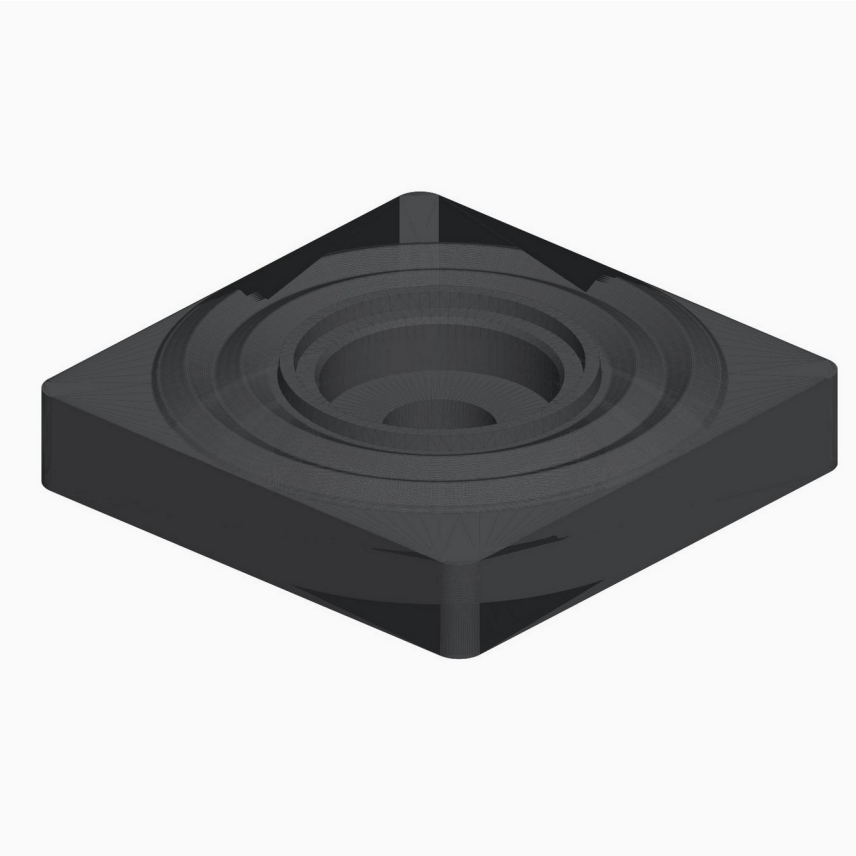
# LAS RotaryLock™ V6 R1

## Engineering & Mathematical Basis

*Rotary Interlock • 25 × 25 mm × 1/4 in validated baseline • Technical Record v1.0*



**VERIFICATION STATUS: PASS**

Original R1 CAD re-export and stored original STL are geometrically identical at six-decimal vertex precision. The 25 × 25 mm × 1/4 in prototype was accepted in hands-on testing for lateral resistance, controlled rotation, stacking, and recessed screw-head accommodation.

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*This record documents geometry and prototype observations. It is not a structural load certification or building-code approval.*

# 1. Executive Summary

V6 R1 is a controlled-rotation rotary interlock. Its circular mating field and annular centering system are designed to resist X/Y translation and rocking while deliberately avoiding a preferred angular index about the vertical axis. Rotation is geometrically permitted; real material friction under compressive preload still produces torque.

Unlike V5, which used a radial height field alone, V6 R1 combines a steeper two-period radial engagement field with a circular collar/groove register, recessed fastener geometry, and outer relief. The R1 implementation was independently re-exported from its original OpenSCAD master and found to reproduce the stored original STL exactly at the tested geometry precision.

The validated commercial baseline is the original 25 × 25 mm × 1/4 in R1 part. The current R1 should not be mechanically scaled into 1/8 in, 1 in, 4 × 4 in, or 6 × 6 in variants without dedicated CAD, because the counterbore depth, underside groove, active annulus, relief, and rotation envelope are coupled.

