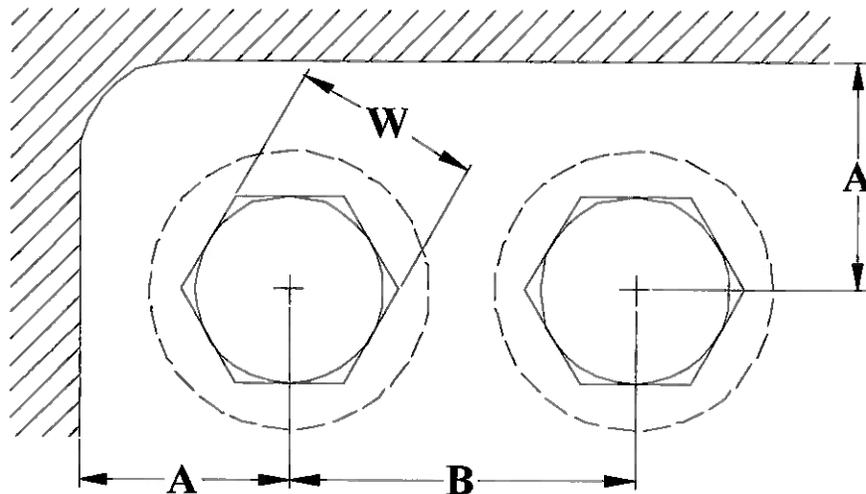


PREFERRED SHEET METAL DESIGN GUIDELINES

Preferred Wrench Clearances for Screws and Nuts

Fastener Size	Dimension W, mm	Preferred	
		A, min	B, min
M3	5	7.5	10
M4	7	11	13
M6	10	15.5	22
M8	13	17	28



Welding

Spot Welding General Guidelines

- Minimum shear strength values for spot welds should be considered for every spot welding application
- Spot welds should be loaded in shear. Avoid situations where a spot weld is stressed in tension
- The shear value of a spot weld is dependant on the shear strength of the thinnest material in the welded system
- Commercial spot welding is not recommended for material less than 0.4 mm
- Enough bearing area must be allowed for the spot welding electrodes to contact the work. In most cases, the preferred flange dimension is 15 mm
- Unless there is a functional requirement, do not locate spot welds with accuracy. Dimensional control of spots increases tooling, inspection costs and time
- High carbon steels (I.e.: spring steels) may give erratic spot weld results
- Use semi-perfs whenever possible to locate parts for spot welding

PREFERRED SHEET METAL DESIGN GUIDELINES

Spot Welding Preferred Materials

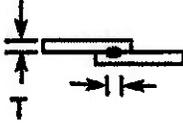
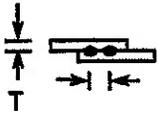
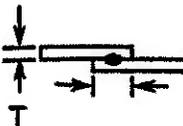
- When spot welding one material to another, the preferred welding materials are those that have the compatible standard chemical composition. Of the common materials, these are the possible combinations:
 - Low carbon steel to Low carbon steel
 - Stainless steel to Stainless steel
 - Low carbon steel to Stainless steel
 - Aluminum to Aluminum (that has been chemically cleaned)
- Plated and pre-plated steels (except chromium plated) can be spot-welded. The strength of the weld is usually not affected by the plating; however electrode life may be lessened
- Spot welded assemblies may be plated after the welding operation.
- Anodizing of aluminum should be performed after the spot welding process

Spot Weld Patterns for Sheet Metal

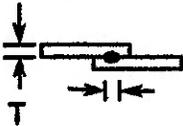
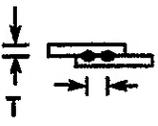
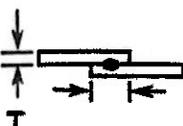
- There are a number of spot arrangements that can be used for sheet metal parts. Usually the most simple pattern which will maintain joint integrity is preferred
 - For severe operating conditions (high vibratory or fatigue loading), a double row or staggered double row may be selected
 - Other variations of spot weld arrangements are possible. They are usually dependant on part geometry, system stresses and layers of metal to be joined
 - Type of supplier welding equipment may be a factor in choice of spot weld pattern
 - Material Thickness Combinations
 - Less than 70% thickness difference will conceal weld marks for aesthetic purposes (the aesthetic part is thicker)
 - The ratio of two unequal sheet thickness should not exceed 5 to 1
 - Preferred: All attachments to the main part should be the same thickness material
-

