LARGE SERIES LOAD SPREADING WASHERS AND SPRING WASHERS

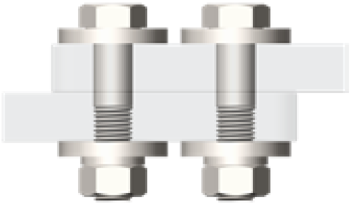


Fig B S/S OR HDG BOLTS AND NUTS WITH LARGE SERIES LOAD SPREADING WASHERS AND DOUBLE NUTS

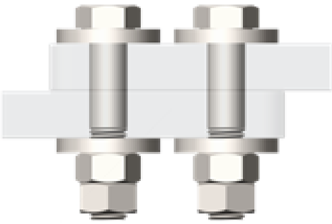


Fig C S/S OR HDG BOLTS AND NUTS WITH STANDARD SERIES WASHERS AND DOUBLE NUTS

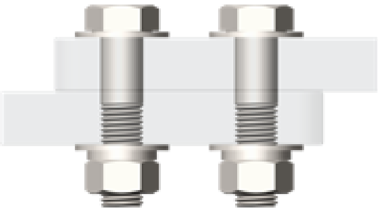
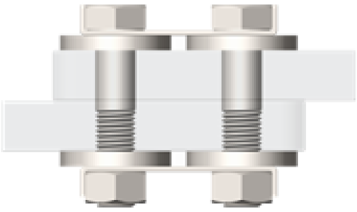


Fig D S/S BOLTS AND NUTS WITH LARGE SERIES WASHERS AND LOCKING PLATES



Non Tension Compression Fittings

Installation Instructions

I. Preparation

Make sure the conductor is in good condition along the full length of the joint. Cut away damaged or corroded sections before constructing the joint and ensure conductor ends are cut square and not deformed. To prevent interlayer slippage and birdcaging, the conductor should be secured at all times using a combination of electrical tape and hose clamps or twisted aluminium wire.

i. Determine the preparation method along the compression length (Fig i):
   a. For new, bright finish, fully greased conductors no unwinding of conductor layers is required. Cleaning and oxide removal is required on the outermost surface of the conductor only.
   b. For partially greased / ungreased conductors, all ungreased layers must be unwound and filled with POWERFORMED® Uni-Seal jointing compound. Cleaning and oxide removal is required down to the layer in contact with the steel core or a maximum of two layers, whichever is less.
   c. For aged or dirty conductors – Ensure that all aluminium and steel strands are not corroded, and prepare as per Case (b) above.

ii. Tools needed for installation (Fig ii) – Hacksaw, conductor trimming tool, tape measure, marker pen, zip ties, insulation tape, utility knife, stainless steel wire brush, Emery paper, Uni-Seal jointing compound, compression dies, compression tool, vernier callipers, file.

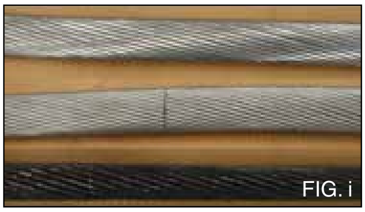


FIG. i


FIG. ii

II. Constructing the Joint

1. Ensure that the work area is clean, dry and protected from dust and water. Mark the conductor end at a distance to the knurl mark of the Joint (Fig 1). Straighten the conductor end to a distance of 2.5 times the marked length. Secure firmly at this point before preparing the conductor end (refer to Part I-i). For Case (a) proceed to Step 2, for Case (b) or (c) proceed to Step 3.

2. Clean the outermost layer of the conductor end using a stainless steel wire brush, scouring pad or Emery paper, and apply POWERFORMED® Uni-Seal jointing compound immediately (Fig 2). Proceed to Step 4.

3. Secure the conductor end firmly at a distance 2.5 times the compression length. Unwind each layer in small groups, following the natural lay of the conductor, and allowing for access along the entire compression length (Fig 3a). Ensure that the strands are not deformed during this process. Starting at the innermost exposed layer, clean strands using a stainless steel wire brush, scouring pad or Emery paper, and apply POWERFORMED® Uni-Seal jointing compound immediately. Wind the layers back (Fig 3b).


