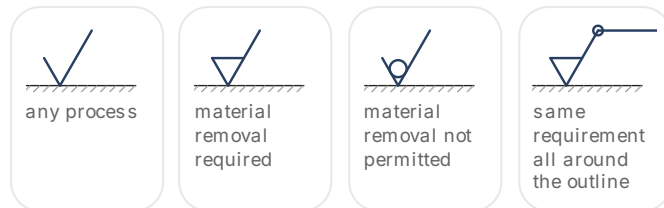


FOR PROCESS AND DESIGN ENGINEERS

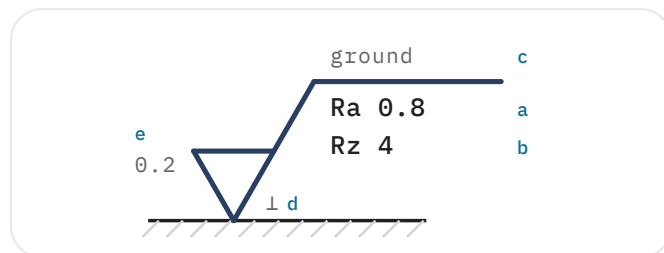
Surface roughness symbols on one page.

Symbol, callout fields, lay, N grades and legacy symbols per ISO 21920-1 and ISO 1302. Print it and pin it next to the machine.

01 SYMBOL VARIANTS



03 CALLOUT FIELDS A-E



- a requirement: parameter and value (under the bar)
- b second requirement (next line)
- c manufacturing method, coating (above the bar)
- d lay direction (at the vertex)
- e machining allowance in mm (left)

05 N GRADES, RA AND OLD ∇ CLASSES

GRADE	RA [μm]	OLD CLASS	TYPICAL PROCESS
N12	50	∇1	as-cast, flame cut
N11	25	∇2	roughing
N10	12.5	∇3	rough turning
N9	6.3	∇4-∇5	medium machining
N8	3.2	∇6	typical machining
N7	1.6	∇7	fine turning
N6	0.8	∇8	grinding
N5	0.4	∇9	fine grinding
N4	0.2	∇10	grinding, honing
N3-N1	≤0.1	∇11-∇14	lapping, polishing

02 SURFACE LAY

- = parallel to the plane of projection
- ⊥ perpendicular to the plane of projection
- X crossed in two directions
- M multi-directional (e.g. face milling)
- C approximately circular about the centre
- R approximately radial about the centre
- P particulate, non-directional (e.g. shot blasting)

04 HOW TO READ A CALLOUT

Ra 1.6	average roughness up to 1.6 μm, 16% rule
Ramax 0.8	no single measurement may exceed 0.8 μm
U Ra 3.2 / L Ra 0.8	band: not rougher than 3.2, not smoother than 0.8
ground + ⊥	process specified, lay perpendicular to the plane of projection
Ra 3.2 (√)	general indication at the title block, exceptions in brackets
3.2 with no symbol	old drawing (ISO 1302 before 2002): means Ra 3.2

06 COMMON MISTAKES

- 01 A bare number without a parameter symbol.
- 02 Symbol on the material side instead of the free side.
- 03 Ra 0.8 on a casting without the material-removal triangle.
- 04 Symbol on a dimension line instead of the edge.
- 05 General indication without brackets when there are exceptions.

07 / LEGACY SYMBOLS

Read an old drawing by the standard in force on its date.

- ∇ with a number: former Polish and Eastern European classes, Ra in the table.
- ∇, ∇∇, ∇∇∇ without a number: old DIN 3141, agree the value with the designer; ~ means raw surface.
- Rz before 1997 was a ten-point height, not today's Rz.