Ra conversion & parameters

Find the value first. Keep the original drawing limit for inspection.

Exact: 1 µin = 0.0254 µm. **Convert:** Ra (µin) = Ra (µm) ÷ 0.0254.

01 Unit conversion and legacy N grades

Legacy grade	Ra (µm)	Calculated Ra (µin)	Nominal Ra (µin)
N1	0.025	0.9843	1
N2	0.05	1.9685	2
N3	0.1	3.9370	4
N4	0.2	7.8740	8
N5	0.4	15.7480	16
N6	0.8	31.4961	32
N7	1.6	62.9921	63
N8	3.2	125.9843	125
N9	6.3	248.0315	250
N10	12.5	492.1260	500
N11	25	984.2520	1,000
N12	50	1,968.5039	2,000

Calculated values are rounded to four decimal places. Nominal values are traditional reference pairs, not exact conversions. N grades are for legacy reference only.

Why this matters: 32 µin equals 0.8128 µm, while 0.8 µm is about 31.4961 µin. Do not substitute a rounded nominal value for an acceptance limit.

02 What can actually be converted?

Relationship	Direct conversion?	Meaning
Ra µm ↔ Ra µin	Yes	Same parameter; only the unit changes.
Ra ↔ Rq / RMS	No universal ratio	Rq weights large profile deviations more strongly.
Ra ↔ Rz or Rt	No universal ratio	Peak-to-valley information depends on the profile.
Ra ↔ cut-off	No	Cut-off is a measurement/filter setting.

Select a machining process

Use ranges to shortlist processes, then confirm actual capability.

03 Machining processes and indicative Ra ranges

The ranges below reproduce DSR's article reference values for preliminary planning. They are not certified capability limits or guaranteed results for a particular material or part.

Process	Ra (µm)	Ra (µin)*	Selection note
Drilling	3.2-12.5	126-492	Bore finish depends on tool condition and chip evacuation.
Rough milling	3.2-12.5	126-492	May leave stock for a separate finishing pass.
Finish milling	0.8-3.2	31-126	Check runout, tool geometry, feed and cutter marks.
Rough turning	3.2-12.5	126-492	Feeds and tooling must suit the material and rigidity.
Finish turning	0.4-3.2	16-126	Confirm stable cutting and the required lay.
Reaming	0.8-3.2	31-126	Starting bore, allowance and tool condition matter.
Surface grinding	0.2-1.6	8-63	Wheel, dressing and thermal control affect results.
Honing	0.1-0.8	4-31	Specify texture and any functional requirements.
Lapping	0.025-0.2	1-8	Material, abrasive and starting surface matter.
Polishing	0.05-0.4	2-16	Appearance alone does not prove a particular Ra.

* µin endpoints are numerical conversions rounded to whole microinches, not nominal grade pairs. Source: DSR article, machining-process table [1]. The ranges have not been independently validated as DSR production capability.

04 Common Ra targets: questions to ask

Ra target	Practical selection question
3.2 µm	Is a general machined finish sufficient for this surface's function?
1.6 µm	Would improved tool marks or contact conditions justify added effort?
0.8 µm	Which surfaces need this limit, and can the chosen process hold it?
0.4 µm or lower	Is the limit functionally necessary, and how will it be measured?

A missing roughness callout does not establish a universal Ra 3.2 default. Read general notes and purchasing requirements. Cost depends on the part, material, quantity, process and inspection; no fixed cost multiplier is assumed.

Choose a surface finish

Separate appearance, treatment process and the measured Ra requirement.

05 Surface treatment and roughness compatibility

Finish names do not uniquely determine Ra. Use this table to discuss the required final condition with the supplier, rather than selecting an acceptance value from appearance alone.

Finish	Surface effect / appearance	What to specify or verify
As machined	Tool marks and lay remain visible.	Specify Ra if it matters; do not assume an industry-wide default.
Smooth machined	Finer machining marks may be achievable.	State a numerical Ra limit and agree the capable machining process.
Bead blasted	Produces a matte texture; may alter or obscure tool marks.	Verify the final Ra. Media and starting surface affect the result.
Brushed	Creates a directional visual texture.	Specify brushing direction and Ra separately when both are functional.
Vapor polished	Can improve clarity and smoothness on suitable plastics.	Confirm material compatibility and the final surface condition.
Electropolished	Can reduce micro-asperities on suitable materials.	Starting finish and process conditions control the outcome; verify Ra.
Mechanical polish	Can reduce roughness and increase gloss.	Do not convert abrasive grit or mirror appearance directly into Ra.
Anodized (Type II)	Underlying tool marks may remain visible.	Pretreatment and anodizing can change Ra; define the inspection stage.
Powder coated	The coating forms the final exposed texture.	Assess the coating surface if functional; substrate Ra alone is insufficient.

06 Details to include with a finish request

Include	Why the supplier needs it
Target surfaces	Identify the faces, bores or contact areas; avoid applying a costly limit everywhere.
Parameter, limit and units	For example, Ra with a limit in µm or µin, as defined on the drawing.
Treatment stage	State whether the requirement applies before or after coating / finishing.
Appearance and lay	Use a separate visual reference and texture direction where needed.

Adapted from the article's surface-finishes table [1]. Universal Ra promises have been removed where process conditions and supporting data are not specified.

Measure & verify

Choose a suitable method and record the conditions behind the result.

07 Surface roughness measurement methods

Method	Useful for	Main limitation / check
Comparator specimens	Fast visual or tactile shop-floor screening.	Subjective; use comparable textures. Not a substitute for required quantitative inspection.
Stylus profilometer	Quantitative profile parameters in routine machining inspection.	Access, tip geometry, filtering and trace direction affect the result.
Optical profilometer	Non-contact topography on suitable surfaces.	Reflectivity, steep slopes and optical method affect suitability; profile and areal parameters differ.
AFM	Small-area micro/nanoscale surface investigation.	Limited scan area and throughput; not a typical choice for routine CNC acceptance.

08 Inspection specification and record checklist

Record	Required detail
Drawing & surface	Drawing revision, surface / feature ID, and before- or after-treatment condition.
Parameter & limit	Ra, Rq, Rz or Rt as required; original units and acceptance limit.
Standard & edition	The specified ISO / ASME or agreed procedure; do not mix defaults.
Equipment & settings	Instrument / probe, calibration status, filter and length settings.
Direction & locations	Trace orientation relative to lay and the required measurement positions.
Results & decision	Individual results, acceptance rule, inspector and date; do not average away local defects.

Parameter reminder: Ra is an arithmetic mean; Rq is a root mean square. Under ISO 4287:1997, Rz is peak-to-valley height within a sampling length, while Rt spans the evaluation length. Apply the standard and edition actually specified on the drawing.

09 Sources and further guidance

[1] DSR - Surface Roughness Chart & Conversion Guide

[2] KEYENCE - Surface Roughness Parameters (ISO 4287:1997)

[3] KEYENCE - Measuring Procedure (legacy ISO 4288 guidance)

Source links are clickable. Article content reviewed 14 September 2026. Legacy teaching references do not replace current contract requirements. For a DFM review, share the drawing, material, quantity and required finished condition with DSR.