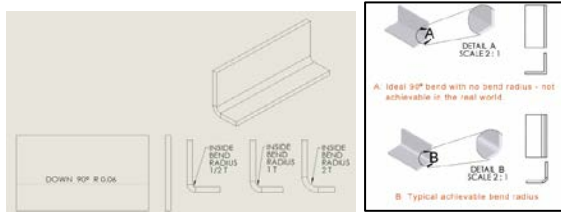


Bend Radii & Minimum Bend Sizes

Bend radii and minimum bends are limited to certain values or ranges, which are determined by the equipment and tooling combinations available to the manufacturer. When designing sheet metal parts and enclosures, it is helpful to use these values as the basis for your design.



It is most economical to use a single bend radius throughout the design, but if necessary, you can utilize multiple radii.

Use this document to choose values that are both manufacturable and meet your needs. If you need help choosing a value, contact us at info@protocase.com or 1-866-849-3911 and we can help. Alternatively, you can design with any value, and we can adjust it for you later in the process.

The tables below show bend radii and minimum bend sizes for materials and tooling combinations stocked by Protocase. We go beyond the general rules of sheet metal bending, as our customers want tight bend radii for sheet metal parts. It is possible to choose other bends if you require, but additional lead time and tooling charges may apply.

To use the tables below:

1. Refer to table(s) for your choice of material.
2. Refer to the first column to choose your material thickness.
3. Consider what minimum bend size you require (Only consider lines that meet your minimum bend requirement).
4. You may choose any bend radius on this line(s).
5. If you have multiple options, optimize your choice.

Optimizing your Choice

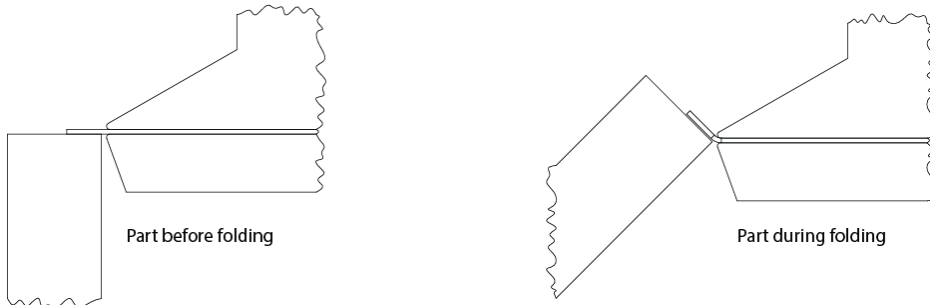
If you have multiple options that will achieved your design goals, we recommend optimizing your choice:

- a) If possible, choose a value that can be achieved on both folder and press brake. In doing so, Protocase Engineering and Design Services will opt to use folding due to the equipment's ability to produce superior dimensional tolerances. If the geometry of the part precludes use of folder, then we can seamlessly move to press brake.
- b) If choosing radii/ bends that are bent with the press brake, you should choose values in blue, as they allow use of a wider variety of tooling.

It is not critical that you meet these criteria as we can produce anything in the tables. However, should you be able to meet them, it will give us more flexibility when manufacturing your job.

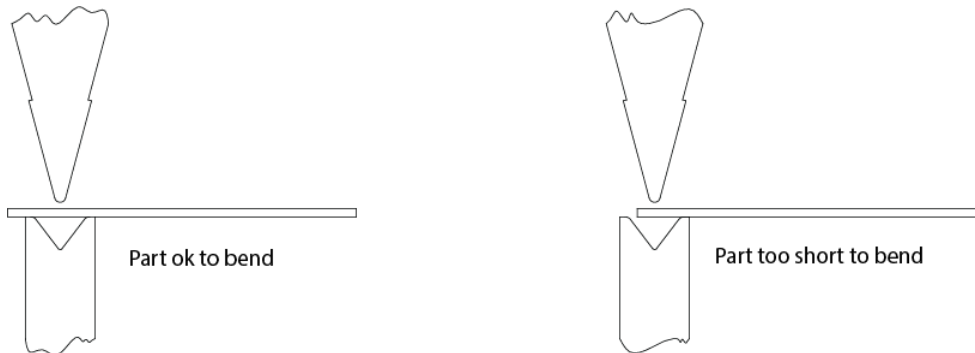
Folder

Folding is the most accurate way for Protocase to bend parts. If you can stick with folder radii, it will get your parts through our manufacturing process faster with the most precise dimensions.



