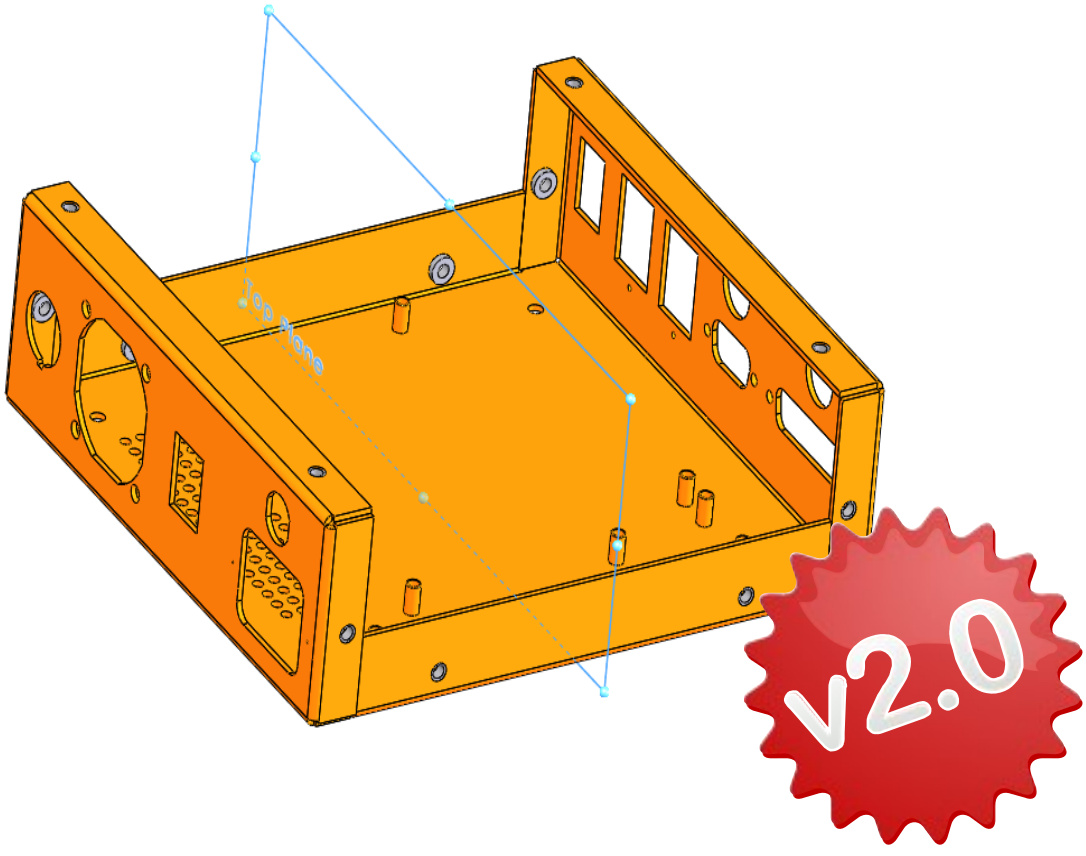
RAPID
SHEET METAL

DESIGN GUIDE



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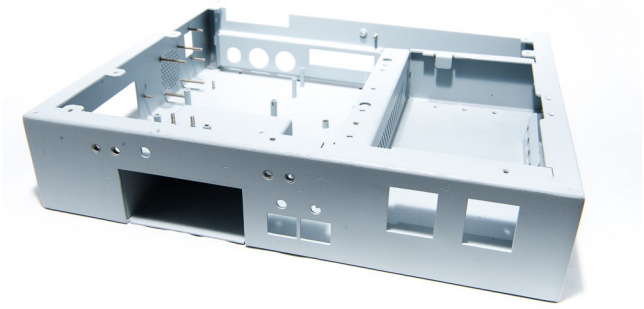
Overview

Rapid Sheet Metal began in 2001 with the mission: “Prototypes First” and it is still the foundation of our business. The shop is structured similar to an additive manufacturing facility. This approach uses 3D CAD data to streamline the quoting and manufacturing processes which eliminates long que times. Currently, Rapid Sheet Metal has two facilities totaling 75,000 square feet of space servicing prototype and low volume production quantities.

Sheet Metal Fabrication is the creation of parts through forming, bending, punching and cutting sheets of metal. This guide will cover sheet metal best practices and tips to ensure your sheet metal parts are optimally designed for durability, manufacturability, and end-use applications.



Capabilities

Part Size: Max 8’ length

In-House Capabilities:

- Laser Cutting
- Punching
- Shearing
- Forming & Bending
- TIG, MIG & Spot Welding
- PEM Hardware
- Hardware Insertion
- Rolling
- Riveting
- Basic Tool Making
- Tumbling
- Secondary Machining
- Assembly
- Plating
- Powder Coating
- Silk Screening
- Part Marking

Certifications & Registrations:

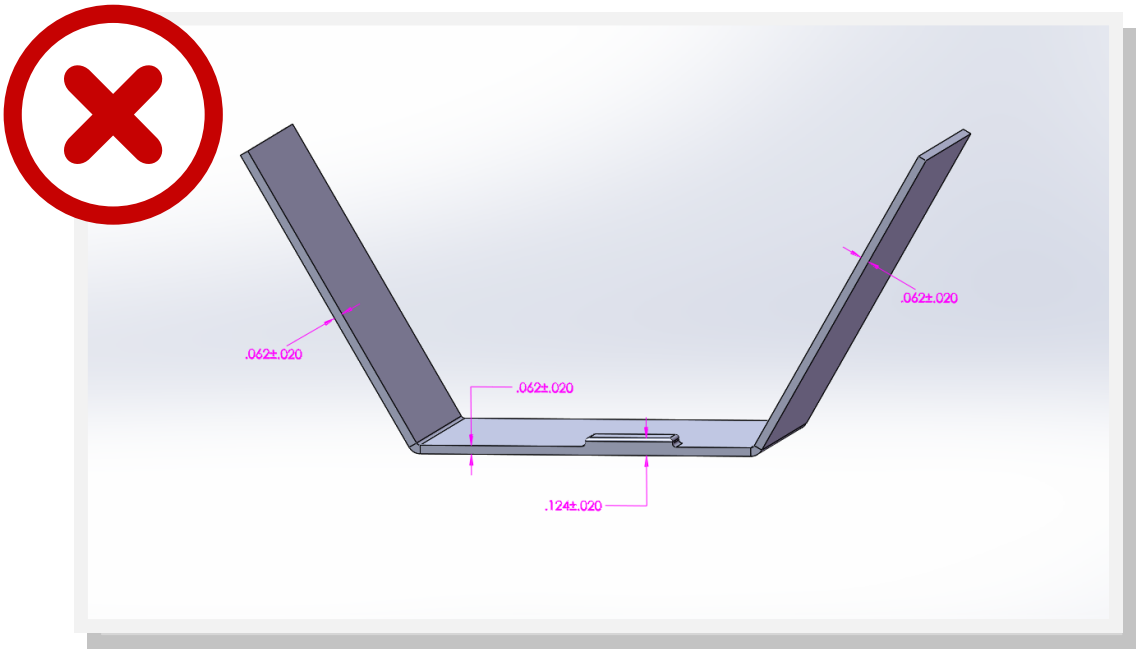
- ITAR Registered
- ISO 9001:2008
- Aerospace Welding
- RoHS Compliant
- Joint Certificate Program
- Central Contractor Registered
- SOLIDWORKS Certified Solution Partner

