Sheet Metal Hole Size & Minimum Feature Chart

Conservative first-pass dimensions for laser-cut holes, punched holes, slots, edge ligaments, bend clearances, tabs, and notches — separating broadly portable DFM rules from process- and tooling-specific limits.

Important: The values below are early DFM starting points, not guaranteed ShincoFab process limits. Final manufacturability depends on material grade and temper, actual thickness, laser or punch system, tooling style, feature geometry, tolerance, burr direction, bend sequence, finish, inspection method, and production quantity.

Sheet Metal Hole Size & Minimum Feature Quick Chart

Use actual material thickness—not a nominal gauge number—as **T**. Where a distance is described as **clear**, measure from the nearest cut edge of one feature to the nearest edge of the next feature, not from centerline to centerline.

FEATURE OR CHECK	EARLY DFM STARTING POINT	MEASUREMENT BASIS	PRACTICAL NOTE
Laser-cut round hole	D ≥ T	Finished nominal diameter	Conservative cross-supplier rule; a validated fiber-laser process may go below T
Laser-cut slot	S ≥ T	Minimum clear slot width	Narrow slots are sensitive to pierce size, heat input, lead-in location, dross, and distortion
Punched hole, aluminum, non-guided tool	D ≥ 0.75T	Punch diameter or narrowest tool width	Match published ratio; confirm tool availability, guidance, stripping, and maintenance
Punched hole, mild steel, non-guided tool	D ≥ 1.0T	Punch diameter or narrowest tool width	Good general punching screen for maintained standard tooling
Punched hole, stainless steel, non-guided tool	D ≥ 2.0T	Punch diameter or narrowest tool width	Higher load and punch-breakage risk require a larger ratio
Punched hole, aluminum, fully guided tool	Published guidance can reach D ≥ 0.5T	Tool-specific	Requires a compatible fully guided tooling family and process review
Punched hole, mild steel, fully guided tool	Published guidance can reach D ≥ 0.75T	Tool-specific	Do not assume the ratio applies to ordinary non-guided tooling
Punched hole, stainless steel, fully guided tool	Published guidance can reach D ≥ 1.0T	Tool-specific	Confirm material strength, die clearance, press alignment, and tool life

FEATURE OR CHECK	EARLY DFM STARTING POINT	MEASUREMENT BASIS	PRACTICAL NOTE
Punched hole to free edge	Clear ligament $E \geq 2T$	Hole edge to sheet edge	Reduces edge bulging, breakout, tearing, and distortion
Between punched holes	Clear web $W \geq 2T$	Hole edge to hole edge	Protects the narrow web and reduces interaction between hits
Round hole to bend	$H \geq R + 2.5T$	Hole edge to bend tangent line	This chart uses an edge-to-tangent convention; confirm the supplier's bend-line convention
Slot to bend	$B_s \geq R + 4T$	Slot edge to bend tangent line	This chart uses an edge-to-tangent convention; slots interact with a larger deformation zone
Notch width	One general DFM starting point: $N \geq 1.5T$	Narrowest clear notch width	Supplier guides vary; confirm the cutting process, deburring method, and feature function
Notch length	Width-based slenderness check: $L_n \leq 5N$	Length relative to notch width	Some guides use thickness-based limits instead; state and confirm the selected convention
Tab width	$B_t \geq \max(2T, 3.2\ \text{mm})$	Narrowest tab width	General DFM reference; confirm if the tab is structural, welded, or repeatedly handled
Tab length	$L_t \leq 5B_t$	Length relative to tab width	Long slender tabs can twist, bow, or overheat
Inside notch corner radius	Start at $r \geq 0.5T$	Internal cut radius	A radius reduces stress concentration and avoids an artificially sharp laser corner
Self-clinching hardware hole	Use the exact manufacturer series value	Finished mounting-hole diameter and tolerance	Thread size alone does not define the correct clinching hole
Drilled or reamed precision hole	No universal D:T ratio	Finished diameter, tolerance, position, and surface requirement	Use machining when fit, true position, cylindricity, or surface quality controls the design

Where the Variables Mean

SYMBOL	DEFINITION
T	Actual material thickness
D	Nominal round-hole diameter
S	Minimum slot width
E	Clear ligament from a hole edge to a free sheet edge

SYMBOL	DEFINITION
W	Clear web between adjacent hole edges
R	Specified inside bend radius
H	Clear distance from a round-hole edge to the bend tangent line
B_s	Clear distance from a slot edge to the bend tangent line
N	Notch width
B_t	Tab width

These dimensions solve different problems. The hole-size ratio protects the cutting or punching process; the edge and web rules preserve surrounding material; the bend-distance rules keep features outside the forming deformation zone.