Press Brake

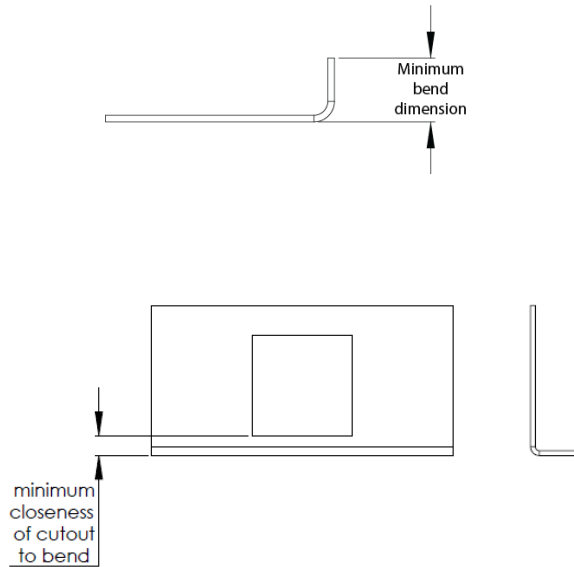
However, if folder radii do not work for you, we can manufacture parts using our press brakes. In fact, press brakes are more flexible and can bend certain parts that the folder just cannot do.



Minimum Bend Dimension

Geometry of tooling imposes a minimum bend dimension. The diagram shows one such mechanism. Refer to the chart for values for folder as well as various press brake tooling combinations.

Tip: Use the minimum bend dimension values in the charts below for your minimum closeness of cutout to a bend.



MATERIAL, BEND RADII AND MINIMUM BEND SIZE CHARTS

Folder

	Minimum Bend Includes Minimum Closeness of Cutout to Bend	Radius
Cold Rolled Steel – 14 gauge (0.075" 1.91mm)	0.415"	0.07"
Cold Rolled Steel – 16 gauge (0.060" 1.52 mm)	0.33"	0.05"
Cold Rolled Steel – 18 gauge (0.048" 1.22 mm)	0.265"	0.05"
Cold Rolled Steel – 20 gauge (0.036" 0.91 mm)	0.18"	0.04"
Galvanneal – 16 gauge (0.064" 1.61 mm)	0.288"	0.05"
Galvanneal – 18 gauge (0.052" 1.32 mm)	0.26"	0.05"
Galvanneal – 20 gauge (0.040" 1.01 mm)	0.2"	0.05"
304 Stainless Steel – 14 gauge (0.078" 1.98 mm)	0.351"	0.078"
304 Stainless Steel – 16 gauge (0.063" 1.59 mm)	0.285"	0.05"
304 Stainless Steel – 18 gauge (0.050" 1.27 mm)	0.25"	0.045"
304 Stainless Steel – 20 gauge (0.037" 0.94 mm)	0.23"	0.04"
Aluminum 5052-H32 – (0.040" 1.02 mm)	0.18"	0.04"
Aluminum 5052-H32 – (0.051" 1.30 mm)	0.255"	0.04"
Aluminum 5052-H32 – (0.064" 1.63 mm)	0.32"	0.04"

Press Brake

Cold Rolled Steel - (CRS A1008 CS TP B) (4ftx8ft sheets)

Gauge	Minimum Bend Includes Minimum Closeness of Cutout to Bend	Radius
11 gauge (0.120" 3.05 mm)	.5"	.045", .06", .085", .115"
	1.375"	.375"
12 gauge (0.105" 2.67 mm)	.5"	.065", .085"
13 gauge (0.090" 2.29 mm)	.375"	.04", .045", .055"
	.5"	.06", .065", .075", .08"
	1.375"	.375"
14 gauge (0.075" 1.91 mm)	.275"	.04", .045", .055", .07"
	.5"	.125"
16 gauge (0.060" 1.52 mm)	.2"	.03", .04", .045"
	.265"	.05", .055", .062"
	.375"	.075"
	.5"	.125"
18 gauge (0.048" 1.22 mm)	.2"	.03", .04", .045"
	.265"	.04", .05", .062", .065"
	.375"	.090", .125"
	.5"	.105", .12"
	1.375"	.375"
20 gauge (0.036" 0.91 mm)	.2"	.035", .04", .05"
	.265"	.055", .065"
	.375"	.07"
	1.375"	.375"
22 gauge (0.030" 0.76 mm)	.2"	.04", .05"
	.265"	.055", .065"
24 gauge (0.024" 0.61 mm)	.2"	.04", .045"
	.265"	.05"