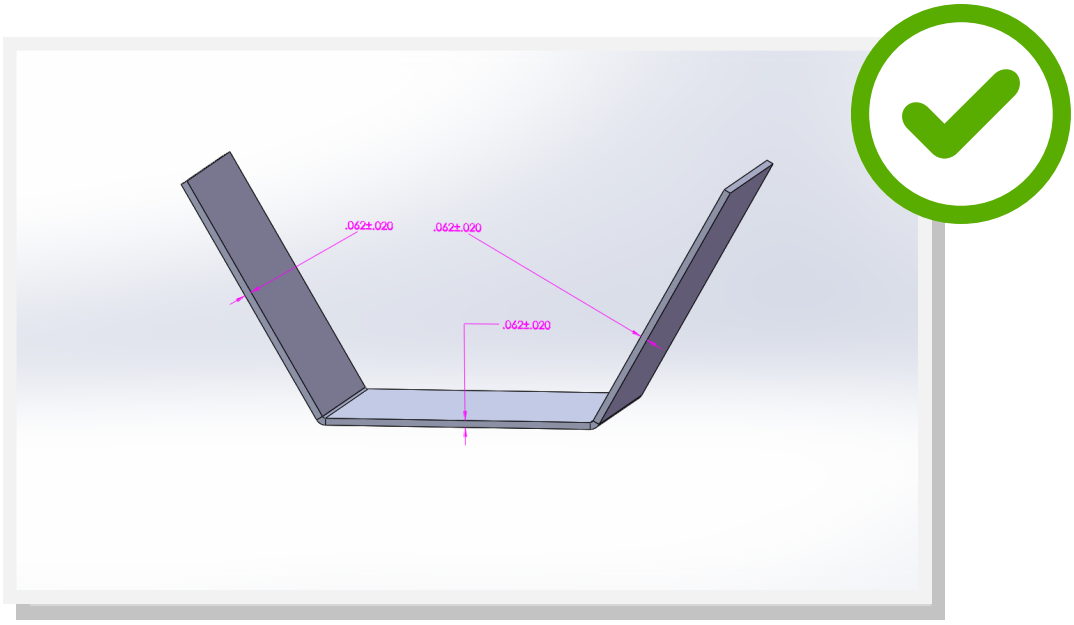
Stock Materials

Gauge	Steel Non RoHS coated steel			Stainless Steel		Aluminum		Copper		Brass
	CRS	Galvanneal	Galvanized	304	316	5052	6061-T6	C101	C110	CDA260
26				0.018						
24	0.024	0.024	0.024	0.024	0.024	0.020		0.020	0.020	0.020
22	0.030	0.029	0.029			0.025	0.025	0.025	0.025	0.025
20	0.036	0.036	0.036	0.036	0.036	0.030	0.030		0.032	0.032
19	0.042							0.040	0.040	0.040
18	0.048	0.048	0.048	0.047	0.047	0.040	0.040	0.050	0.050	0.050
16	0.060	0.060	0.060	0.059	0.059	0.050	0.050	0.062	0.062	0.062
14	0.075	0.075	0.075	0.074	0.074	0.062	0.062	0.080	0.080	0.080
13	0.090	0.089	0.089	0.089	0.089			0.090	0.090	0.090
12	0.104	0.104	0.104	0.104	0.104	0.080	0.080			
11	0.119	0.119	0.119	0.119	0.119	0.090	0.090	0.125	0.125	0.125
10	0.134	0.134	0.134	0.134		0.100	0.100			
8	0.164					0.125	0.125			
7	0.179			0.179						
6						0.160	0.160			
	0.250			0.250		0.250	0.250			

Uniform Wall Thickness

Because Sheet Metal parts are manufactured from a single sheet of metal the part must maintain a uniform wall thickness. Rapid Sheet Metal is capable of manufacturing sheet metal parts with a minimum of 0.010” to 0.25” in thickness.

