1 Revision History (Revised section)

Date	Rev.	Change type	Section #	Section Name/Notes
14-Apr-2017	31	Revised	3.4	Added contributor: Wan-Muhammad Arief.
		Revised	4.6	Rephrased Figure #1.
		Revised	4.7	Added Layer Fan-duct & 2 versions of Side-mounted drag-chain.
		New	4.8	External MOSFET Mounting
		Revised	7.5.2	Replaced awg with AWG.
		New	7.5.6	BW Wires.
		Revised	8.3.6	Rephrased & added cautions.
		Revised	10.1.1	Added stock hot-ends V1 & V2.
		Revised	11.4	Rephrased & added note regarding new hot-end thermistor table.
		New	11.7	“Babystep-Z” & “Live Adjust-Z”
16-Apr-2017	32	Revised	11.1.3	Updated links to RC8 V4 FW.
		Revised	11.4	Rephrased due to RC8 V4.
		Revised	13.3.1	Rephrased due to RC8 V4.
12-May-2017	33	Revised	6.2.3	Added picture and link to assembly video.
		New	6.3.3	Z-Wheel Plates.
		Revised	6.4.1	Added note to “Corrective actions”.
		Revised	7.2	PSU section overhauled.
		Revised	7.5.6	1) Added pre-tinned wire. 2) Added drag-chain braided sleeve.
		New	8.1.5	E-Steps Tuning via LCD or M92 Command
		Revised	11.1	Moved general instructions from13.3.4.
		Revised	11.3	Rephrased.
		Revised	11.5	Added E-Steps Tuning via M92 Command.
		Revised	11.7	Error corrected.
		Revised	13.3.4	Moved general instructions to 11.1, caution rephrased.
14-Jul-2017	34	Revised	3.4	List of contributors updated.
		Revised	4.1	Rephrased due to added section 4.1.3.
		New	4.1.3	Added link to new video series.
04-Aug-2017	35	Revised	3.3	Updated new location of this CG doc.
		Revised	3.4	List of contributors updated.
		Revised	6.5.4	Added note about extruder “pre-filing”.
		New	10.1.6	Heat-breaks.
		Revised	10.2.3	Updated note of heat-bed V4 thermistor.
		Revised	12.2.1	Added Cura 2.6.2

2 Table of Contents (Revised section)

3 Introduction

3.1 Preface

Dear BW (Black Widow) user. Temporary solutions, troubleshooting……and important upgrade information…for newbies…. and so called pro's brought to you by JupaCreations.com & Doron Shalev

If you bought a TEVO Black Widow, you will find out that there is no manual for software, firmware or other electronic stuff so far.

By reading this BWCG (Black Widow Community Guide) from start to end, you can overcome some problems, so read this manual first **fully**.

If you need, for any reason, to open a support ticket for TEVO use this link:
http://www.tevoprinter.com/osticket/

Check your spam folder if you do not get an answer soon.
Also only reply by web-browser link through the ticket system for updates of your problem. Don't answer by email…………..!

As this document continues to grow, therefore as of revision 23 this document has been re-arranged according to chapters, paragraphs & sub-paragraphs in hierarchy of 3 levels. A TOC (Table of Contents) has been added, as well as revision history page.

The main chapters in this document are: Building Instructions & Videos, Operation, Mechanical, Electrical, Firmware & Software. Please note that elements which involve conversion of energy between electricity and another entity, e.g. motion, light & heat, has been given their own chapters, i.e. Electro-Mechanical, Electro-Optical & Electro-Thermal respectively.

Please note that few sections have been duplicated to streamline the reading of some topics. These are denoted in the appropriate headlines, where applicable.

An Annexes section has been added, which contains hard to find documents, as well as Glossary of terms and abbreviations. Please note that each abbreviation is explained once at the 1st appearance.

Items which require special attention are highlighted in Bold Green font.

Items which may either result in erratic operation, or pose safety issue under normal operation, are marked "Caution" and highlighted in Bold Red font.

Items which pose safety issue under abnormal operation, and/or should be avoided, are marked "Warning" and highlighted in Bold Red font.

3.2 Disclaimer, Proper Disclosure & Donations

3.2.1 Disclaimer

All the information in this document is gathered, verified and prepared by volunteers.

The authors are not responsible for any damage caused by reading this document and the use of it.

This document comes to you as is. Proposals and omission requests can be sent to the authors Doron Shalev and Paco Raap. Requests will be checked by the authors for usability and if found valuable, will be incorporated in this document.

3.2.2 Proper Disclosure

The authors have no personal or financial affiliation with TEVO or any other 3D manufacturer or any 3D web shop.

3.2.3 Donations

If you think you benefit one way or another from using this Community Guide and you like to show that, then think about donating any amount of your choice to a charity fund that helps people in need like for example "Doctors without borders".

Just post a FB message with the name of the charity organization and the amount donated. So we all know that the Community Guide can lead to a better world, not only in 3D.

All previous donations have been transferred to the mentioned charity organization.

Donations

Name	Date	Amount in Euro
Tobias Muller	1-Dec-2016	20
Allan Shillito	15-Dec-2016	20
Donald Hricko	22-Dec-2016	20
Stefan Haderer	14-Jan-2017	30
Wu Qiaoru	14-Jan-2017	95
Donal Atwood	26-Jan-2017	18.25
Peter Truskier	16-Feb-2017	18.50
Russell Cole	01-Mar-2017	20
MOTORCYCLE PANEL & PAINT	27-Mar-2017	20

3.3 Document location (Revised section)

This document is no longer available in the files section of this Facebook group.

The latest version can be found **HERE** .

The link is also sticky as part of the pinned post, at the top of the “Discussion” pane of the “TEVO Black Widow Owners Group”.

3.4 Acknowledgments (Revised section)

We would like to thank **Wan-Muhammad Arief**, **Tash Bhairo**, **Rui Cabral** aka **Rui Raptor**, **Ed Farias**, **Tom Keidar**, **Fred Kratky**, **Rob Mendon**, **Laurent Paillard**, **Allan Shillitto**, **Jari Tulilahti**, **Pest Vic**, **Bruce Walker** & **Dean Walsh** for their contributions to this manual, either directly or by linked videos & FW.

We have tried to identify all the contributors to this manual, and may have missed someone. If you feel that you have a contribution that was not acknowledged, please let us know.

4 Building Instructions & Videos

4.1 Video Links

There are excellent three set of BW build videos on YouTube. Each one of these is showing the build from a different perspective. **It is strongly recommended that you watch these before starting to build your own**.

There is also an excellent series of videos, by **Thomas Sanladerer**, that each newbie should watch, as they explain the basics of 3d printing, and apply to any printer. These can be seen at **Tom's Guides**.

4.1.1 BW Video series by Dean Walsh

TEVO Black Widow Assembly Series (8 videos)

In addition, Extruder + Flow Rate Calibration, can be seen HERE.

4.1.2 BW Video series by Pest Vic

Everything TEVO Black Widow! (13 videos)

4.1.3 BW Video series by Rui Cabral aka Ruiraptor

TEVO Black Widow 3D printer - All assembly videos (15 videos)

Please note
This series from May-July 2017 covers the latest BW V3 elements shown and explained in other sections of this CG.

4.2 How to square & parallel the frame and leadscrews?

The document, can be found at **Annex section 13.2** of this document.

4.3 Gift Parts

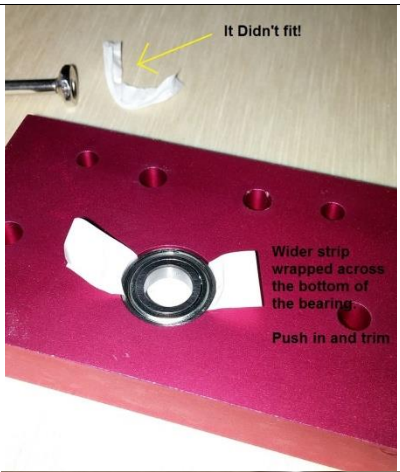
	With your kit you receive two items as a gift. One item is a thermistor for the hot-end heat-block. **Please note** **This thermistor can't be used on the heat-bed, as is, since the heat-bed uses an SMD (Surface Mount Device) type thermistor. If you need to use it for the heat-bed, refer to Section 10.2.3 for instructions.** The other item is two LED (Light Emitting Diode) strips which you can connect directly to the 24 VDC (Volt Direct Current) of the Power Supply Unit. If they do not work check the polarity. There have been reports that the polarity signs on the strip were wrong. So double check.

4.4 XYZ proximity sensors adjustment (Duplicate 1 of 2)

The X Y and Z sensors are proximity inductive sensors which sense metal. To get them working properly adjust them at a very close distance (maximum 1mm) to the part that should activate it. The sensors have a small orange LED built-in. When the sensor is activated the orange LED is ON. You can use a tip of a screw driver to test the sensor for working.

4.5 Z bottom and top plate bearing fitting not correct (Duplicate 1 of 2)

 	If you experience play on bearings, use the following tip. Use regular thin paper and glue with a little bit of glue stick glue the piece to the outer race of the bearing and with care slide both in place. All depends on the play. When ready remove the paper remains not needed. If you experience such play you can use this trick temporary and file a support ticket at TEVO for a correct version. Bearing type: MR688ZZ, ID: 8mm; OD: 16mm; Width: 4mm. **Please note** **Some suffixes, e.g. ZZC have 5mm width. They**

	**might fit, however this has not been verified.**

4.6 E3D-V6 Hot-end & Bowden Tube Assembly

Assembly instructions can be found here: **http://wiki.e3d-online.com/wiki/E3D-v6_Assembly**

The Stock V3 Hot-end breakdown is as follows:

A) Heat-sink: Modified E3D-V6.
- The J-Head and the fins are the same as E3D-V6, however the thread for the heat-break is M6, not M7.

B) Heat-block: Modified E3D-V5.
- Different dimensions. An E3D-V5 heat-block may not function properly, thermal-wise.

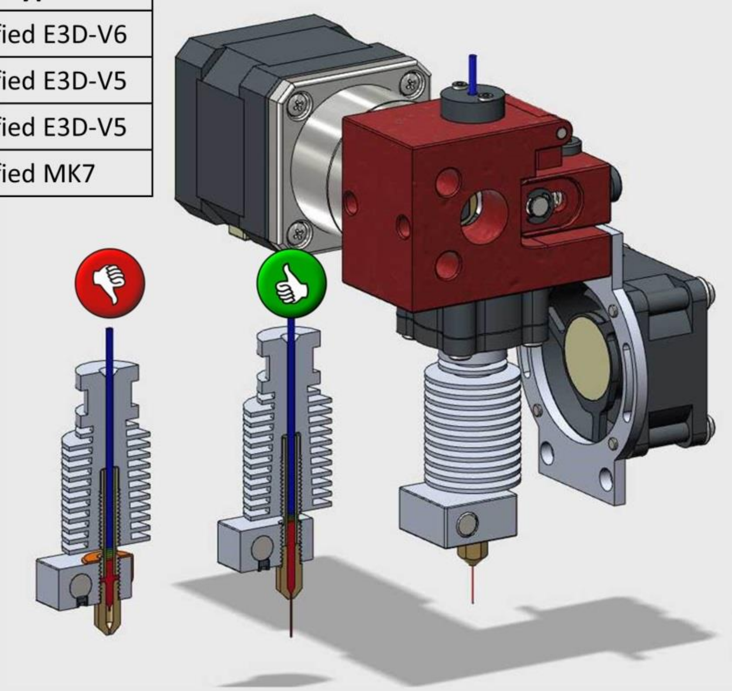
C) Heat-break: Modified E3D-V5.
- Longer by 1mm.
- Actually for 3mm filament, fited with 3mm OD, 2mm ID PTFE liner (PTFE: Poly-Tetra-Fluoro-Ethylene, known as Teflon).

D) Nozzle: Modified MK7.
- The nozzle is not from the E3D family.

1

BW Extruder & Stock-V3 Hot-end
General & Cross-Sections Views

Hot-end Breakdown	
Element	**Type**
Heat-sink	Modified E3D-V6
Heat-block	Modified E3D-V5
Heat-break	Modified E3D-V5
Nozzle	Modified MK7



It is recommend for anyone who has one of it's components faulty, to do the following:

1) Get replacement parts from TEVO. Getting replacement parts from other vendors would be extremely difficult, if not impossible on one hand, and trying to use the originals/clones won't work, as most probably they won't fit, or not work properly thermal-wise.

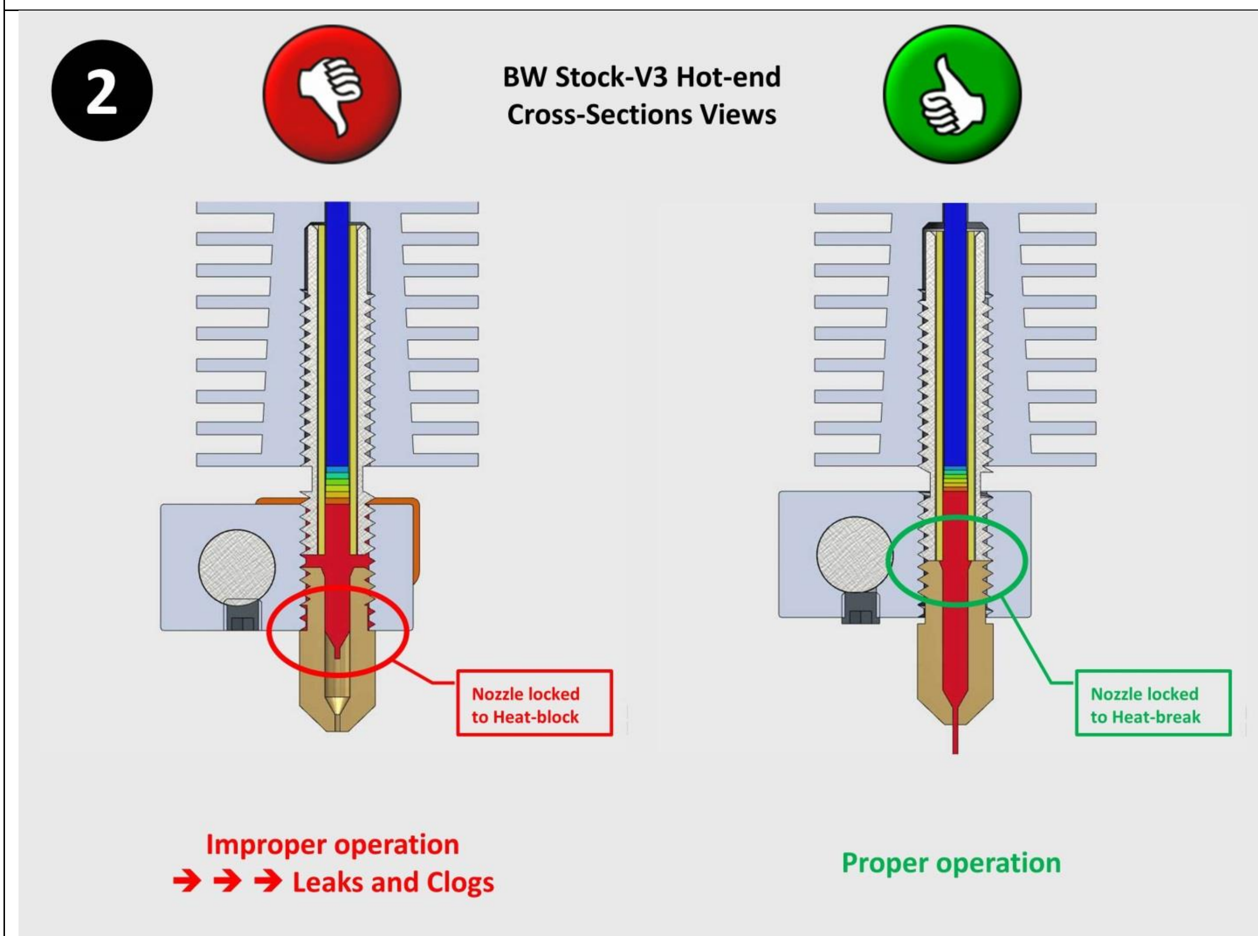
2) Replace the TEVO Stock-V3 with either a genuine E3D-V6, or a good clone, as depicted in the following Figures #3 & #4.

One of the most common errors, when assembling the hot-end, which is the #1 cause for leaks and clogs, is the way the nozzle is assembled with relations to the heat-block and heat-break.

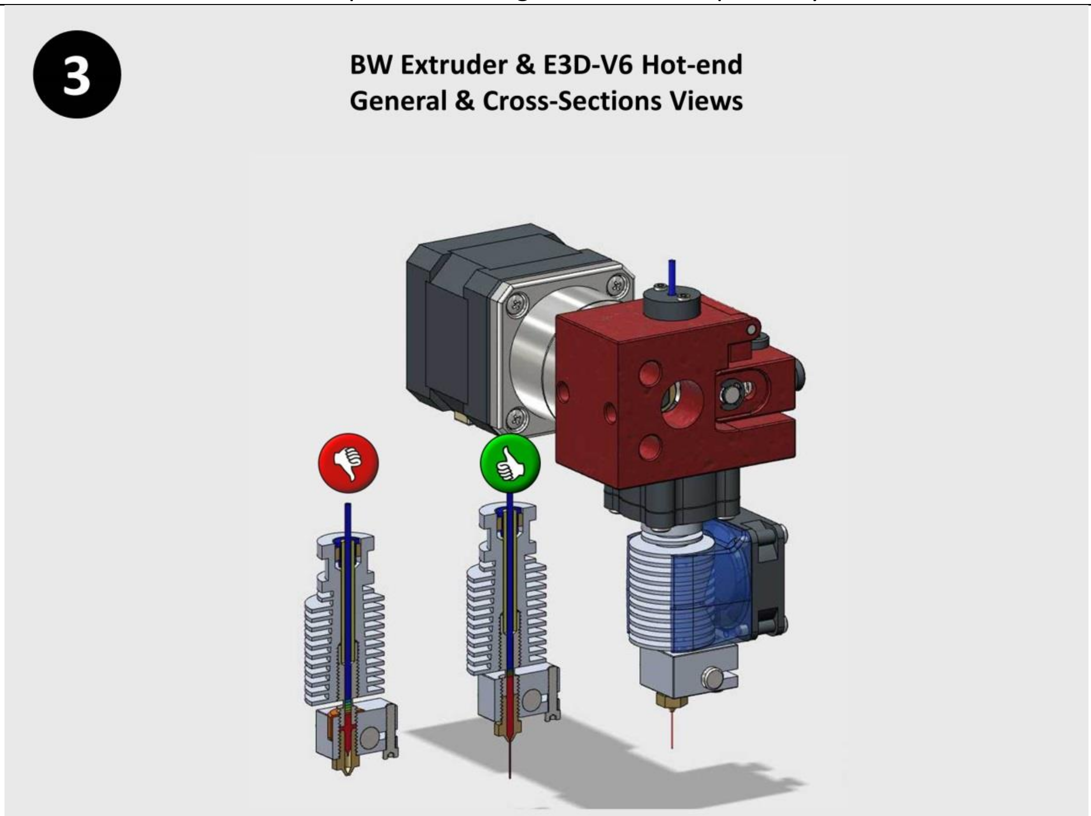
The nozzle must be locked to the heat-break, not the heat-block, as depicted in Figure #2 below.

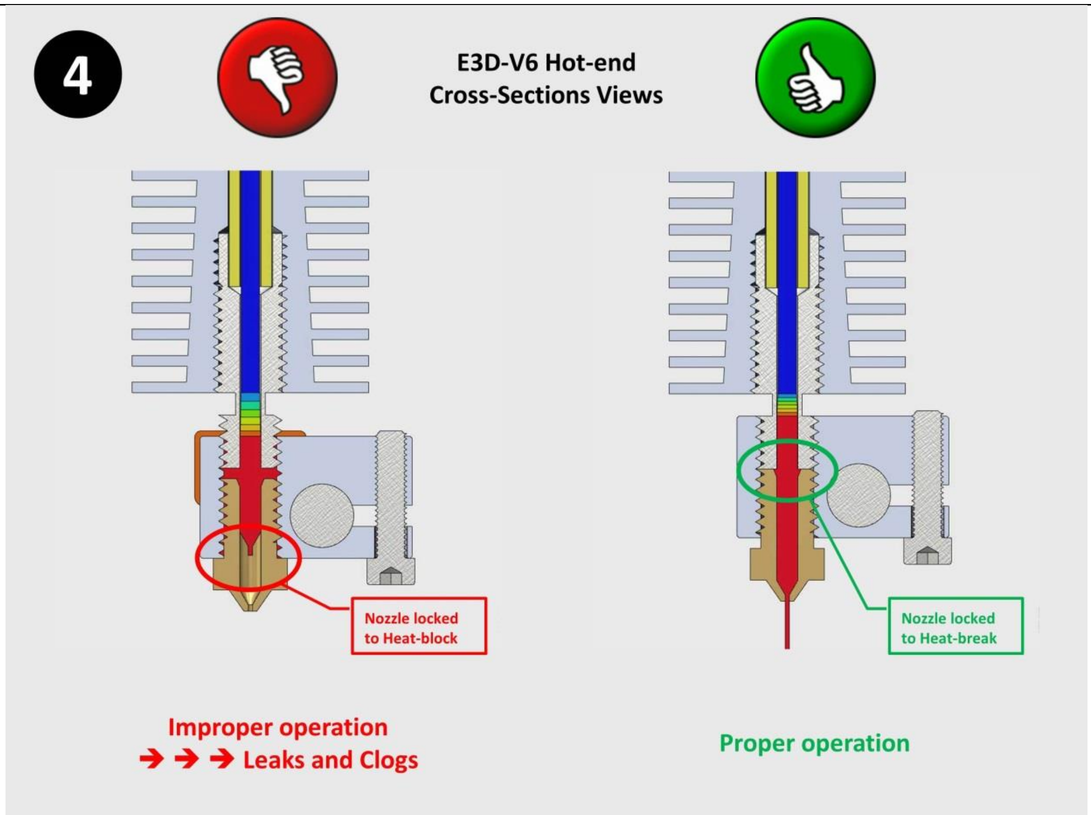
When locking the nozzle to the heat-block, a gap is formed between the nozzle and the heat-break. (**The gap is exaggerated in the figure, to enhance readability**) This gap will let the high-pressure molten filament to flow between the threads, and will start leaking at the top of the heat-block. In some cases, depending on manufacturing tolerances, it may leak from the bottom of the heat-block as well.

If the gap is large enough, the rapid temperature changes during retractions, will eventually cause it to clog.



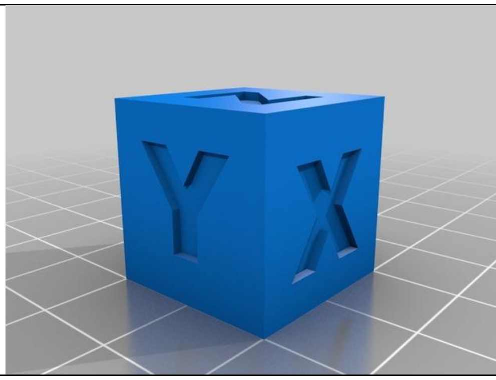
Figures #3 & #4 show the E3D-V6 equivalents of figures #1 &#2 respectively.





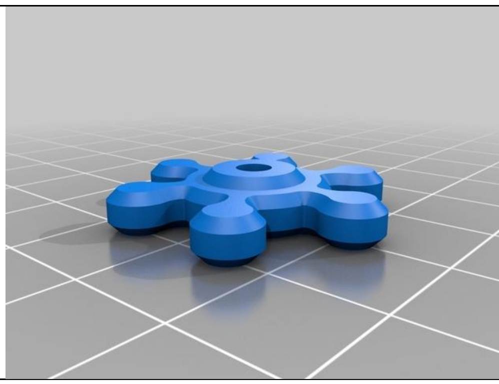
4.7 Recommended prints to start with

Parts you might like to print to enhance the machine performance at start up.



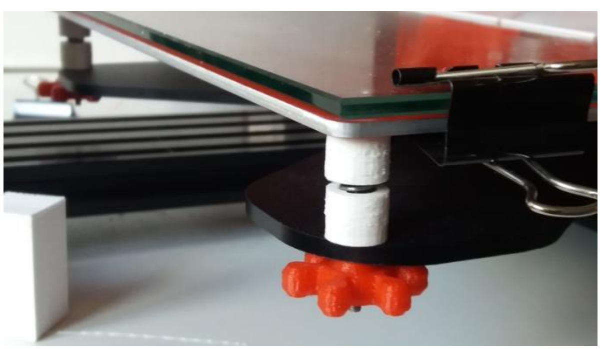
Your first print!

20 mm XYZ calibration cube for checking the calibration and extrusion
http://www.thingiverse.com/thing:214260



http://www.thingiverse.com/thing:1571664

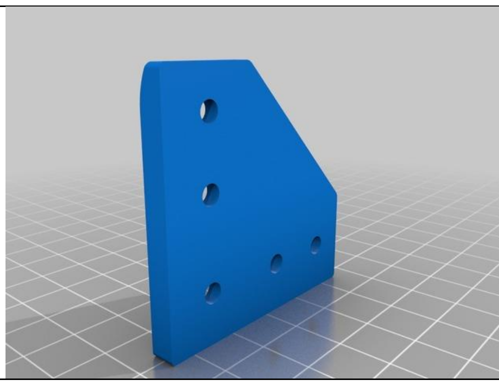
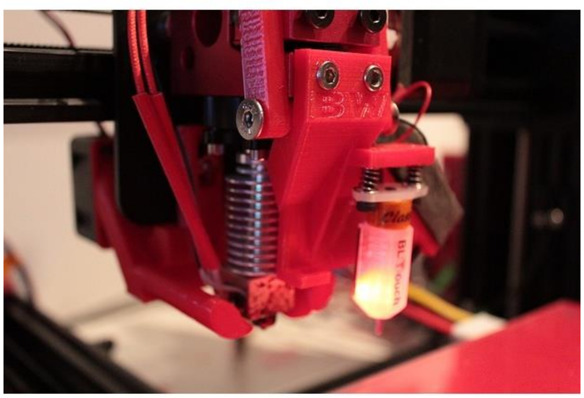
Thumbwheels
Print them in XY scale 1.05 enlarged so the 3 mm nut can be pressed in more easily.
Four 3 mm regular nuts need to be purchased.

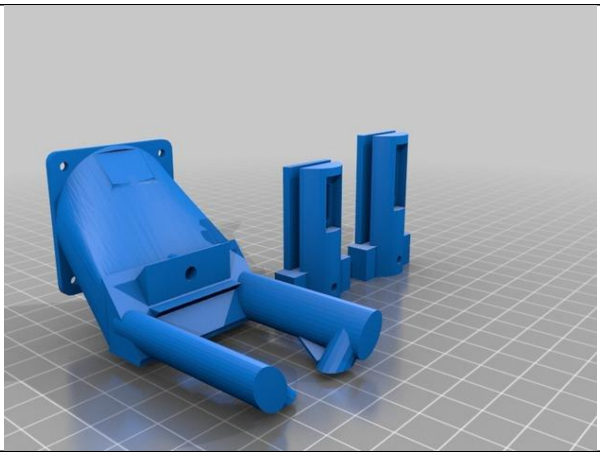


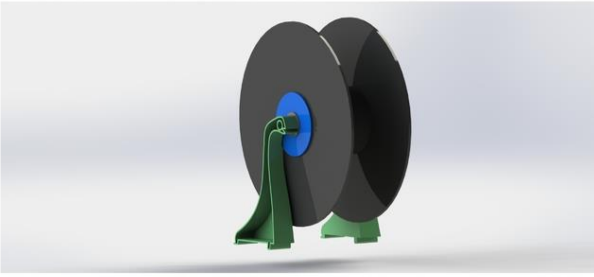
Bed bushings to capture the springs can be found here.

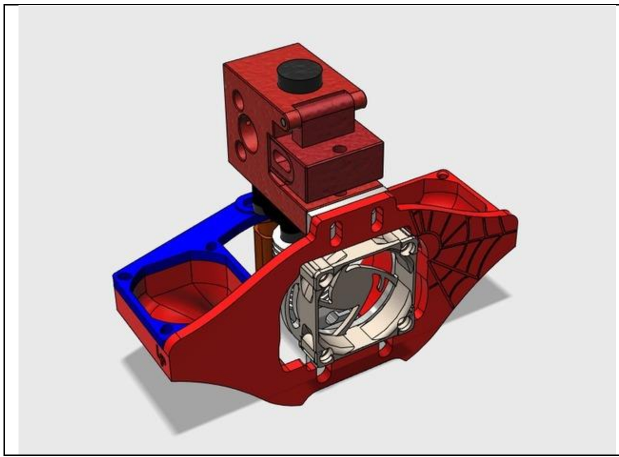
http://www.thingiverse.com/thing:1994198

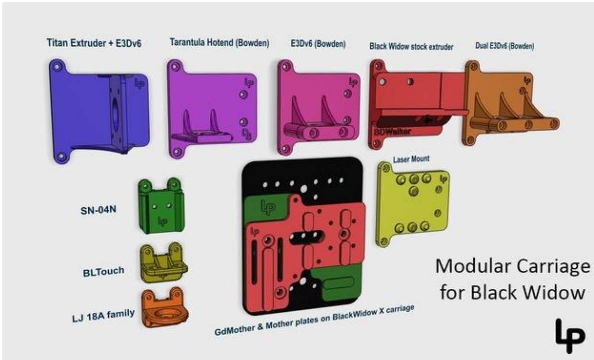
They also prevent the spring to carve into the bed electronic resistance tracks.
Needs four M3 nuts for upper bushings. Lower bushings do not need M3 nuts. Four 3 mm regular nuts need to be purchased.

	Internal corner brackets. http://www.thingiverse.com/thing:1764563
	Outside corner bracket. http://www.thingiverse.com/thing:1706643
	Heater cooler with right hand side mounting of the original 40 mm cooler fan. Can be used with or without a BL-Touch. Uses BL-Touch with the springs that come with them by standard since Nov-2016. http://www.thingiverse.com/thing:1937278 This part prevent uncontrolled nozzle cooling as mentioned in the Hot-end can't go higher than 180 Degrees-C section. Air release is to the free left side. No air is bouncing against the black rear X -Axis plate. Replace the kit heater fan as this gives unwanted resonances to the BL-Touch if mounted.

