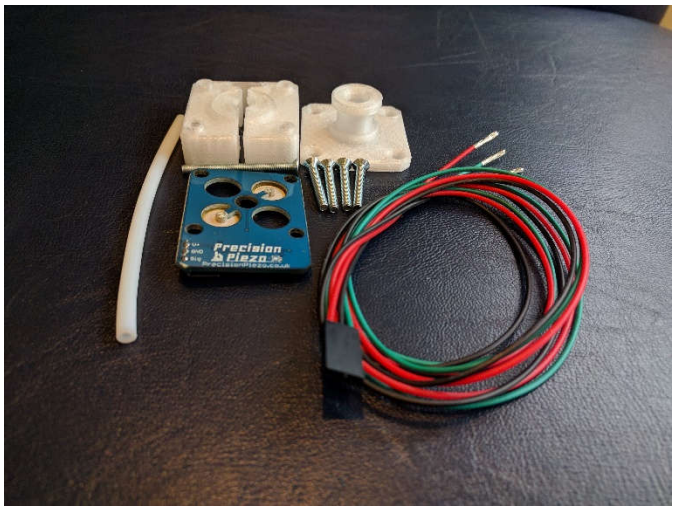
Precision Piezo v2.0 – Orion module Z-Probe For V6 Hotend

Thank you for purchasing the Orion module. This device can detect the contact of your 3D printer's nozzle with the print bed to a precision better than 5 microns, using as little as 15g of force.

Contents of package



- Orion PCB
- Heatsink clamp
- Mounting adapter
- 3way endstop cable
- 3pin dupont connector shell
- 4pin dupont connector shell
- 4x M3x20 or M3x16 screws
- 1x M3x35 screw

Specifications

- Operating Voltage 3.3-5vdc, approx 5ma (**NOT** tolerant of higher than 5v input)
- Indicator: LED Red power on, Blue Triggered
- Digital output: Active low when triggered
- Analogue output: Voltage increases on trigger.
- Accuracy 0.005mm depending on printer's mechanical precision
- Repeatability std deviation: 0.003mm
- Probing Speed: 4-7mm/s
- Probing Force: 10-15g
- Operating temperature 10-35 deg C unless retuned (see below).

Safety

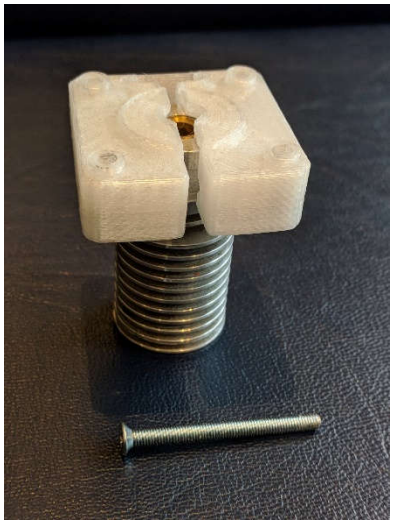
Piezo discs contain PZT which contains Lead (Pb) do not ingest or inhale the ceramic material within. However, there are a couple of things to consider for safe operation. Attach the electrical connections carefully and as directed getting the polarity of the power (red), ground (black) and signal wires correct. We are not responsible for damage to 3D printer controllers caused by incorrect wiring.

It is sensible to test the sensor before each printing session by just pushing up gently on your **cold** nozzle and observing to see the triggered LED light up to ensure it is working normally. Failure to do so in rare cases may occasionally result in a head crash.

The system of using piezo electric sensors for nozzle contact detection on 3D printers has been developed by Njål Brekke, Mike Simpson , Idris Nowell and Simon Khoury all active members of the reprap 3D printing community, and is an open source hardware project. If you want to adapt and develop this technology please get in touch and work with us, if you prefer to work alone all we ask is that our contribution is given attribution going forwards.