FIG. 1


FIG. 2


FIG. 3a


FIG. 3b

Non Tension Compression Fittings

Installation Instructions

4. Fully insert the conductor end into the compression barrel up to the mark. Using the correct aluminium die, compress the joint on to the conductor, starting at the knurl line and working out towards the conductor (Fig 4a). The die bites should be overlapped by a minimum of a half inch. Keep the joint as level as possible and rotate the fitting or die by one flat with each compression to avoid 'banana-ing' (Fig 4b).

5. Remove any die flash or sharp edges with a file or Emery paper. Wipe away any excess jointing compound.

6. Measure the AF (across flat) dimensions across all faces of the joint in several locations to ensure that the correct compression has been achieved.


FIG. 4a


FIG. 4b

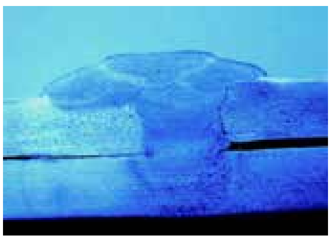
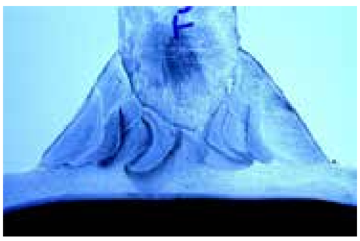
Welding

SUBLIGN™ and BUSLIGN™ Aluminium Fittings

Welding of high current aluminium substation busbar tubes, BUSLIGN™ busbar tube fittings and SUBLIGN™ flexible conductor fittings must be completed in accordance with a welding specification and welding procedure and must only be completed by properly trained and qualified personnel.

Welding Equipment	Both Metal Inert Gas (MIG) and Tungsten Inert Gas (TIG) welding are acceptable. The shielding gas must be pure argon or a helium argon mix and the filler wire must be type 4043.
Welding Environment	Welding must be carried out in a still, clean and dry environment. Welding POWERFORMED® fittings, aluminium busbars or flexible conductors on a substation site will normally require an enclosure or tent to be erected around the welding area and the welder.
Welding Test Piece	Before site welding of POWERFORMED® fittings, aluminium busbars or conductors, PLP recommends that a welding test piece is completed to demonstrate compliance with welding specifications and procedures. Contact PLP for welding test piece details.
Welding Procedure	The weld procedure must include (but not be limited to) specific instructions and details around weld preparation (chamfering), degreasing, tack welding, use of a stainless steel wire brush for cleaning, preheating, post weld cooling, location of the root run and the maximum temperature of the work for subsequent passes. Post weld processing and surface finish criteria should also be addressed.
Welding Destructive Testing	Macro examinations and fillet break-over tests are acceptable testing techniques for prequalifying weld test pieces.
Welding Non Destructive Testing	Both X-Ray and Ultrasound are acceptable non-destructive testing techniques for prequalifying weld test pieces and in-process testing of aluminium welds. Typical industrial x-rays images or busbar tube welds below.
Welding Acceptance Criteria	Loss of cross section of the weldment as a result of internal porosity shall not exceed 5% of the total cross sectional area of the weld. Good quality welding should not require grinding of the cap weld.