PREFERRED SHEET METAL DESIGN GUIDELINES

Spot Weld Shear Strength in Low Carbon Steel

Low Carbon Steel Spot Shear Strength				
Thinner Member Metal Thickness (T), mm	Minimum Shear Strength Low Carbon Steel (per spot), N	Nugget Diameter (reference only), mm 	Minimum Spacing, mm 	Minimum Contact Overlap, mm 
0.6	1670	3.6	20	13
0.8	2400	4.1	23	13
1	3340	4.8	29	13
1.2	4900	5.3	32	15
1.5	5380	6	35	16
2	10540	7.4	43	18
2.6	15000	8	50	20
3	18260	8.4	53	21

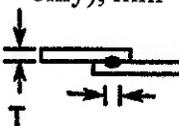
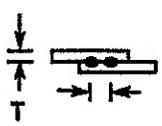
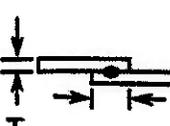
Spot Weld Shear Strength in Stainless Steel

Stainless Steel Spot Shear Strength				
Thinner Member Metal Thickness (T), mm	Minimum Shear Strength Stainless Steel (per spot), Class 1 N	Nugget Diameter (reference only), mm 	Minimum Spacing, mm 	Minimum Contact Overlap, mm 
0.6	1670	2.8	10	9
0.8	2400	3.3	13	10
1	3340	4	16	11
1.2	4900	4.6	18	12
1.5	5380	5.7	25	15
2	10540	7.3	32	18

Note: Class 1 materials are those with ultimate strengths below 620 N/mm²

PREFERRED SHEET METAL DESIGN GUIDELINES

Spot Weld Shear Strength in Aluminum Alloys

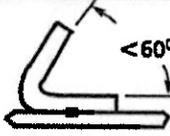
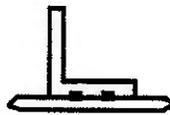
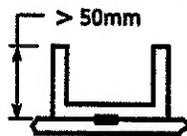
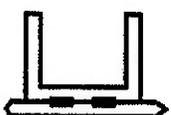
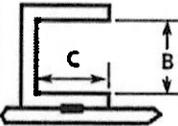
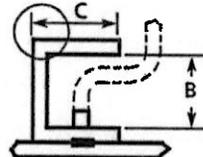
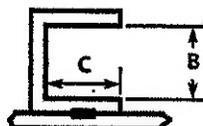
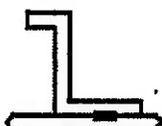
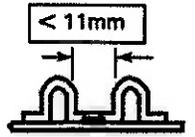
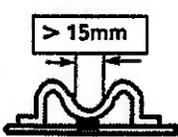
Aluminum Spot Shear Strength					
Thinner Member Metal Thickness (T), mm	Minimum Shear Strength Aluminum (per spot), Class B N	Minimum Shear Strength Aluminum (per spot), Class C N	Nugget Diameter (reference only), mm 	Minimum Spacing, mm 	Minimum Contact Overlap, mm 
0.8	700	780	4	22	13
1	1000	1035	4.5	26	16
1.2	1170	1235	5	26	16
1.5	1680	1850	6	28	18
2	2555	2850	7.5	30	22