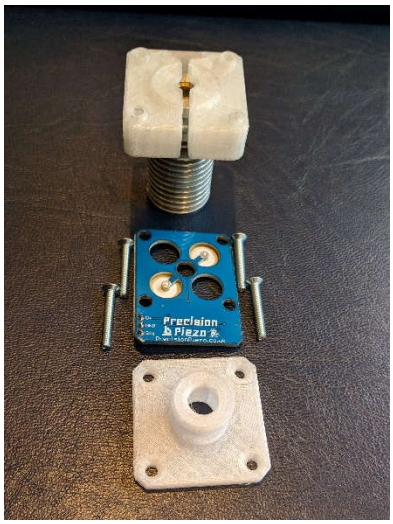
Instructions: Assembly

Assembly is similar for all versions whether groovemount, screwmount, Bowden or direct. Please note that the threaded inserts on the sides of the screwmount adapter must not be used to mount the module to your printer, they should only be used for mounting fans or accessories to the unit.



Gently spread the two halves of the heatsink clamp apart and press the heatsinks groovemount into the clamp.

Insert the M3x35 bolt through the heatsink clamp and tighten firmly so that the heatsink does not wobble or rotate.



Assemble the parts as shown, tighten each screw alternately until all are tight.

Instructions: Electrical

1. The unit has LEDs on the front showing power (red) and triggered (blue).
2. The cable comes ready to connect to the Orion unit by the three way plug at one end. Please ensure you place it correctly, reverse polarity might damage the PCB and/or your 3D printer controller. To use the digital output of the Orion, connect the three way plug to the three pins next to the “D” on the PCB. To use the analogue output connect to the three pins next to the “A” on the PCB.
3. The other end has crimped connections. A 3 way and 4 way plug are provided. Please insert the crimped connectors into the plug housing in the correct order for your controller board. You should check your controller to ensure they are the right way around.

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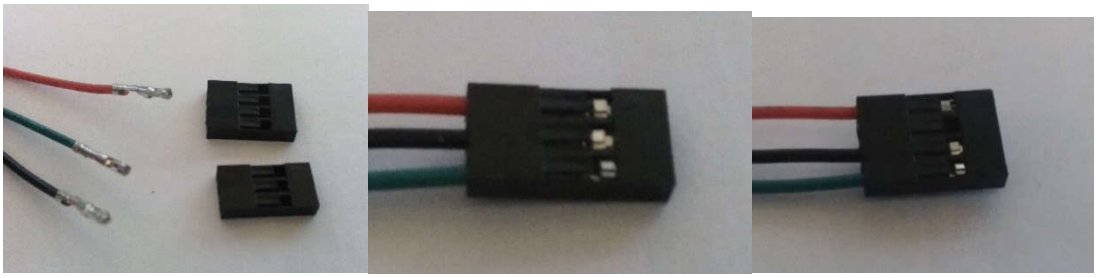

The 3 pin plug shown here (middle) is suitable for ramps, the four pin (right) is setup for Duetwifi, other boards may connect in a different way, please ensure you have the wires in the correct order at both ends of the cable. Make sure the crimp locks into place in the plug housing, if not rotate it and re-insert it.

4. To test the basic functionality of the device, which was pre-set at assembly, power up your machine. The red power LED should be visible on the Orion PCB.
5. Press upwards on your (cold) nozzle with your finger. A light tap should cause the blue LED to light up briefly which indicates that the unit has triggered.

Instructions: Firmware

In your firmware you need to configure a z_min_endstop or z_probe. Follow your manufacturer's instructions and those for your firmware. You will need to configure the firmware to accept an active low signal. More details can be found on thingiverse http://www.thingiverse.com/thing:2069480 however firmware changes so use the forums to keep up to date.

Tuning for Digital output

The unit has been setup at assembly so that it functions, and has been through tests simulating normal use, and a variety of probing speeds however some drift of this tuning may occur in transit or it might require retuning if you are using it in a heated chamber. Set your hotend to around 130 Deg C (see "operation" below for why). If using in a chamber heat your chamber to normal printing temperature.

If you find that the probe sometimes triggers before touching the bed while probing, turn the potentiometer (circled in red) counter clockwise slightly and try again. If you feel that the probe hits the bed too hard, turn the potentiometer clockwise slightly and try again. Later board revisions allow for adjustment from above through a hole in the PCB, use a small flat blade screwdriver, adjustment directions will be reversed.