Aluminum - (5052-H32) (4ftx8ft sheets)

Gauge	Minimum Bend Includes Minimum Closeness of Cutout to Bend	Radius
0.250" 6.35mm)	1.375"	.375"
0.188" 4.78mm)	1.375"	.375"
8 gauge (0.1285" 3.26mm)	.5"	.04", .05", .125"
	1.375"	.225", .375"
10 gauge (0.102" 2.59mm)	.375"	.062"
	.5"	.04", .045", .07", .125"
11 gauge (0.091" 2.31mm)	.375"	.04", .045", .05", .062"
	.5"	.05, .125"
	1.375"	.375"
12 gauge (0.081" 2.06mm)	.275"	.04", .062"
	.5"	.04", .045", .05"
	1.375"	.375"
14 gauge (0.064" 1.63mm)	.2"	.035", .04", .045"
	.265"	.035", .04", .062"
	.375"	.04", .06"
	.5"	.04", .05", .125"
	1.375"	.4"
16 gauge (0.051" 1.30mm)	.2"	.035", .04", .045"
	.265"	.035", .04", .05", .062"
	.5"	.04", .05", .125"
18 gauge (0.040" 1.02mm)	.2"	.035", .04"
	.265"	.04", .05", .062", .07"
	.375"	.045"
	.5"	.04", .06", .125"
	1.375"	.45"
20 gauge (0.032" 0.81mm)	.2"	.035", .04"
	.265"	.04", .045", .05", .062", .07"
	.375"	.055"
	.5"	.04", .06"
	1.375"	.4"

Stainless - (A240 TP304 2B) (4ftx8ft sheets)

Gauge	Minimum Bend	
	Includes Minimum Closeness of Cutout to Bend	Radius
11 gauge (0.125" 3.18mm)	.5"	.045", .07", .08", .09", .1", .125"
14 gauge (0.078" 1.98mm)	.275"	.05", .055", .062", .07", .075"
	.375"	.07", .105"
	.5"	.09", .11", .115", .12"
16 gauge (0.062" 1.57mm)	1.375"	.4"
	.2"	.035", .05"
	.265"	.05", .055", .075", .08"
18 gauge (0.050" 1.27mm)	.375"	.07"
	.5"	.105", .12"
	.2"	.04", .045", .05"
20 gauge (0.037" 0.94mm)	.265"	.06", .07", .08", .085"
	.375"	.1", .125"
	.5"	.115", .12"
22 gauge (0.031" 0.79mm)	.2"	.05"
	.265"	.06", .07"
	.375"	.095"
24 gauge (0.025" 0.64mm)	.2"	.05"
	.265"	.04", .08"
26 gauge (0.019" 0.48mm)	.2"	.04"
	.265"	.08"
	.2"	.04", .05"
	.5"	.14"
	1.375"	.21"

Galvanneal - (A653 CS TP B A01) (4ftx8ft sheets)

Gauge	Minimum Bend Includes Minimum Closeness of Cutout to Bend	Radius
14 gauge (0.078" 1.98mm)	.275"	.04", .055", .06", .062", .08"
	.5"	.08", .09"
	.2"	.035", .04", .05"
16 gauge (0.064" 1.61mm)	.265"	.05", .055", .062"
	.5"	.10", .08", .125"
	.2"	.04", .05"
18 gauge (0.052" 1.32mm)	.265"	.04", .05", .055", .062", .07"
	.5"	.125"
	1.375"	.375"
20 gauge (0.040" 1.02mm)	.2"	.04", .05"
	.265"	.04", .055", .062", .07"
	.5"	.08", .09"
22 gauge (0.034" 0.86mm)	.2"	.04", .06"
	.265"	.055", .065"
	.5"	.08", .095"
24 gauge (0.028" 0.71mm)	.2"	.04", .05"
	.265"	.05", .062"
	.5"	.08"

Copper Stocked in 36" x 96" (914.40mm x 2,438.40mm) sheets

Gauge	Minimum Bend Includes Minimum Closeness of Cutout to Bend	Radius
0.064" 1.63mm	.2"	.035"
	.265"	.04", .045", .055"
	.5"	.125"
	1.375"	.375"
0.093" 2.36mm	.375"	.04"
	.5"	.05", .115"
0.125" 3.18mm	.5"	.06", .08", .125"
	1.375"	.375"
0.250" 6.35mm	1.375"	.375"