# 2. Authoritative Source Record

| Parameter | Verified value |
|---|---|
| CAD master | LAS_PAD_V6_R1_Rotary_Interlock.scad |
| CAD SHA-256 | 4c66f8625bfe61a24de26959f36576b1b06203644ab81a1784647620b2966eb9 |
| Original STL | LAS_PAD_V6_R1_Rotary_Interlock.stl |
| STL SHA-256 | 6d0fc7671d433f34f1f1499bd41d2062d32b994f9f7f166fc41ec4f641e7daf0 |
| Validated footprint | 25.00 × 25.00 mm |
| Validated stack increment | 6.35 mm (1/4 in) |

# 3. Exact Radial Mathematics

Let $r = \sqrt{(x^2+y^2)}$ and $S = 1 + 1/9 + 1/25$. Define the normalized rounded-triangle harmonic:

$$\mathbf{q(\varphi) = [\cos\varphi + \cos(3\varphi)/9 + \cos(5\varphi)/25] / S}$$

For $D = 0.75$ mm, $\lambda = 2.40$ mm, $r_0 = 7.35$ mm, and $r_1 = 12.15$ mm:

$$\mathbf{p(r) = D/2 \cdot [1 - q(2\pi(r - r_0)/\lambda)]}$$

The active annulus contains exactly two complete radial periods. Dense independent recomputation gives $q \in [-1,+1]$, $p \in [0,0.75]$ mm, max $|dp/dr| = 0.7960116521$, mean $|dp/dr| = 0.6250000000$, and a maximum local surface angle of approximately 38.5202°.

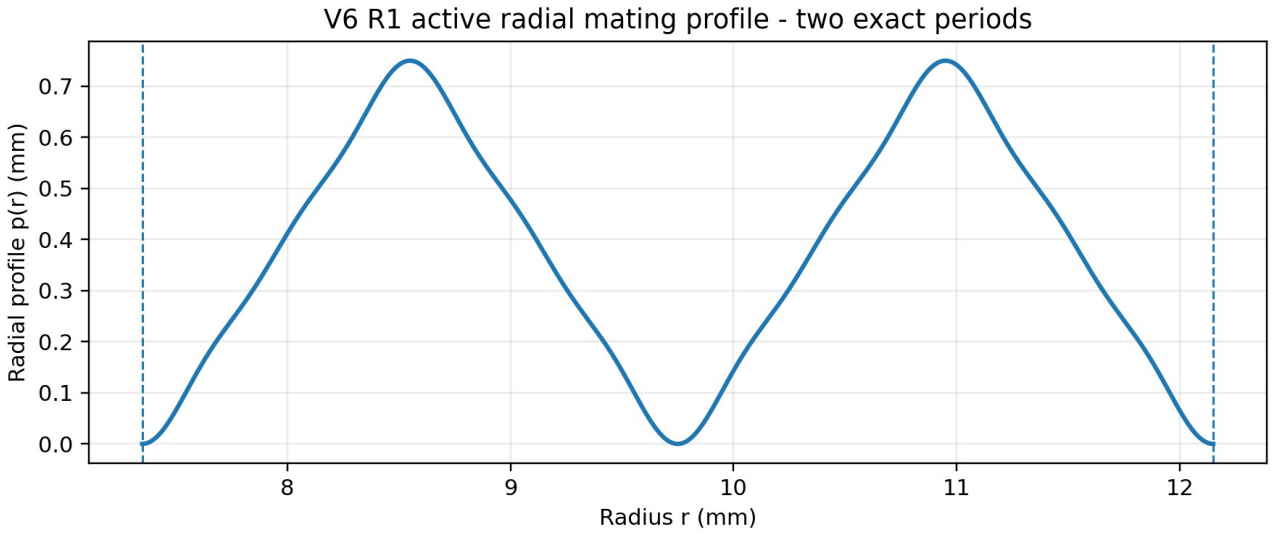


*Figure 1. Exact V6 R1 active radial profile, computed directly from the frozen CAD parameters.*

## 4. Why the Geometry Rotates but Resists Translation

The mating field depends on radius r but not on polar angle θ. Therefore $\partial p/\partial \theta = 0$ for the ideal active field. Rotating one centered part about the common Z axis does not require climbing a mathematically defined angular hill.

Translation is different. A lateral shift changes the radial registration of the two surfaces, and the steep radial profile creates a vertical-lift/interference barrier. The circular collar and groove provide a second translation constraint while remaining angularly symmetric.