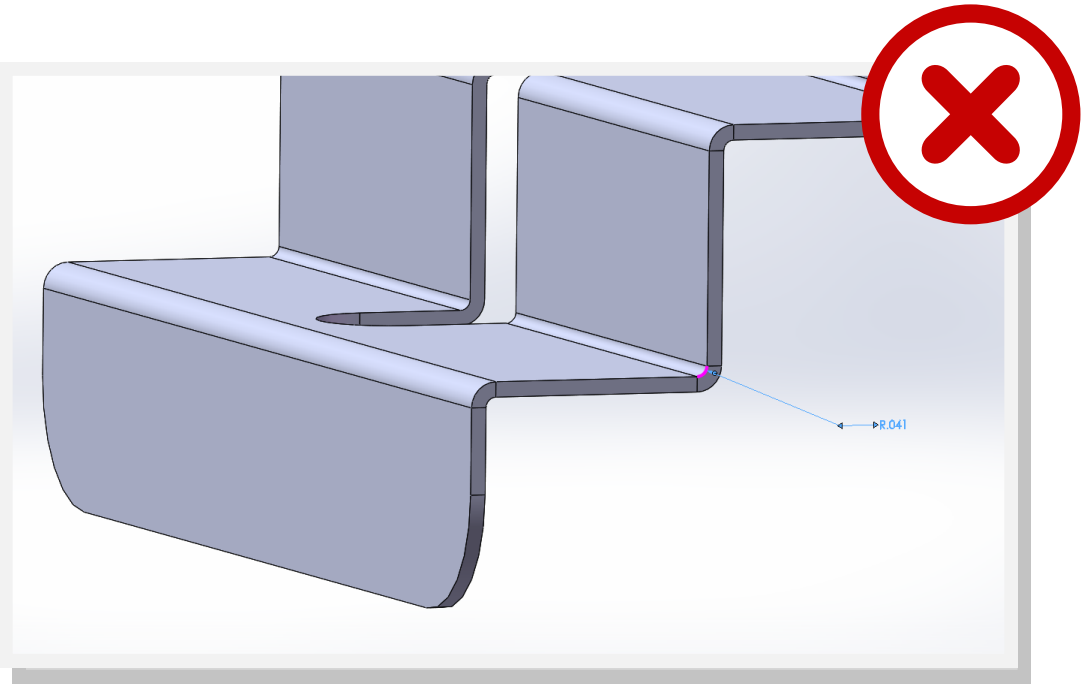


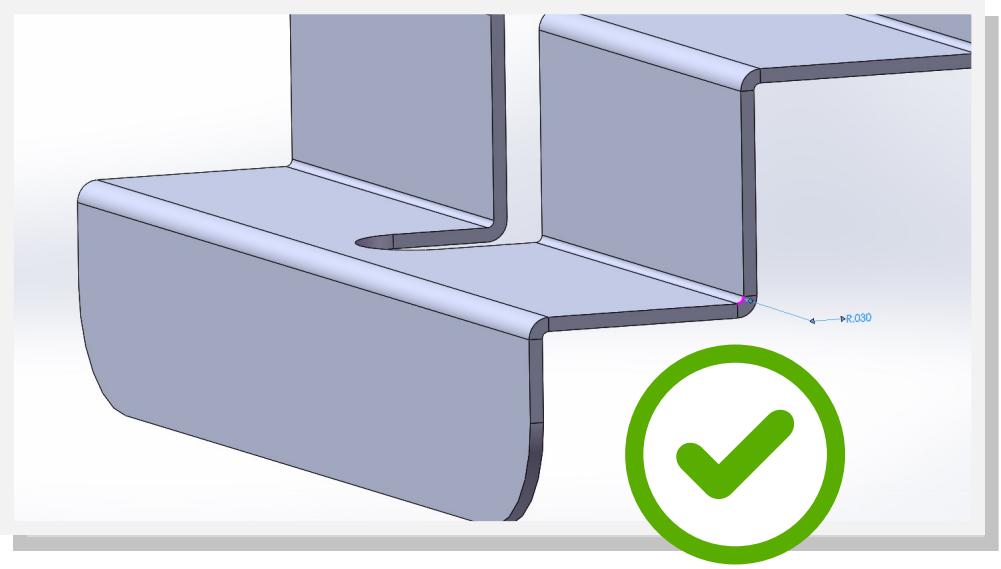


Bends

Bends in sheet metal are manufactured using sheet metal brakes. RAPID will hold a +/- 1 degree tolerance on all bend angles. RAPID's preferred bend radius is 0.030". Other standard bend radii available, some of which will add additional cost to your part, include:

- 0.060"
- 0.090"
- 0.120"
- 0.188"
- 0.250"
- 0.375"
- 0.500"
- 0.750"
- 1.000"

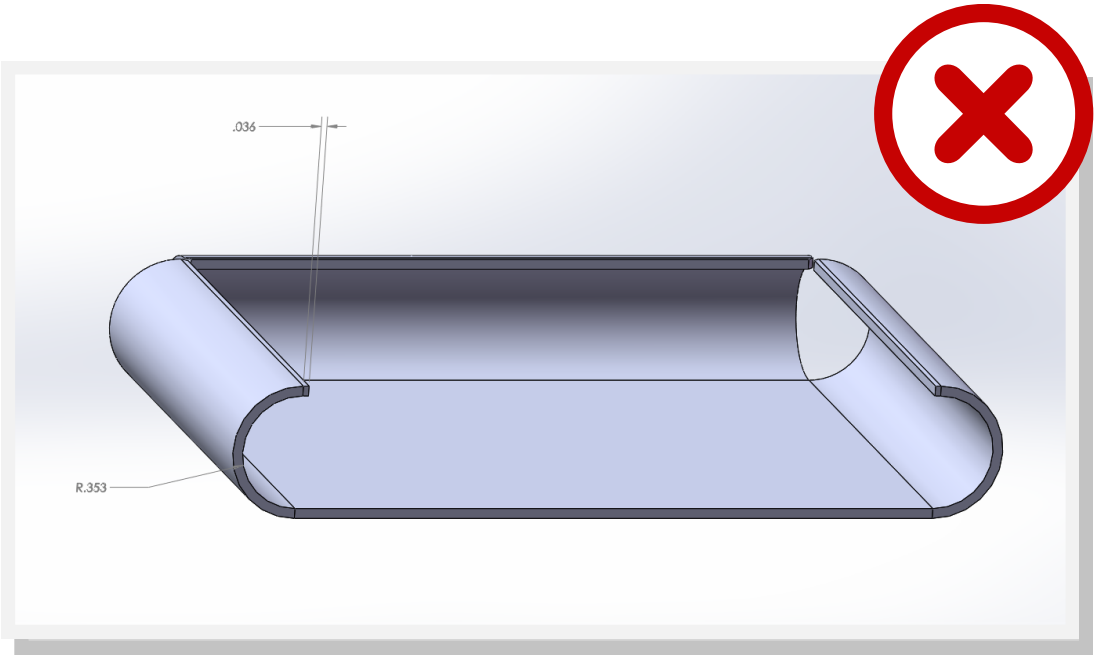


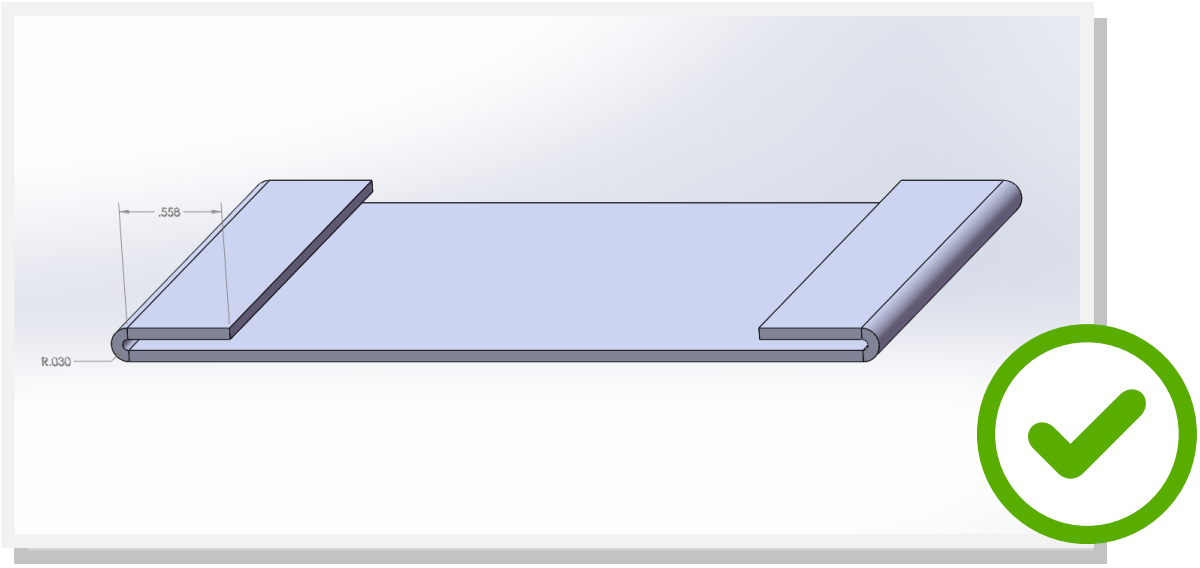


NOTE: *RAPID recommends keeping the same bend radii across all bends when possible. This helps minimize the amount of brake setups and keeps cost down.*

Hems

Hems are folds at the end of a part to create a rounded edge. RAPID can form both open and closed hems as required. The tolerance of a hem is dependent upon the hem's radius, material thickness and features near the hem. It is recommended the minimum inside diameter equals the material thickness and the hem return length is 4 times the thickness.