Converting Clear Distances to Drawing Dimensions

If a drawing dimensions a hole from its center, convert the clear-ligament rules explicitly.

SYMBOL	FORMULA	MEANING
C_e	$C_e \geq (D / 2) + 2T$	Hole center to free edge
P	$P \geq (D_1 / 2) + (D_2 / 2) + 2T$	Center-to-center pitch between two holes
C_b	$C_b \geq (D / 2) + R + 2.5T$	Hole center to bend tangent line

Worked example: For two equal 4.0 mm holes in 2.0 mm sheet: center to free edge $C_e \geq 2.0 + 4.0 = 6.0$ mm (0.236 in); hole pitch $P \geq 2.0 + 2.0 + 4.0 = 8.0$ mm (0.315 in); with an inside bend radius of 2.0 mm, center to bend tangent $C_b \geq 2.0 + 2.0 + 5.0 = 9.0$ mm (0.354 in). State the measurement origin on the drawing—a note such as “6 mm from edge” is ambiguous unless it is clear whether the dimension controls the hole center or the remaining ligament.

Minimum Punched Hole Size by Material and Thickness

Non-guided punch starting diameters calculated from Mate's published ratios. Aluminum values are rounded upward to the next 0.1 mm. Metric values control; inch equivalents are rounded to the nearest 0.001 in for reference and should not be used to infer a tighter manufacturing tolerance. These are calculations, not a catalog of available punch sizes.

SHEET THICKNESS T	ALUMINUM AT 0.75T	MILD STEEL AT 1.0T	STAINLESS STEEL AT 2.0T
0.8 mm (0.031 in)	0.6 mm (0.024 in)	0.8 mm (0.031 in)	1.6 mm (0.063 in)
1.0 mm (0.039 in)	0.8 mm (0.031 in)	1.0 mm (0.039 in)	2.0 mm (0.079 in)
1.2 mm (0.047 in)	0.9 mm (0.035 in)	1.2 mm (0.047 in)	2.4 mm (0.094 in)
1.5 mm (0.059 in)	1.2 mm (0.047 in)	1.5 mm (0.059 in)	3.0 mm (0.118 in)
2.0 mm (0.079 in)	1.5 mm (0.059 in)	2.0 mm (0.079 in)	4.0 mm (0.157 in)

SHEET THICKNESS T	ALUMINUM AT 0.75T	MILD STEEL AT 1.0T	STAINLESS STEEL AT 2.0T
3.0 mm (0.118 in)	2.3 mm (0.091 in)	3.0 mm (0.118 in)	6.0 mm (0.236 in)
4.0 mm (0.157 in)	3.0 mm (0.118 in)	4.0 mm (0.157 in)	8.0 mm (0.315 in)
6.0 mm (0.236 in)	4.5 mm (0.177 in)	6.0 mm (0.236 in)	12.0 mm (0.472 in)

> The ratios describe punch strength and tooling risk, not finished-hole quality. A punched wall normally includes rollover, burnish, fracture, and an exit burr. If the hole receives a dowel, bearing, precision pin, or close-fit fastener, punching may create a pilot that is machined to final size.

Minimum Laser-Cut Hole and Slot Size

For a broadly portable design, use a laser-cut hole diameter and slot width at least equal to material thickness. The rule provides a practical starting point without assuming a specific laser source, power, nozzle, assist gas, focus position, piercing strategy, or proprietary small-contour cycle, and leaves room for a supplier to change machines without invalidating every small feature.

FEATURE	STARTING POINT
Round hole	D ≥ T
Slot width	S ≥ T

> The rule is deliberately conservative. The Fabricator describes D ≥ T as the generally accepted laser-hole guideline, while also reporting that controlled fiber-laser processes can cut holes down to roughly one-quarter of material thickness in some conditions. That aggressive result is equipment- and quality-specific, not a universal replacement for D ≥ T.

Why Supplier Laser Charts Can Be Smaller Than T

Selected values from one production system's minimum-hole tables, using the nitrogen column for steel. These values demonstrate what one validated production system accepts; they do not define ShincoFab capability or a general industry limit.