This is a geometry statement, not a claim of frictionless rotation. Friction, print texture, preload, debris, material compliance, and wear can all create real rotational torque.

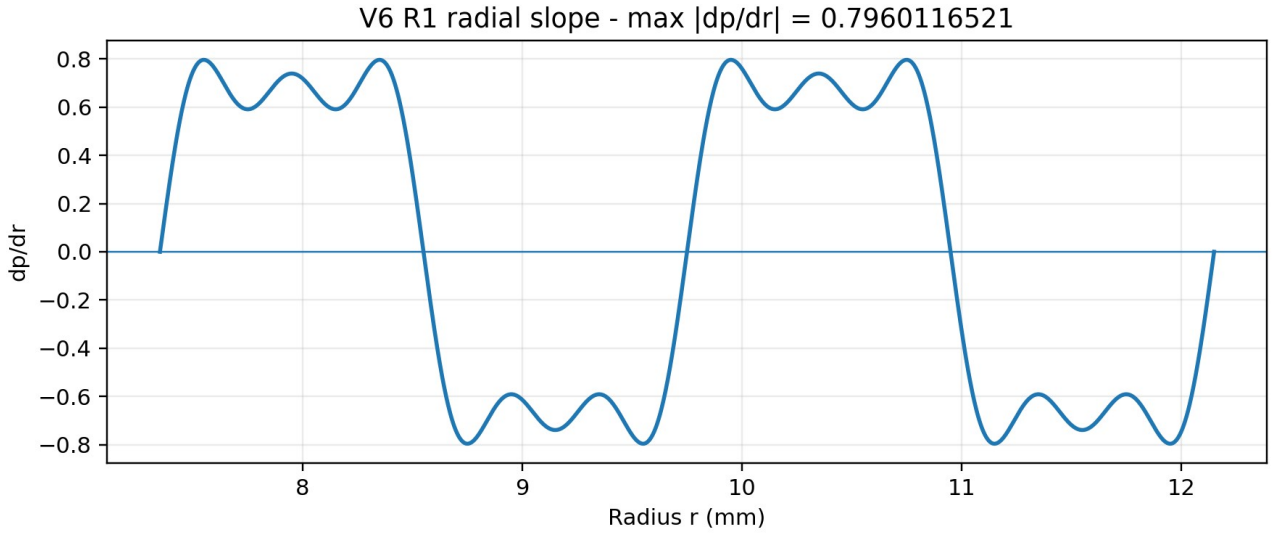


*Figure 2. Exact radial slope of the two-period V6 R1 field.*

## 5. Collar, Groove and Fastener Engineering

| Parameter | Verified value |
|---|---|
| Through hole | Ø5.00 mm |
| Counterbore | Ø10.40 mm × 3.40 mm deep |
| Entry chamfer | Ø10.40 → Ø10.80 mm over 0.40 mm |
| Counterbore floor | z = 2.95 mm |
| Top collar | ri 6.20 mm; ro 7.00 mm; h 0.90 mm |
| Bottom groove | ri 6.05 mm; ro 7.15 mm; depth 1.05 mm |
| Nominal radial clearance | 0.15 mm per side |
| Nominal axial clearance | 0.15 mm |
| Minimum chamfer-to-collar wall | 0.80 mm |
| Active wave annulus | r = 7.35 to 12.15 mm |