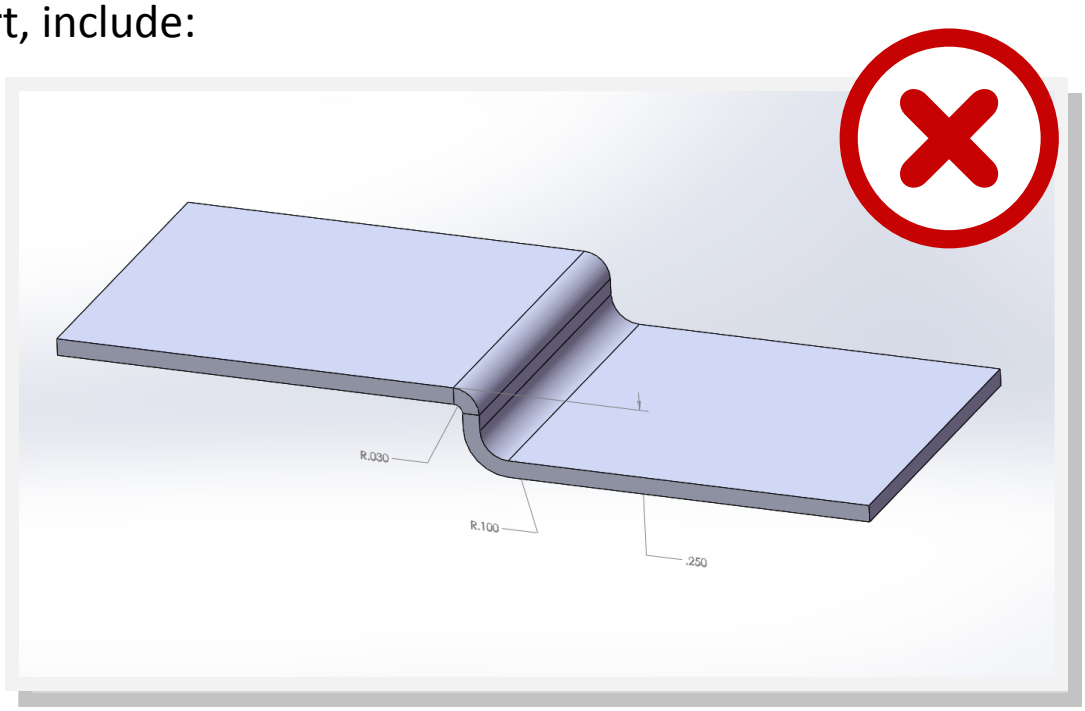


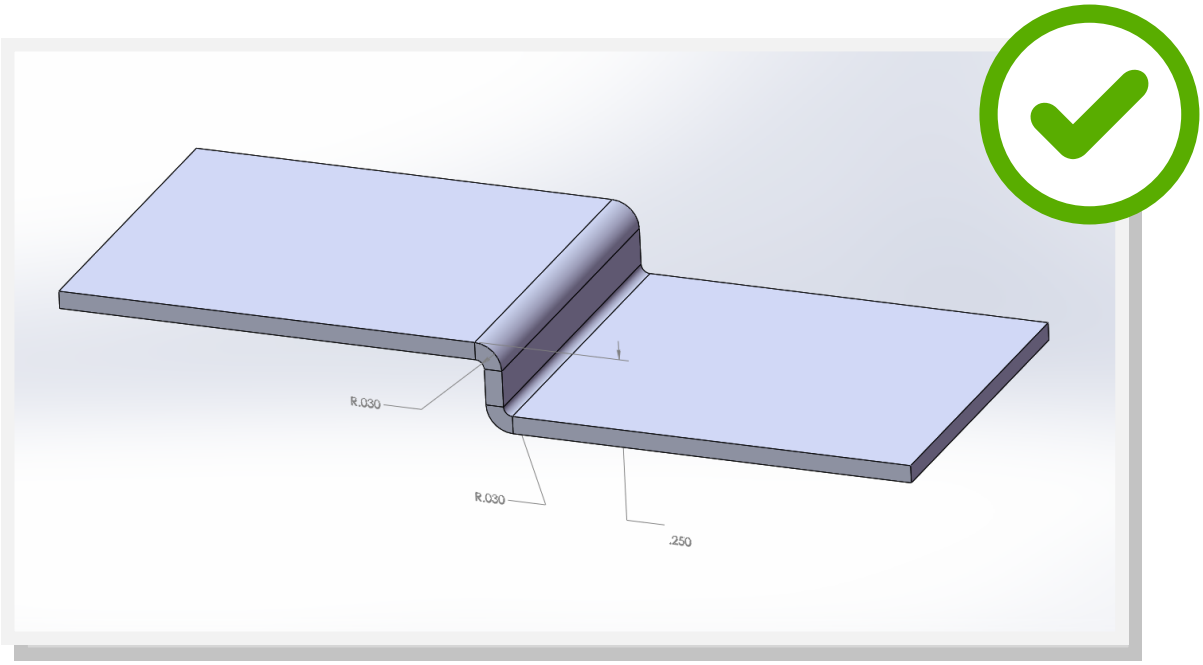


Offsets

An offset is used to create a “Z” shaped profile in a sheet metal part. RAPID’s offset height tolerance is +/- 0.012” top of sheet / top of form. RAPID’s preferred offset is 0.030”. Other standard offsets, which can add costs to your part, include:

- 0.060”
- 0.093”
- 0.125”
- 0.187”
- 0.213”
- 0.250”
- 0.281”
- 0.312”