	Filament cooler for E3D V6 with regular or Volcano heater Block. Uses a 40 mm cooler fan. This is a layer fan duct which cools the object, not the hot-end's heat-sink. **http://www.thingiverse.com/thing:1937134**

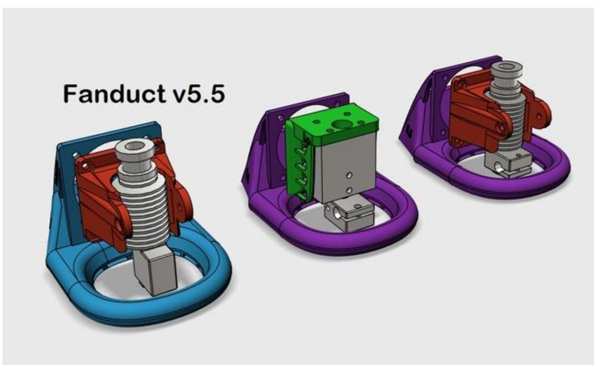
	Filament spool holder **http://www.thingiverse.com/thing:2016435**

	Another popular and effective layer fan-duct. **http://www.thingiverse.com/thing:1726112**



A Modular X-Carriage which enables you to fit any extruder/hot-end/sensor combination.

http://www.thingiverse.com/thing:1829292

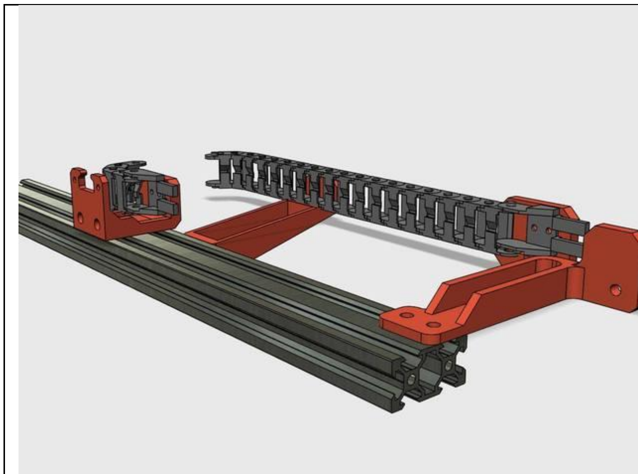


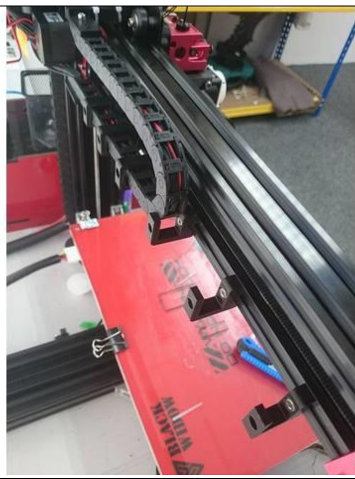
This efficient layer fan-duct and hot-end adapters have been originally designed for the TEVO Tarantula.
However they are compatible with the modular X-carriage shown above, and can complement it for the BW-stock, E3D-V6, E3D-Volcano and Tarantula/Chimera hot-ends.

http://www.thingiverse.com/thing:1953697

A Modular Spool Holder which can fit all kinds of spools.

http://www.thingiverse.com/thing:1853170

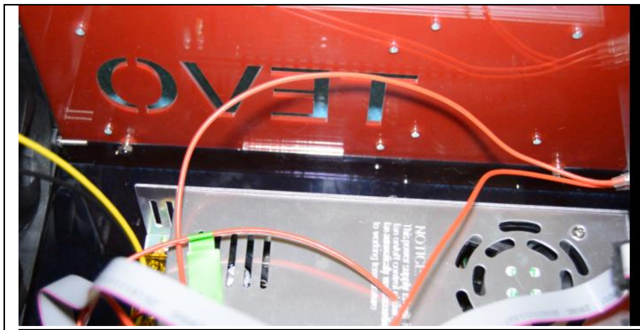
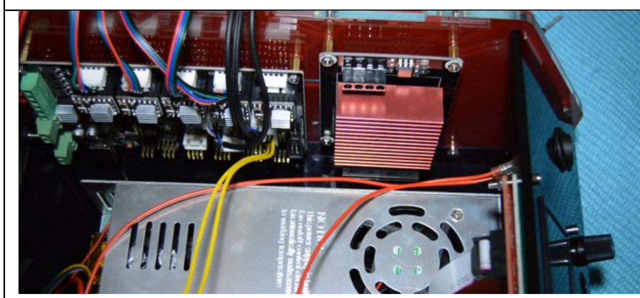
	A side-mounted Drag-Chain that enables you to squeeze the max height on your Z-travel. http://www.thingiverse.com/thing:1777681

	Another version of side-mounted Drag-Chain that enables you to squeeze the max height on your Z-travel. https://www.thingiverse.com/thing:2086253

4.8 External MOSFET Mounting

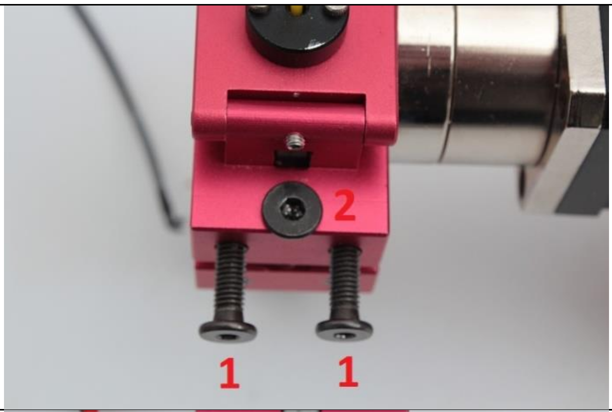
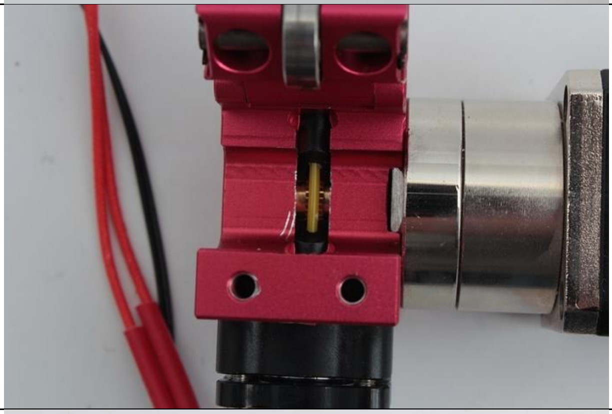
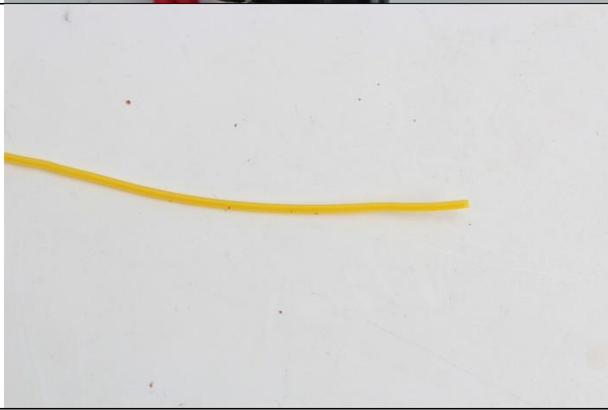
As of Mar-2017, BW control box has pre-drilled holes for mounting the external MOSFET with the supplied mounting HW, e.g. stand-offs & screws.

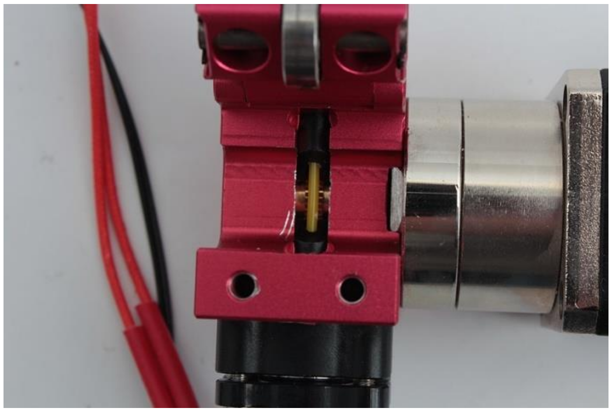
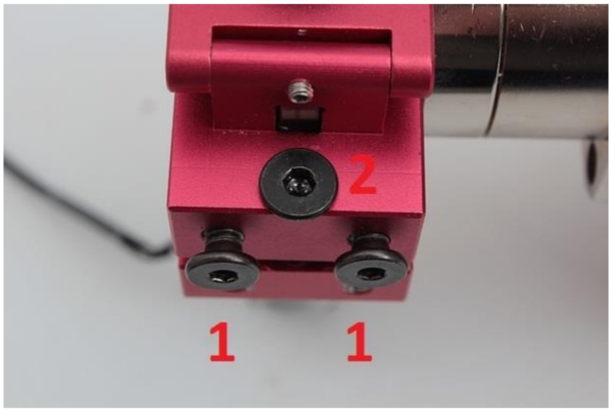
Refer to the table below for details.

	**Control-Box inside view** Pre-drilled holes for the external MOSFET on the "TEVO" side acrylic wall.
	**Control-Box inside view** External MOSFET mounted on the "TEVO" side acrylic wall.

5 Operation

5.1 Filament Change / Load Procedure

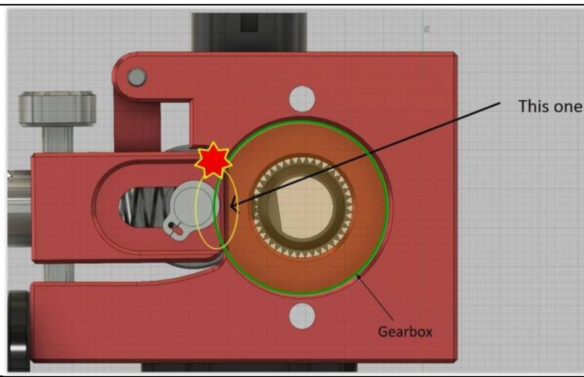
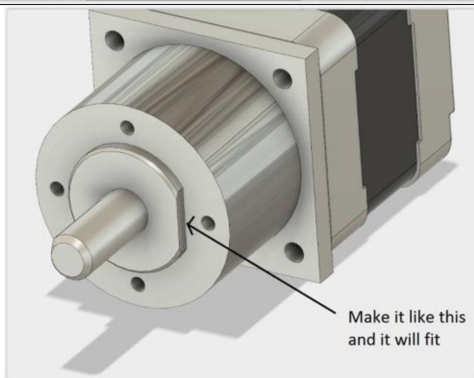
	Heat your heater to 160 degrees Celsius. Unscrew the two filament pressure screws fully (1) Remove the center clamp screw(2)
	Open the filament clamp fully. Pull the filament out in one pull.
	Prepare the new filament so the first 5 cm are straight when it is loaded. If not uncurl it first for easier placing. Cut the tip at a 45 degree angle.

	Guide the filament past the Extruder drive gear until there is friction. Raise your heater temp to your regular setting for the filament used. When reached slowly press the filament through the nozzle.
	Close the center clamp screw fully (2). Tighten up the filament pressure screws (1) until you feel pressure. Then turn them in one full turn and a ½ turn back. By the control panel or software feed the Extruder motor at low speed until a good constant flow of filament exits the nozzle. Adjust the filament pressure screws according to the needed filament pressure.

5.2 Manual Bed Leveling Procedure

1. Remove the glass plate if it used.
2. Make sure the heat-bed springs are approximately equally halfway compressed on all sides.
3. At the right hand side of the machine is the Z-min sensor placed on the vertical part.
4. Adjust it so that the nozzle does not touch the heat-bed when you give a G28 Z command (home Z only).
5. Compensate for the glass plate height + 2 mm.
6. Then place the glass plate back if used.
7. Then home machine with G28 (home all axis).
8. Adjust the bed screw so there is A4 paper size thickness height between heat bed and nozzle.
9. Do this for all corners by moving the heat bed and hot-end unit by hand.
10. When all corners are done start printing....and check with a bed leveling print file if the layers are at the correct height.

5.3 Intermittent Filament Extrusion

	If the filament clamp is closed, it can hit the extruder gear unit. This can cause intermittent filament extrusion even when the pressure screws are fully turned in.
	Take off (grind) the marked part of the gear unit with a file tool and refit it. Other option is to fit two bronze 0.5 mm shim washers between the gear unit and extruder block. But then you have to readjust the brass drive gear to align in the center again.

5.4 Machine Noise Reduction

From the packaging you can use the black foam to put it under the four feet of the machine. To reduce it even more, you can also use it underneath the table poles. It reduces noise and vibrations.

5.5 Hot-end Temperature Calibration

Some filament vendors provide a temperature printing recommendation which is very wide, e.g. 190-220C for PLA. Even if they give a single number, this is probably not accurate for the spool you are holding.

This parameter is highly variable between vendors, between different colors for the same vendor, and even between different batches of the same color and the same vendor.

Therefore it is recommended to print a temperature calibration tower, for each new spool, and note the best printing temperature on the label. This will bypass all temp related errors, such as thermistor readings, heat transfer and cooling issues of the hot-end.

For PLA, you can use the G-code given here: **http://www.thingiverse.com/thing:656001**

For other materials, you should edit the G-code for the appropriate range using a text editor.

5.6 Infill Calibration

Test square to adjust layer height & infill between closed up lines. If the infill line is higher than the neighbor lines, raise the nozzle slightly until the infill is flat.

Designed for 0.4 mm nozzle and 0.2 mm layer height.

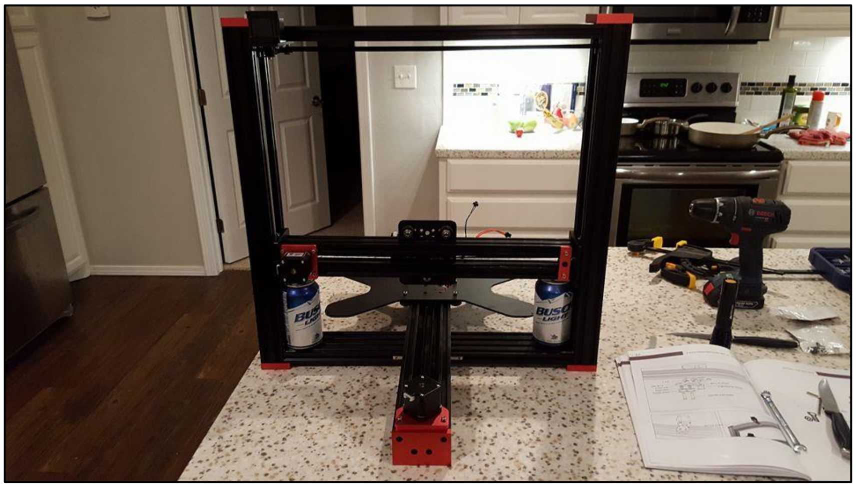
STL can be found here: **http://www.thingiverse.com/thing:2135964**

6 Mechanical

6.1 X-Axis

6.1.1 X-axis Leveling Easy Way

Tip! To align the X-Gantry. Use two soda or beer cans as shown in the picture to make both sides level. Then tighten the appropriate screws.



6.1.2 Wrong X Homing

If your X-axis homes to the right you have the X belt connector placed at the bottom instead of top of the X-axis carriage.

6.1.3 Bronze Shim Washers

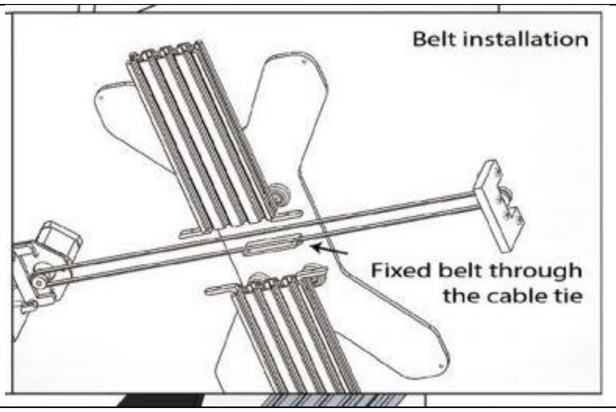
The BW manual advices to mount 1 mm bronze shim between the X-axis and the mini wheel's carriage. This is usually not necessary, and in many cases would lead to improper alignment of the frame. Refer to the [Parallel & Square] document for proper alignment procedure.

6.1.4 X-belt Idler Pulley –Type

	20T Ø5mm Bore 6mm GT2 Belt Toothed idler pulley aluminum with bearing. As the belt is running in the teeth there is less ripple then with the original tooth-less idler pulleys.

6.2 Y-Axis

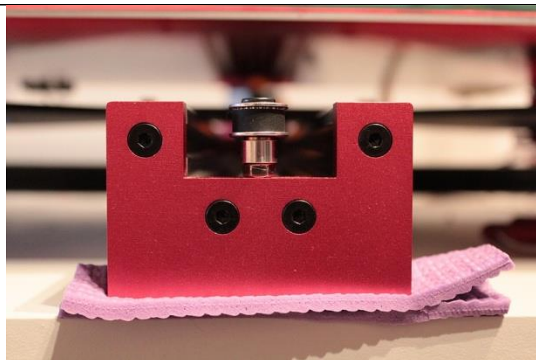
6.2.1 Wrong Y Homing

	If your machine homes the print bed to the front 99.99% you put the belt connection at the left hand side seen from the front. The correct place is the right hand side as mentioned in the building manual.

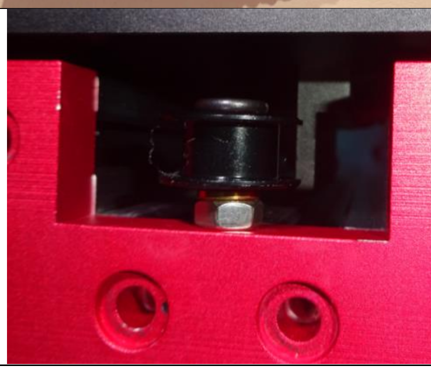
6.2.2 Y-belt Idler Pulley –Type

	20T Ø5mm Bore 6mm GT2 Belt Toothed idler pulley aluminum with bearing. As the belt is running in the teeth there is less ripple then with the original tooth-less idler pulleys.

6.2.3 Y-belt Idler Pulley – Assembly

<table>
<tr><td></td><td rowspan="2">Depending on the Y-wheel assembly, and your specific kit, you may need between 2 shims (2mm) and full spacer (6mm) in order to align the Y-belt idler with the rest of the system.

If you need the wider spacing, and don't have a suitable spacer, you may add two M5 nuts between the supplied nut and the supplied shim.

The following video shows how to do this alignment: Here.</td></tr>
<tr><td></td></tr>
</table>

6.3 Z-Axis

6.3.1 Wrong Z Homing

If you have a new machine with the factory installed firmware and you home the machine and the Z axis goes only up there is probably installed the wrong firmware / BL-Touch combination!
Also check if you use a BL-Touch you need to connect the three wire cable to **Servo port 1**
For all newbies best advice is ***not to use*** the BL-Touch at first yet. First install **STOCK FW** version which uses the stock proximity/inductive Z-min endstop switch. Get used to manual bed leveling and later install the BLT when you feel comfortable and then use the **BLT FW** version. (BLT, is BL-Touch, is Bed Level Touch)

6.3.2 Z bottom and top plate bearing fitting not correct (Duplicate 2 of 2)

<table>
<tr>
<td>


</td>
<td>
If you experience play on bearings, use the following tip.

Use regular thin paper and glue with a little bit of glue stick glue the piece to the outer race of the bearing and with care slide both in place.
All depends on the play. When ready remove the paper remains not needed.
If you experience such play you can use this trick temporary and file a support ticket at TEVO for a correct version.

Bearing type: MR688ZZ, ID: 8mm; OD: 16mm; Width: 4mm.

Please note
Some suffixes, e.g. ZZC have 5mm width. They might fit, however this has not been verified.
</td>
</tr>
</table>

6.3.3 Z-Wheel Plates

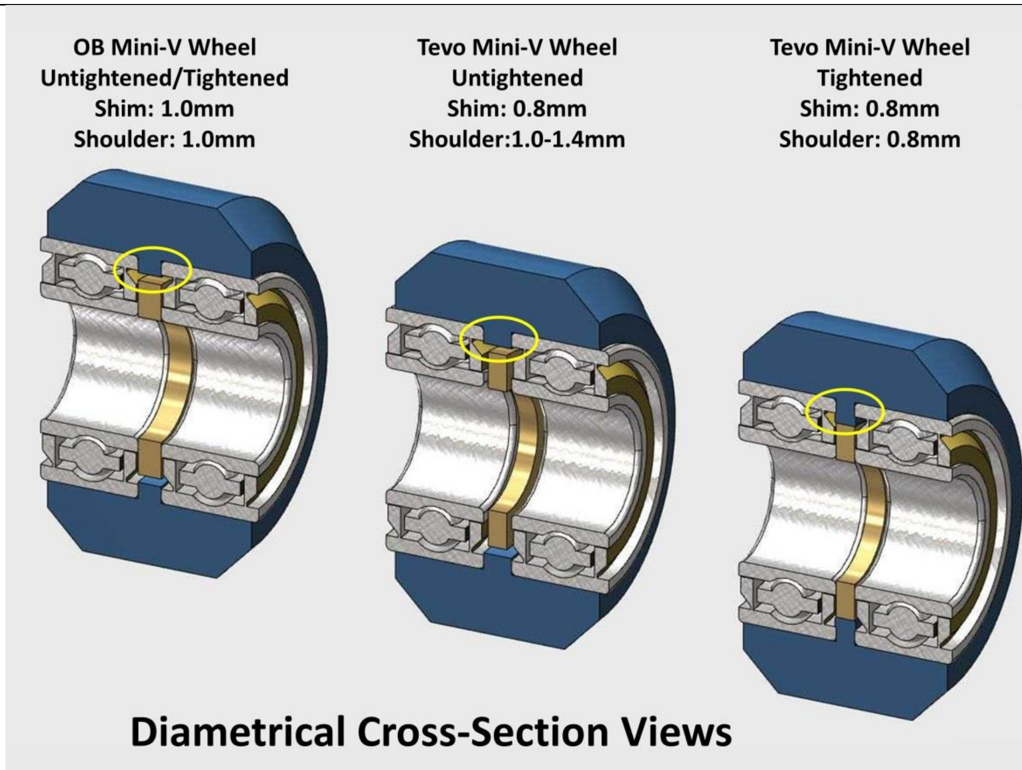
	As of Apr-2017, The stock Z-wheel plates come with tapped M5 holes for the POM ACME nut screws. In order to lock the screws, you need a regular nut. In the older version, the holes are not tapped, and a Nylock nut is needed to lock the screws.

6.4 Wheels

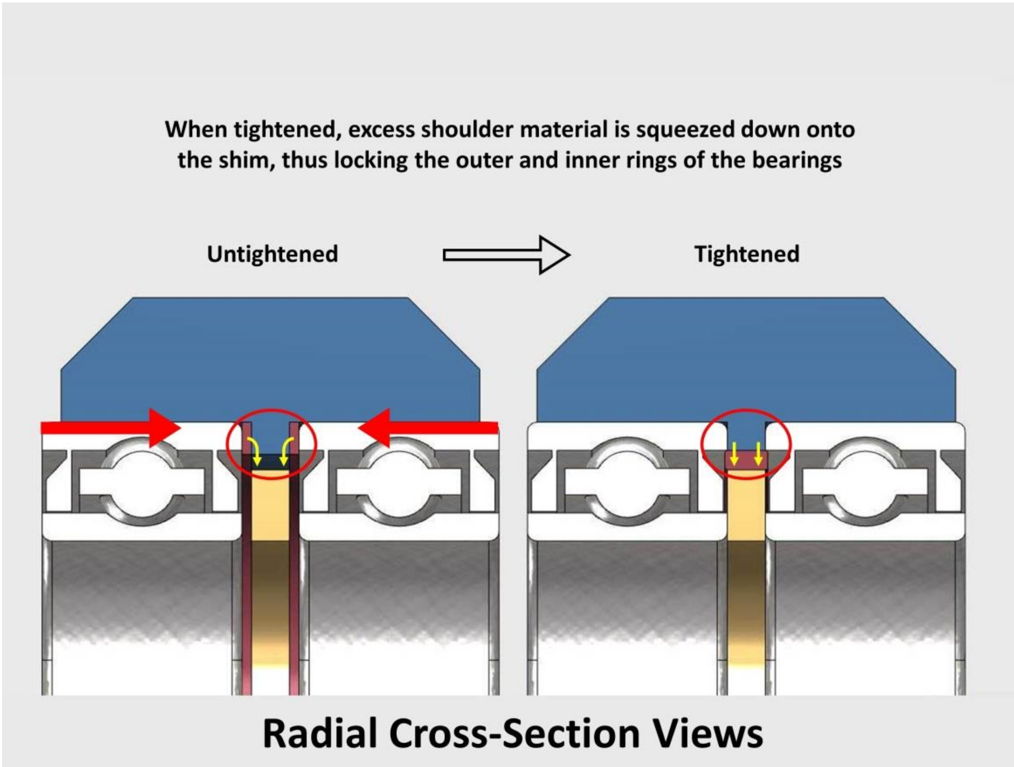
6.4.1 "Sand feeling" or "locked" wheels

These are dissects of two Tevo Mini-V wheels, and one OB Mini-V wheel.
Watch the shoulder width.

Tevo wheels have 2 issues: 1) Thinner shim & 2) Thicker shoulder



Below picture shows the locking mechanism.



Corrective actions:

1) Try untightening the wheel to find the sweet spot where the wheel doesn't lock or has the "sand feeling", however still doesn't wobble.
2) If there is no such sweet spot in your case, replace the 0.8mm shim with 1.0mm one.
3) If it is not enough, increase the width of the shim. There are cases where up to two 0.8mm, totaling 1.6mm width, were needed for proper operation.

Please note
Using steps 2 or 3 would increase the width of the X-Gantry. For proper operation of the Z-system, you would need to compensate this increased width as described in the "Square & Parallel" annex.

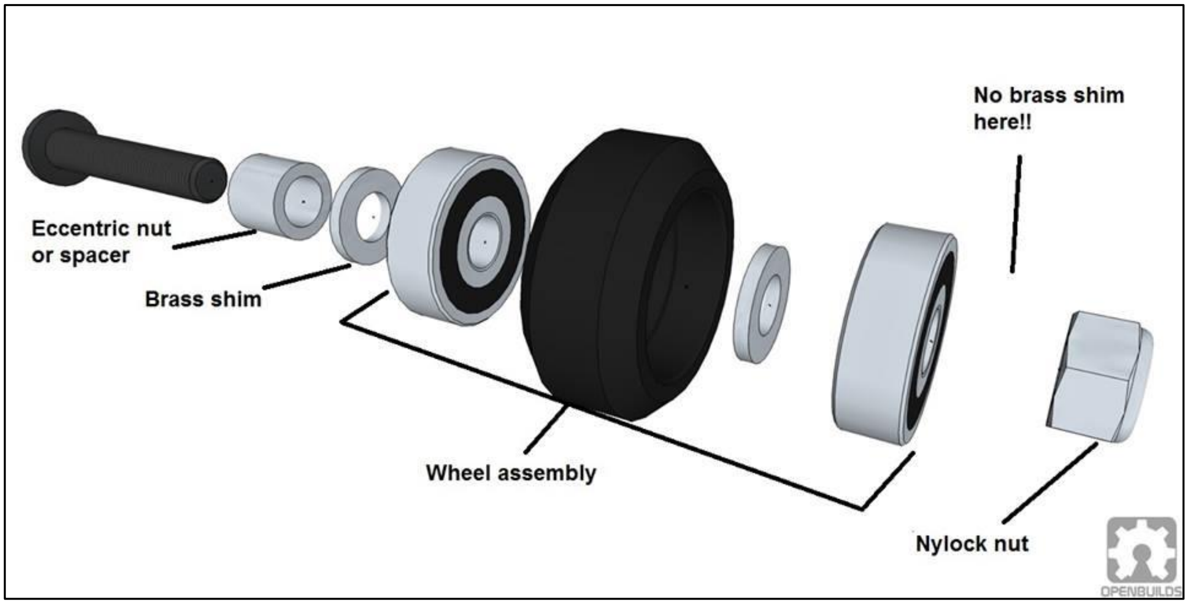
Please note
At some unknown time, Tevo has increased the shim width to 1.0mm. If this is your case, then corrective action #2 is already done and you should go from corrective action #1 to #3.