Note, the small potentiometers used on these board are very delicate. They must be treated carefully and gently and should be adjusted slowly to avoid damage.

Tuning for Analogue output

Currently the analogue output of the Orion v2.0 has only been tested with the DuetWIFI and RepRapFirmware therefore these instructions will be written for the Duet. The analogue output should be compatible with any controller and firmware that can trigger at an adjustable threshold. This section will be updated as more boards are tested.

To use the analogue output with the duet we need to set the probe parameters using M558 and set the threshold and offset using G31. A suggested starting point is to use the following M558 line in config.g, You may wish to set travel speed using the Txxx argument.

M558 P1 I0 H2 R0.5 F420 Txxx ; Use Mode P1, non inverted, Probe height 2mm, Delay 0.5s,

Probe at 7mm/sec.

Due to manufacturing tolerances the untriggered output voltage of the Orion v2.0 will vary from board to board therefore to set the trigger threshold we need to read the untriggered Z-probe reading from the web interface. The Z-probe reading is shown at the bottom left of the “Machine Status” panel of the webinterface. The probe threshold in G31 should be between 2 and 15 higher than the untriggered Z-probe reading. For example, if the untriggered reading is 530 we might set the threshold at 535:

G31 P535 X0 Y0 Z0

If you find that the probe triggers before contacting the bed you may need to increase the P offset, for example you might increase from P535 to P540 or P545. The most sensitive and accurate setting is to have the offset as close to the untriggered setting as possible without causing false triggers.

Important Note:

When used in analogue mode the onboard potentiometer is bypassed and does not affect triggering, however, the potentiometer still sets the threshold for the LEDs meaning that the LEDs may not flash even though the Orion has triggered.

Operation

Probing is done by contact of the nozzle with the bed surface. Probing speed should be between 4-7mm/s (240-420mm/min) it is the equivalent of a gentle tap on the bed. Very slow probing might not trigger the device which works by detecting a sudden voltage rise as it is compressed quickly, think of it as somewhere between a microswitch and a microphone. You might need to increase your Z max federate if you use fine pitched leadscrews on your z axis.

Piezo Sensors are very sensitive this makes them excellent z-probes however they are so sensitive false triggers can occur If your probe is on an axis that moves during the actual probing "dive" use zero jerk and low acceleration for probing (in your start gcode or macro). If the probe is on an axis that is stationary when the probing dive takes place you can use pause before probing (now

available on all major firmwares after we requested it) coupled with Z-acceleration of 100-200 mm/s².

When first testing if possible (and easy to do from software) reduce your stepper motor currents to a minimum so that if it does not trigger no damage will occur, this is practical if your motor currents are set from software, i.e. digipot etc.. Move your nozzle away from the bed around 100mm, command a single probe (G30 in most firmware) and then lightly tap the nozzle upwards as it descends with a finger/tool **before it hits the bed**. The firmware should respond, usually by moving the nozzle upwards (or bed downwards in the case of a bed moving in Z). This indicates that the module is working and that the firmware is properly configured. If nothing happens, kill the power to avoid a head crash, check the firmware z_min or Z-probe logic is correct, if unsure reverse it and try this test again.

When you are confident it triggers on contact you can now use the module for 3 functions:

1) Homing to Z-min.
2) Autolevelling/grid levelling/auto calibration
3) Setting the first layer height/enabling quick bed changes.

Homing to Z_min

This is self-explanatory, when firmware is set to home to Z-min the probe will trigger when the nozzle contacts the bed. This sets the z origin or z=0 level. This is best done with the probe at the bed centre but ensure the nozzle is over the bed when homing z.

Autolevelling/grid levelling/auto calibration

Probing across the bed can compensate for irregularities, tilt and in the case of deltas with appropriate firmware can calibrate the machine.

