What should retraction distance be?

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Published October 30, 2026 · Last verified October 30, 2026

Abstract. Direct drive: 0.7 to 0.8 mm, as Bambu Lab, Prusa and Creality profiles ship. Bowden: 2.5 to 6.5 mm (Prusa MINI 2.5 to 3.2 mm, UltiMaker S5 6.5 mm).

Keywords: retraction, slicer-settings

Table 1. The number

Printer	Extruder	Slicer	Retraction length	Retraction speed
Bambu Lab X1 Carbon, P1S, P1P	Direct drive	Bambu Studio	0.8 mm	30 mm/s, 30 mm/s deretraction
Bambu Lab A1, A1 mini	Direct drive	Bambu Studio	0.8 mm, inherited from Bambu's base profile	30 mm/s, 30 mm/s deretraction
Prusa MK4S	Direct drive (Nextruder)	PrusaSlicer	0.7 mm	35 mm/s, 25 mm/s deretraction
Prusa Core One	Direct drive (Nextruder)	PrusaSlicer	0.7 mm	45 mm/s, 25 mm/s deretraction
Prusa MK3S, MK3S+	Direct drive	PrusaSlicer	0.8 mm	35 mm/s both ways
Creality Ender-3 S1	Direct drive	UltiMaker Cura	0.8 mm	40 mm/s
Prusa MINI, MINI+ with Input Shaper firmware	Bowden	PrusaSlicer	2.5 mm	70 mm/s, 40 mm/s deretraction
Prusa MINI, MINI+	Bowden	PrusaSlicer	3.2 mm	70 mm/s, 40 mm/s deretraction
UltiMaker S5 (2.85 mm filament, 850 mm tube)	Bowden	UltiMaker Cura	6.5 mm	45 mm/s, 15 mm/s prime

1 What should retraction distance be?

Set retraction distance to 0.7 to 0.8 mm on a direct-drive extruder: that is what Bambu Studio, PrusaSlicer and UltiMaker Cura ship for direct-drive printers with a 0.4 mm nozzle. On a Bowden extruder, start at 2.5 to 6.5 mm: Prusa's MINI ships 2.5 or 3.2 mm, Cura's UltiMaker S5 profile 6.5 mm. Then tune with a retraction test.

1.1 The number

Every row is the 0.4 mm nozzle profile, read at a release tag and followed through its inheritance chain: Bambu Studio v02.08.02.61, the Prusa profiles bundled with PrusaSlicer 2.9.6, and UltiMaker Cura 5.13.0 (UltiMaker's own PLA adds no override on the S5′s AA 0.4 print core). The S5′s tube length is from UltiMaker Support.

1.2 Why does a Bowden extruder need a longer retraction?

Because its drive gear sits on the frame, a whole tube away from the nozzle. The gear has to take up the give in all that filament before the tip moves. On a direct drive the gear rides on the print head just above the hotend, so only a short stretch of filament separates gear and nozzle.

Two things absorb the start of a Bowden pull-back:

- **Compression.** Marlin's Linear Advance docs model the free filament between gear and nozzle as a spring that is squeezed while printing, and list Bowden length among the things that change it. A retraction first lets that spring relax.
- **Room in the tube.** Capricorn's spec sheet puts ordinary PTFE (polytetrafluoroethylene) tubing for 1.75 mm filament at a 2.0 to 2.1 mm bore, so the strand has room to bend. Capricorn, whose XS tube has a 1.90 mm bore, says switching to it lets you reduce retraction.

Bondtech builds the tube into its recommendation for its original LGX Lite extruder: 0.4 mm for rigid filament on a direct drive, about 5 mm on a Bowden, worked out as 0.4 mm plus 0.015 mm for every millimeter of tube. Prusa gives the same reason for its MINI: the presets are "much longer" because of the Bowden extruder.