6.4.2 OB (OpenBuilds) Replacement Wheels

	If you have problems with the small stock wheels used in the Z-plates, 8 in Total. The OB name for these is "Mini-V Wheel". http://openbuildspartstore.com/xtreme-mini-v-wheel-kit/ or http://openbuildspartstore.com/delrin-mini-v-wheel-kit/
	If you have problems with the large stock wheels used for the X and Y axis, 7 in Total. The OB name for these is "Solid-V Wheel". http://openbuildspartstore.com/xtreme-solid-v-wheel-kit/ or http://openbuildspartstore.com/solid-v-wheel-kit/

6.4.3 OB Wheels Assembly

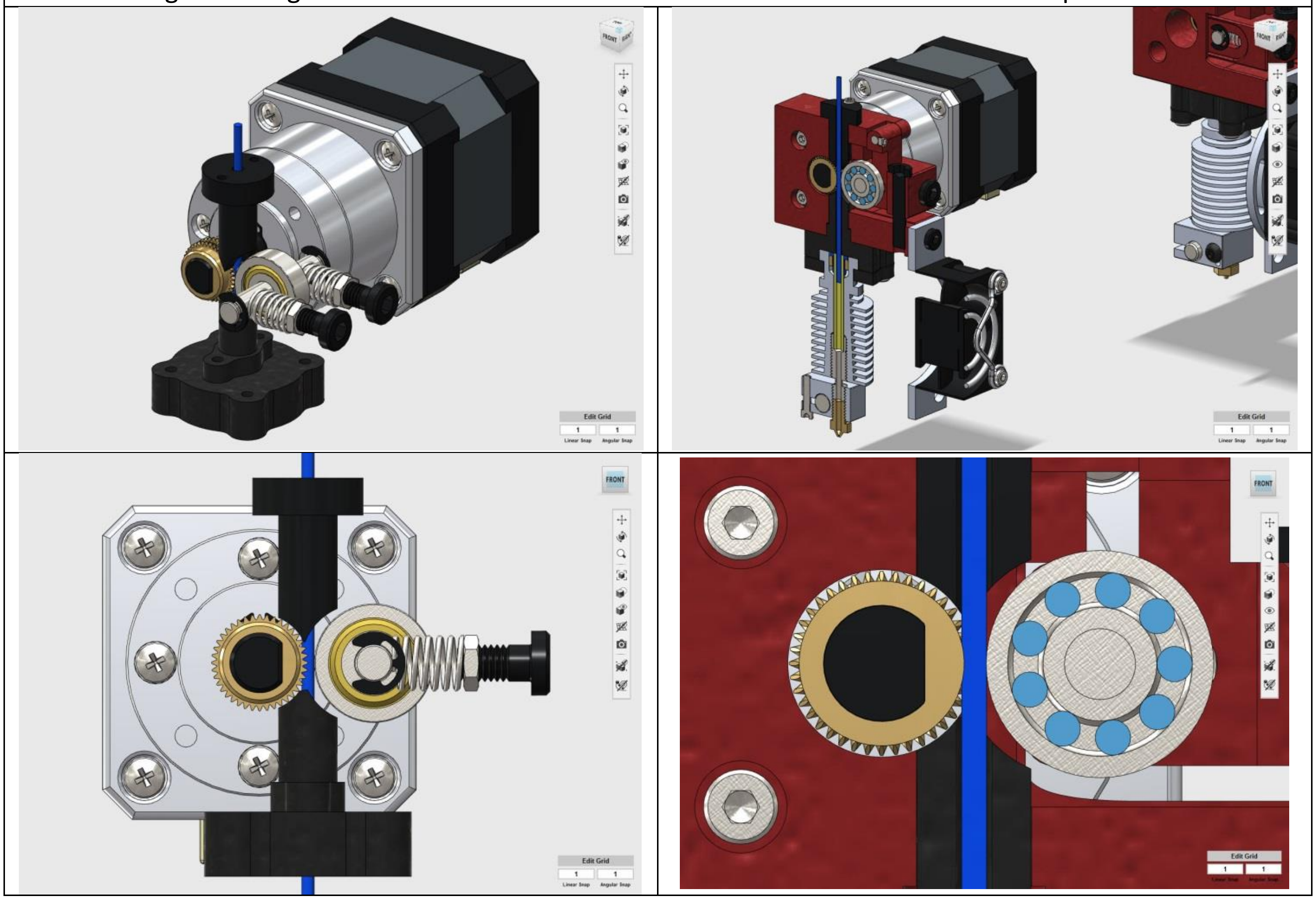
The following diagram applies to both the Mini-V and the Solid-V wheels.



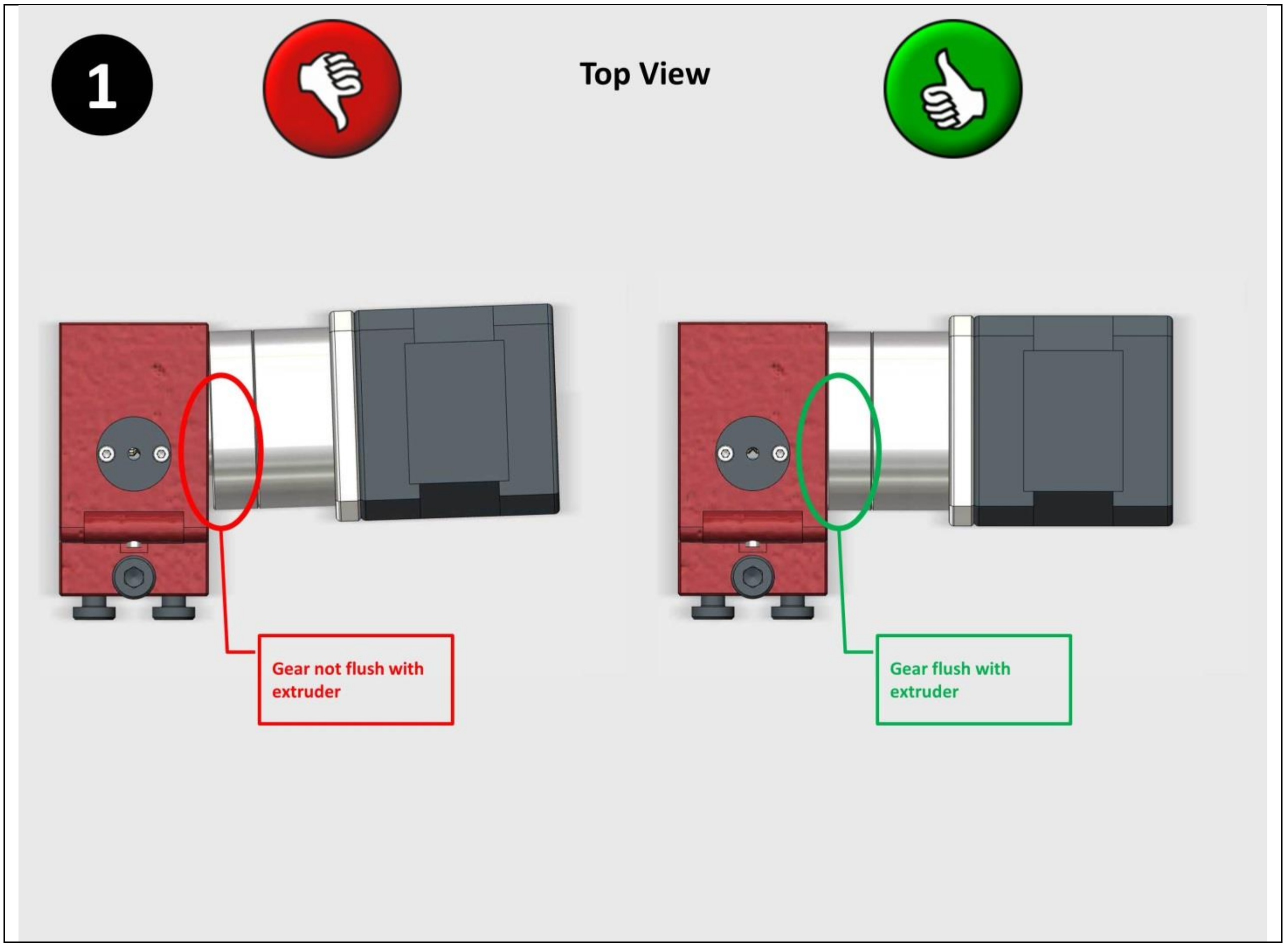
6.5 Extruder

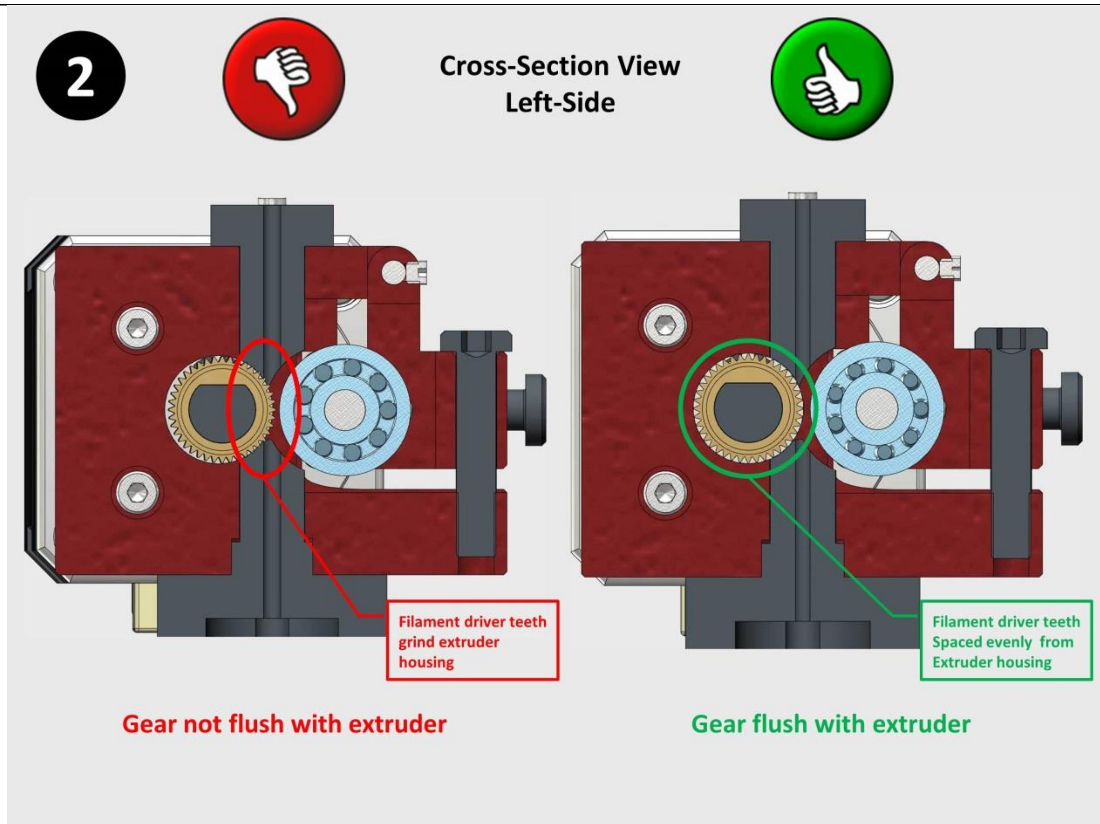
6.5.1 Construction and operation

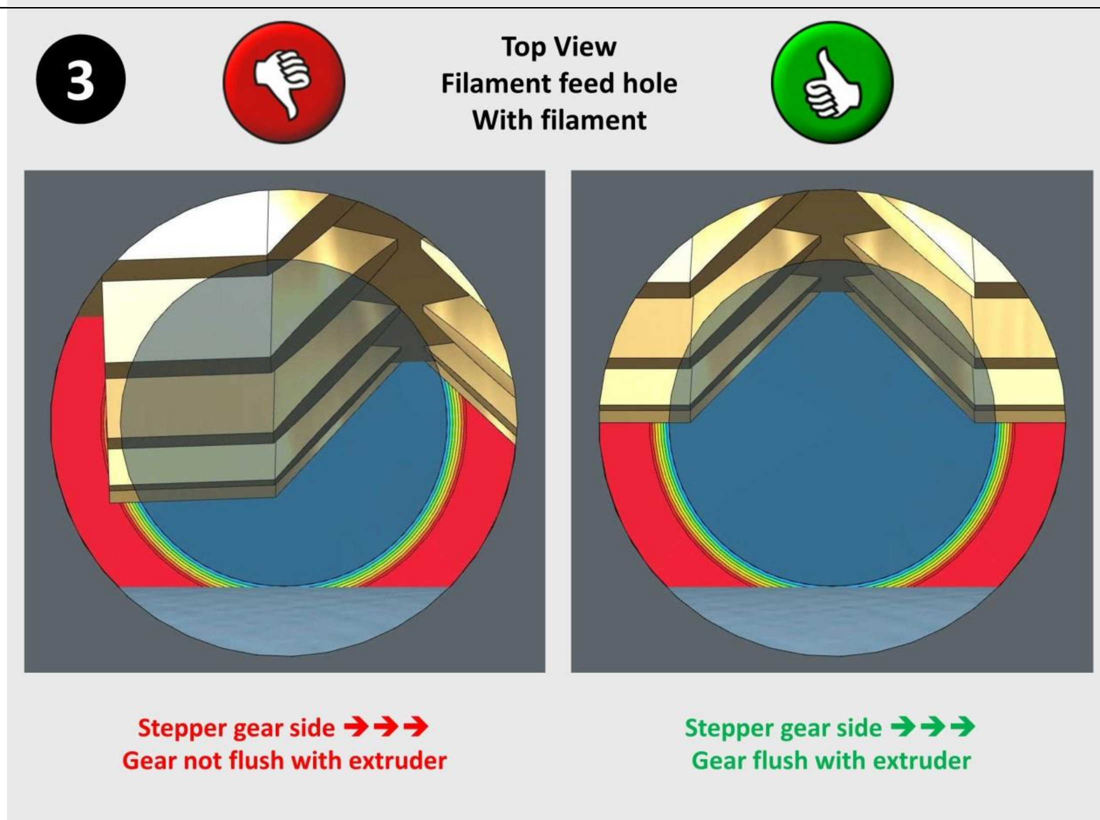
The following renderings and cross sections show how the extruder is constructed and operates.



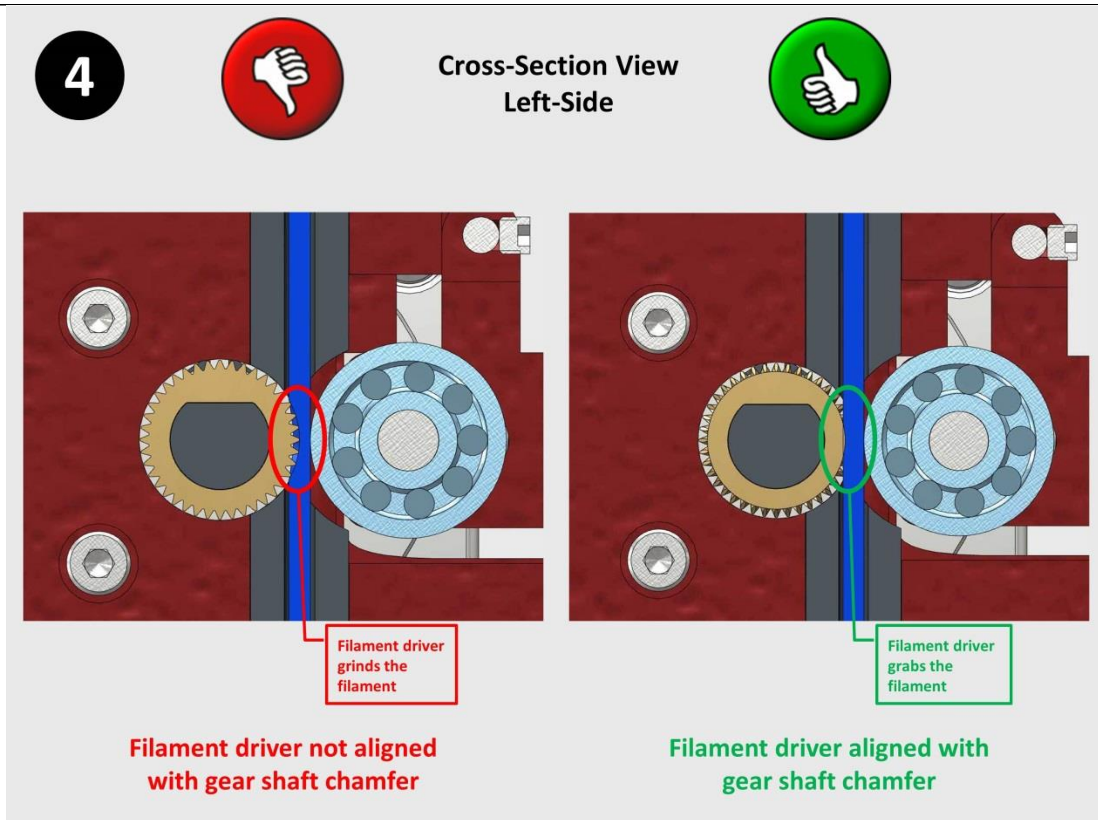
6.5.2 Misalignment of the stepper motor gear

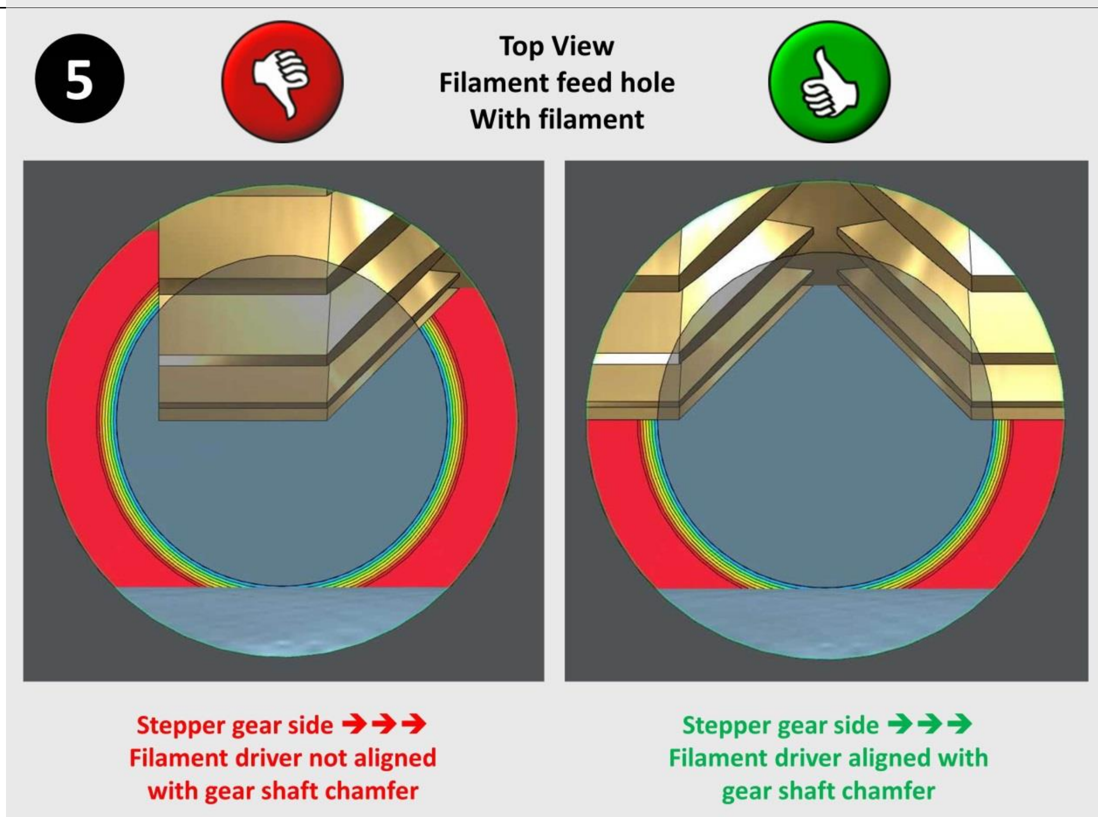



2
Cross-Section View
Left-Side
Filament driver teeth grind extruder housing
Filament driver teeth Spaced evenly from Extruder housing
Gear not flush with extruder
Gear flush with extruder

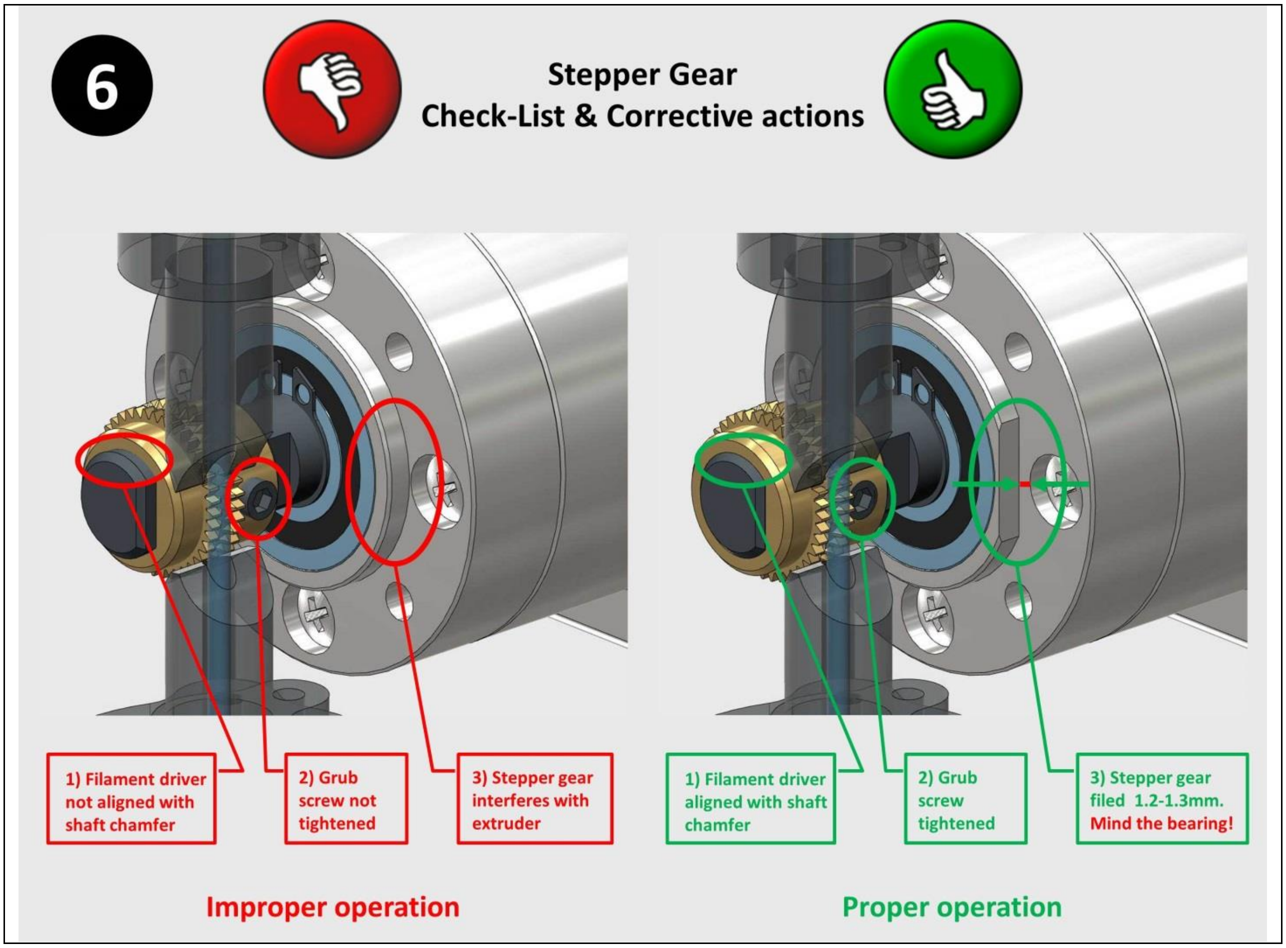

3
Top View
Filament feed hole
With filament
Stepper gear side →→→
Gear not flush with extruder
Stepper gear side →→→
Gear flush with extruder

6.5.3 Misalignment of the filament driver





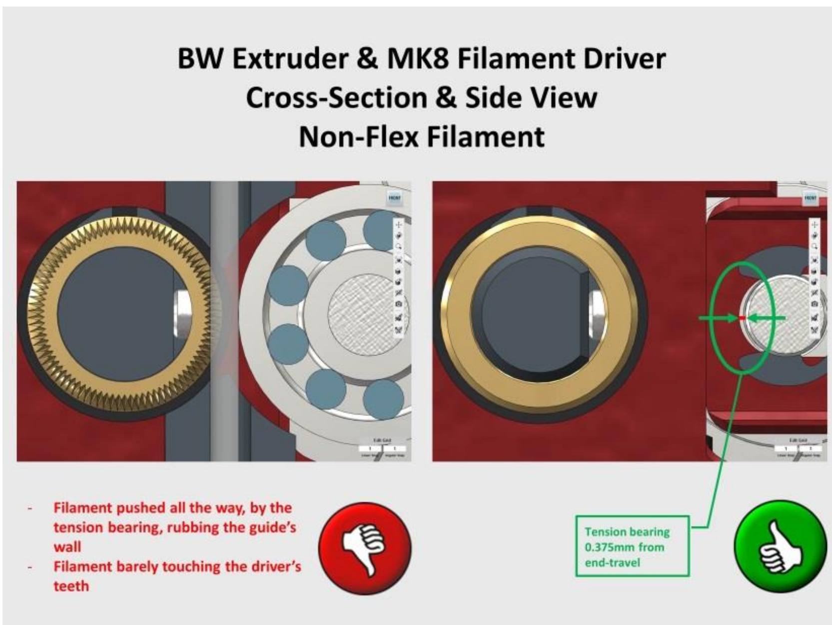
6.5.4 Check-list & Corrective actions (Revised section)

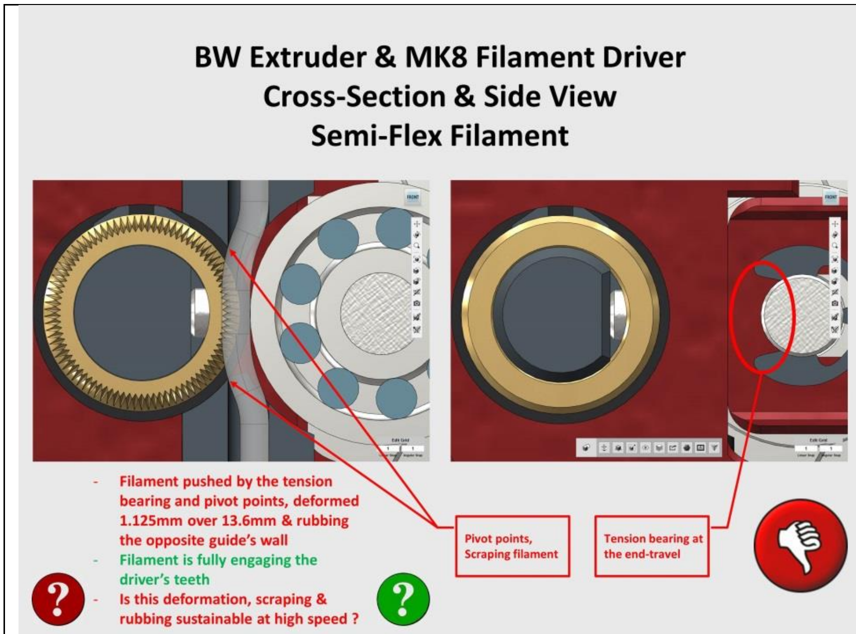


Please note

As of Jul-2017, there are few owners who received their extruders "pre-filed", see item #3 in the above picture. We are still awaiting confirmation from TEVO whether this is a permanent change, or only a test batch.

6.5.5 Using the MK8 filament driver

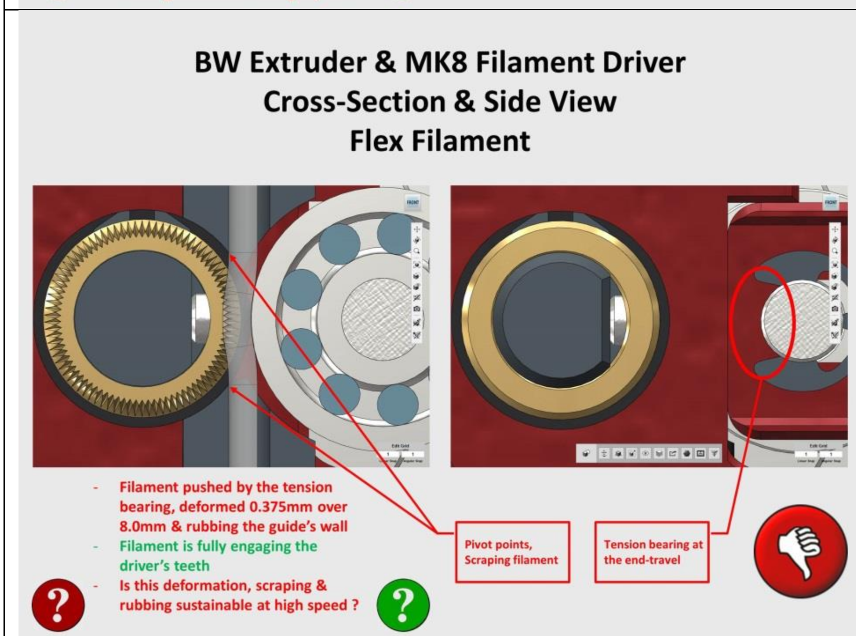
	To the left, the stock BW filament driver. To the right, the MK8 filament driver.
	<u>Non flex filament</u> **Does not work!**

<table>
<tr>
<td>


</td>
<td>

<u>Semi-flex filament</u>

Questionable!

</td>
</tr>
<tr>
<td>


</td>
<td>

<u>Flex filament</u>

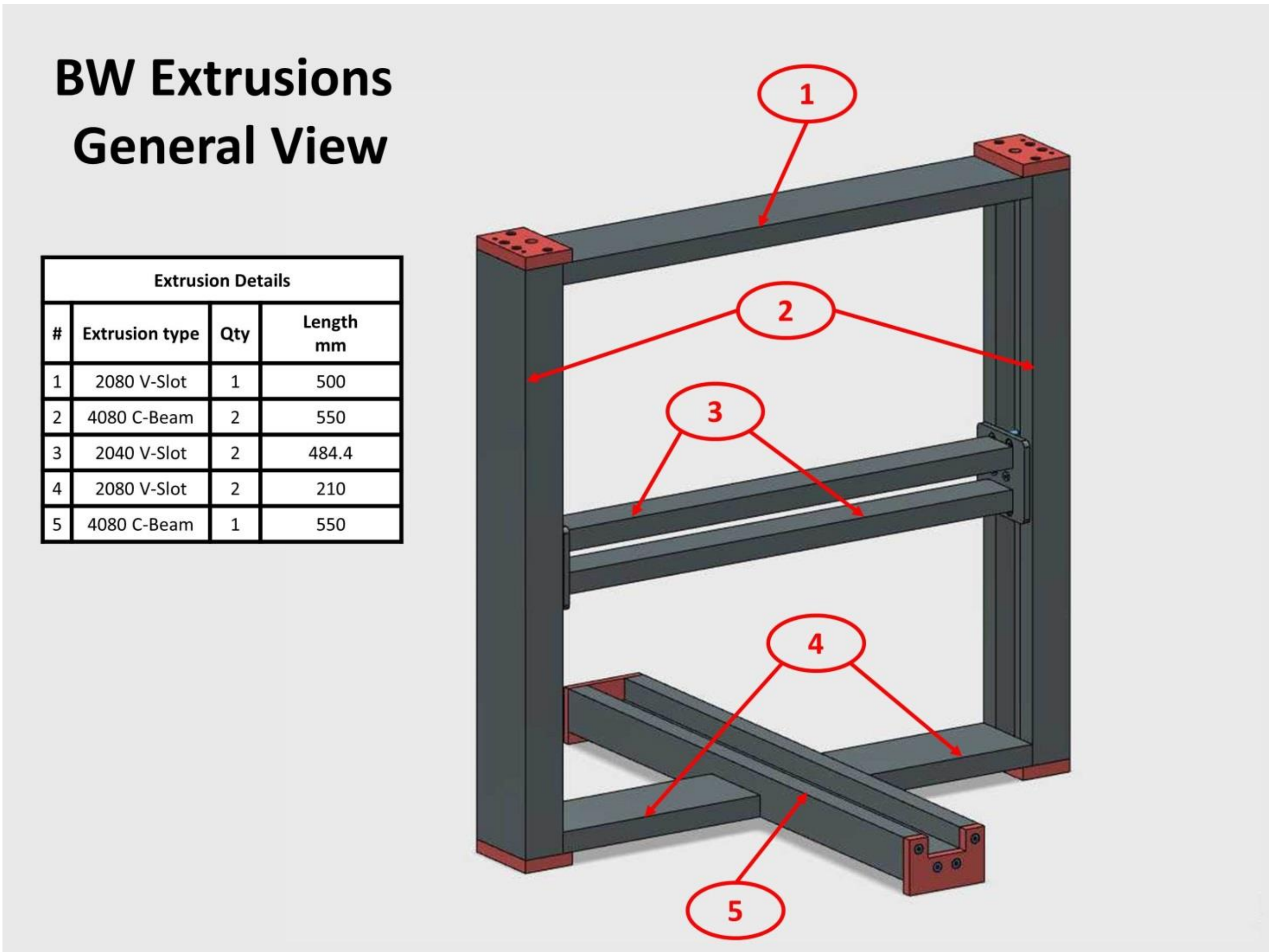
Questionable!