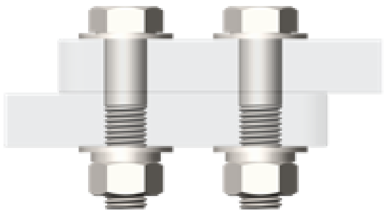
Typical X-Ray Non Destructive Weld Quality Analysis Images:

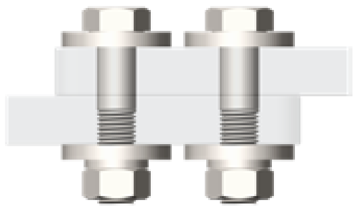
Overhead & Landing Span Fittings

Fasteners

Galvanised & Stainless Steel Assemblies



Assembly D



Assembly E

Assembly F

Part Number (Galvanised)	Part Number (Stainless Steel)	Assembly Type	Metric Type
GHBA-12050D-8.8	SHBA-12050D-S/S	D (1 BOLT, 1 NUT , 1 SPRING WASHER, 2 FLAT WASHERS)	M12
GHBA-12060D-8.8	SHBA-12060D-S/S		
GHBA-12070D-8.8	SHBA-12070D-S/S		
GHBA-12080D-8.8	SHBA-12080D-S/S		
GHBA-12090D-8.8	SHBA-12080D-S/S		
GHBA-12050E-8.8	SHBA-12050E-S/S	E (1 BOLT, 1 NUT, 1 SPRING WASHER, 2 HEAVY DUTY WASHERS)	
GHBA-12060E-8.8	SHBA-12060E-S/S		
GHBA-12070E-8.8	SHBA-12070E-S/S		
GHBA-12080E-8.8	SHBA-12080E-S/S		
GHBA-12090E-8.8	SHBA-12090E-S/S		
	SHBA-12050F-S/S	F (1 BOLT, 1 NYLOC NUT, 1 SPRING WASHER, 2 HEAVY DUTY FLAT WASHER)	
	SHBA-12060F-S/S		
	SHBA-12070F-S/S		
	SHBA-12080F-S/S		
	SHBA-12090F-S/S		
GHBA-16050D-8.8	SHBA-16050D-S/S	D (1 BOLT, 1 NUT, 1 SPRING WASHER, 2 FLAT WASHERS)	M16
GHBA-16060D-8.8	SHBA-16060D-S/S		
GHBA-16070D-8.8	SHBA-16070D-S/S		
GHBA-16080D-8.8	SHBA-16080D-S/S		
GHBA-16090D-8.8	SHBA-16090D-S/S		
GHBA-16050E-8.8	SHBA-16050E-S/S	E (1 BOLT, 1 NUT, 1 SPRING WASHER, 2 HEAVY DUTY WASHERS)	
GHBA-16060E-8.8	SHBA-16060E-S/S		
GHBA-16070E-8.8	SHBA-16070E-S/S		
GHBA-16080E-8.8	SHBA-16080E-S/S		
GHBA-16090E-8.8	SHBA-16090E-S/S		
	SHBA-16050F-S/S	F (1 BOLT, 1 NYLOC NUT, 1 SPRING WASHER, 2 HEAVY DUTY FLAT WASHER)	
	SHBA-16060F-S/S		
	SHBA-16070F-S/S		
	SHBA-16080F-S/S		
	SHBA-16090F-S/S		

To minimise the risk of 'galling' or cold welding that occurs with stainless fasteners, PLP does two things.

1. Threads are lubricated with black graphite grease. Care should be taken to ensure this is not wiped completely off during handling.
2. By using different stainless alloy grades for the bolt and the nut galling can be reduced. The key is the mating of materials that have different hardness. By using 316 nuts and 304 bolts, there is less chance of galling than if the two are the same alloy grade. This is because the different alloys work-harden at different rates and so cold welding in minimised.

SSLP

Stainless Steel Locking Plates (GR 304)

Part Number	Hole Centres (mm)	Length (mm)	Width (mm)	Hole Diameter (mm)
SSLP-25-44-3	44	82	25	14
SSLP-25-50-3	50	90	25	14
SSLP-30-60-3	60	114	30	18

Conductors

PLP imports a full range of AAC, AAAC-1120, ACSR, aluminium clad steel (SC/AC), and Optical Fibre Ground Wire (OPGW) for overhead transmission, and distribution power lines and substation. A range of commonly used conductors are stocked in Sydney in full length drums. PLP provides a de-coiling service for the supply of less than drum lengths. Conductor is manufactured to Australian Standard and/or IEC and supplied with Factory Acceptance Test reports as is required by these Standards.