SHEET THICKNESS	STEEL MIN. HOLE	STAINLESS MIN. HOLE	ALUMINUM MIN. HOLE
1.0 mm	0.5 mm	0.5 mm	0.5 mm
2.0 mm	1.0 mm	1.0 mm	1.5 mm
4.0 mm	2.0 mm	2.0 mm	2.5 mm
6.0 mm	4.0 mm	3.0 mm	4.0 mm

> As holes and slots become smaller, the pierce occupies a larger share of the contour and heat has less room to dissipate. Common effects include: entrance spatter or a pierce witness; top-to-bottom diameter taper; lead-in flatness or reduced roundness; dross and directional burr; local discoloration or recast; melted or distorted narrow webs; and greater sensitivity to nesting, sheet flatness, and parameter changes.

Hole, Slot, Edge, and Bend Clearance Rules

The material surrounding a hole often controls manufacturability more than the diameter itself.

RULE	MINIMUM CLEAR	MEASUREMENT BASIS	NOTE
Hole to free edge	$E \geq 2T$	Hole edge to sheet edge	The remaining strip can discolor, warp, melt back, vibrate, or be damaged during deburring and handling. If a narrow bridge is required, state its minimum finished width and whether bow, discoloration, or edge rounding is acceptable.
Between holes	$W \geq 2T$	Hole edge to hole edge	Convert to center-to-center pitch using the actual diameters. Large patterns also need review for sheet stiffness, distortion, press sequence, heat accumulation, and percentage of open area.
Round hole to bend	$H \geq R + 2.5T$	Hole edge to bend tangent line	Interpret as a clear distance from the feature edge to the tangent line. The final requirement changes with bend angle, V-die opening, grain direction, relief geometry, material strength, and whether the hole is cut before or machined after bending.
Slot to bend	$B_s \geq R + 4T$	Slot edge to bend tangent line	Slots interact with a larger deformation zone. Show the measurement origin explicitly and confirm it against the fabricator's flat-pattern and tooling method before releasing the drawing.

> When a critical hole cannot move outside the bend zone, consider drilling or reaming after forming, using a relief, changing the bend sequence, increasing the radius, or changing the part architecture.

Minimum Slots, Notches, Tabs, and Narrow Features

Round holes are not the only features that become fragile as their width approaches material thickness.

FEATURE	EARLY DFM REFERENCE	MAIN FAILURE MODE
Laser-cut slot width	$S \geq T$	Pierce consumes the slot, walls taper, or the slot closes with dross
Notch width	One general guide recommends $N \geq 1.5T$	Narrow notch distorts, overheats, or becomes difficult to deburr
Notch length	Use $L_n \leq 5N$ as a width-based slenderness check	Long narrow notch twists or produces a weak tongue
Tab width	$B_t \geq \max(2T, 3.2\text{ mm})$	Tab bends, bows, overheats, or breaks during handling
Tab length	$L_t \leq 5B_t$	Slender tab loses positional stability
Inside notch radius	$r \geq 0.5T$	Sharp internal corner concentrates stress and cannot remain perfectly sharp after laser cutting

These ratios are general DFM references rather than controlling standards. This chart adopts 1.5T for notch width and five times the notch width for length only as an early screening method. Confirm the final convention with the fabricator, and increase the dimensions for high-strength material, heavy deburring, structural tabs, welded attachments, cosmetic surfaces, or features exposed to repeated loading.

Hardware, Threads, Countersinks, and Precision Holes

Some features should not be designed from a generic thickness ratio.

FEATURE	GUIDANCE	KEY REQUIREMENT
Self-clinching hardware	Use the exact mounting-hole diameter and tolerance from the chosen manufacturer series; a nut and a stud with the same thread can require different mounting holes. Thread size alone does not define the correct clinching hole.	Manufacturer, product family, thread, panel material, hardness, and thickness
Tapped holes	Specify the thread standard, class, pitch, pilot diameter, minimum engagement, panel condition, and whether the thread is cut, formed, extruded, or installed as hardware. Thin sheet may not provide adequate direct engagement even when the pilot hole can be cut.	Thread standard, pilot diameter, and minimum engagement
Countersinks	Check screw standard, head angle and diameter, remaining material at the bottom of the countersink, distortion risk, and whether machining is required. Do not infer a universal countersink depth from the minimum laser-hole rule.	Remaining material under the countersink
Dowel, bearing, and locating holes	Laser cutting and punching can create useful pilots, but they do not automatically provide the cylindrical wall, close size, surface finish, and true position required for a precision fit. Drill, bore, interpolate, or ream when the functional tolerance demands it.	Fit, true position, cylindricity, and surface finish