</td>
</tr>
</table>

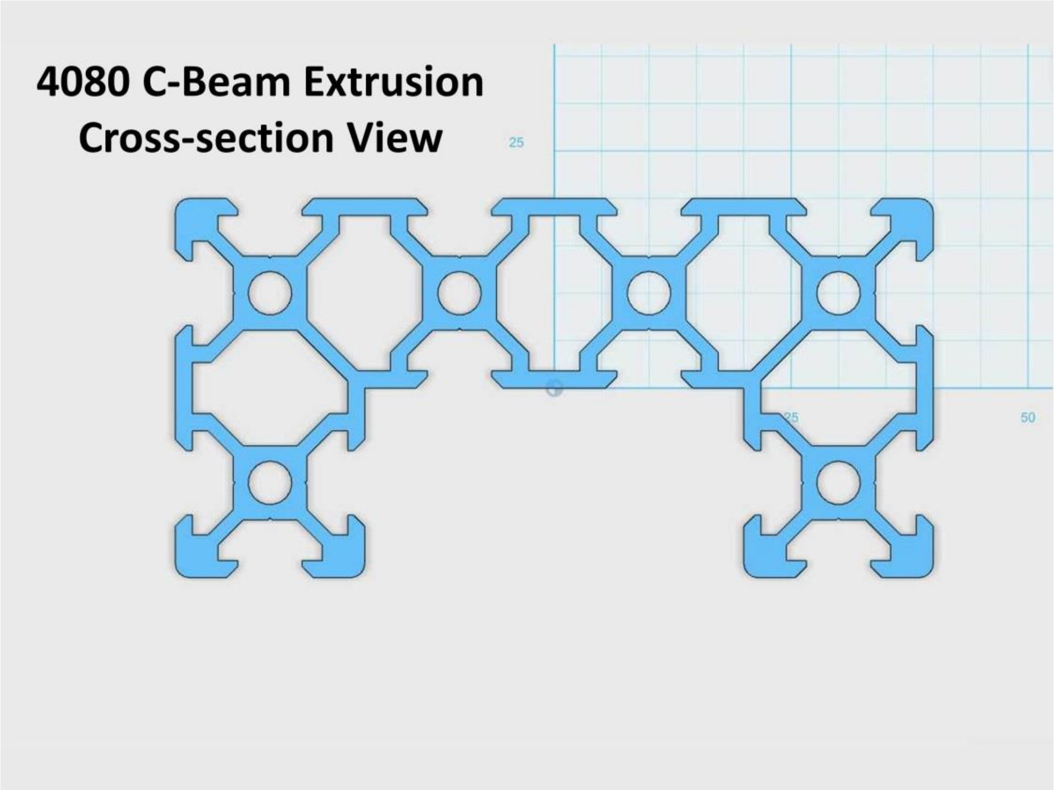
6.6 Extrusions

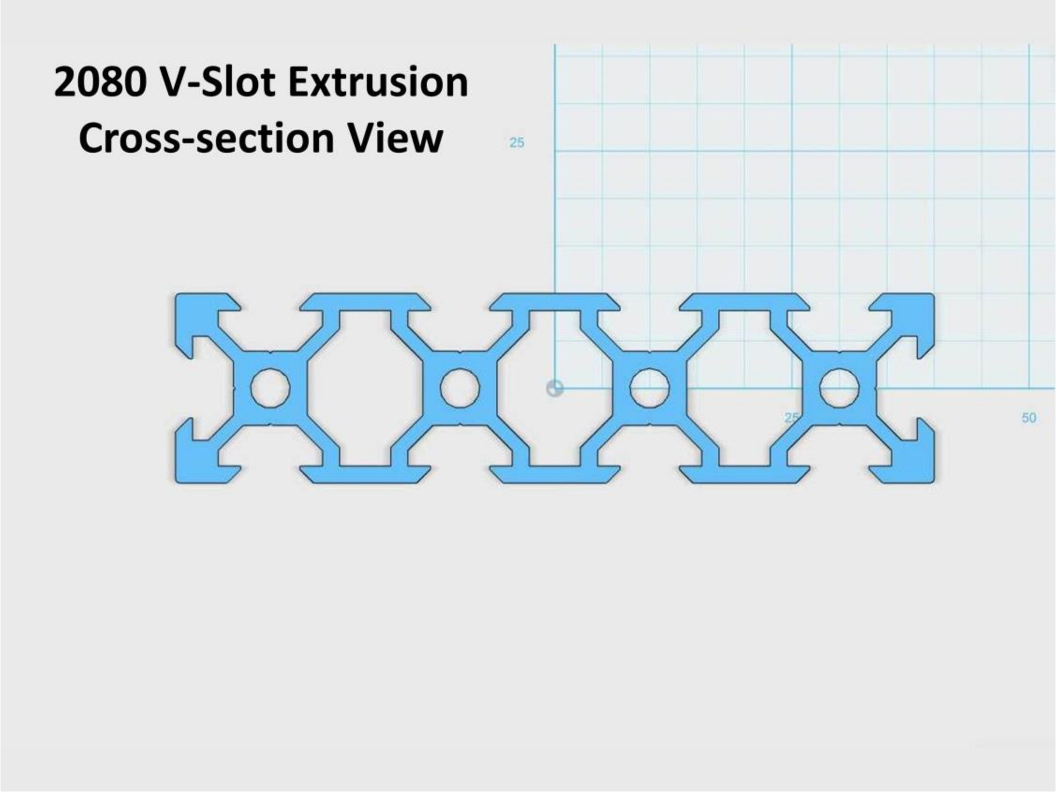
The following illustrations show the various extrusions comprising the BW frame.
The lengths shown in the table are nominal. Due to manufacturing/cutting tolerances the best you can expect these to be within +/- 0.5mm.

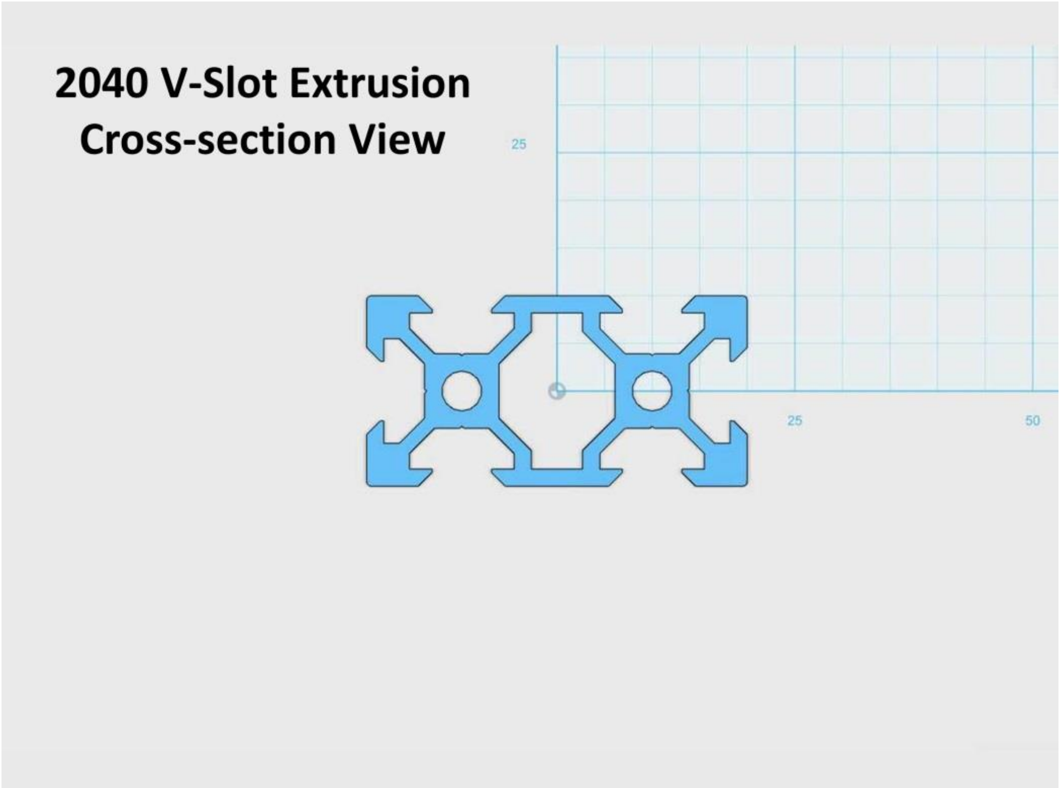
Please refer to **Annex 13.2, Square & Parallel**, in order to assemble these extrusions correctly.



Extrusion Details			
#	Extrusion type	Qty	Length mm
1	2080 V-Slot	1	500
2	4080 C-Beam	2	550
3	2040 V-Slot	2	484.4
4	2080 V-Slot	2	210
5	4080 C-Beam	1	550


4080 C-Beam Extrusion
Cross-section View
25
25
50


2080 V-Slot Extrusion
Cross-section View
25
25
50

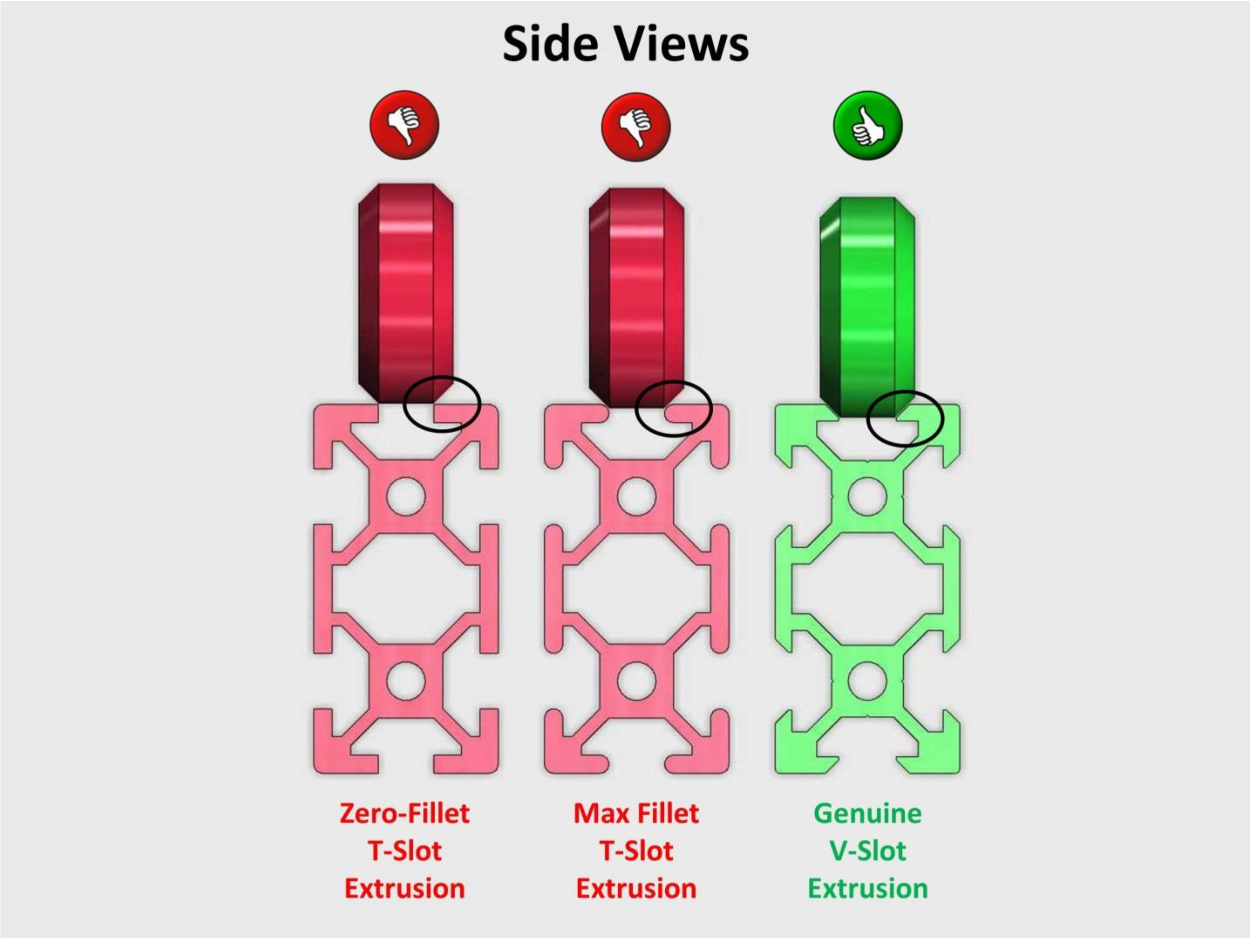

2040 V-Slot Extrusion
Cross-section View
25
25
50

The T-Slot version is a family of extrusions with varying fillet radius at the edges, from sharp edges shown as “Zero-Fillet T-Slot”, to full semi-circle edges shown as “Max-Fillet T-Slot”.

The V-Slot version is a special v-shaped extrusion profile, intended to be used as linear rail, in conjunction with the chamfered shaped wheels.

Please note

If you ever need to replace any of the BW extrusions, make sure these are genuine V-Slot type, as shown below. Some sellers claim V-Slot however selling a T-Slot version, which does not have enough contact area with the wheels, and would also cause accelerated deterioration of the wheels.



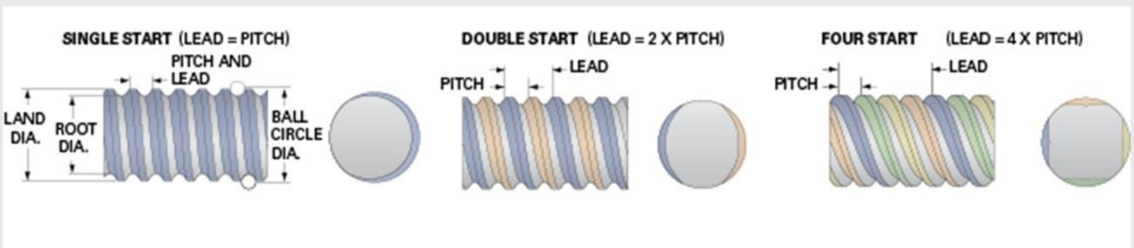
6.7 Leadscrews

The illustration below summarizes the basic information regarding leadscrews in general and the specific BW leadscrews in particular.

BW Leadscrew

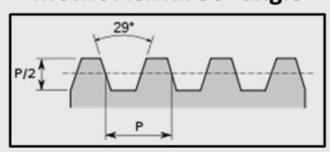
BW Leadscrew Details

Leadscrew type	Qty	Diameter mm	Pitch mm	Starts	Lead mm	Length mm
Metric ACME	2	8	2	Single	2	570



Lead: the distance along the screw's axis that is covered by one complete rotation of the screw (360°).
Pitch: The distance from the crest of one thread to the next.
Starts: The number of parallel, non-crossing, helix threads.
Relations: **Lead=Starts*Pitch**
ACME: Thread having trapezoidal profile.

ACME thread profile
Metric ACME: 30° angle



Standard Metric ACME nomenclature

TrDDxLL-PPp ([RH]LH)

Tr: Trapezoidal (In some places you will see "**T**" only)

DD: Diameter in mm.

LL: Lead in mm.

PP: Pitch in mm.

RH (Default) / **LH**: Right Hand / Left Hand.

Example-1

Stock BW: **T8x2** (Metric ACME, OD: 8mm, Lead=Pitch: 2mm)

Example-2

OB: **Tr8x8-2p** (Metric ACME, OD: 8mm, Lead: 8mm, Pitch: 2mm (4-starts))

Please note

There is a lot of confusion among the Ali sellers regarding the parameters of their leadscrews. Some of the sellers will not assume responsibility, unless you buy both leadscrew and nut from the same store, and some would even sell them only in pairs.
In any case you MUST make sure to specify the Tr/DD/LL/PP parameters listed above and depicted in the illustration in order to prevent confusion. Mentioning the "Starts" would not hurt either. And don't forget to specify the length you want, otherwise you'll get the store's default length.

Please note

OB leadscrews are 2mm pitch, 4-start, 8mm lead. They are good for fast Z travel, however you pay with resolution. If you are going to use these in your BW, make sure to order the ACME POM nuts as well, and adjust your FW Z-steps accordingly.

7 Electrical

7.1 Voltage Rating

All electronics like the power supply, heaters, fans on the machine are rated for 24 VDC.

7.2 PSU (Power Supply Unit)

If your machine does not power-up, check the following:

- That the 110/220 cables are connected correctly.
- That the power switch is working properly.
- That you have the correct AC voltage on the PSU's input terminals, 110 V_{AC} or 220 V_{AC} according to your locale.
- That the green LED on the power supply is lit then 110/220 V_{AC} is applied. If the green LED is not lit on the power supply, then the unit is probably defective, and you can create a support ticket with TEVO.

One known cause, which is relatively easy to detect, is related to the NTC (Negative Temperature Coefficient) resistor/resistors inside the PSU. These resistors decrease their resistance when the temperature rises. In the case of the PSU, they are used to reduce inrush current when the power supply is switched on. In 3DP we also find them as thermistors in both the hot-end and the heat-bed, as described in other sections of this document.

Please note
The following procedure is recommended for those who have the knowledge and skills with power electronics.

Warning
Opening the PSU, while the 110/220 V_{AC} mains power is connected may be lethal. Disconnect the PSU from the mains power, as well as from the control box, before attempting to open it.

Remove the top cover of the power supply unit, by removing the screws at the side.

Please note
In some PSU models, there are two of these NTC parts soldered in parallel on the PSU board, and labeled NTC1 & NTC2.

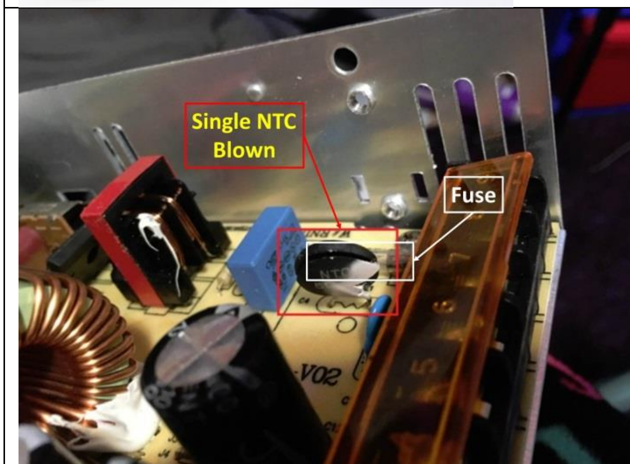
Per the pictures in the table below, and depending on your PSU model, visually check that the black NTC part/parts is/are still in good shape. If the part/parts is/are damaged, it is clearly visible, as can be seen in the picture below.

In case your PSU has 2 NTCs, and only one of them is damaged, then for safety reasons always replace both.

The table below detail the most common PSU issues.

Check the V_{AC} selector switch.
It should correspond to your locale, either 110 V_{AC} or 220 V_{AC}. If the voltage is set to 110 V_{AC} in a 220 V_{AC} location, then the heat-bed might give problems with heating.

Warning:
2 x 12 V_{DC}, PC (Personal Computer) power supplies in series will not work, and shouldn't be attempted.



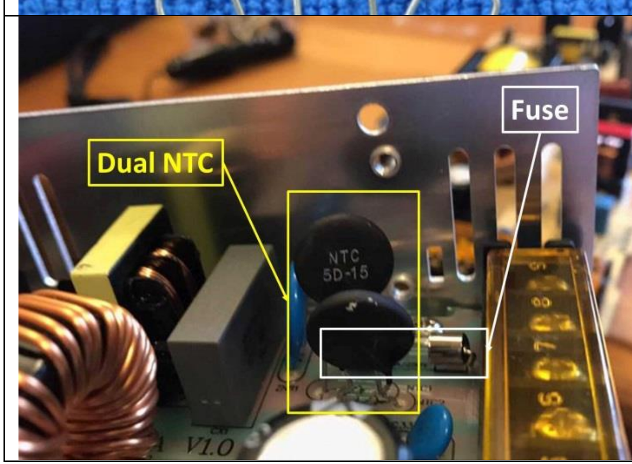
Check the NTC resistor.
If blown, as shown, it should be replaced with a proper NTC resistor, as detailed below.

If you're not into electronics and want to claim warranty submit a support ticket at http://www.tevoprinter.com/osticket/

Add a picture of the blown NTC resistor to the support ticket.

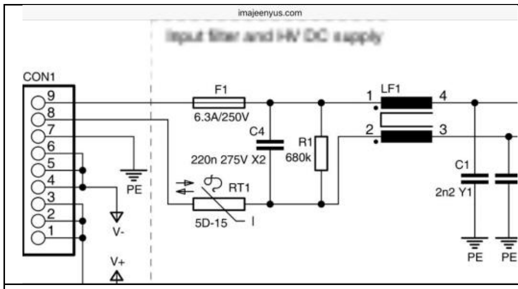
If you have the knowledge and the experience to remove (de-solder) the one or two NTC resistors, replace them with an **NTC 5D-15** version only.

Example eBay link



Check the fuse.
When blown, usually the glass cylinder becomes grey or black on the inside. To make sure, measure it with a digital volt meter on OHM range.

If the fuse is blown replace it with a fuse which has the same rating only.



An example of the NTC and fuse schematics.
The NTC resistor is marked RT1.
The fuse is marked F1.

From 11-Nov-2016 BW printers are equipped with updated power supplies, rated @ 500W (24V_{DC} /21A).
If you want to have a spare or replacement PSU, then replacement PSU should have a minimum of 600 Watt rating (24V_{DC}/25A).

Recommended PSU unit is the **Meanwell SE-600-24**

Please note
Higher Watt power supplies might have different dimensions!

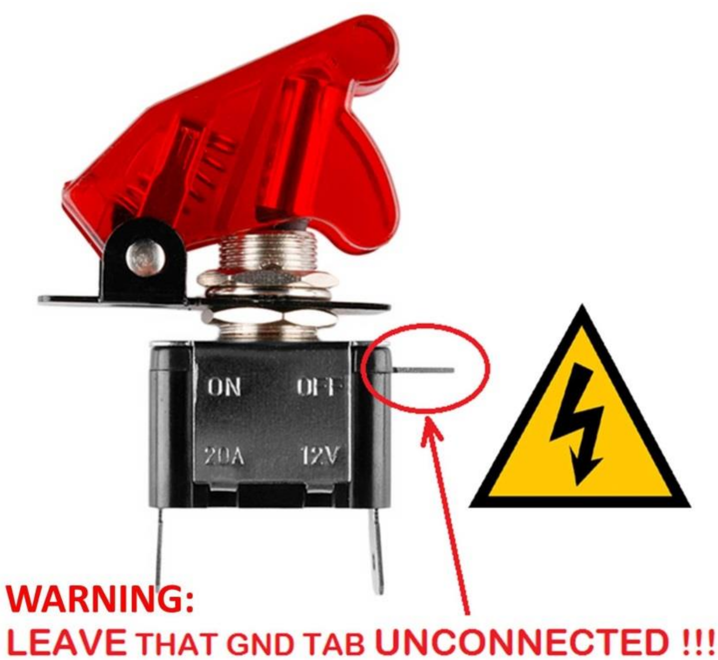
7.3 Power On/Off Switch

The first series of machines were equipped with a low quality power switch. If you press the power button switch and the machine is not any more powered ON or OFF then the switch is defective. This is a known issue at TEVO. You can issue a support ticket for a replacement part. **http://www.tevoprinter.com/osticket/**

If the switch stays in ON position you can unplug the power cable to stop the machine. If the power button switch is in the state that it is OFF you have to replace the power button switch or bridge the switch (take care this switch carries 110/220 VAC lines).

<table>
<tr>
<td></td>
<td>Power switches V1 & V2 were the illuminated type, rated for 220VAC.

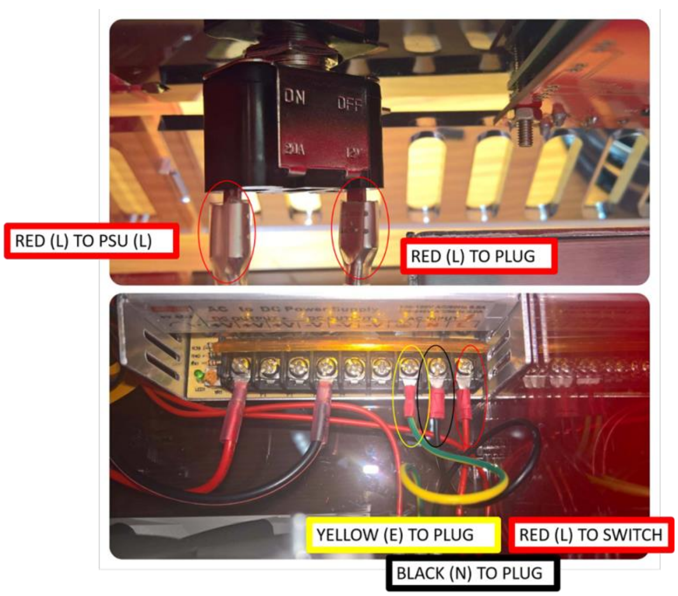
The difference between V1 & V2 supposedly was better quality, as V1 tended to get stuck in the "ON" position, without enabling the "OFF" position.

In practice, it was found out that V2 has had the same problems, and was replaced by V3 in the next section.</td>
</tr>
<tr>
<td></td>
<td>From 11-Nov-2016 all the machines are shipped with a different switch, V3 The switch has a rating of 12 VDC/ 20A however has no 110/220 VAC rating.

Warning
The GND terminal of the switch MUST NOT BE CONNECTED TO EARTH-GROUND!!! Doing so would short the high voltage to ground, through the internal LED and 1 KOhms small resistor.

It is recommended that you will replace the switch with a one rated for 110/220VAC, like the one in the following picture, or similar</td>
</tr>
</table>

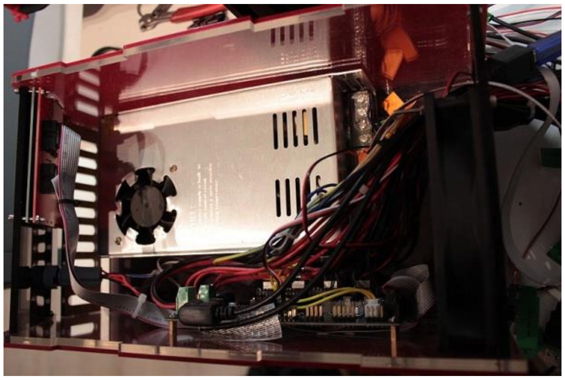
<table>
<tr>
<td>
</td>
<td>This is how it looks like if you don’t follow the warning/

<u>Warning</u>
Either the LED, or the series resistor, or both will blow, and the residues which are conductive will short the high voltage mains to ground.</td>
</tr>
<tr>
<td></td>
<td>You can buy a simple round ON/OFF switch like this one. The 110 VAC/10A – 220 VAC/6A rating is more than enough to switch the 110/220 VAC side of the power supply. Click on the picture for an eBay seller.</td>
</tr>
<tr>
<td>
</td>
<td>With the new supplied power switch from TEVO you need to route the 110/220 VAC wires as shown on the pictures.

<u>Warning</u>
1) The Earth-Ground (E) wire is either colored Green, or Green/Yellow stripes. In older kits, this wire was missing, and should be added for your protection.

2) There were kits with different color schemes for the Live (L) and Neutral (N) wires. If you are in doubt, you should consult a certified electrician, as if wired incorrectly, it may pose a SAFETY HAZARD.</td>
</tr>
</table>

7.4 EMI (Electro-Magnetic Interference)



When you are printing direct from a SD (Secure Digital) card and you have random problems during printing like reverse extruding, motors stopping, shifting layers and other unexpected movements make sure the grey LCD (Liquid Crystal Display) cables are not running over the power supply. If you use a SD card for printing the data from the card to the main board gets corrupted due to electronic signals from the power supply. Reroute the cables away from the power supply like the picture shows.

SD Association

You are advised to use a known working SD card to start with. If there are problems with the gift SD card that comes with the machine, you should replace it. Also low format any SD card before use. Click on the logo left for the formatter.