Type AAC 1350 – All Aluminum Conductor
AS 1531-1991

Part Number	Conductor Code	Stranding and Wire Diameter (No/mm)	Nominal Overall Diameter (mm)	Cross Sectional Area (mm^2)	Approx. Mass (kg/km)	Breaking Load (kN)	Modulus of Elasticity (GPa)	Coefficient of Linear Expansion (x10-6/oC	DC Resistance (Ω/km)
AAC-7/2.50	Leo	7/2.50	7.50	34.36	94.3	5.71	65	23.0	0.833
AAC-7/2.75	Leonids	7/2.75	8.25	41.58	113	6.72	65	23.0	0.689
AAC-7/3.00	Libra	7/3.00	9.00	49.48	135	7.98	65	23.0	0.579
AAC-7/3.75	Mars	7/3.75	11.30	77.28	211	11.8	65	23.0	0.370
AAC-7/4.50	Mercury	7/4.50	13.50	111.30	304	16.9	65	23.0	0.258
AAC-7/4.75	Moon	7/4.75	14.30	124.00	339	18.9	65	23.0	0.232
AAC-19/3.25	Neptune	19/3.25	16.30	157.60	433	24.7	65	23.0	0.183
AAC-19/3.50	Orion	19/3.50	17.50	182.80	503	28.7	65	23.0	0.157
AAC-19/3.75	Pluto	19/3.75	18.80	209.80	576	31.9	65	23.0	0.137
AAC-37/3.00*	Saturn	37/3.00	21.00	261.60	721	42.2	64	23.0	0.110
AAC-37/3.25	Sirius	37/3.25	22.80	307.00	845	48.2	64	23.0	0.094
AAC-19/4.75	Taurus	19/4.75	23.80	336.70	924	51.3	65	23.0	0.0857
AAC-37/3.75*	Triton	37/3.75	26.30	408.50	1120	62.2	64	23.0	0.0706
AAC-61/3.25*	Uranus	61/3.25	29.30	506.10	1400	75.2	64	23.0	0.0573
AAC-61/3.50	Ursula	61/3.50	31.50	586.90	1620	87.3	64	23.0	0.0493
AAC-61/3.75*	Venus	61/3.75	33.80	673.40	1860	97.2	64	23.0	0.0429

* Represents conductors held in stock at PLP Australia. Stocked conductors can be supplied to required length.
All remaining conductors have a minimum order quantity of 1000 metres.
Please contact PLP Australia for more details

Conductors

Type AAAC 1120 – All Aluminum Alloy Conductor
AS 1531-1991

Part Number	Conductor Code	Stranding and Wire Diameter (No/mm)	Nominal Overall Diameter (mm)	Cross Sectional Area (mm²)	Approx. Mass (kg/km)	Breaking Load (kN)	Modulus of Elasticity (GPa)	Coefficient of Linear Expansion (x10-6/oC	DC Resistance (Ω/km)
AAAC/1120 - 7/2.50	Chlorine	7/2.50	7.50	34.36	94.3	8.18	65	23.0	0.864
AAAC/1120 - 7/2.75	Chromium	7/2.75	8.25	41.58	113	9.91	65	23.0	0.713
AAAC/1120 - 7/3.00	Fluorine	7/3.00	9.00	49.48	135	11.8	65	23.0	0.599
AAAC/1120 - 7/3.75	Helium	7/3.75	11.30	77.28	211	17.6	65	23.0	0.383
AAAC/1120 - 7/4.50	Hydrogen	7/4.50	13.50	111.30	304	24.3	65	23.0	0.266
AAAC/1120 - 7/4.75	Iodine	7/4.75	14.30	124.00	339	27.1	65	23.0	0.239
AAAC/1120 - 19/3.25	Krypton	19/3.25	16.30	157.60	433	37.4	65	23.0	0.189
AAAC/1120 - 19/3.50	Lutetium	19/3.50	17.50	182.80	503	41.7	65	23.0	0.163
AAAC/1120 - 19/3.75*	Neon	19/3.75	18.80	209.80	576	47.8	65	23.0	0.142
AAAC/1120 - 37/3.00	Nitrogen	37/3.00	21.00	261.60	721	62.2	64	23.0	0.114
AAAC/1120 - 37/3.25	Nobelium	37/3.25	22.80	307.00	845	72.8	64	23.0	0.0973
AAAC/1120 - 19/4.75	Oxygen	19/4.75	23.80	336.70	924	73.6	65	23.0	0.0884
AAAC/1120 - 37/3.75*	Phosphorus	37/3.75	26.30	408.50	1120	93.1	64	23.0	0.0731
AAAC/1120 - 61/3.25	Selenium	61/3.25	29.30	506.10	1400	114	64	23.0	0.0592
AAAC/1120 - 61/3.50	Silicon	61/3.50	31.50	586.90	1620	127	64	23.0	0.0511
AAAC/1120 - 61/3.75*	Sulphur	61/3.75	33.80	673.40	1860	145	64	23.0	0.0444