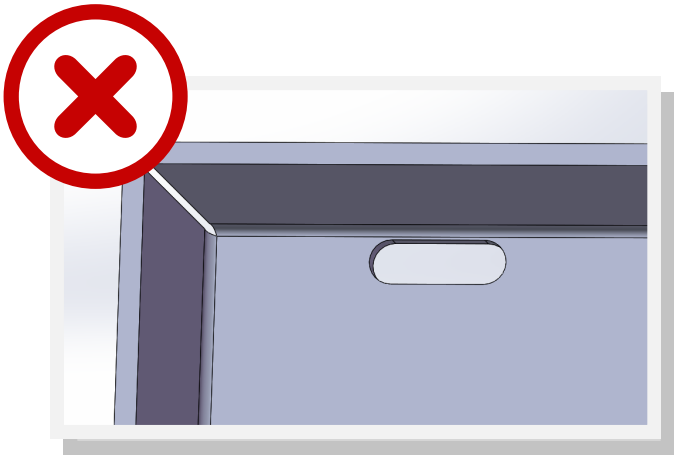


Holes & Slots

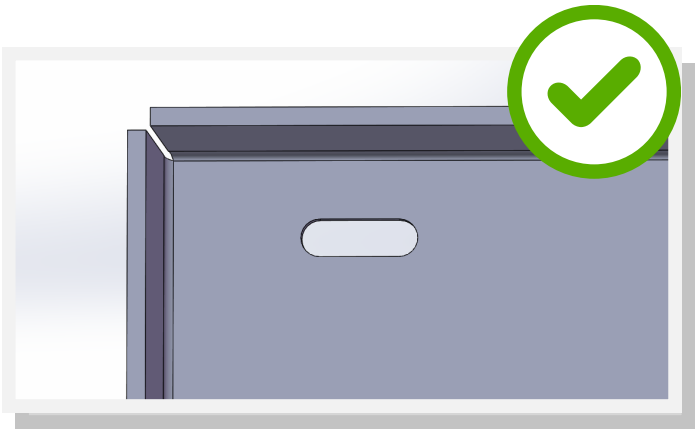
Holes and slots should be a minimum of material thickness in diameter. If a material is 0.036” or thinner the hole should be 0.062” from the material edge. If the material is thicker than 0.036” then the hole should be at least 0.125” from the material edge to avoid distortion. If hardware inserts are required the spacing should be according to manufacturer’s specifications.

Hole Tolerances:

Hole Diameter	+/- 0.005”	Unless otherwise specified
Hardware Hole Diameter	+0.003”/-0.000”	Per manufacturers specifications
Counterbore & Spotfacing 0.063 to 0.250	+0.010”/-0.005”	
Counterbore & Spotfacing 0.251 to 0.500	+0.015”/-0.005”	
Counterbore & Spotfacing >0.500	+0.020”/-0.005”	
Machined Diameter	+/-0.001”	



NOTE: *If using eRAPID, all holes and cut-outs need to be a minimum of 4x the material thickness away from the material edge to avoid additional costs in estimating.*

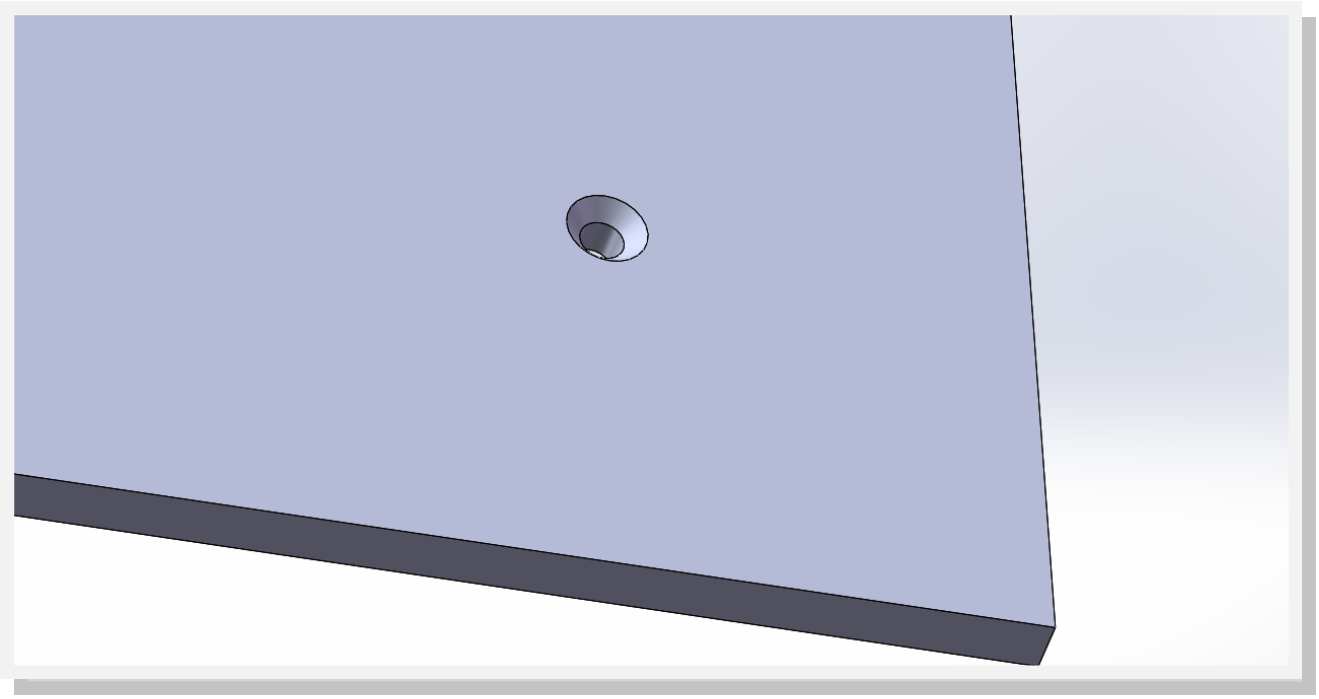


Counter Sinks

Rapid Sheet Metal offers both machined and formed countersinks. Machined counter sinks are created with a drill press while formed counter sinks are created with punch press tooling.