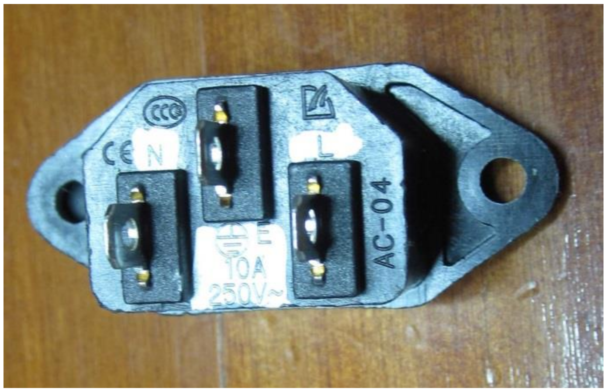
7.5 Wiring

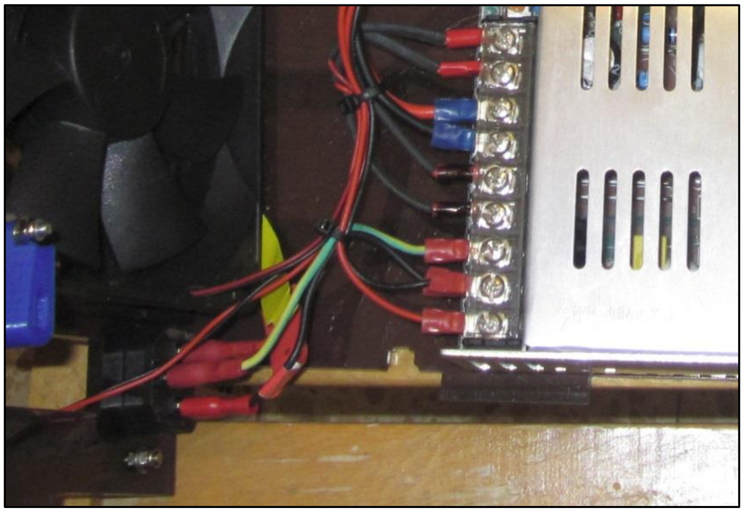
7.5.1 Earth Ground

The Earth-Ground (E) wire is either colored Green, or Green/Yellow stripes. In older kits, this wire was missing, and should be added for your protection. As shown in the pictures, it is connected between the (E) terminal on the PSU's terminal strip, and the corresponding terminal on the power plug.

Warning

If you are in doubt how to do it, you should consult a certified electrician, as if wired incorrectly, it may pose a SAFETY HAZARD.


CE
N
L
E
10A
250V~
AC-04



7.5.2 Crimped Wire Terminals

Crimped wire terminals are preferred over either soldered terminals or bare wires, as they withstand vibrations and prevent shorts with adjacent circuits. Using these will prevent most of the connector melt-down issues. The following tables summarize the recommended terminals and crimping tools for the required applications.

	Single Crimp – Not recommended	**Double Crimp - Recommended**
Description	1) Plastic sleeve extends just about the metal barrel. 2) Metal barrel having one diameter throughout, allowing for crimping only the wire strands, not the wire coating. 3) In the case of a single-crimp terminal, the crimper tool crimps at a force determined by the user hand. 4) Additionally, in the case of a double-crimp terminal, the crimper tool crimps at once only one side of the wire, either the strands, or the coating. Thus two crimps are needed to complete the operation. This may lead to stress between the two crimping points which will lead to a premature failure.	1) Plastic sleeve extends few mm beyond the metal barrel. 2) Metal barrel having two diameters, allowing for crimping the wire strands, as well as the wire coating, thus providing strain-relief. 3) Crimper tool crimps at once, both the wire stands, and the wire coating sides of the terminal, at a predetermined force required by the specs, for durable operation.
Terminal		
Crimper Tool		

Color / Type	Red	Blue	Yellow	Recommended use
Gauge Note-1	**22-18**	**16-14**	**12-10**	
Ring Note-2	 9A-17A	 18A-30A	 35A-50A	**M4** ring for PSU terminal block.
Pin Note-3	 9A-17A	 18A-30A	 35A-50A	For MKS-Gen Green Screw-terminals, e.g. H_1, H_0, Fan, Bed & PSU.
Blade Female Note-2	 3A-7A	 10A-15A	 20A-24A	Insulated, for quick disconnect, e.g. PSU to MKS-Gen lines. **Recommended 6.35mm (0.25”) width blades.**
Blade Male Note-2	 3A-7A	 10A-15A	 20A-24A	Male types suitable for the Female types above. **Recommended 6.35mm (0.25”) width blades.**
Blade Female				**Caution** **These are NOT recommended as they are uninsulated type, which may cause shorts.**
Spade Note-2	 9A-17A	 18A-30A	 35A-50A	**M4** spade for PSU terminal block, in case the PSU is in location where the terminal screws are difficult to reach.
Butt-Splice Note-4	 9A-17A	 18A-30A	 35A-50A	For wires requiring permanent extension.

Please note

1) AWG (American Wire Gauge) number decreases, as the wire diameter increases, therefore the lower the AWG number, the higher the current rating.

2) Current ratings (A) for the Ring, Blade & Spade types are taken from Farnell specs.

3) Current ratings (A) for the Pin types are assumed to be the same as for the Ring types, as these types are clamped by screws.

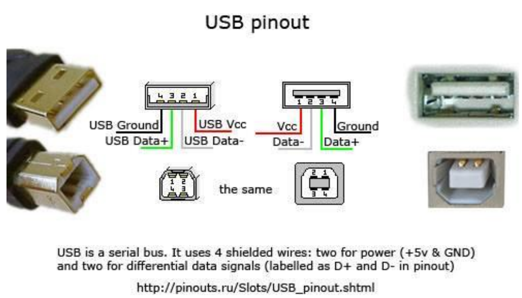
4) Current ratings (A) for the Butt-splice types are assumed to be the same as for the Ring type, as the region between the 2 crimped wires is a solid metal.

The following table summarizes the crimped terminals nomenclature, as it is used by some vendors, which will help you when ordering these.

Type	Nomenclature
Ring	RV(x)-4 for 4mm screws (m4), where (x) should be replaced with 1.25 for 16-22AWG, 2 for 14-16AWG, 3.5 for 12-14AWG and 5.5 for 10-12AWG. E.g. if you're crimping a 12AWG wire you would look for RV3.5-4 or RV5.5-4 (both would fit 12AWG) on the various sales sites.
Pin	PTV(x)-9 or PTV(x)-10 where x remains the same as before specifying the AWG and 9 or 10 are the length of pin terminal (9 and 10 being the most common between all AWG sizes except for 10-12AWG who only have a 13 model IIRC).
Blade Female	FDFD(x)-250 (for the double insulated female), where x again represents the AWG and 250 is for the 0.25" (6.35mm). E.g. a female 12AWG 0.25" would be FDFD3.5-250 (or 5.5-250).
Blade Male	MDD(x)-250 (for the male), where x again represents the AWG and 250 is for the 0.25" (6.35mm). E.g. a male 12AWG 0.25" would be MDD3.5-250 (or 5.5-250).
Spade/Fork	Same nomenclature as Ring-type, except SV replaces RV. Therefore in the Ring-type example above for a 12AWG wire to an m4 screw you would look for SV3.5-4 or SV5.5-4
Butt-Splice	BV(x) - where x is the yet again the convention mentioned above. E.g. for 12AWG you would use BV3.5 or BV5.5.

7.5.3 USB (Universal Serial Bus) Cable

If you use a USB cable to print or to upload firmware you might opt for this kind of **angled USB adapter cable**. With this cable the cover of the control box can be closed!



Please note
When using the stock MKS-Gen controller, or any other Arduino/RAMPS derivative, and you need the USB cable connected:
In order to prevent damage to certain add-ons, e.g. TMC2100 drivers as cautioned in Section 8.1.3, you should cut the 5V line from the cable. Another option is to pull out the 5V pin from the connector header.

7.5.4 Layer Cooling & Layer Cooling Fan

Filaments might benefit if they are cooled when they leave the extruder nozzle in molten state, other filaments may not be cooled.

Cooling table	PLA	ABS	PETG
Regular layer	YES	NO	NO
Overhang	YES	NO	YES

PLA is known to have a better print quality finish and less warp/curling/lifting on the edges when cooled properly. Also overhangs look better when cooled down properly.

ABS however may not be cooled at all during printing as this introduce warp/lift/curling

PETG might can be cooled at overhangs but for other printing no object/layer cooling is advised.

The filament leaving the nozzle is in a molten state and first need to stick to the heat bed or next layer. Once the first layer is on the heat bed or next layer you need to cool it to make it from molten to fixed state.

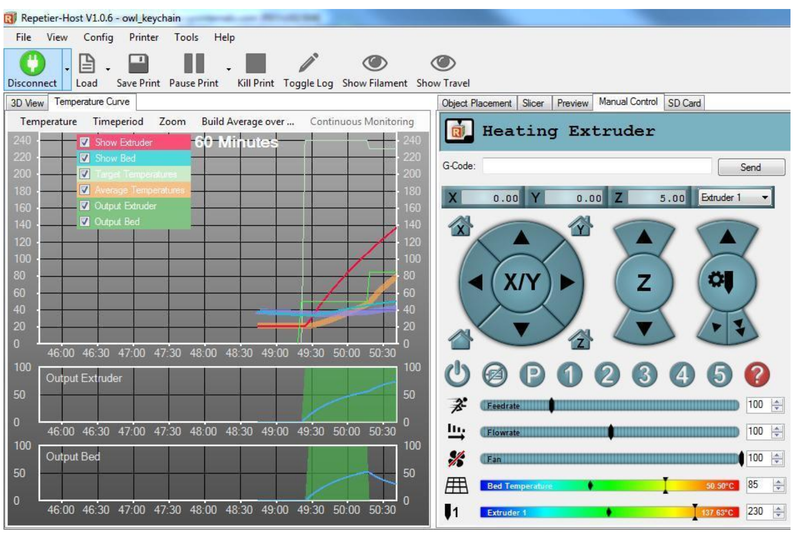
So put cool air on the layer when laid down and it has no time to warp, but if you cool the first layer it might not bond to the heat bed. So it is advised to skip cooling the first layer and preferable the first few like 0.6 mm. This can be selected and set in your preferred slicer.

If the nozzle is near the heat bed and you push a lot of cool air through the fan duct it will be reflected by the heat bed and results in an uncontrolled nozzle cool down. It might that Marlin based firmware as used in the Black Widow will show a thermal runaway if the cooling is to effective while printing.

So putting 2 fans to cool the object is overkill. What we are looking for is a fan with a fan duct that runs at a rate without cooling down the nozzle, less noise as possible with the lowest weight as possible. More is not always better…………….

How to setup an effective cooling system.

In Repetier HOST connect the machine by USB. We assume the object/layer fan is connected to the FAN port on the MKS GEN V1.3 or V1.4 main board. This port can be controlled by G-code to set the speed in real time or in the slicer G-code by PWM mode.



In the Manual Control section home first X/Y and Z in this order and if it is not the case move the nozzle to the center of the heat-bed with the cursor control.

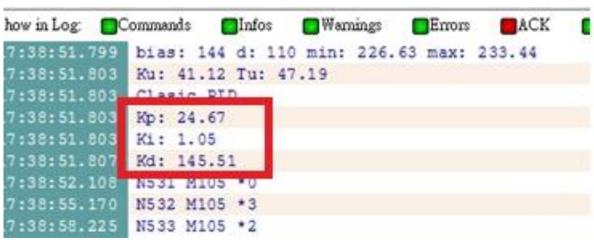
In the Manual Control section:
Heat the heater to 220 degrees Celsius and when it has reached this value let it idle for 3 minutes.
Heat the heat-bed to 60 degrees and let it idle for 3 minutes.

Now use the FAN slider and set it @ 10 %. Check if the fan is working as some fans need a higher value to start turning. Check on the temp graph and the nozzle temp value in the slider graph and watch if the temp goes down or stay stable. The lowest value at which the fan is working is your minimum Fan cooling value.

If the temp is not influenced and stays stable by the fan value set, raise the fan value in 1 minute intervals by 5 % until you see the temp go down by 5 degrees or more.

Your final maximum cooling fan value is the highest value reduced by 5%.

Now perform a heater/nozzle PID tune with the fan at the maximum cooling value you have obtained. In the G-code fill-in box type M303 E0 S220 P8 and click the send button to obtain the Kp-Ki-Kd values. This process of heating and cooling the nozzle will take a few minutes. The results will be shown in the bottom screen under the graph and looks like this.



You need to fill the Kp-Ki-Kd values in Marlin firmware by LCD or FW: **Up to RC8 V3:** "**Configuration.h**" file. **As of RC8 V3.2:** "**Configuration_xxxx.h**" file, see **Section 11.1.3**. In your slicer you have options to set the minimum and maximum fan speed values for the cooling.

This way you use the maximum efficiency the cooling system has to offer without errors.

Please note

If you want to use a layer cooling fan, you need to add two extra (+) and (–) wires into the drag chain.

These wires should come from the MKS-Gen board FAN connection. The fan speed on this connection is controlled by G-code PWM (Pulse Width Modulation) from 0 to 255.

7.5.5 BW Connector Types

Please note

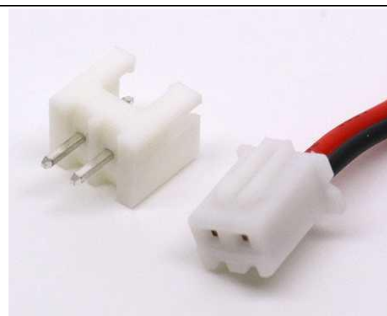
Connector location in the following tables means CABLE/WIRE-TERMINATION side. The mating connector, on the appropriate element, is of the opposite gender, and may be either a cable type or a board type as appropriate.

Please note

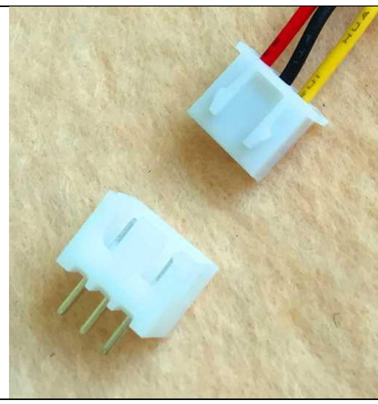
JST connectors are designed whereas the pins are built into the receptacle housing, and the sockets are built into the plug housing. Therefore there is INCONSISTENCY of the Male/Female definitions among the various vendors. When ordering replacement parts, make sure to use the JST standard Plug/Receptacle definitions. If not available, make sure you are ordering the right gender.

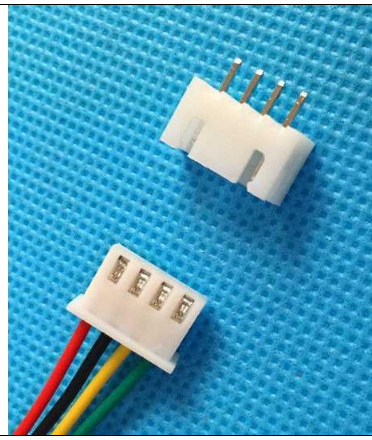
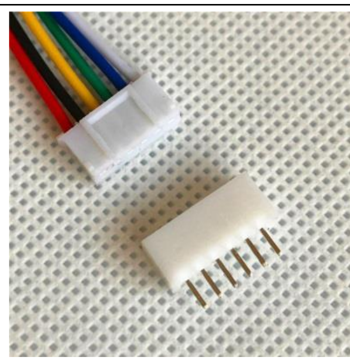
Caution

The pictures in the following tables are for CONNECTOR IDENTIFICATION ONLY. Wire polarities and/or colors and/or positions DO NOT correspond to the actual BW wiring. For actual BW wiring, refer to Section 7.10 – Connection Diagrams.

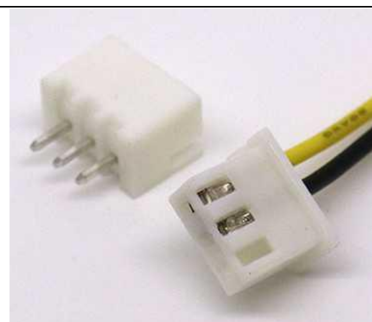
Function	Picture	Details
Thermistors.		Type: JST-**XH** (2.5mm pitch) # of circuits: 2. Gender: Plug. Color: White. Location: MKS-Gen board.
		Type: JST-**SM** (2.5mm pitch) # of circuits: 2. Gender: Receptacle. Color: Black. Location: Drag-chain, both sides.

Function	Picture	Details
1) Hot-end heater. 2) Heat-sink fan. 3) Layer fan (if installed)		Type: JST-**SM** (2.5mm pitch) # of circuits: 2. Gender: Receptacle. Color: Black. Location: Drag-chain, both sides.

Function	Picture	Details
End-stops.		Type: JST-**XH** (2.5mm pitch) # of circuits: 3. Gender: Plug. Color: White. Location: MKS-Gen board.
		Type: JST-**SM** (2.5mm pitch) # of circuits: 3. Gender: Receptacle. Color: Black. Location: Drag-chain, MKS-Gen side.

Function	Picture	Details
Stepper motor controls.		Type: JST-XH (2.5mm pitch) # of circuits: 4. Gender: Plug. Color: White. Location: MKS-Gen board. Steppers: X/Y/Z/E.
		Type: JST-SM (2.5mm pitch) # of circuits: 4. X/Y/Z-Gender: Receptacle. E-Gender: Plug/Receptacle, depending on side. Color: Black. X/Y/Z-Location: Drag-chain, MKS-Gen side. E- Location: Drag-chain, both sides.
		Type: JST-PH (2.0mm pitch) # of circuits: 6, of which 4 connected. Gender: Plug. Color: White. X/Y/Z-Location: Drag-chain, stepper side. E-Location: Stepper side.

Function	Picture	Details
Heat-bed control & thermistor.	 **Caution** **5 circuits shown, 6 circuits needed.**	Type: JST-VH (2.5mm pitch) # of circuits: 6. Gender: Plug. Color: White. Location: Heat-bed.

Function	Picture	Details
BL-Touch control.		Type: JST-XH (2.5mm pitch) # of circuits: 3, 2 of which are connected. Gender: Plug. Color: White. Location: MKS-Gen board.
		Type: 3 position 2.54mm pitch header. # of circuits: 3. Gender: Female. Color: Black. Location: MKS-Gen board, Servo-1 header.

7.5.6 BW Wires

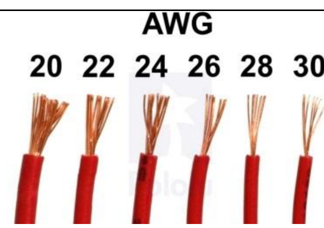
The electrical wires in the BW, as in any 3D printer, are subject to rapid movements and flexing, which can repeat thousands of times during one printing session. Therefore in order to survive these working conditions, they must be extremely flexible.

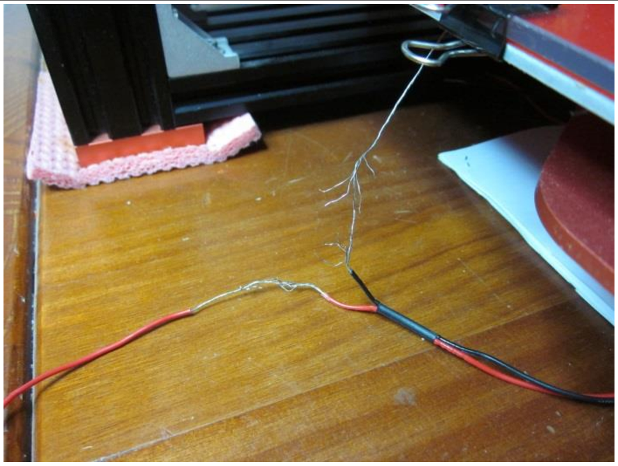
On the other hand, some of the wires carry large amounts of currents, therefore must be of the lowest resistance possible. This requirement can be met by using a low specific resistance metal, and/or larger wire diameter, aka gauge.

The wire which fulfills both requirements is a Copper stranded wire type, in which the core is comprised of multiple thin Copper wires stranded together.

Please note
The use of CCA (Copper Clad Aluminum) wires is not recommended. They are less flexible as well as having higher resistance than their pure Copper wire counterparts having the same diameter.

The following table summarizes the types of available wires.

Wire construction **Wire Metal**	**Solid**	**Stranded**
Copper	 **Not recommended**	 **Recommended**
CCA	 **Not recommended**	 **Not recommended**
Pre-Tinned Copper **(See next table)**	 **Not recommended**	 **Not recommended**



The pre-tinned stranded Copper wire **is not recommended** for use inside the drag-chain.

It seems that the strands are "fused" by the tin coating, thus making the wire kind of solid, which could not survive the flexing.

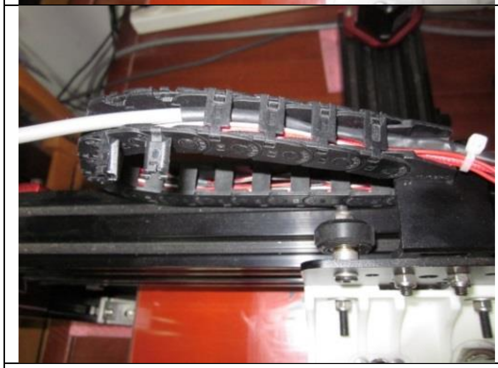
If you must use this wire for anything running inside the drag-chain, as you have no alternative, strip a small portion of the insulation and verify that the strands are free and not fused together. If they are fused, and the wire feels stiff, you can't use it, as it will break.

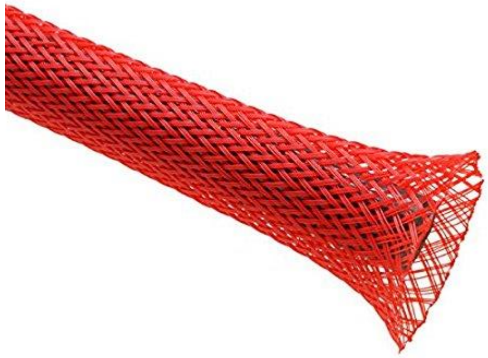
The following table details the various wires used in the BW.

Function	# of wires	US (AWG)	EU-Metric (mm^2)	Insulation
Heat-bed (+V)	2	16	1.310	Silicone
Heat-Bed (-V)	2	16	1.310	Silicone
Heat-Bed (Thermistor)	2	20	0.518	Silicone
Hot-end Fan (+/-)	1/1	22	0.326	Silicone
Layer Fan, when installed (+/-)	1/1	22	0.326	Silicone
Control-box Fan (+/-)	1/1	22	0.326	Silicone
Hot-end Thermistor	2	24	0.205	PTFE
Hot-end Heater	2	22	0.326	Braided Glass-Fiber
PSU to MKS-Gen (+/-)	1/1	12	3.310	Silicone
External MOSFET/SSR, when installed (+/-)	1/1	12	3.310	Silicone
Stepper-Motor control	4	22	0.326	Silicone
End-stop	3	22	0.326	Silicone
BLT (When installed) (Servo/End-stop)	3/2	22	0.326	Silicone
Proximity Sensor, when installed	3	22	0.326	Silicone
Mains (L/N/E)	1/1/1	14	2.080	PVC

The Hot-end wires (Heater, thermistor & fan), as well as the end-stop cables are pre-managed inside drag chains. If you want to add a layer-fan or a proximity sensor or the optional BLT, you need to add the wires of these into the drag-chain. The BW drag-chains have clip-on doors on each link; therefore it's quite easy to manage additional wires, as shown in the table below.

<table>
<tr><td></td><td>1) Open 2-3 doors at a time.
2) Manage the new wires/cables.
3) Close the doors.

Shown In the picture, door #1 already closed; doors #2, #3 & #4 open.</td></tr>
<tr><td></td><td>Shown in the picture, doors #2, #3 & #4 closed; doors #5 & #6 open.</td></tr>
<tr><td></td><td><u>Caution</u>
Drag-chain may wear the wire insulation, which may lead to electrical shorts. Inspect the wires periodically and replace when needed.</td></tr>
</table>

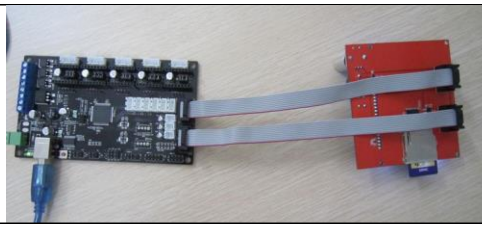


Technical data	
Material	Polyester
Operating Temperature	-50℃-+150℃
Melt point	240±10℃
Flammability	VW-1
Standard color	Black and grey
Approval	UL,ROHS,PFOS,REACH,Halogen Free
Cutting tool	Hot knife

A way to prevent this is by inserting the drag-chain wires inside a braided sleeve, with appropriate characteristics, as shown in the pictures.

7.6 LCD

7.6.1 LCD cable connection diagram

<table>
<tr><td></td><td>LCD cables need to be connected like shown in the picture when using a MKS GEN V 1.3 board.</td></tr>
</table>

7.7 Control Board

7.7.1 Hot-end Power MOSFET (Metal Oxide Semiconductor Field Effect Transistor) Issue

Warm up time of the hot-end from 20 to 245 degrees Celsius should take less than 2 minutes. If it takes much longer, check the 110/220 VAC switch on the side of the PSU for correct setting.

Warning

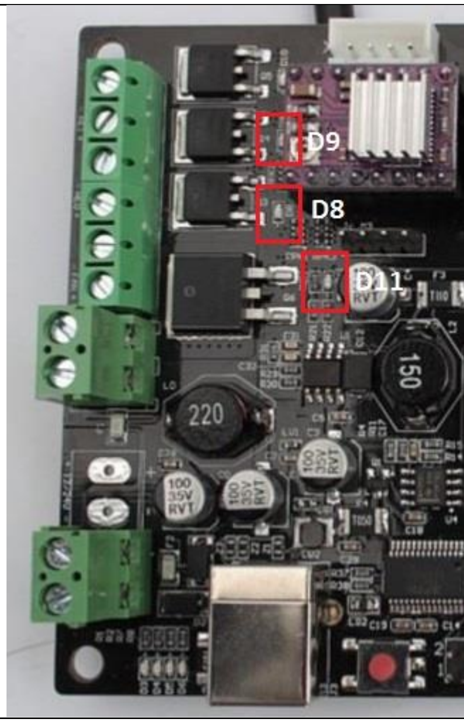
High Temp, don't touch with bare hands!

Warning

High Voltage, don't touch with bare hands!

<table>
<tr><td>
</td><td>If the machine shows this message, after start of heating: PRINTER HALTED, this means there is an electrical or timeout problem. Press the reset button or power cycle the machine and follow troubleshoot below to start. There are a few reasons why this message pops up.

Check also the linked section of this document <u>Heater can't go higher than 180 degrees C</u> , as this message might be related to too much fan cooling, rather than the power MOSFET.</td></tr>
</table>



Hot-end check:
Check by heating the hot-end only to 35 degrees Celsius for a minimum of 10 minutes and check if the temp stays stable.

Check if LED D9 is constant ON, or blinking Green.

If it blinks, the heater hardware and cables are correct.

If it is constant ON, check if the screw, that clamps the heat-cartridge in the heat-block, is present and tightened sufficiently. Check all cables and connectors. Check with a Digital voltmeter if the Green E0 connector has 24 VDC when the Green LED D9 is constant ON.

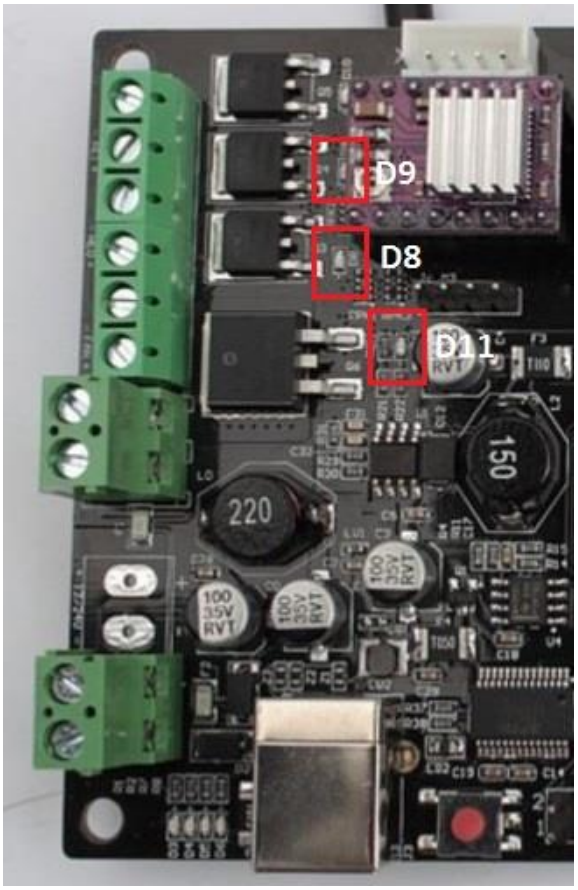
7.7.2 Heat-bed Power MOSFET Issue

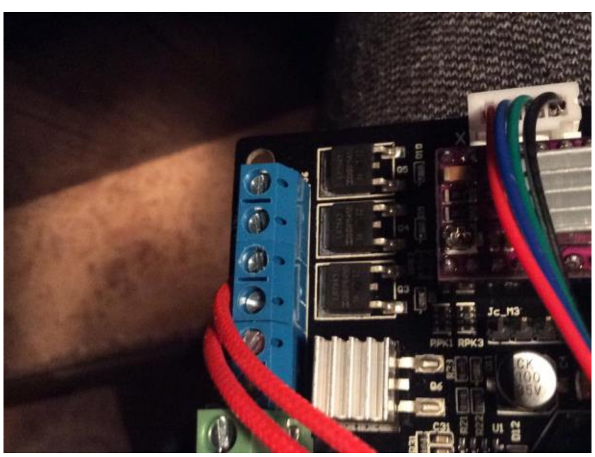
Warm up time of the heat-bed from 20 to 80 degrees Celsius takes ~3 minutes. If it takes much longer, check the 110/220 VAC switch on the side of the PSU for correct setting. And check by hand touch if all parts of the heat-bed are equally heated.

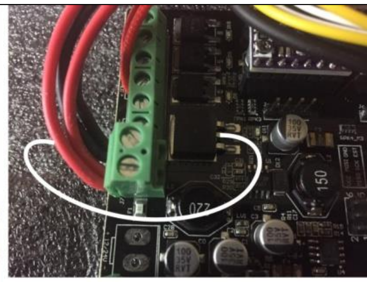
Caution: Temp higher than 60 C may cause burns !

Warning: High Voltage, don’t touch with bare hands!

If the machine shows this message, after start of heating: **PRINTER HALTED,** this means there is an electrical or timeout problem. Press the reset button or power cycle the machine and follow troubleshoot below to start. There are a few reasons why this message pops up.