Note: Class B: 6063-T5, 3003-H14

Note: Class C: 2024-T3, 6061-T6, 5052-H32, 5052-H34

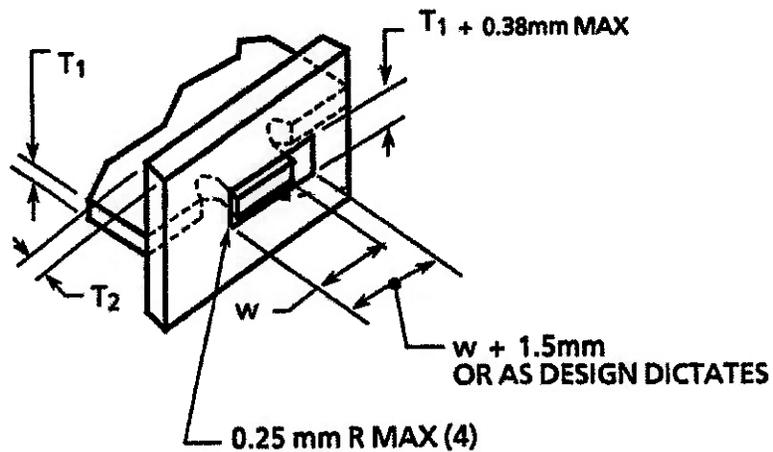
PREFERRED SHEET METAL DESIGN GUIDELINES

Illustrations of Preferred Spot Weld Design Applications

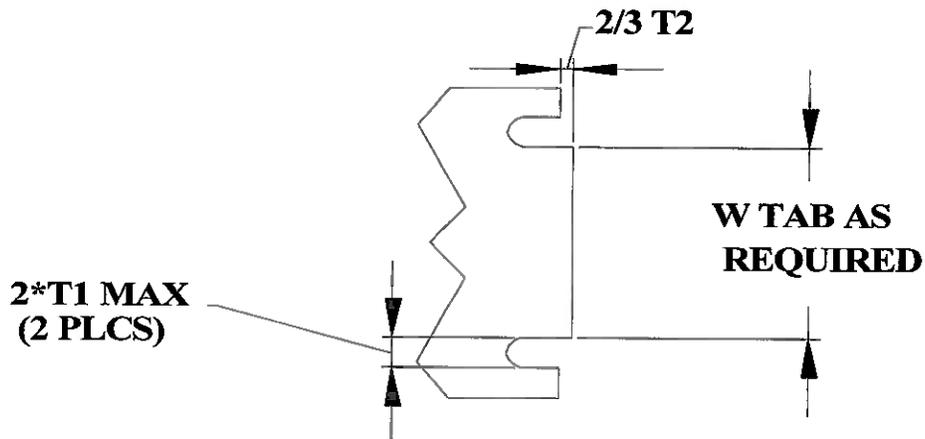
NOT RECOMMENDED	POOR	FAIR	PREFERRED
 <p><math>< 60^\circ</math></p>		 <p>LONG LENGTH</p>	
	 <p>> 50mm</p>		
 <p>B AND C < 45mm</p>	 <p>B AND C < 75mm</p>	 <p>B AND C > 75mm</p>	
			
	 <p>< 11mm</p>		 <p>> 15mm</p>

PREFERRED SHEET METAL DESIGN GUIDELINES

Slot and Tab Welding Guidelines



- Grinding for flush surfaces can weaken the joint strength and also increases the cost. Therefore, unless there is a clearance or aesthetic demand, grinding is not recommended
- Slot width can be tighter if positioning is critical
- Preferred tab projection dimension is $2/3$ to flush of mating stock (T_2) thickness
- Typical 'W' dimensions, mm
 - 4
 - 12
 - 15

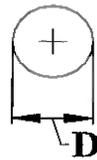
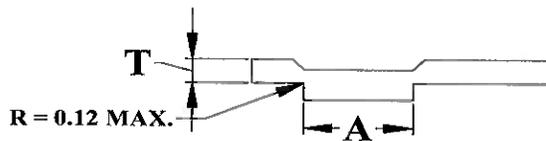


PREFERRED SHEET METAL DESIGN GUIDELINES

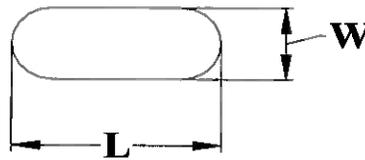
Semi-Perforations (Half-Shears) Guidelines

- Semi-perforations are used in sheet metal for two reasons:
 1. To co-locate sheet metal members so that a subsequent fastening operation may be employed (i.e.: spot welding)
 2. For locating to assist the assembly process (Design for Manufacturing & Assembly)
- The preferred configuration for a mating member is the "Hole & Slot method". Matching of semi-perfs with mating holes only (no slot) is possible, but not recommended. Accuracies required to match the two holes would increase the cost.
- It is a recommended practice that the engineering drawing indicate where semi-perfs are permissible.
- If semi-perfs are used, then the Preferred Drawing Note should read: SEMI-PERFS OR HOLES PERMISSIBLE APPROXIMATELY AS SHOWN.

Recommended Dimensions for Semi-Perfs and Mating Holes					
Material Thickness (T, mm)		Semi-Perf Diameter A, mm	Mating Hole Diameter D, mm	Mating Slot Dimensions W x L, mm	
Over	Thru	+0 / -0.1	+0.1 / -0	W +0.25 / -0	L +0.5 / -0
0.8	1.2	3	3.1	3.2	8
1.2	2	4	4.1	4.4	10
2	3	5	5.1	5.6	13



ROUND HOLE



SLOTTED HOLE