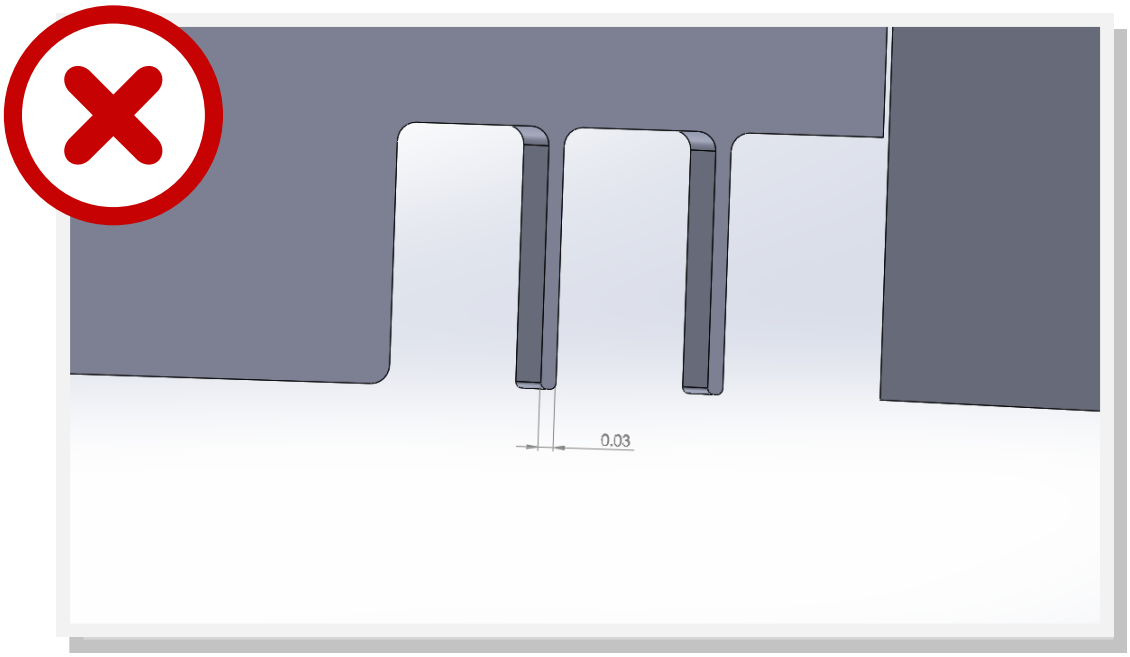
Counter Sink Tolerances:

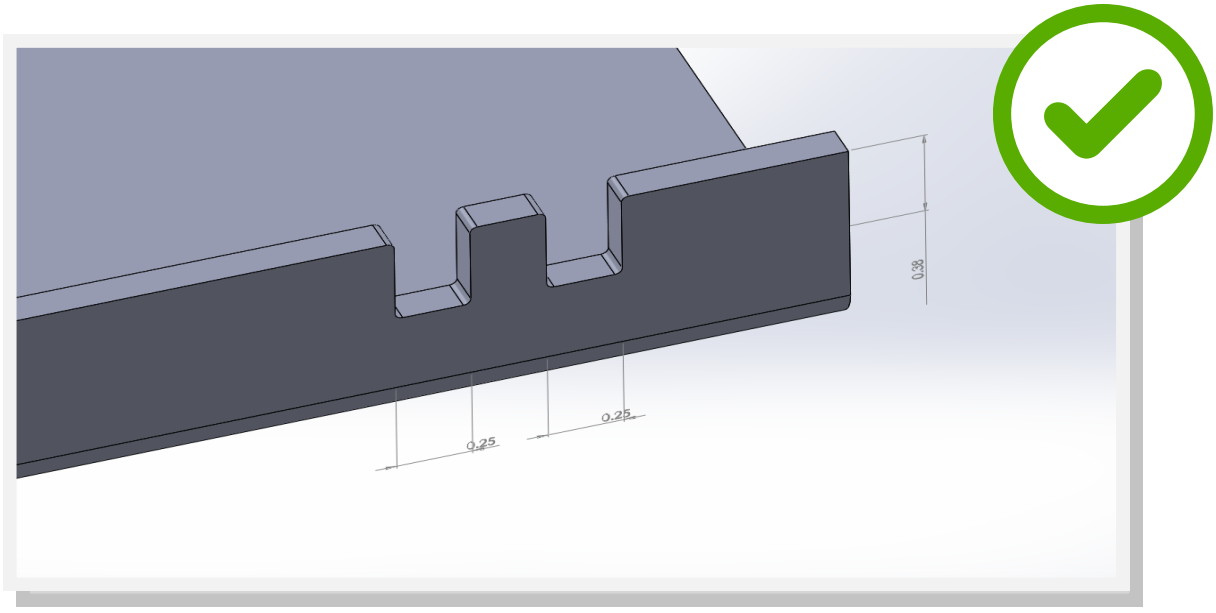
Machined Counter Sink Major Diameter	+/-0.010”	
Machined Counter Sink Minor Diameter	+/-0.010”	2/3 thickness
Formed Counter Sink Major Diameter	+/-0.015”	
Formed Counter Sink Minor Diameter	+/-0.015”	



Notches & Tabs

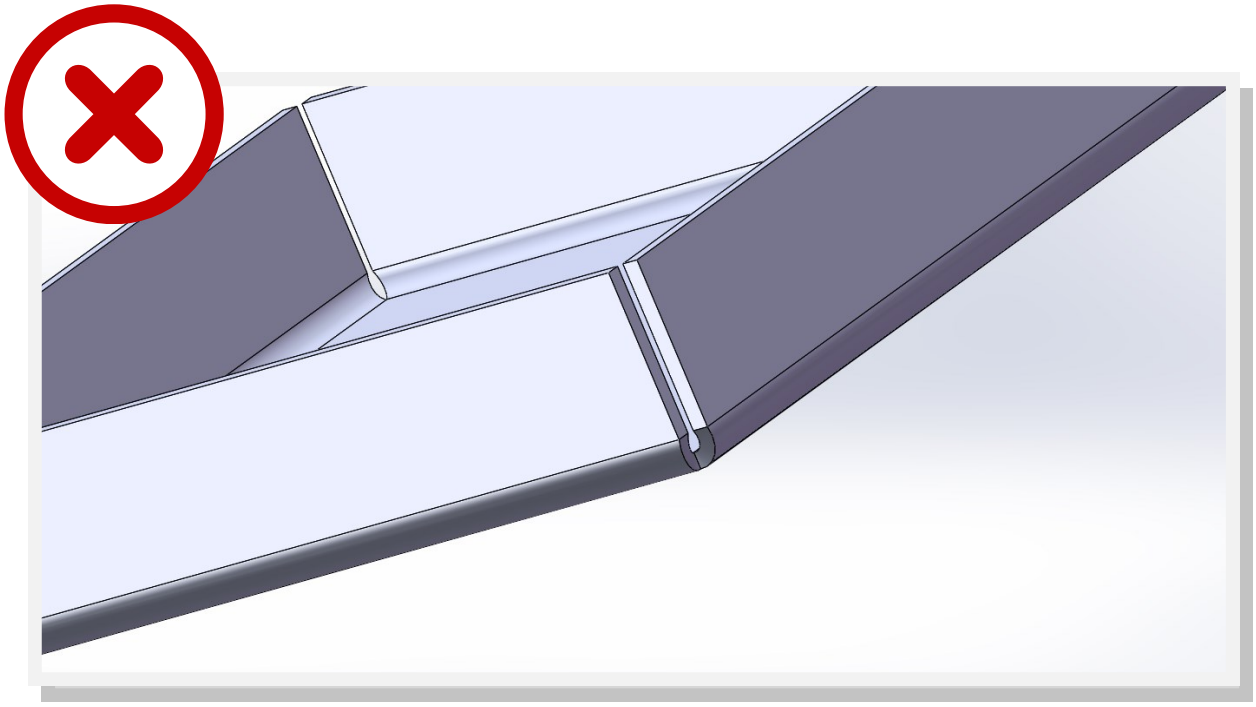
Notches must be at least the material's thickness or 0.04", whichever is greater, and can be no longer than 5 times its width. Tabs must be at least 2 times the material's thickness or 0.126", whichever is greater, and can be no longer than 5 times its width.