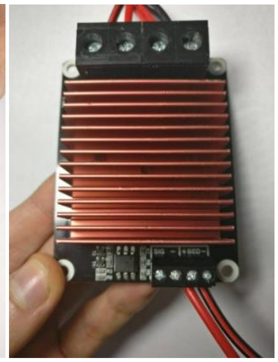
	Heat-bed check: If you power up the machine and the LED D11 is constant ON (heat-bed temp rises without control) the main board MKS V1.3 or V1.4 is defective. Open a service ticket. In others cases……. Check by heating the heat-bed only to 35 degrees Celsius for a minimum of 10 minutes and check if the temp stays stable. **Check if LED D11 is constant ON, or blinking Green.** If it blinks, the heat-bed hardware and cable are correct. If it is constant ON, check with a Digital voltmeter if the Green heat-bed connector has 24 VDC when the green LED D11is constant ON. Also check by hand if the heat-bed is evenly warm. **If the machine heats up the heat-bed uncontrollable and D11 is constant ON at power up then the Q6 FET is blown. Open a support ticket at TEVO to exchange the mainboard.**

	Due to failing Q6 power MOSFETs which control the heat-bed (reason is probably over-stressing of Q6), then from 18-Dec-2016 TEVO QC (Quality Control) checks all boards (they say) and adds a small heat-sink on the heat-bed MOSFET. The heat-sink will not do any work but it lets you know you have a factory QC tested board. If you opened a support ticket, because you had a main board with failed Q6, TEVO ships replacements MKS GEN V1.4 main boards from 25-Dec-2016 now equipped with new type power MOSFET named [AOB1404L] Replacement versions known to be working for DIY (Do It Yourself) jobs: [CSD18536KTTT]

 	In case you have a new MKS GEN V1.4 main board, which is not sourced from TEVO, and you don’t trust the soldering of the Q6 power MOSFET, you can use this trick to bypass a possible bad soldering problem. Solder a thick wire of 1 mm^2 minimum (preferable Silicone), from the center pin of the Q6 FET to the Minus (-) pin of the heat-bed connector, at the bottom of the board as shown.

If after a repower of the machine LED 9 or LED11 are constant on then the MKS main board is defective.

7.7.3 Heat-bed Offload - External Power MOSFET

 	Due to the problems with the MKS GEN V1.4 boards TEVO designed a high power **EHD** (**E**xternal **H**eat-bed **D**river) board. From 13-Jan-2017 all warranty MKS GEN V1.3 and V 1.4 replacements boards get this **EHD** standard shipped along with a new MKS GEN V1.4 main board. For connection diagram, refer to Section 7.10.4. **Caution** **Take care of the polarities.**

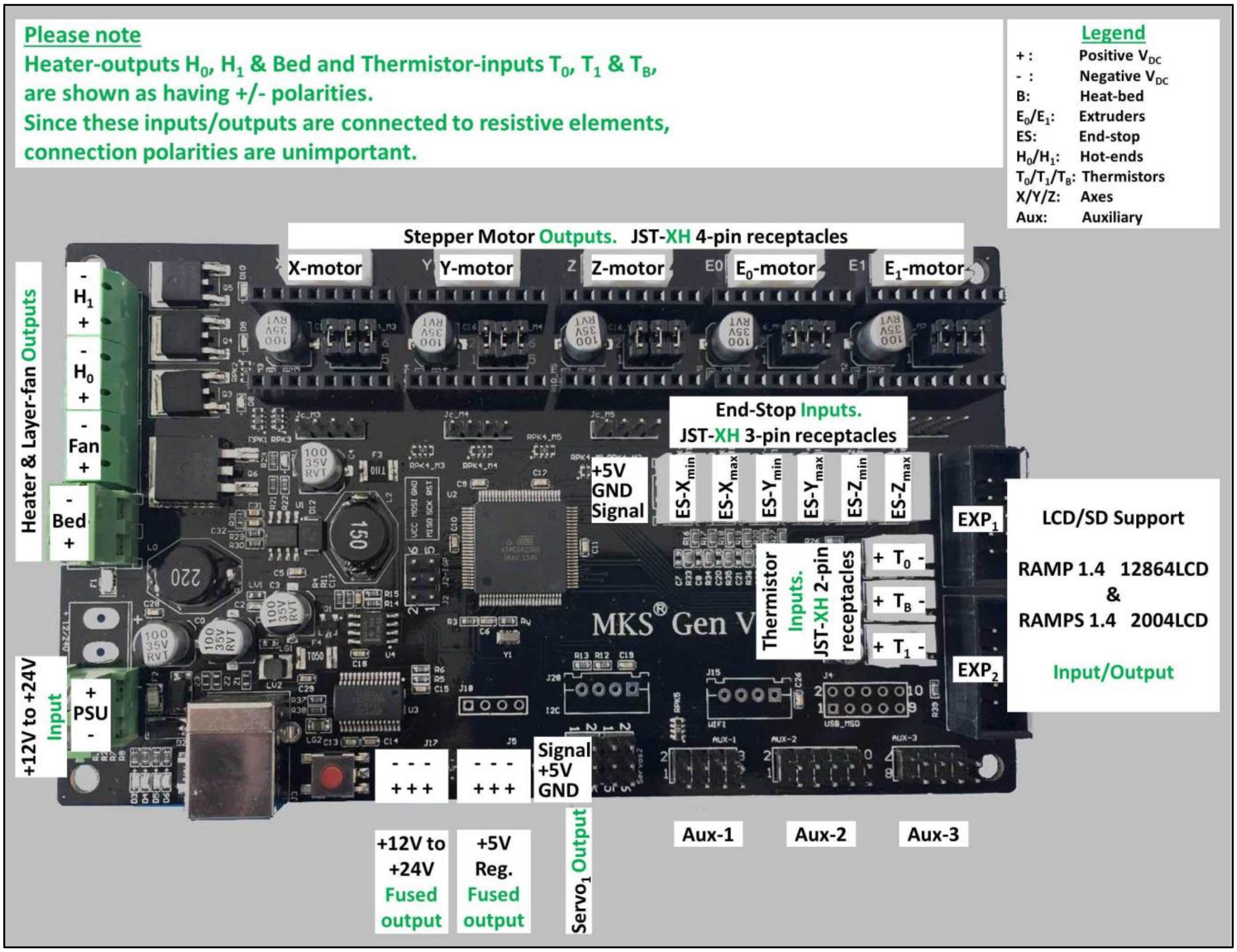
7.7.4 Heat-bed Offload - External SSR (Solid State Relay)

	You may accomplish the same heat-bed offload functionality, by using an industry standard SSR. This is an electronic SPST (Single Pole Single Throw) switch, which is connected in series on the +24V line, between the PSU and the heat-bed, and is controlled by the "Bed" output of the MKS-Gen controller. **Please note** **The SSR should be rated for AT LEAST 40A, and fitted with an appropriate heat-sink, as shown in the picture.** For connection diagram, refer to Section 7.10.7. **Caution** **Take care of the polarities.**

7.7.5 Connectors

Please note

MKS GEN V1.3 and V1.4 boards are the same as far as functionality is concerned, and either can be used in a Black Widow.



7.8 Endstops

7.8.1 XYZ proximity sensors adjustment (Duplicate 2 of 2)

The X Y and Z sensors are proximity inductive sensors which sense metal. To get them working properly adjust them at a very close distance (maximum 1mm) to the part that should activate it. The sensors have a small orange LED built-in. When the sensor is activated the orange LED is ON. You can use a tip of a screw driver to test the sensor for working.

7.8.2 Using proximity sensor for heat-bed ABL (Auto Bed Leveling)

For heat-bed auto leveling, you may opt to use a capacitive or an inductive proximity sensor, instead of the BLT. This sensor will do both functions of Z-endstop and heat-bed auto-leveling.

Since these sensors are neither BW stock , or BW option, the mounting/connection-diagrams/FW for these are annexed to this guide, and full instructions can be found in **Annex 13.3**.

7.9 Octoprint

Octoprint is a print server based on a Raspberry Pi. Currently with the Raspberry Pi3 which has on board Wi-Fi the use of it has been made easier. What do you need? Raspberry Pi3, 2 Amp 5 VDC power supply with USB micro connector, 4Gb SD micro card, USB A-B cable. Follow Toms video and you're done.
https://www.youtube.com/watch?v=MwsxO3ksxm4

7.10 Connection Diagrams

Warning

Heat-bed versions V1, V2 & V3 ARE NOT synchronized in time with the power switch versions V1, V2 & V3 respectively. You must verify your setup according to the heat-bed and power switch sections, and then use the appropriate diagram.

The power switch V1 & V2 has the "N" terminal connected to the "N" terminal of the PSU. In power switch V3, the "GND" terminal MUST NOT be connected to either the "N" or the "E" terminals of the PSU.

Please note

In order to reduce clutter and enhance readability, some wire bundles are drawn with a single line having the backlash symbol and a number, e.g. \2, denoting the number of wires in the bundle.

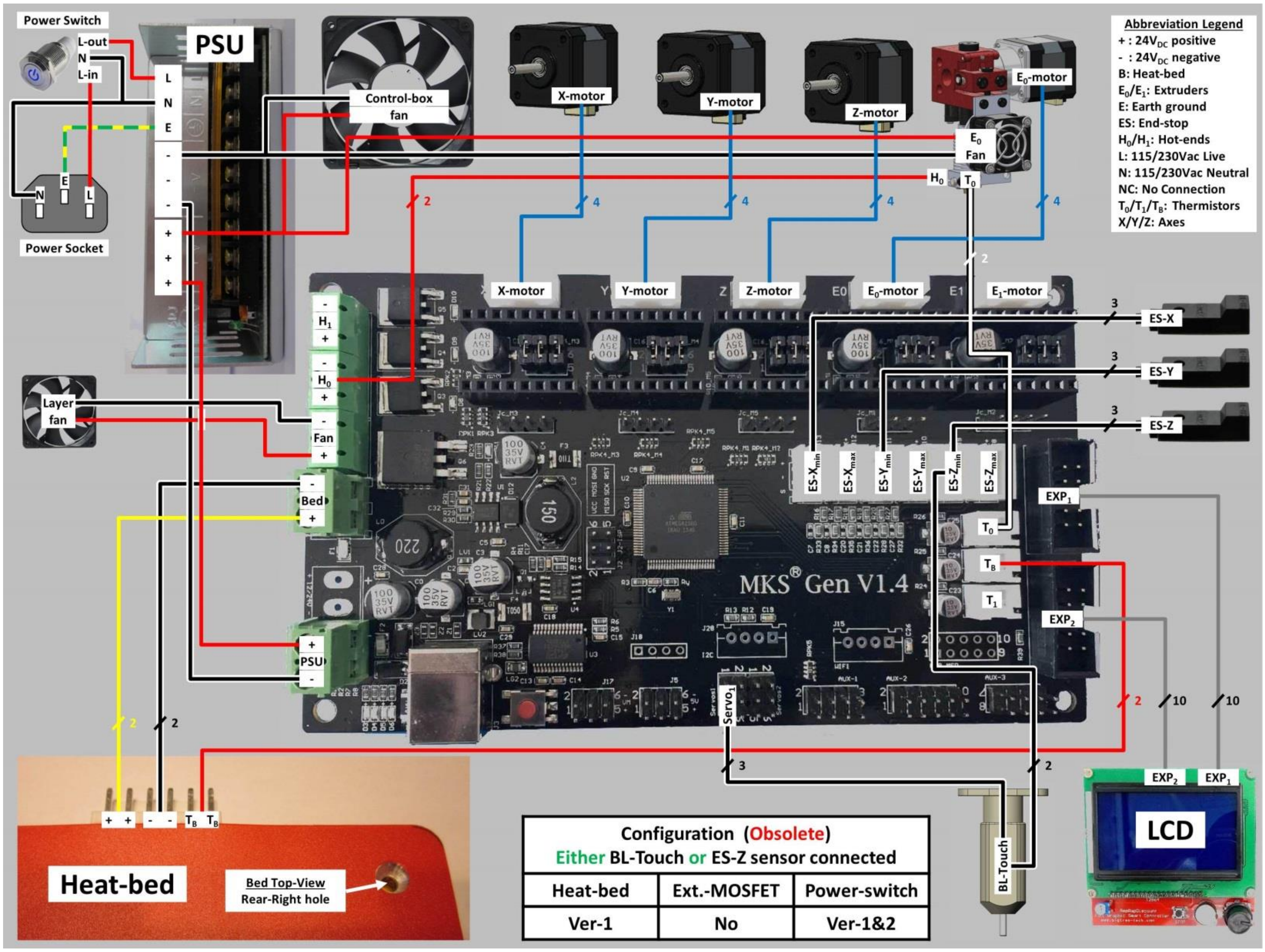
Please note

The BL-Touch option can be fitted to any heat-bed/power-switch combination, however the BL-Touch is mutually exclusive with the end-stop Z-min sensor, therefore only one of them can be connected to the controller board.

Please note

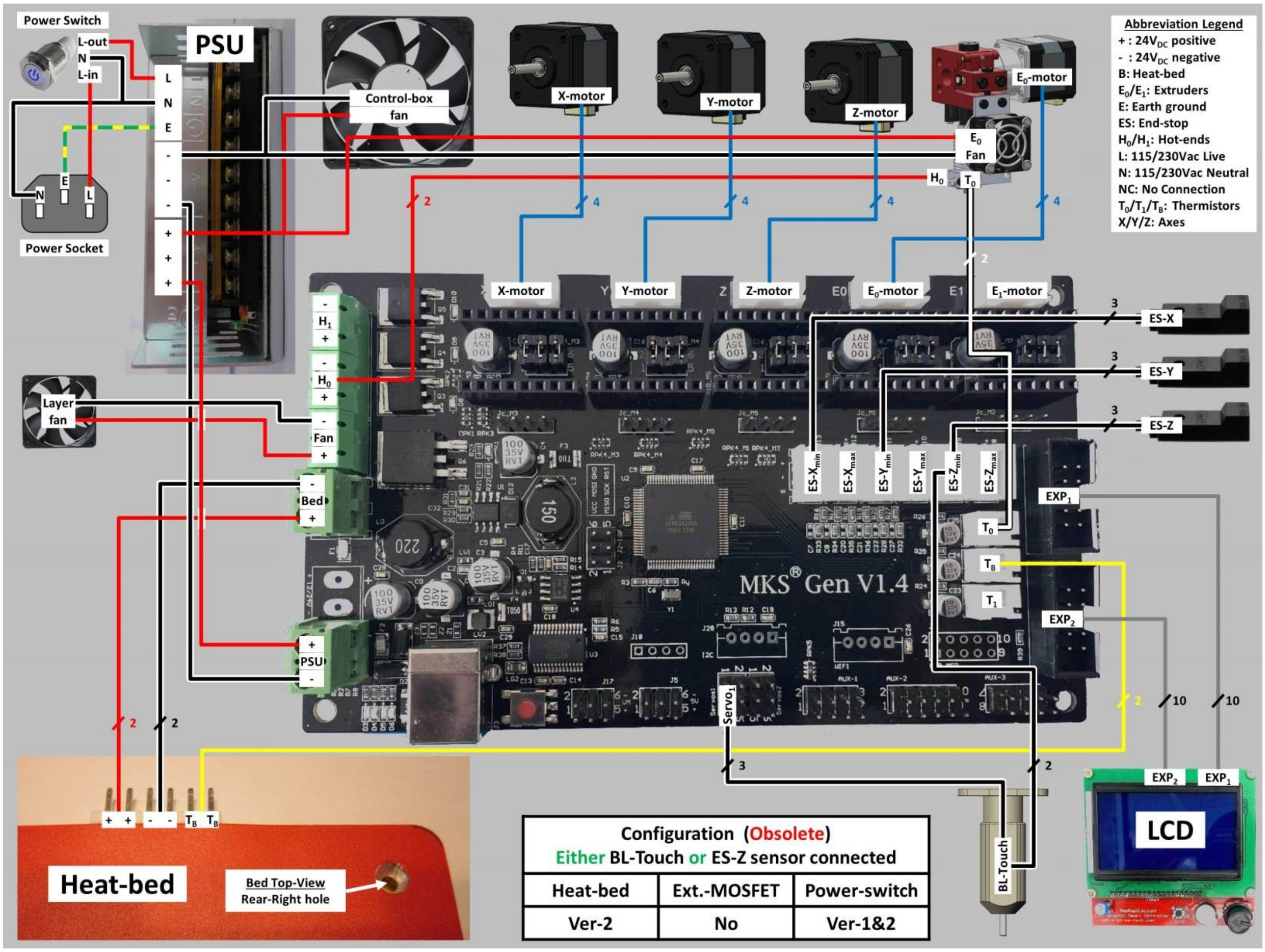
Layer fan has been added to the diagrams although it is neither stock, nor an option, as this is a must for PLA and most users opt to add it as one of the first mods after the build.

7.10.1 Heat-bed – V1; Power-switch – V1&V2

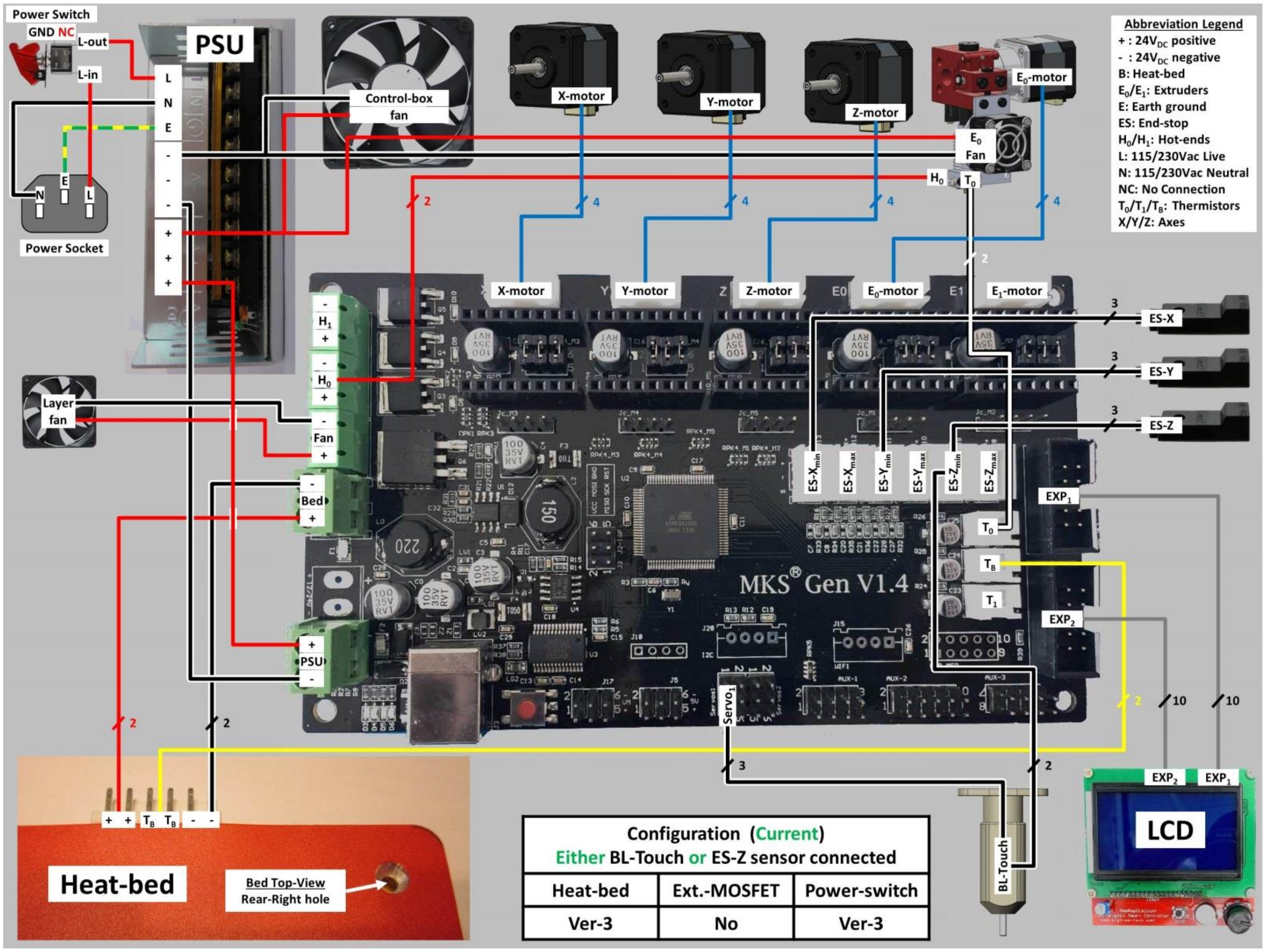


Configuration (Obsolete) Either BL-Touch or ES-Z sensor connected		
Heat-bed	Ext.-MOSFET	Power-switch
Ver-1	No	Ver-1&2

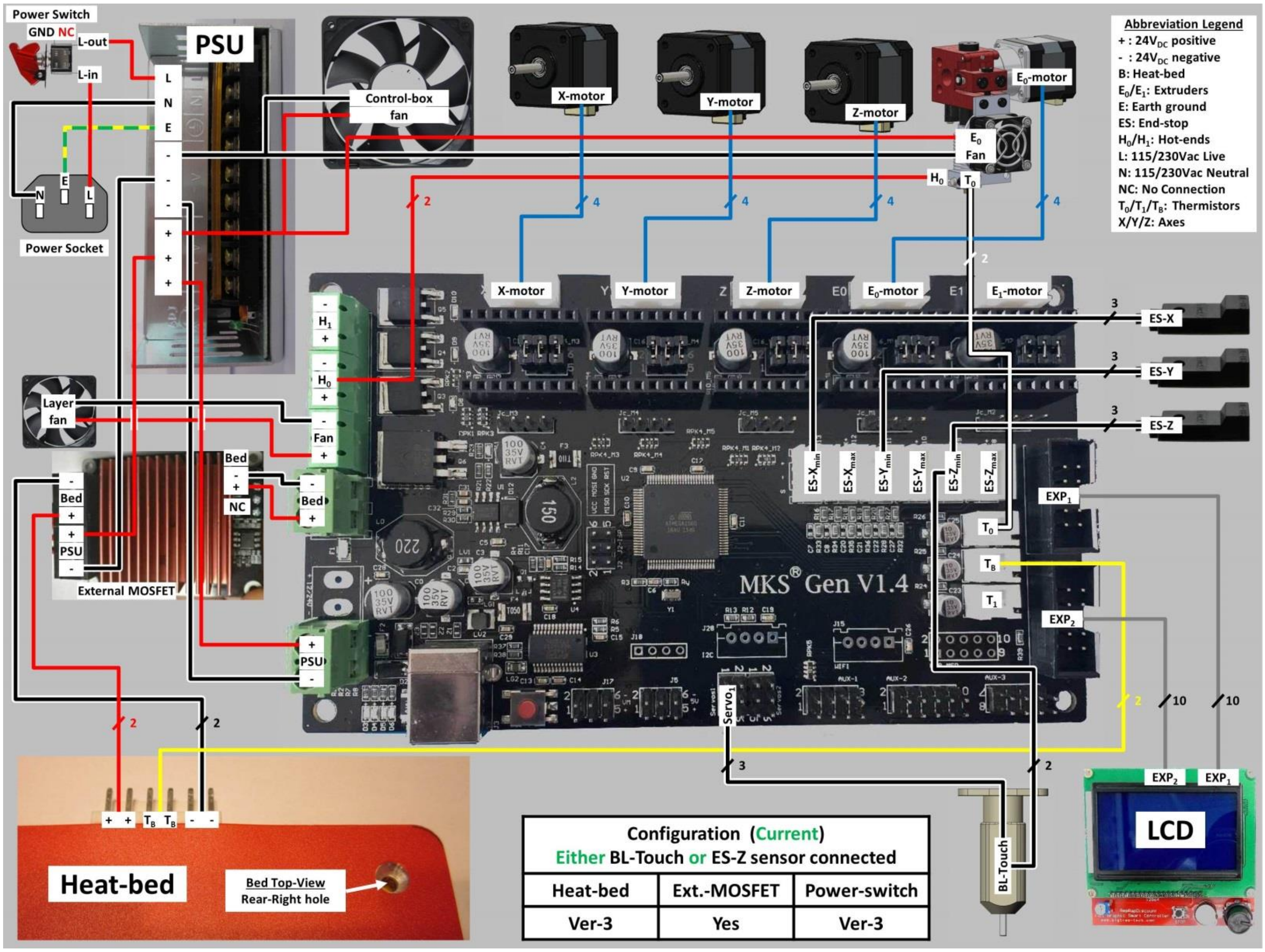
7.10.2 Heat-bed – V2; Power-switch – V1&V2



7.10.3 Heat-bed – V3; Power-switch – V3



7.10.4 Heat-bed – V3; Power-switch – V3; with External MOSFET

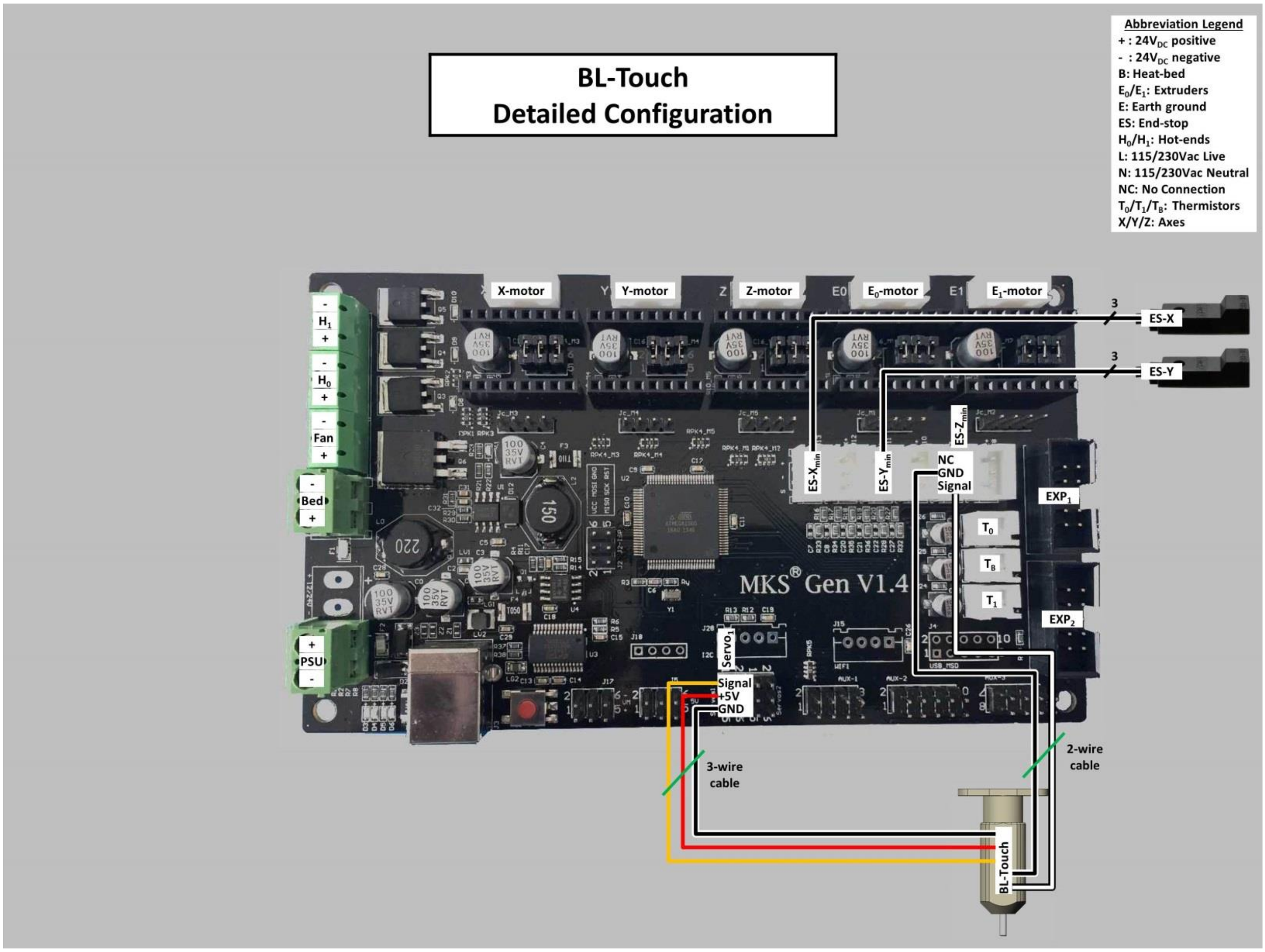


Configuration (Current) Either BL-Touch or ES-Z sensor connected		
Heat-bed	Ext.-MOSFET	Power-switch
Ver-3	Yes	Ver-3