Type ACSR-GZ 1350
AS 3607-1989

Part Number	Conductor Code	Stranding and Wire Diameter		Nominal Overall Diameter (mm)	Cross Sectional Area (mm²)	Approx. Mass (kg/km)	Breaking Load (kN)	Modulus of Elasticity (GPa)	Coefficient of Linear Expansion (x10-6/oC	DC Resistance (Ω/km)
		Aluminum (No/mm)	Steel (No/mm)							
ACSR - 61/2.50	Almond	6/2.50	1/2.50	7.5	34.36	119	10.5	83	19.3	0.975
ACSR - 61/2.75	Apricot	6/2.75	1/2.75	8.3	41.58	144	12.6	83	19.3	0.805
ACSR - 61/3.00	Apple	6/3.00	1/3.00	9.0	49.48	171	14.9	83	19.3	0.677
ACSR - 61/3.75	Banana	6/3.75	1/3.75	11.3	77.31	268	22.7	83	19.3	0.433
ACSR - 6/4.75 /7/1.60	Cherry	6/4.75	7/1.60	14.3	120.4	402	33.4	80	19.9	0.271
ACSR - 30/7/2.50	Grape	30/2.50	7/2.50	17.5	181.6	677	63.5	88	18.4	0.196
ACSR - 30/7/3.00	Lemon	30/3.00	7/3.00	21.0	261.5	973	90.4	88	18.4	0.136
ACSR - 30/7/3.25	Lychee	30/3.25	7/3.25	22.8	306.9	1140	105	88	18.4	0.116
ACSR - 30/7/3.50	Lime	30/3.50	7/3.50	24.5	356.0	1320	122	88	18.4	0.100
ACSR - 54/7/3.00	Mango	54/3.00	7/3.00	27.0	431.2	1440	119	78	19.9	0.0758
ACSR - 54/7/3.25	Orange	54/3.25	7/3.25	29.3	506.0	1690	137	78	19.9	0.0646
ACSR - 54/7/3.50	Olive	54/3.50	7/3.50	31.5	586.9	1960	159	78	19.9	0.0557
ACSR - 54/3.719/2.25	Pawpaw	54/3.75	19/2.25	33.8	672.0	2240	178	77	20.0	0.0485
ACSR - 3/4/2.50	Rasin	3/2.50	4/2.50	7.5	34.36	195	24.4	136	13.9	1.59
ACSR - 4/3/3.00	Sultana	4/3.00	3/3.00	9.0	49.48	243	28.3	119	15.2	0.897
ACSR - 4/3/3.75	Walnut	4/3.75	3/3.75	11.3	77.31	380	43.9	119	15.2	0.573

* Represents conductors held in stock at PLP Australia. Stocked conductors can be supplied to required length.
All remaining conductors have a minimum order quantity of 1000 metres.
Please contact PLP Australia for more details