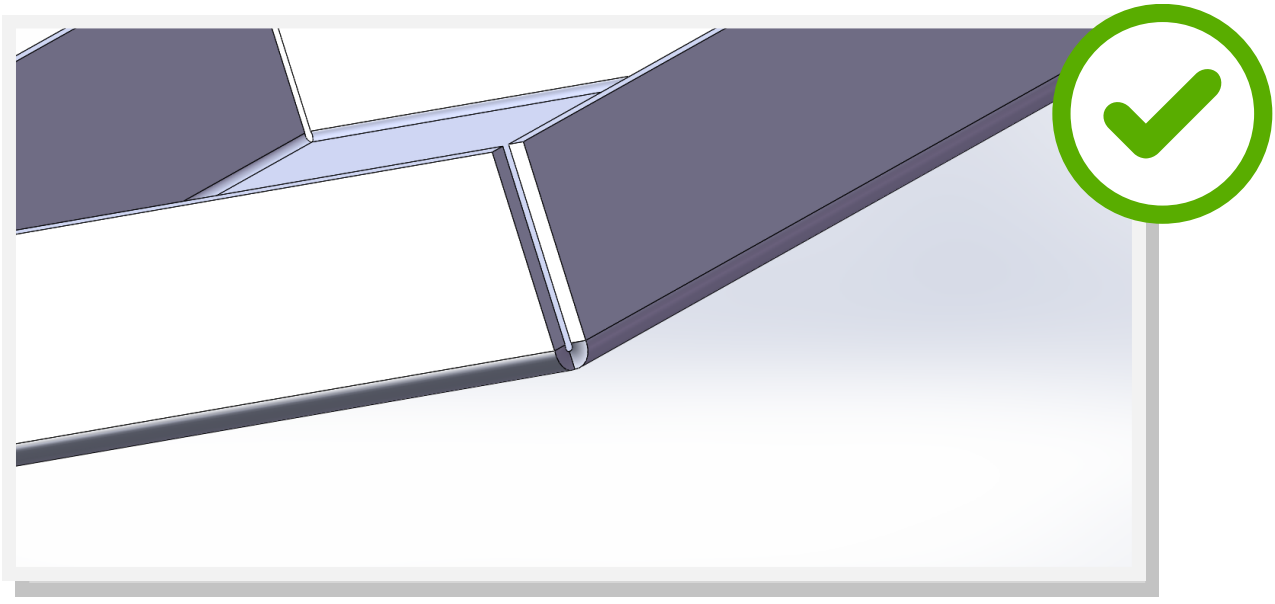




Bend Relief

Bend reliefs are implemented where a bend extends on an edge. The relief notch is added to prevent tearing. Bend reliefs will be no deeper than the material thickness plus the bend radius and no wider than 0.030”.





Welding

When designing a part requiring welding, it is best to not specify the exact method or type of welding unless required for function. This provides the manufacturer increased flexibility when fabricating the sheet metal part which often results in the most economical and fastest lead-time choice for the customer.

The three most common types of welding include Resistance Spot Welding (RSW), Gas Metal Arc Welding (MIG), and Gas Tungsten Arc Welding (TIG).

PEM Hardware

When designing sheet metal parts with PEM Hardware it is important to make sure the hardware is not too close to a bend, edge or other fastener. When designing near a bend or edge, use the Centerline-to-Edge (C/L to Edge) value to find the minimum distance to the outside edge. When calculating the spacing between multiple pieces of hardware, use the C/L to Edge formula plus ½ the diameter of the second mounting hole.

Hardware Plating Specifics

“Before” means hardware is required to be inserted before plating. “After” means hardware is required to be installed after plating.

Material	Hardware	Iridite, Chromate, Alodine	Zinc	Nickel Plate	Black Oxide	Anodize	Tin Plate	Passivate
Aluminum	AC, CLS, CLSS, FHS, SOS, BSOS	Before				After	After	
Aluminum	CLA & FHA	Before		After		Before	After	
Stainless Steel	SP, FH4, SO4, BSO4			Before	Before		Before	Before
CRS	AS, BSO, FH, S, SO, SS		Before	Before			Before	
Galvanneal	AS, BSO, FH, S, SO, SS	**PAINT / POWDER ONLY**						
Galvanized	AS, BSO, FH, S, SO, SS	**PAINT / POWDER ONLY**						

Hardware Lengths

Hardware Type	0.25”	0.312”	0.375”	0.5”	0.625”	0.75”	0.875”	1”	1.25”	1.5”
FH, FHS, FH4, FHL, FHLS, TFH, TFHS, HFH, HFHS	4	5	6	8	10	12	14	16	20	24
	All metric lengths are in millimeters (ex. Dash 10 is 10MM long)									

PEM Hardware

Material Thickness vs. Shank Numbers

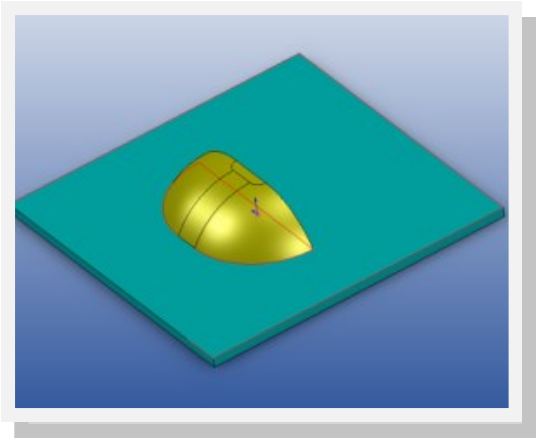
Hardware Type	Thread Code	Min Sheet Thickness	Shank
S, SS, CLS, SP, CLA	AC, CLS, CLSS, F, FHS, SOS, BSOS, CLA	0.03”	0
		0.04”	1
		0.056”	2
	632, 832, 024, 032	0.091”	3
S, SS, CLS, SP, CLA	0420, 0428, 0518	0.056”	1
		0.091”	2
	M6, M8	0.0125”	3
F	256, 440, 632, 832, 032	0.060” – 0.090”	1
	M2.5, M3, M4, M5	0.090” – UP	2
SO, SOS, SO4, BSO, BSOS, BSO4	440, 6440, 632	0.040” IF LESS THAN 0.40” USE TSO TO TSIS (0.025” MINIMUM)	
	M3, M4		
SO, SOS, SO4, BSO, BSOS, BSO4	8362, 832, 032	0.050”	
FH, FHS, FH4, FHA	256, 440, 632, 832, 024, 032, M2.5, M3, M4, M5	0.040”	
		0.062”	
	.0420.	0.93”	
	.0518.		
FEO (Locking), FEOX	440, 632, 832, 0.032. M3, M4, M5	0.039” - 0.045”	AFTER PLATING
FE (Locking), FEX	440, 632, 832, 0.032. M3, M4, M5	0.059” - 0.070”	