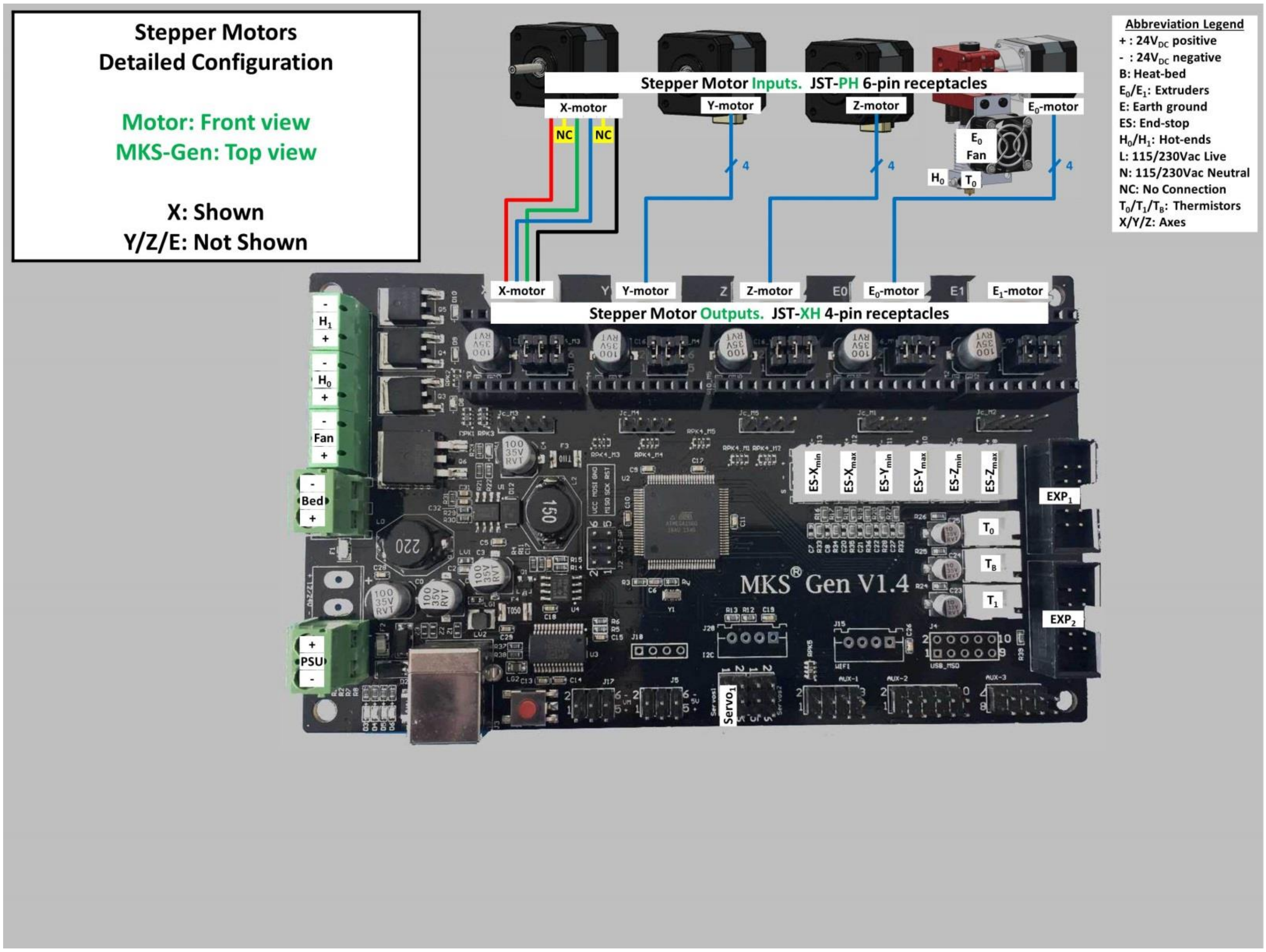
7.10.5 BL-Touch Detailed

Please note

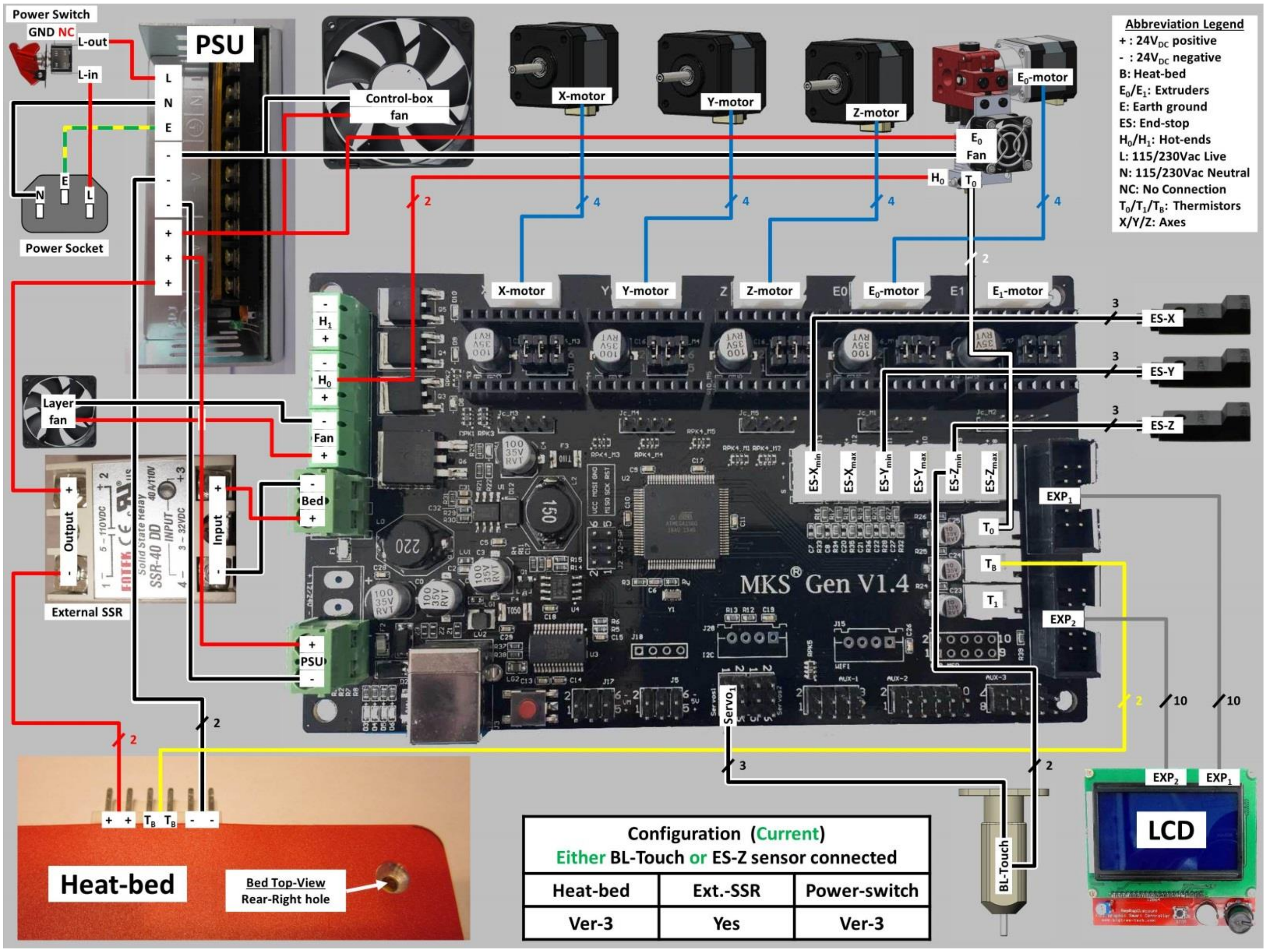
The BL-Touch option can be fitted to any heat-bed/power-switch combination, however the BL-Touch is mutually exclusive with the end-stop Z-min sensor, therefore only one of them can be connected to the controller board.



7.10.6 Stepper Motor Detailed



7.10.7 Heat-bed – V3; Power-switch – V3; with External SSR



Configuration (Current) Either BL-Touch or ES-Z sensor connected		
Heat-bed	Ext.-SSR	Power-switch
Ver-3	Yes	Ver-3

7.10.8 Heat-bed V4

Please note
Although it has not been officially confirmed by TEVO, heat-bed V4 is the same as V3 as far as electrical design is concerned, with the addition of a thermal insulator on the bottom side.

Please refer to the previous sections for the appropriate V3 connection diagrams.

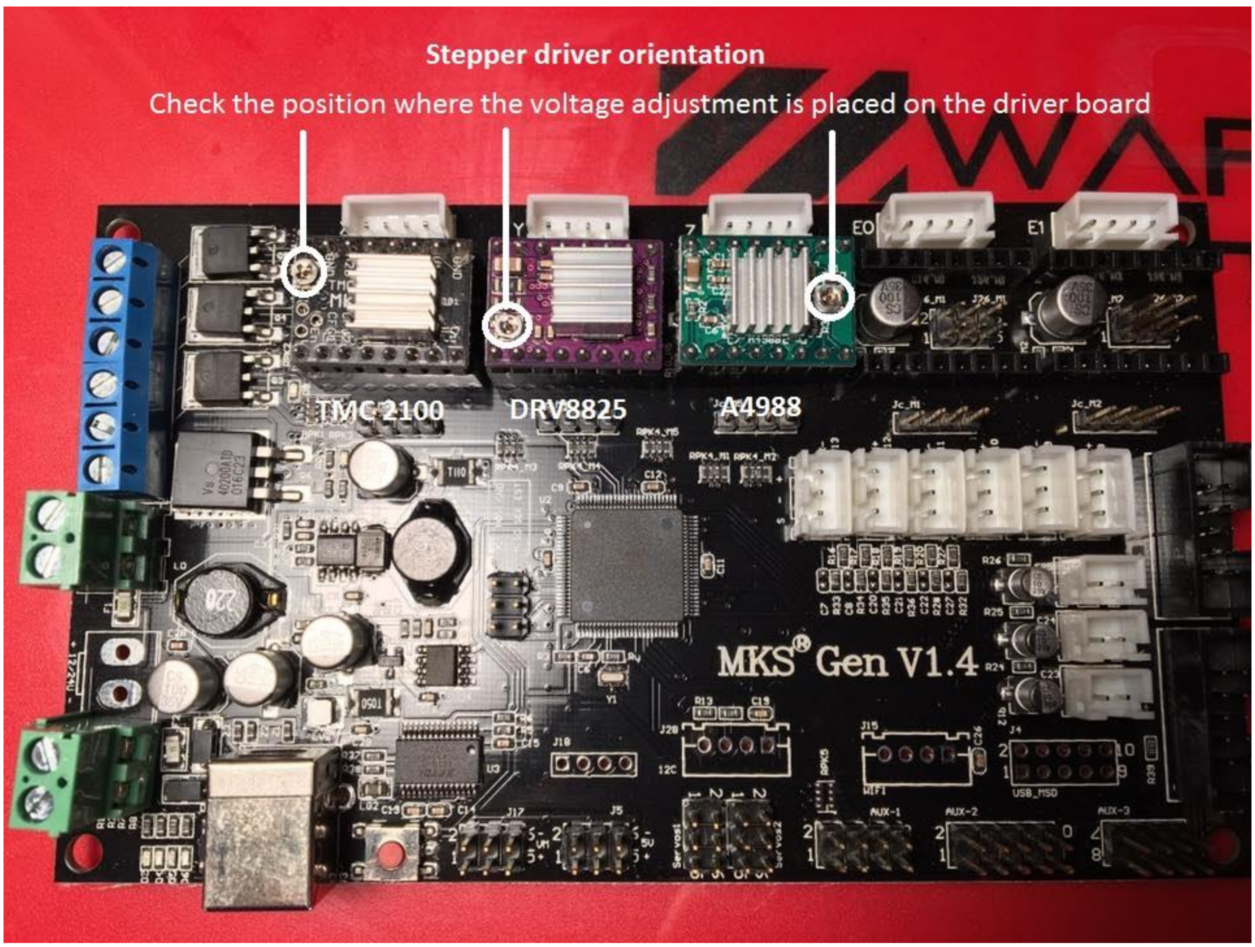
8 Electro-Mechanical

This section is for elements which convert electrical energy to mechanical energy (motion), and vice versa, e.g. stepper motors, fans and mechanical end-stops like the BL-Touch.

8.1 Stepper-Motors

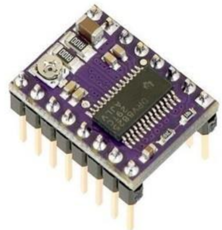
There are three "driver sticks" which are compatible with the MKS-Gen V1.3/V1.4 controllers and the stock stepper motors, which used by the stock BW. These are the stock TI-DRV8825, the Allegro-A4988 and the Trinamic-TMC2100. The detailed instructions for each of these driver sticks appear in the following sections. The orientation of these sticks on the driver pin headers is shown in the following picture.

Please note
One stick from each type is shown. Normally all 4 drivers are of the same type.



8.1.1 Stepper Motor Drivers – DRV8825

The MS1 to MS3 drivers jumpers are located underneath the driver board on the MKS GEN V1.3 and V1.4 main board. MS1 position is the one most left near the power connector side.



DRV8825	MS1 Jumper	MS2 Jumper	MS3 Jumper
Single Step	0	0	0
1/2 Step	1	0	0
1/4 Step	0	1	0
1/8 Step	1	1	0
1/16 Step	0	0	1
1/32 step	1	0	1
1/32 step	0	1	1
1/32 step	1	1	1

The Black Widow comes standard with DRV8825 driver boards set at 1/32 micro steps. However the machine with this setting has troubles for printing with the so called Salomon Skin effect. To reduce the effect it is recommended to use other drivers or set the DRV8825 drivers into 1/16 micro steps, by removing the MS1 & MS2 jumpers as shown in the table.

Please note
If you change the micro stepping from 1/32 to 1/16, you should halve the E-Steps in FW, and check your E-Step calibration, as described in **Section 8.1.3 Step-5**.

Vref (V) = Imax (A) * 0.5 (V/A)

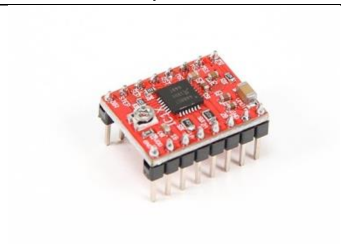
Set motor current by adjusting the potentiometer and monitoring Vref.

You may use this **video** which shows how to do this for the MKS-Base controller used on the Tarantula. The procedure is the same, only the BW MKS-Gen controller uses drivers & potentiometers on sticks, rather than soldered to the board.

For the BW using the Busheng 17HD40005-22B steppers as stock:
Imax=1.3A
Vref=0.65V

8.1.2 Stepper Motor Drivers – A4988

The MS1 to MS3 drivers jumpers are located underneath the driver board on the MKS GEN V1.3 and V1.4 main board. MS1 position is the one most left near the power connector side.



A4988	MS1 Jumper	MS2 Jumper	MS3 Jumper
Single Step	0	0	0
1/2 Step	1	0	0
1/4 Step	0	1	0
1/8 Step	1	1	0
1/16 Step	1	1	1

Due to the different working the A4988 drivers are less prone to show the Salmon Skin effect when set at 1/16 micro steps.

Please note
If you are using the MKS-Base controller, you should follow the instructions under this section, as the MKS-Base is using the Allegro A4982 drivers which are similar in functionality to the A4988. However the BW MKS-Base controller uses drivers & potentiometers soldered to the board, rather than on sticks.

Vref (V) = Imax (A) * 8 * Rs (ohm)

Please note
Rs is usually 0.1 Ohm, denoted as R100 on the sensing resistors. However there are some clones with 0.05 Ohm, denoted as R50, and 0.200 Ohm, denoted as R200. Use the formula as appropriate.

Set motor current by adjusting the potentiometer and monitoring Vref.

You may use this video which shows how to do this for the MKS-Base controller used on the Tarantula. The procedure is the same, only the BW MKS-Gen controller uses drivers & potentiometers on sticks, rather than soldered to the board.

For the BW using the Busheng 17HD40005-22B steppers as stock:
Imax=1.3A
Vref=1.04V (for Rs=0.1ohm)

FW
Up to RC8 V3: "Configuration.h" file.
As of RC8 V3.2: "Configuration_xxxx.h" file, see Section 11.1.3.

1) You need to invert the stepper motor direction, as explained in Section 8.1.3, Step-4.

2) You need to halve the stepper motor E-Steps, as explained in Section 8.1.3, Step-5.

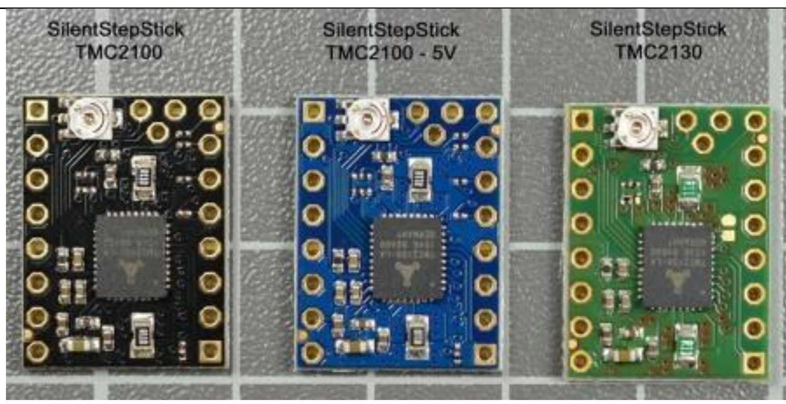
8.1.3 Stepper Motor Drivers – TMC2100

The MS1 to MS3 drivers jumpers are located underneath the driver board on the MKS GEN V1.3 and V1.4 main board. MS1 position is the one most left near the power connector side.

This picture shows what is called the "Salmon Skin" effect.

To reduce the Salmon Skin effect completely, you should use the [official TMC2100-5V Silent StepSicks from Watterott](). These drivers are also reducing the stepper noise to a minimum. Preferably on the X-Y-Z-E axis.

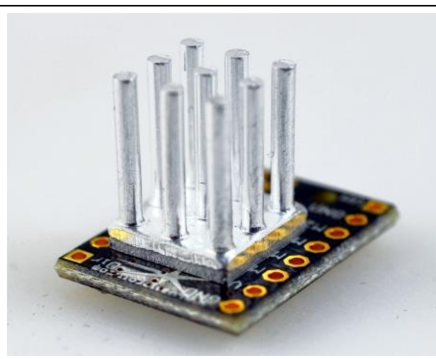
Please note
1) Since the cloned TMC2100 driver modules do not adhere 100% to the Trinamic specifications, and furthermore not all clones behave the same, we will not provide any information regarding the clones. To the best of our knowledge, the only reliable source is Watterott, whereas the Black PCB version is also distributed by DigiKey.
2) Older version of Watterott modules have gold plated hole matrix. Current version has the hole matrix covered with solder mask.



Caution: When using the Black version, you MUST disconnect the USB cable, or ANY OTHER external 5V line, BEFORE powering off the BW, in order to prevent driver damage. See Section 7.5.3.
It is highly recommended that external devices connected to the MKS-Gen will have their own 5V PSU, and no 5V line running between the MKS-Gen and the external device.

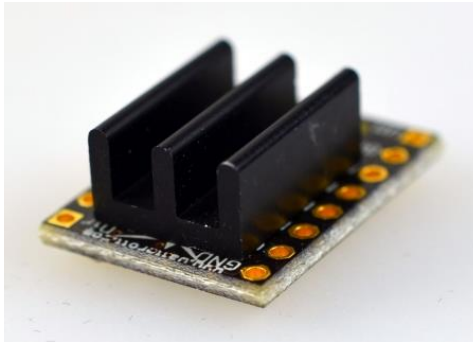
Please note
1) You should use the TMC2100 – 5V version (Blue PCB) as "internal voltage regulator deactivated -> lower power dissipation."

2) If you intend to use Method-1 below for connecting CFG1 to GND, you should buy the version with pin-headers soldered. If you intend to use Method-2, you should buy the unsoldered version.



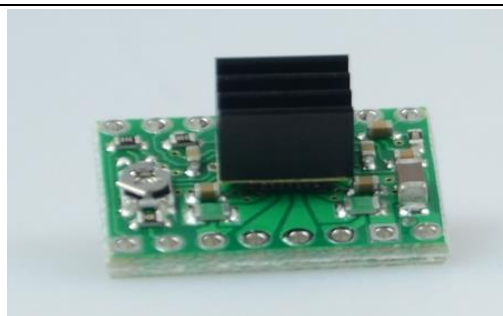
When using the **TMC2100 Black-PCB 3.3V-5V version**, you'll probably need these heatsinks in order to get the max torque out of the stock motors, without entering into the thermal protection zone.

Pin heatsink square ICK S
10.0 x 10.0 x 12.5mm (L x W x H)
Rth: 22.5-15.5 C/W



When using the **TMC2100-5V Blue-PCB 5V-only version**, the power dissipation is lower, therefore these heatsinks suffice in order to get the max torque out of the stock motors, without entering into the thermal protection zone.

Heatsink for DIL-IC, PLCC und SMD
13.0 x 10.0 x 6.0mm (L x W x H)
Rth: 61 C/W



These small heatsinks have very large thermal resistance.

These are not recommended for the TMC2100 family of sticks.

Heatsinks
8.0 x 6.3 x 4.8mm (L x W x H)
Rth: 87 C/W

Watterott TMC2100

CFG1	CFG2	CFG3	Steps	Interpolation	Chopper Mode
GND	GND	Open	1	No	spreadCycle
Vio	GND	Open	1/2	No	spreadCycle
Open	GND	Open	1/2	Yes, to 1/256	spreadCycle
GND	Vio	Open	1/4	No	spreadCycle
Vio	Vio	Open	1/16	No	spreadCycle
Open	Vio	Open	1/4	Yes, to 1/256	spreadCycle
GND	Open	Open	1/16	Yes, to 1/256	spreadCycle
Vio	Open	Open	1/4	Yes, to 1/256	stealthChop
Open	Open	Open	1/16	Yes, to 1/256	stealthChop

Watterott TMC2100 modes table

1) CFG1, CFG2 & CFG3 correspond to MS1, MS2 & MS3 respectively.

2) The recommended mode of operation for the BW is the spreadCycle mode, highlighted in Yellow.

The last line in the table, whereas all configuration pins are left open, is the stealthChop 1/16 step mode.

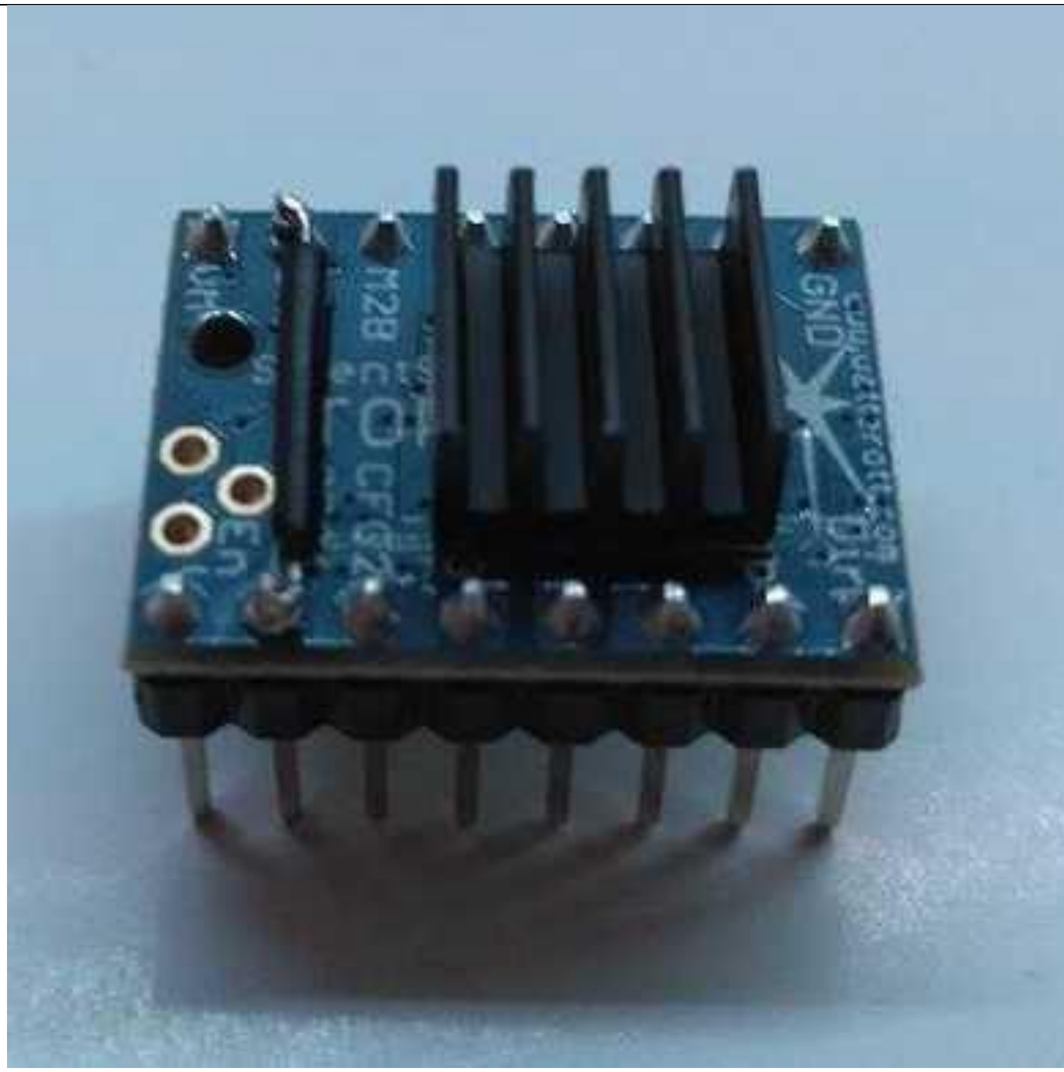
It is not recommend using the stealthChop mode for the BW, as it does not provide enough torque for the heavy loads on the X and Y axes.

Method-1 for connecting CFG1 to GND

Solder a jumper as shown in the below picture.

Please note

Make sure you remove ALL jumpers, located below the drivers, before you continue.



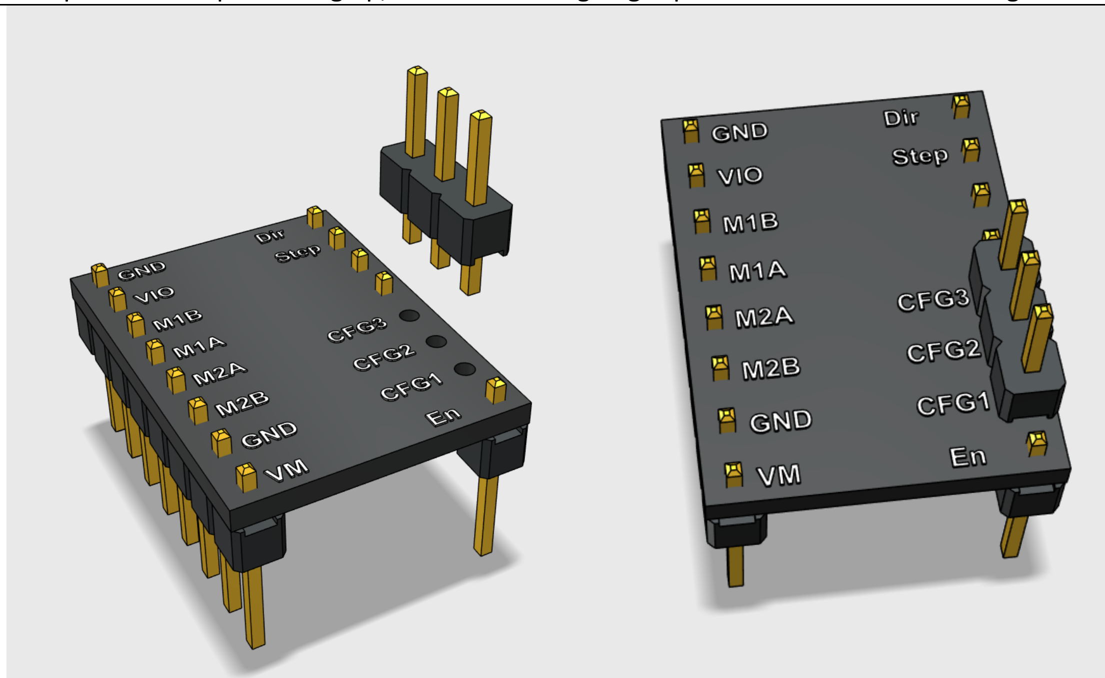
Method-2 for connecting CFG1 to GND

Inverting the CFG header pins on the module, then connecting CFG1 pin, by a jumper wire, to the stepper extension GND header pin on the MKS-Gen, as shown in the below pictures.

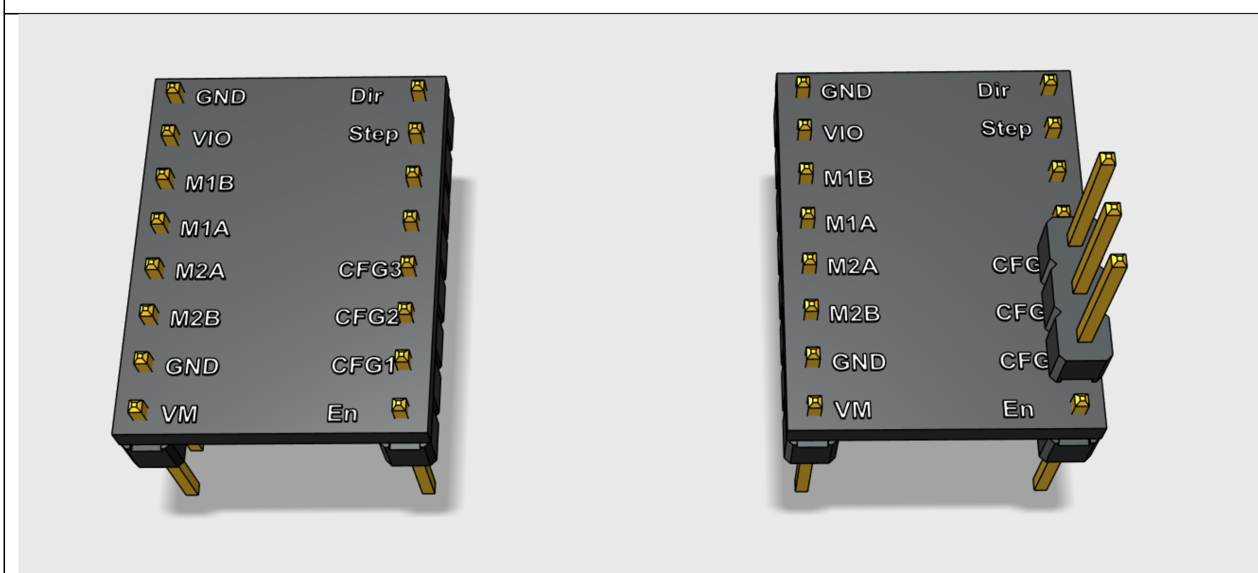
Please note

Make sure you remove ALL jumpers, located below the drivers, before you continue.

Below left picture: CFG pins facing up, before soldering. Right picture shows after soldering.