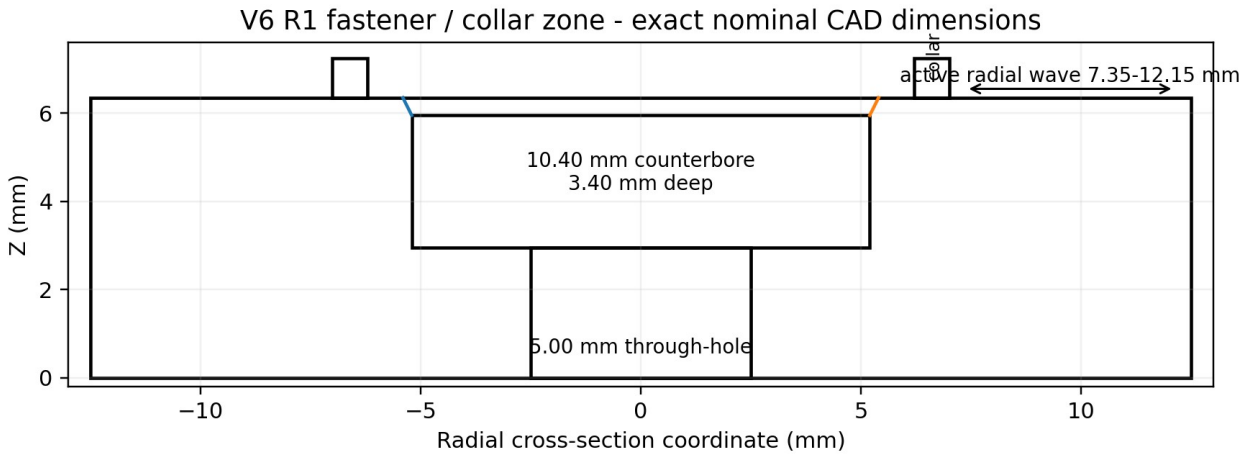


*Figure 3. Cross-section schematic using the exact nominal R1 CAD dimensions. The authoritative geometry remains the CAD/STL, not the schematic.*

## 6. CAD → STL Verification

| Parameter | Verified value |
|---|---|
| Original STL watertight | YES |
| Winding consistent | YES |
| Connected components | 1 |
| Processed vertices | 14,112 |
| Triangles | 28,224 |
| Bounding extents | 25.000 × 25.000 × 7.252 mm |
| Volume | 3553.759756 $mm^3$ |
| Surface area | 2231.367653 $mm^2$ |
| Six-decimal vertex sets | IDENTICAL to independent CAD re-export |
| Max nearest-vertex difference | 0.000000000000 mm |

The re-export STL has a different byte hash because STL facet ordering/serialization can differ. That does not indicate a geometry difference; the processed geometry comparisons above were identical.

## 7. Actual-STL Directional Check

Independent analysis of triangle normals on the exported active annulus produced a mean-absolute directional-slope spread of approximately 0.06095%, RMS directional-slope spread of approximately 0.00003%, and maximum-positive directional-slope spread of approximately 0.14826%. These small spreads are polygonization effects and confirm that the exported mesh preserves the intended near-isotropic lateral engagement.

## 8. Physical Prototype Evidence

After the original digital R1 report, the 25 × 25 mm × 1/4 in prototype was physically printed and repeatedly tested by hand. The prototype was accepted for the behaviors it was designed to demonstrate:

- strong resistance to X/Y translation under hands-on loading
- controlled/free rotation about the vertical axis
- repeatable stacking of identical parts
- recessed screw-head accommodation without blocking the mating interface

These observations are qualitative prototype evidence. No calibrated torque, breakout-force, structural-load, fatigue, wear-life, or code-compliance rating is established by the hands-on test.

*Figure 4. Three identical V6 R1 parts stacked at the exact 6.35 mm increment; rendered directly from the original STL.*

## 9. Commercial Variant Boundary

Only the original 25 × 25 mm × 1/4 in R1 is represented as the current validated configuration. This differs from the simpler V3/V4/V5 family setup because V6 contains coupled fastener, collar, groove, relief, and rotation-envelope geometry.

A direct 1/8 in substitution is not compatible with the current R1 fastener zone: 1/8 in = 3.175 mm, while the current counterbore alone is 3.40 mm deep, exceeding that nominal body thickness by 0.225 mm before the underside groove/wave geometry is considered.

A 1 in thickness or 4 × 4 / 6 × 6 footprint may be engineerable, but those versions require dedicated CAD and physical validation. They are not selectable commercial V6 R1 variations in this record.

## 10. Rights, Licensing and Claim Boundary

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No structural load rating, coefficient of friction, calibrated breakout force, rotation torque under preload, fatigue life, universal substrate performance, or building-code approval is established by this paper.

## 11. Source and Traceability Record

Primary source files: LAS_PAD_V6_R1_Rotary_Interlock.scad and LAS_PAD_V6_R1_Rotary_Interlock.stl. Independent verification record: V6_R1_ORIGINAL_CAD_STL_VALIDATION.md. All product renders designated as verified V6 renders were produced from the original R1 STL without redrawing the product geometry.