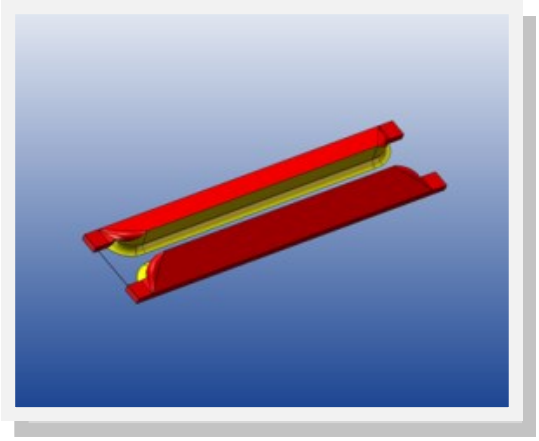
Special Cases

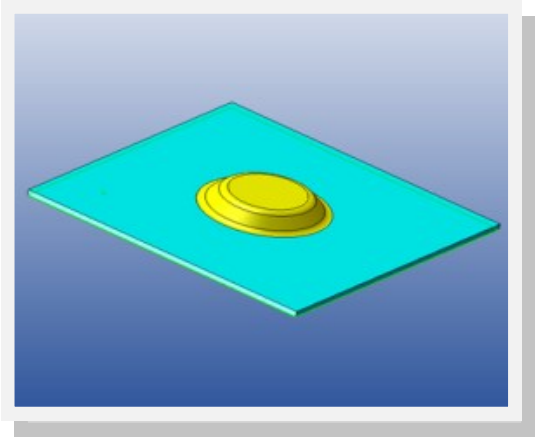
Hardware Type	Special Info	Install In Stainless
PL, PLC	Nylon Threads	NO
TD, RAS, RSS	Steel Only	NO
All Panel Fasteners: PF11, PF12, PFC2	Installed Post Finishing (This includes powder coat)	NO
LK, LKS, LKA	Treated w/ Black Dry Lubricant	NO

Standard Tooling Library

By using standard tooling features you can be assured we have the in-house punch tooling to create the geometry you are modeling. This eliminates the phone calls and e-mails back and forth to match your needs with our in-house tooling, and avoids the time and expense of ordering custom tooling. SOLIDWORKS and PTC Creo™ users can download a model of their specific tooled feature and immediately integrate it into their design.







- Embossments
- Card Guides
- Louvers
- Lances
- Forming Tools

NOTE: *In addition to native file formats, STEP files are also available in either SOLIDWORKS or PTC Creo.*

Plating

Plating	Type	Description	Class
ANODIZE			
MIL-A-8625	Type II	Sulphuric Acid Electrolyte **Standard**	Class I – Non Dyed **Natural or Clear** Class II – Dyed **Specify Color: Black, Blue, Red, etc.**
MIL-A-8625	Type III	Hard Coat **Specialty**	Class I – Non Dyed **Natural or Clear** Class II – Dyed **Specify Color: Black, Blue, Red, etc.**
Chromate			
MIL-DTL-5541	Type I	Contains Hex Chrome **Non RoHS Yellow Unless Specified**	Class IA – Maximum Protection, Thick Coating Class II – Corrosion Protection, Thin Coating
MIL-DTL-5541	Type II	Contains Non-Hex Chrome **RoHS Clear Only**	Class IA – Maximum Protection, Thick Coating Class II – Corrosion Protection, Thin Coating
Zinc			
ASTM-B-633	Type I	Non Chromate Conversion	SC1- Durability Mild SC2 – Durability Moderate SC3 – Durability Severe SC4 – Durability Very Severe
ASTM-B-633	Type II	Colored Chromate Conversion **Black or Yellow, Yellow is RoHS Compliant**	SC1- Durability Mild SC2 – Durability Moderate SC3 – Durability Severe SC4 – Durability Very Severe
ASTM-B-633	Type III	Colorless Chromate Conversion **Please Specify RoHS Compliancy**	SC1- Durability Mild SC2 – Durability Moderate SC3 – Durability Severe SC4 – Durability Very Severe
Tin			
MIL-T-10727	Type I	Electrodeposited	
MIL-T-10727	Type II	Hot-dipped	
Black Oxide			
MIL-C-13924			Class I – Iron & Steel Class II – 400 Series Stainless Steel Class III – Fused Salt Process Class Iv – Stainless Steel MIL-f-495

Powder Coating & Silk Screening

RAPID offers in-house powder coating and silk screening to ensure fast deliveries. RAPID facilities are ITAR registered and we powder coat or silk screen your parts in compliance with government regulations. In addition, we can order any other powder you need but it will extend lead-times. Silk screen colors can be matched to any Pantone number you provide and all inks are in stock.

Resources

eRAPID:
eRAPID is a FREE instant sheet metal part quoting, ordering and design for manufacturing feedback plugin for SOLIDWORKS.
To download the plugin go to www.erapid.com

myRAPID:
myRAPID is the RAPID customer portal. It allows you to quote multiple files at once (instantly quoting sheet metal parts), see past quotes, update contact and shipping information, and order multiple parts.
Visit: rapidmanufacturing.com/myrapid

RapidQuote:
Upload 3D CAD files and our team of engineers will process your request and send a quote out within 24 hours.
Visit: quote.rapidmanufacturing.com/

Powder Coat Library:
To see a list of powders we keep in stock.
Visit: rapidmanufacturing.com/powdercoat

CAD Tooling Library:
To download the CAD Tooling Library.
Visit: rapidmanufacturing.com/3d

Sheet Metal Design for Manufacturing – LinkedIn Group:

This group is designed for engineers who design sheet metal parts. It provides them with an on-line forum to collaborate and discuss techniques to better design sheet metal parts for manufacturability.
Join: https://www.linkedin.com/groups/8531417