1.3 What is retraction distance?

The length of filament the extruder pulls back before a travel move so the nozzle does not ooze, measured on the raw filament before it enters the extruder. Set to 0, it turns retraction off. Bambu Studio labels it "Length", PrusaSlicer "Retraction length" and UltiMaker Cura "Retraction Distance".

1.4 How do direct drive and Bowden retraction settings differ?

A Bowden needs several times the length, and Prusa runs it faster. In Prusa's profiles the Bowden MINI pulls back 2.5 to 3.2 mm at 70 mm/s, 3.6 to 4.6 times as far as the direct-drive MK4S and Core One at 0.7 mm and 35 to 45 mm/s.

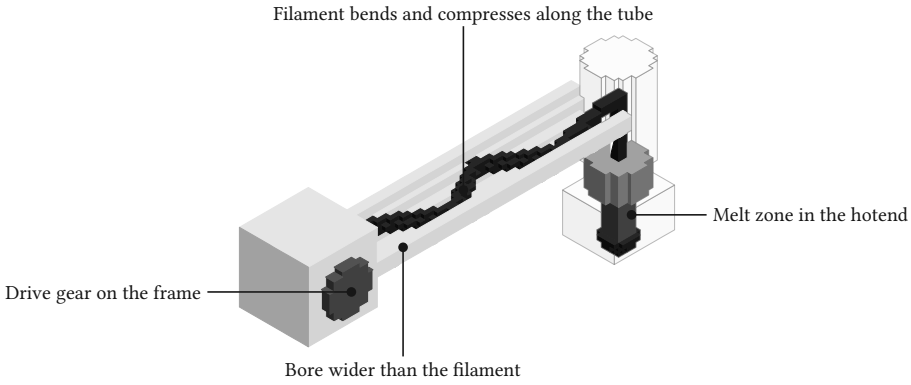


Figure 1. Before the filament tip leaves the melt zone, a Bowden extruder's gear has to take up the compression and the room to bend along the whole tube, which is why it needs a longer retraction than a direct drive.

1.5 Is my printer direct drive or Bowden?

Look for the drive gear, not for a tube. On Prusa's MINI the extruder motor is fixed on the side of the frame and pushes filament through a Bowden tube to the print head. The Core One also feeds filament through a PTFE tube, but into the Nextruder on the moving carriage, so it is direct drive.

1.6 Does the filament change retraction distance?

Yes. A filament profile can override the printer's length; in Bambu Studio that sits under Filament Settings, Settings Overrides. Starting values are on the PLA, PETG, TPU and ABS and ASA pages.

1.7 Is there a maximum retraction distance?

No universal one, but two makers set a line. Prusa says retraction length should be at most 2 mm on the MK2.5/S and MK3/S/+. UltiMaker Cura shows a warning once Retraction Distance passes 10 mm. Bambu Lab's wiki gives no figure but warns that too much retraction causes under-extrusion and layer gaps, with some chance of a clog (signs it is too high).

1.8 How to check it on your own print

1. **Read what your slicer sends.** Bambu Studio: Printer Settings, Extruder, "Length", then the filament's Settings Overrides, where a gray or N/A field means the printer value applies. PrusaSlicer: Printer Settings, Extruder 1, "Retraction length". UltiMaker Cura: the Travel section, "Retraction Distance".
2. **Dry the spool first.** Bambu Lab says stringing from damp filament usually cannot be fixed by retraction settings alone.
3. **Print a retraction tower.** OrcaSlicer's Retraction test defaults to 0 to 2 mm in 0.1 mm steps for direct drive. For a Bowden, its wiki suggests 1 to 6 mm in 0.2 mm steps (full calibration method).
4. **Pick the shortest length that gives the cleanest section,** as OrcaSlicer's wiki advises. Keep it under your maker's ceiling, such as 2 mm on a Prusa MK3S.
5. **Save it where it belongs:** in the printer profile if it fixes every filament, or as a filament override if only one spool strings.

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Cite as: Asked 3D. “What should retraction distance be?.” October 30, 2026. https://asked3d.com/answers/retraction-distance. Last verified October 30, 2026.