Design Checks Before Releasing a Drawing

ITEM	WHAT TO SPECIFY OR CONFIRM	WHY IT MATTERS
Material	Grade/alloy, temper or condition, and applicable standard	Strength and ductility affect punching load, burr, forming, and crack risk
Thickness	Actual millimeter or decimal-inch thickness	Every ratio in the chart depends on T; gauge alone is material-specific
Process intent	Laser, punch, drill, ream, or supplier-selected	Prevents a precision requirement from being assigned to an unsuitable primary process
Feature function	Clearance, ventilation, locating, bearing, thread pilot, or cosmetic	Functional features need different tolerance and inspection controls
Diameter or width	Nominal value plus unilateral/bilateral tolerance where needed	Separates CAD geometry from acceptance criteria

ITEM	WHAT TO SPECIFY OR CONFIRM	WHY IT MATTERS
Position	Datums and true position for mating patterns	Hole-size capability does not define location capability
Edge and web spacing	Clear distance and measurement convention	Prevents breakout, distortion, and ambiguous centerline interpretation
Bend relationship	Hole/slot edge, tangent line, inside radius, angle, and bend sequence	Prevents ovalization and feature movement during forming
Burr direction	Functional or cosmetic face	Punching, drilling, and cutting can leave directional burrs
Finish condition	Before or after deburring, forming, plating, anodizing, or powder coating	Secondary operations can change size, fit, and inspection results
Inspection method	Pin gauge, optical measurement, bore gauge, or CMM as appropriate	The method must reflect the functional requirement and tolerance
Quantity	Prototype, batch, or repeat production	Determines whether dedicated punching or secondary machining is economical

Common Minimum-Feature Problems

SYMPTOM	LIKELY CAUSE	DESIGN OR PROCESS RESPONSE
Laser hole is tapered or not round	Hole is too small for the validated pierce/cut cycle	Increase diameter, approve a machine-specific limit, or machine the final bore
Narrow slot closes or fills with dross	Slot width and lead-in are too small	Increase width, move the pierce, change parameters, or machine the slot
Punch breaks or deflects	Punch-to-thickness ratio is too aggressive	Increase the feature, use fully guided tooling, or change process
High burr or galling	Tool wear, clearance, lubrication, or material adhesion	Review die clearance, tool condition, coating, and burr direction
Hole breaks out at the edge	Clear ligament is too small	Move the hole, enlarge the surrounding flange, or change the attachment method
Web between holes deforms	Adjacent features interact or the pattern removes too much material	Increase clear web, stagger hits, or review perforation sequence
Hole becomes oval after bending	Feature lies inside the bend deformation zone	Move the feature, add relief, or machine it after forming
Fastener will not fit after finishing	Coating, burr, taper, or inspection condition was not defined	Add masking/allowance, deburr, or machine after finish where required
Self-clinching hardware spins or pushes out	Wrong hole family, diameter, tolerance, panel hardness, or edge distance	Use manufacturer data and review installation sequence and tool access

SYMPTOM	LIKELY CAUSE	DESIGN OR PROCESS RESPONSE
Precision pin binds despite nominal diameter	Size alone was controlled; position, cylindricity, taper, or burr was not	Add GD&T and use an appropriate secondary machining/inspection process

What to Do When a Feature Is Below the Recommended Minimum

OPTION	WHEN IT HELPS	TRADE-OFF
Increase the hole, slot, web, tab, or notch	Function permits more material or a larger opening	May affect fit, airflow, shielding, sealing, or appearance
Use a supplier-approved fiber-laser limit	Small-batch geometry can be validated on a specific laser	Reduces sourcing flexibility and may need first-article approval
Use fully guided punch tooling	Repeat volume justifies dedicated small-feature tooling	Adds tool cost, maintenance, and press-compatibility constraints
Cut an undersized pilot, then drill	A clean wall or smaller diameter is needed	Adds workholding, cycle time, and burr control
Ream or bore the final hole	Close fit, finish, or cylindrical geometry is critical	Requires machining access and does not automatically correct a poor pilot location
Machine the hole after bending	Forming would distort a critical feature	Adds a formed-part fixture and may restrict tool access
Move the feature or add relief	Edge or bend clearance is the limiting condition	Changes local geometry and may affect assembly space
Replace direct thread with inserted hardware	Sheet is too thin for adequate engagement	Requires a manufacturer-specific mounting hole and installation clearance
Split the geometry into separate parts	A tab, slot, or formed feature cannot be produced reliably	Adds joining, tolerance stack, labor, and possible distortion

Reference values are early DFM starting points, not guaranteed ShincoFab process limits. Verify material grade and temper, actual thickness, cutting or punching process, tooling, and clearances before releasing a drawing.