Setting the first layer height/Quick Bed Changes

This is most useful where a machine is perhaps not mechanically perfect and the level varies from time to time. After levelling or calibration, you can send G30 Z0 in Smoothieware or G30 in RepRapFirmware to reset the Z level which should mean the nozzle is the correct distance when you begin printing (provided you set the correct z offset - see below). This command can be added to your starting gcode, so if you remove one printing surface, and insert another a variation in thickness will not require you to perform lengthy calibration/adjustment, one quick probe or home and you can print immediately. This probe is not affected by reflectivity of the surface or coatings like hairspray/3dlac on the bed.

Z offset

Whilst there is no x or y probe offset as the probe is the nozzle, and this is one of the most advantageous features of this system, there does need to be a slight Z offset as the assembly bends slightly on probing. To measure this home_z (if using probe as z_homing device) or send G30 to probe once. Then raise the nozzle and insert a piece of paper, lowering it manually in small increments (0.1mm) until it is gripped firmly. Measure the difference between the z=0 after the G30 and the Z level with the firmly gripped paper between nozzle and bed. This is likely to be 0.1-0.2mm now enter that in your firmware as z_probe offset, use a negative value i.e. enter it as -0.1. You can add this in your slic3r instead using Z-offset +0.1 for example. Use something thinner than paper for

an even more accurate result. Some firmware such as RRF allows G30 S-1 which reads out the distance travelled from which you subtract from the height before you sent the command, this means no paper is needed.

Temperature of Nozzle and Bed, Cleaning the nozzle

You should probe with a **clean nozzle**. Clip any residual filament from it with a wire cutter or similar instrument. It is possible to probe with slight residue on the nozzle if probing hot (see below) but large amounts of filament might affect the accuracy of your result (and leave blobs of filament on your printbed).

For best practice, we advise to set the nozzle to 130 deg C or thereabouts, which should be below the “ooze-temperature” of almost all filaments. To the best of our knowledge a momentary contact of a hot nozzle will not damage any common printing surface, but this slightly lower nozzle temperature, is recommended to avoid this occurring. Clip any residual filament from the nozzle. The bed should be set to the normal first layer temperature for the material you are using. This is especially important if your bed deforms when hot and you intend to use grid-levelling or equivalent to facilitate better printing.

It is possible to probe with nozzle and bed cold, if your nozzle is very clean. After probing heat up your printer’s bed and nozzle then use the method above to calculate the z-offset.

We calculate for an e3d v6 hotend the thermal expansion of the heater block and heatbreak from 130 to 250 deg C is only 0.02mm you might choose to factor that in to your z-probe offset, but it will make little difference to a typical 0.2-0.3mm thick first layer.

Additional Information

As your nozzle moves over a previous layer, the triggered LED might flicker or light up, the sensor is so sensitive you are detecting nozzle contact with the previous layer. This will not affect your printer’s operation as long as your firmware is set to "use endstops only for homing" or if you have connected the sensor to a dedicated z-probe connector. However, it is useful to see if your print is progressing well, a lot of contact with the previous layers may indicate over-extrusion or curling of overhangs or blobs on the print. More triggering on one side of the print than the other might indicate a bed level issue.

Maintenance, repair and retuning

The unit requires no maintenance under normal operation. The piezo sensors are extremely robust and will survive normal probing for many years and probably an occasional head crash.

If you are using the unit in a higher-than-normal temperature environment, i.e. heated chamber or in a climate where air temperatures are likely to be 40 deg C or higher the PCB may need to be re-tuned. Please see “tuning” above. 60 deg C or will result in unexpected behaviour, if your chamber can go higher than this please probe at or below 60 deg C.

If it is necessary to replace parts dismantle the unit carefully, being especially careful of the PCB. Reassemble in reverse.

Go to "Tuning" above and complete these steps.

If you have any issues we have a thread running in Reprap General Forum. Search it first as your issue may already be covered.

If you wish to dismantle the unit and rebuild it into your own version of the piezo hotend z-probe please do so, see our website for more resources. Please note that warranty will not be offered if the unit is reassembled into something else, although support can still be obtained via our support thread on reprap forums (please see www.precisionpiezo.co.uk).