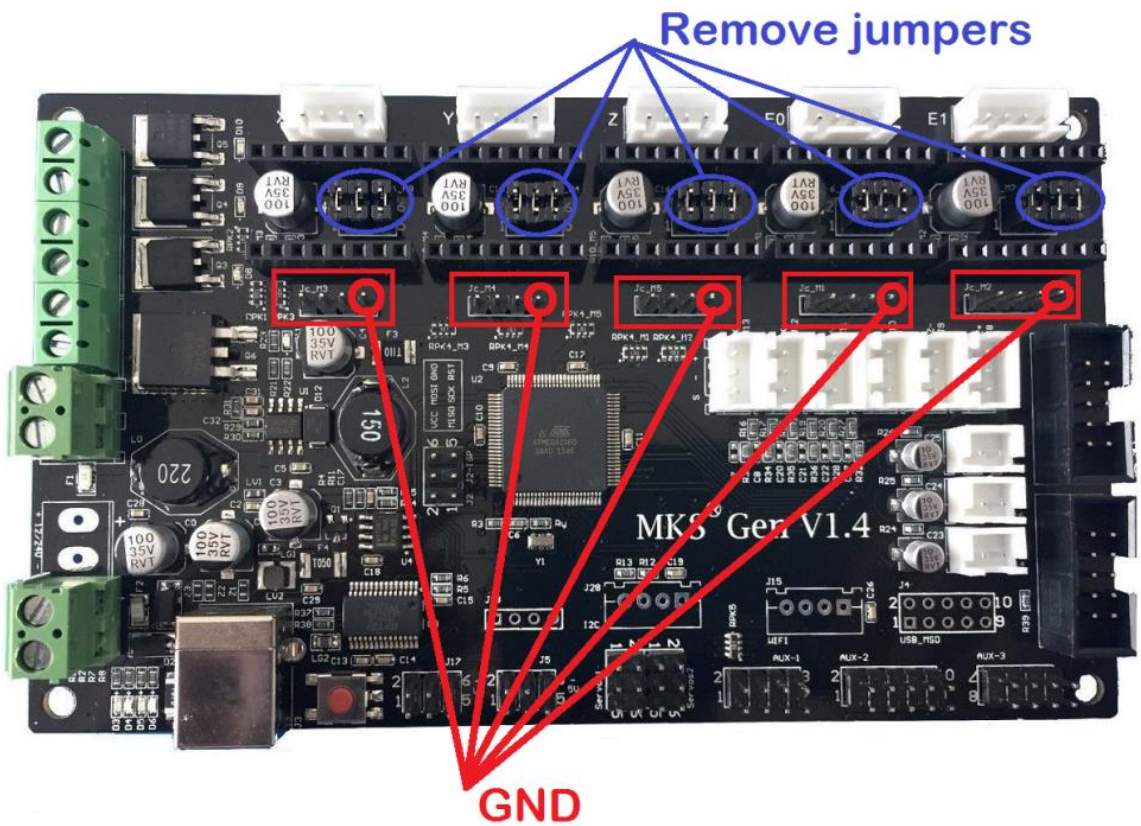


Below left picture: “Standard” driver stick. Right picture shows CFG pins facing up.



Step-1
Remove all jumpers underneath the driver module board.

Hi-Res picture. Increase PDF view up to 400% to enhance intelligibility



Step-2

Connect CFG1 pin to GND for each driver using a standard connectored jumper wire, **as required by the official Watterott documentation**. This will make 1/16 steps interpolated into 1/256 micro steps in spreadCycle mode.

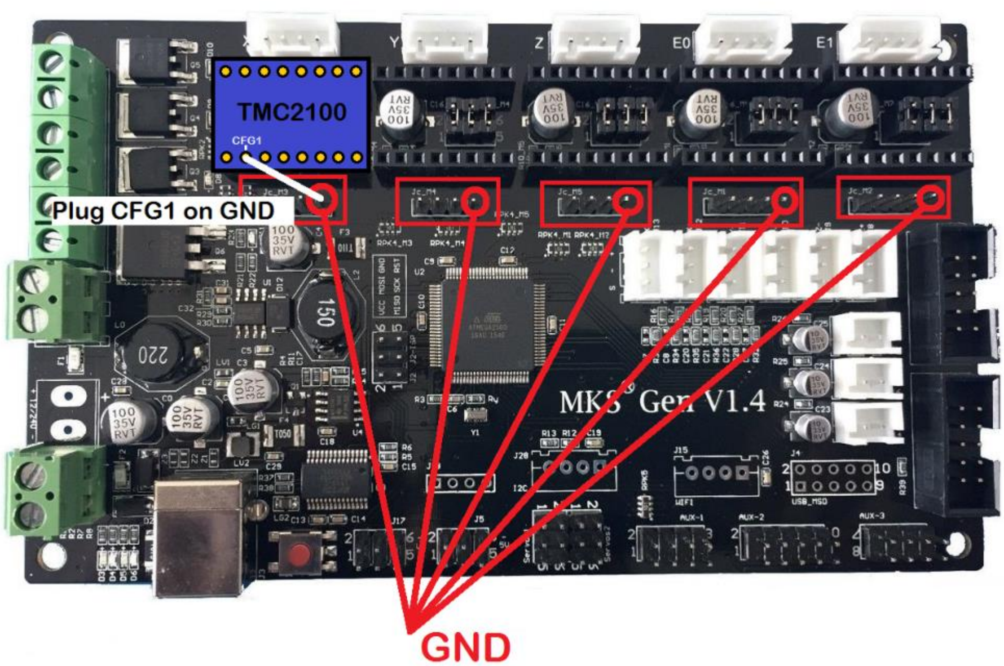
Please note

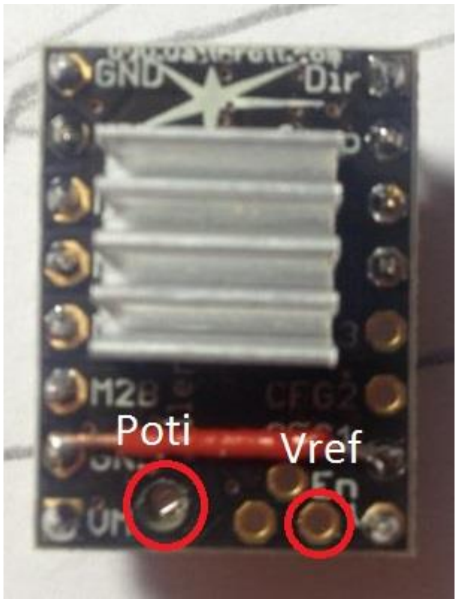
1) The 100Kohm pulldown resistor on the MKS-Gen board is not enough for proper operation !!!

2) Disconnecting the "En" pin in the Watterott stick, would result in an undocumented mode, which may lead to improper operation!!!

If you have the unsoldered header pins version, solder the header pins so the adjustable potentiometer is facing down. On the hole matrix middle section place a proper heat-sink, as shown above, that is used with double side adhesion tape. **Do not use thermal paste!**

Hi-Res picture. Increase PDF view up to 400% to enhance intelligibility





Vref (V) = Imax (A) * 1.0 (V/A)

Vref (V) = Irms (A) * 1.41 (V/A)

<u>Step-3:</u>
Set motor current by adjusting the potentiometer and monitoring Vref.

You may use this video which shows how to do this for the MKS-Base controller used on the Tarantula. The procedure is the same, only the BW MKS-Gen controller uses drivers & potentiometers on sticks, rather than soldered to the board.

For the BW using the Busheng 17HD40005-22B steppers as stock:
Imax=1.3A➔Vref=1.3V
Irms=1.2A➔ Vref=1.69V (Max. permissible for the stick)

<u>Please note</u>
1) These sticks are built with components on the lower side. Use the hole to access the potentiometer and the Vref pad to measure Vref, as shown in the picture.

2) There is debate whether stepper rated current corresponds to Imax, or to Irms. Also the temp rise depends on the type of stick, whether 2100 or 2100-5V, and the type of heatsink used. To be on the safe side, start with Vref=0.8V and increase by 0.1V steps, <u>if skipping steps</u>, until Vref=1.69V which is the max allowed.
There are reports of proper operation with as low as 0.8V for the 2100, and as high as 1.15V for the 2100-5V.

<u>Caution</u>
Watch the temp of both the steppers and the drivers. Too high temp on the motors can cause faulty operation and/or damage. Too high temp on the driver may cause it to enter into thermal protection mode, which will result in layer shifts.

<u>From:</u>
#define INVERT_X_DIR false
#define INVERT_Y_DIR true
#define INVERT_Z_DIR true
#define INVERT_E0_DIR false

<u>To:</u>
#define INVERT_X_DIR true
#define INVERT_Y_DIR false
#define INVERT_Z_DIR false
#define INVERT_E0_DIR true

<u>Step-4:</u>
Invert the motor direction in FW:
Up to RC8 V3: "Configuration.h" file.
As of RC8 V3.2: "Configuration_xxxx.h" file, see **Section 11.1.3**.

From: #define DEFAULT_AXIS_STEPS_PER_UNIT {XXX,YYY,ZZZZ,EEE} **To:** #define DEFAULT_AXIS_STEPS_PER_UNIT {XXX/2,YYY/2,ZZZZ/2,EEE/2} **Example:** **From:** #define DEFAULT_AXIS_STEPS_PER_UNIT {160,160,3200,935} **To:** #define DEFAULT_AXIS_STEPS_PER_UNIT {80,80,1600,467.5}	**Step-5:** Halve the E-Steps in FW, as shown on the left pane. **Up to RC8 V3:** "**Configuration.h**" file. **As of RC8 V3.2:** "**Configuration_xxxx.h**" file, see **Section 11.1.3**. If you have calibrated your E-Steps before, the calibration would remain valid, after halving your E-Steps. However if you haven't done so, and relied of the default numbers, you may find that dimensions deviate more than you would like, after halving the E-Steps. Therefore now is the time to perform the calibration. You may use this **video** which shows how to do this for the Tarantula. The procedure for the BW is the same, and you should use the BW equivalent locations for attaching the needles and rulers.

8.1.4 Stock Stepper Motors

Since the beginning of 2017, TEVO is shipping the BW with TEVO branded 17HD40005-C5.18 stepper motors.

TEVO has officially confirmed that these are an OEM version of the previously shipped Busheng 17HD40005-22B.

8.1.5 E-Steps Tuning via LCD or M92 Command

If you have to change any of the steps of X-Y-Z- E and you upload the firmware always check, using the LCD menu, that the new settings are accepted.

Changing the values through the LCD panel:

1) >control>motion>Steps/mm and adjust the value required (press the knob to accept new value).

2) >control>store memory (press knob to save values to EEPROM).

Changing the values by using G-code command line from Pronterface, or other utility:

1) M92 X?? Y?? Z?? E??. Fill in the value you like to be used at the question marks.

2) M500. To finish the sequence. This saves the values in the EEPROM.

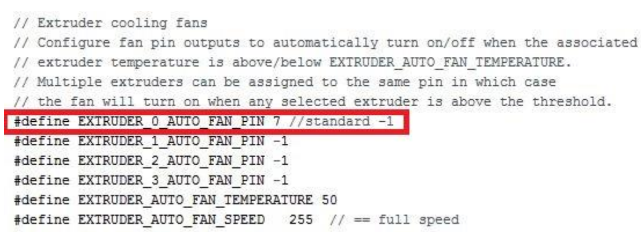
8.2 Fans

8.2.1 Extruder/Hot-end fan noise reduction

Implementing automatic enable and disable of active cooling fan for the BW.

Step -1

Identify your fan wires and note the polarity orientation, (Red + ,Black-), then disconnect the wires from the PSU, and connect them to the MKS Gen V 1.3 or V1.4 main board, into the "HE1" (Heater E1) socket and take care of the polarity.



```
// Extruder cooling fans
// Configure fan pin outputs to automatically turn on/off when the associated
// extruder temperature is above/below EXTRUDER_AUTO_FAN_TEMPERATURE.
// Multiple extruders can be assigned to the same pin in which case
// the fan will turn on when any selected extruder is above the threshold.
#define EXTRUDER_0_AUTO_FAN_PIN 7 //standard -1
#define EXTRUDER_1_AUTO_FAN_PIN -1
#define EXTRUDER_2_AUTO_FAN_PIN -1
#define EXTRUDER_3_AUTO_FAN_PIN -1
#define EXTRUDER_AUTO_FAN_TEMPERATURE 50
#define EXTRUDER_AUTO_FAN_SPEED   255  // == full speed
```

Step -2

Enabling the auto cooling in the firmware: Open the Marlin FW: **Up to RC8 V3:** "**Configuration_adv.h**" file. **As of RC8 V3.2:** "**Configuration_adv_xxxx.h**" file, see **Section 11.1.3**. Scroll about a third the way down until you see the "Extruder cooling fans" section. Change the current #define E0_AUTO_FAN_PIN -1 to #define E0_AUTO_FAN_PIN 7. If the function is disabled remove the forward slashes (//) before the "#define E0_AUTO_FAN_PIN"

Now verify and upload the firmware to your printer.

8.2.2 Heater fan failure

The stock heater fan is prone to fail at start or after a while in use. If you have to tap it to get it start running or it varies in speed constantly you have to file a support ticket at TEVO or buy a new one which should be 24 VDC or use a 12 VDC one with a step down converter. **Noctua 40mm fans** are known for their silent working and are resonance free. A fan without resonance also enhances the measuring of the BL-Touch if this one is used.

8.3 BL-Touch Option

Caution

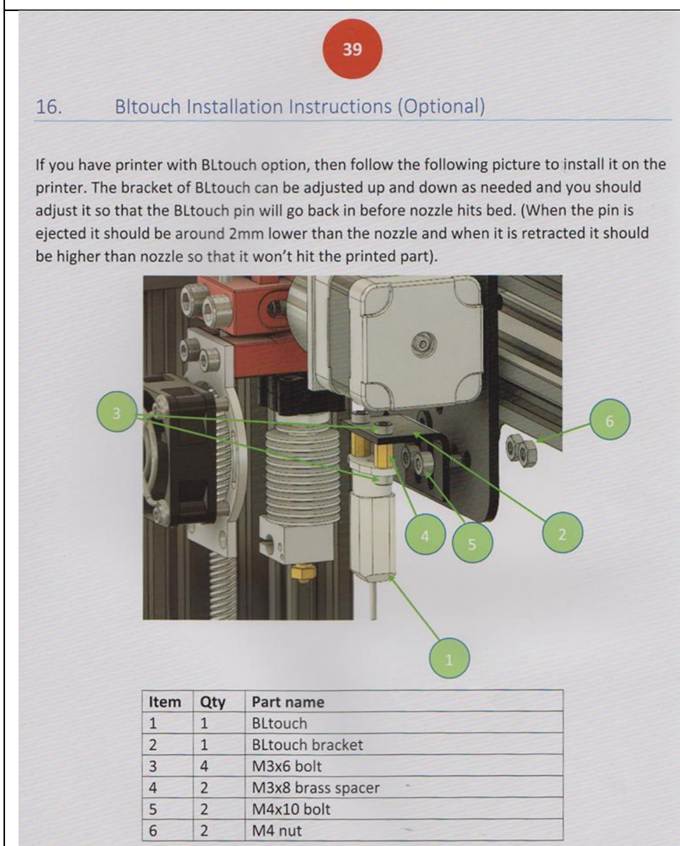
The BLT sections in this guide are valid ONLY to the ANTCLABS BL-Touch. If you are using a clone, some or all of the relevant information, including the FW, may not apply and/or not work properly.

8.3.1 Mounting Bracket

Up to Mar-2017, this option did not come with a mounting bracket for the BLT sensor!!! Therefore the machine could not be used for printing with BLT when assembly is done. If you have an older machine and would like to overcome this problem, you need someone to print for you a BLT mounting bracket. This can also be done by a local 3D print-service/hub.

Please note

As of Apr-2017, TEVO is providing a metal BLT mounting bracket, shown below, when ordering the BW with the BLT option. Therefore it is possible to print upon finishing the assembly using the stock BLT FW. However it is highly recommended to upgrade to the latest RC8 community BLT FW, in order to have all the Marlin/community updates/bug-fixes.



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16. Bltouch Installation Instructions (Optional)

If you have printer with BLtouch option, then follow the following picture to install it on the printer. The bracket of BLtouch can be adjusted up and down as needed and you should adjust it so that the BLtouch pin will go back in before nozzle hits bed. (When the pin is ejected it should be around 2mm lower than the nozzle and when it is retracted it should be higher than nozzle so that it won't hit the printed part).

Item	Qty	Part name
1	1	BLtouch
2	1	BLtouch bracket
3	4	M3x6 bolt
4	2	M3x8 brass spacer
5	2	M4x10 bolt
6	2	M4 nut

Please note

This is an excerpt from TEVO's manual regarding this mounting bracket.

It has not yet been confirmed whether this bracket is compatible with the layer fan mountings which are linked in this guide and used by the community.

When this information is available, the guide will be updated.

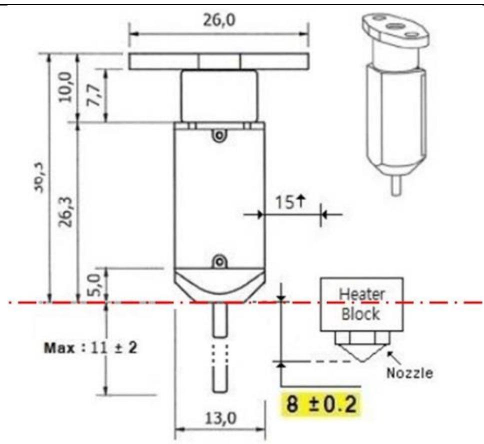
A community simple bracket can be found at **http://www.thingiverse.com/thing:1950504**.

Official mounting brackets by the BLT vendor:
http://www.thingiverse.com/thing:1761761 Large version. You need two M4 screws and nuts!

http://www.thingiverse.com/thing:1721703 Small version. You need two M4 screws and nuts!

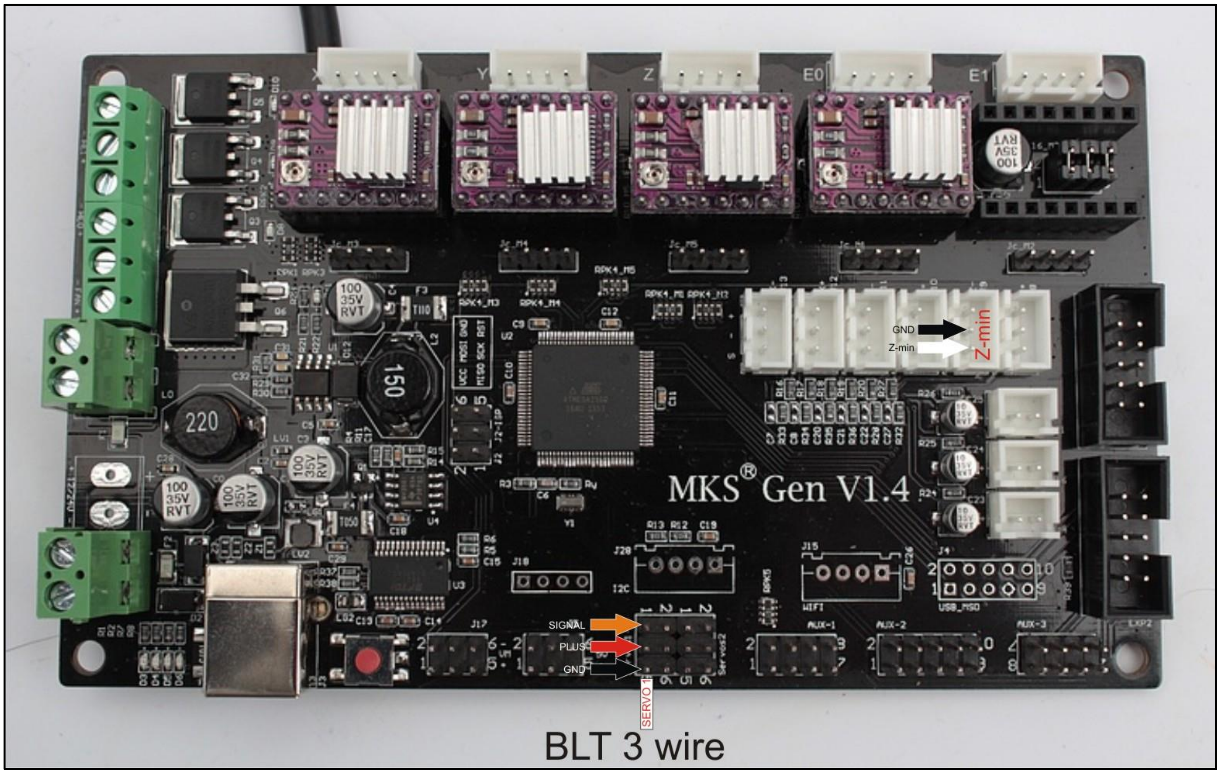
A modular design which allows for many combinations of Hot-end/Extruder/Sensor can be found at **http://www.thingiverse.com/thing:1829292**.

8.3.2 Installation

	We assume the BLT is correctly installed on the machine 8.0 mm from tip nozzle to BLT reference line, as shown in the picture.

8.3.3 Wiring & Connection Diagram

This is the correct connection schematic for hooking up the BL-Touch. You can only connect one Z-min endstop connector!



Connector Legend

BLT 3-wire, which connects to the Servo-S1 connector:

Orange arrow: SIGNAL.

Red Arrow: PLUS.

Black Arrow: GND.

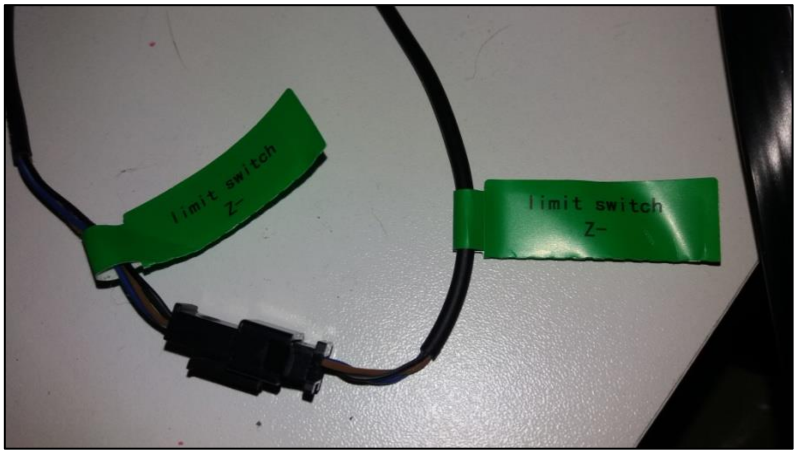
BLT 2-wire, which connects to the Z-Min connector:

Black Arrow: GND.

White Arrow: Z-Min.

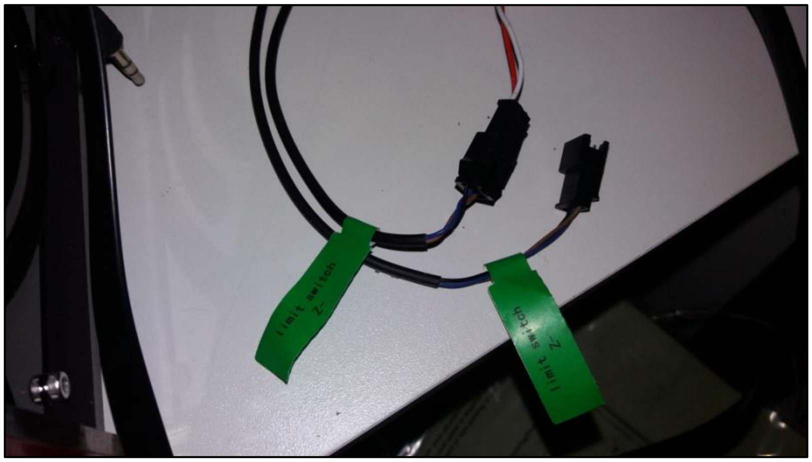
Test your BLT when it is connected this way only. Do not use any other servo port even if it is shown in the video we refer to. That video is purely for how to install Arduino IDE and U8glib but uses servo port 4, which is not used in the Marlin firmware for the Black Widow with BL-Touch.

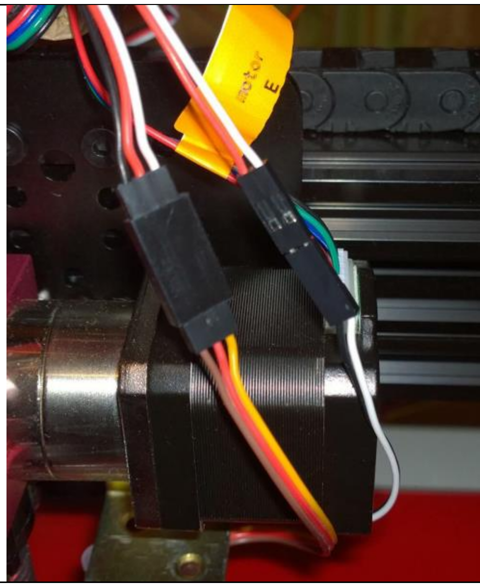
If you order a BL-Touch option, you get two extra cables which you need to put in the drag chain.
There is also a third 3 wire extension cable. Connect this one to the 3 wire cable in the drag chain and **servo port 1 on the MKS V1.3 board**. So this cable is built now from two parts. Search the connector green labeled “Limit switch Z-“. Disconnect the connectors.



Connect the white/red cable coming from the BL-Touch 2 wire cable to the Limit switch Z-.

Do not disconnect the Z-min endstop on the main board. The connection needs to be made outside the control box.



	Make sure the BL-Touch cables are connected like the picture shows. 2 wire > White / White – Red / Black 3 wire > White / Orange – Red / Red – Black / Black

8.3.4 FW (Firmware) (Duplicate 1 of 2)

This machine is equipped with Marlin RC7 BL-Touch firmware. At power up it will show the TEVO and BL-Touch logo. **Up to Mar-2017, this option did not come with a mounting bracket for the BLT sensor!!! Therefore the machine could not be used for printing with BLT when assembly is done.** If you have an older machine and would like to overcome this problem, you need someone to print for you a BLT mounting bracket. This can also be done by a local 3D print-service/hub. Or you have to downgrade the firmware first to **STOCK FW**, **and use the stock proximity/inductive Z – min endstop first.**
Therefore this machine/BL-Touch combo is not recommended for newbie 3D printing. The BL-Touch can be purchased later and installed if needed.

Please note
As of Apr-2017, TEVO is providing a metal BLT mounting bracket, shown below, when ordering the BW with the BLT option. Therefore it is possible to print upon finishing the assembly using the stock BLT FW. However it is highly recommended to upgrade to the latest RC8 community BLT FW, in order to have all the Marlin/community updates/bug-fixes.

8.3.5 Self-Test

Always start with this first !!!!!!!!!!!!!!!!!!

1] Disconnect the USB cable. Power on the machine. The BL-Touch pin should go out and in 2 times and then the light should be solid red.
If it does not go in and out check the 3 wire servo cable as it does not get 5 Volt power. No need to proceed if the self-test is not working! Solve this first! By doubt if the cable and connectors from MKS GEN V1.3 board to the BLT are not faulty you can try to connect the 3 wire servo cable directly to the Servo port 1 on the MKS GEN V1.3 board.
If the BLT starts to flash red. It might that the top of the BL-Touch pin is deformed as it ran into the heat bed during previous test!! Remove the hexagon screw at the top of the BL-Touch. Remove the pin and check the top. The heat shrink part should be uniform round. The picture shows a deformed top part. If this is the case use a hairdryer and warm the heat shrink and form it to a circular round shape.

Assemble the BLT again and make sure the top of the hexagon screw is flush with the top of the BLT mounting.
Do not adjust the BL-Touch screw for adjustments reason if the pin gets stuck. The screw should be flush.

2] Connect the USB cable to the machine. The BL-Touch cable should be connected to the correct spot on the MKS V1.3 board servo port 1. Make sure the correct firmware is on the MKS V1.3 board. Currently we advise the **BLT FW** version. Open **Repetier**, **Pronterface** or any controller program that can send G-codes on a command line. Make sure the machine is detected by the software!

Send the following M-codes to test the BL-Touch:
M280 P0 S10 ; pushes the pin down
M280 P0 S90 ; pulls the pin up
M280 P0 S120 ; Self-test – keeps going until you do pin up/down or release alarm
M280 P0 S160 ; Release alarm

8.3.6 Calibration

These instructions were written to explain how to calibrate using a computer connected through the USB port to your printer.

Caution
During the whole procedure, you must have your hand on the master switch, ready to shut off the printer. This is a look ahead measure in order to prevent the BLT and/or the nozzle from crashing into the heat-bed, in case of improper operation.

1) ANTCSLABS BLT pin test for Z-home:
1.1) Send G28 XY; Homing X and Y axis first.
You can only use G28 Z if G28 XY is performed first otherwise you get an error message on the display: "**Z forbidden**".

1.2) Send G28 Z; Homing the Z-axis only downwards.

Caution
Z-homing should be at the center of the heat-bed. If it's not, you are probably not using the correct FW variant.

1.3) As soon as the Z axis moves downwards, touch the tip of the BLT and verify that it detects the pin correctly. It should stop and resume moving downwards after you release the pin. Touch the tip of the BLT again, to double check that the Z-min endstop is working correctly.
1.4) If the Z axis keeps moving downwards, switch off the main power immediately. Check first that the 2-wire sensor cable, from the ANTCLABS BLT to the main board, is wired correctly.
1.5) If your head moves upwards only, then you have the 2 wire sensor cable, from the ANTCLABS BLT to the main board, connected wrong, i.e. connected to the Zmax (X+) instead of the Zmin (Z-).

2) End stop status:
2.1) Send M119 which is the G-code command to check the end stop status.
X,Y and Z should report their status as **OPEN** when not activated. If Z says **TRIGGERED** then your wiring is faulty. The 2 wire cable and connector should be checked for reverse and/or faulty connection.

3) Calibration:
3.1) Send M851; note the number.
3.2) Send M851 Z0; sets the offset to zero.
3.3) Send G28; homing all axes.
3.4) Send G1 Z0; when homed the LCD display should show **Z = 0**.

3.5) From the machine LCD display go to **Menu** then: **Prepare**/**Move axis**/**0.1mm**/**Move Z.**
Now move the Z axis slowly down until the nozzle is at the right distance from the build plate (an A4 paper thickness).
Please note
The Z axis value on the display it should be something like -1.5.

3.6) Send M851 Z-1.5; to set the offset you got in the previous step.
If you find that you need to increase or decrease the gap then do either:
3.6.a) Send M851 Z-1.4; this would make the gap bigger.
3.6.b) Send M851 Z-1.6; this would make the gap smaller.

4) EEPROM:

10) Send M500; to save the value to EEPROM so that it is not reset when you power the printer off and on (Remember the -1.4, -1.5 and -1.6 are just examples, yours may be different).

8.3.7 Auto bed leveling

For correct so called Auto-bed levelling the official Marlin RC7 BLT supplied on the machine might not be working correct. This has nothing to do with the BL-Touch itself but is (was) Marlin bug related. Download the **BLT FW** version.

9 Electro-Optical

This section is for elements which convert electrical energy to optical energy (light), and vice versa, e.g. LEDs.

9.1 Led Strip

	With your kit you receive two items as a gift. One item is two LED strips which you can connect directly to the 24 VDC of the Power Supply Unit. If they do not work check the polarity. There have been reports that the polarity signs on the strip were wrong. So double check.

10 Electro-Thermal

This section is for elements which convert electrical energy to thermal energy (heat), and vice versa, e.g. hot-end, heat-bed and thermistors.

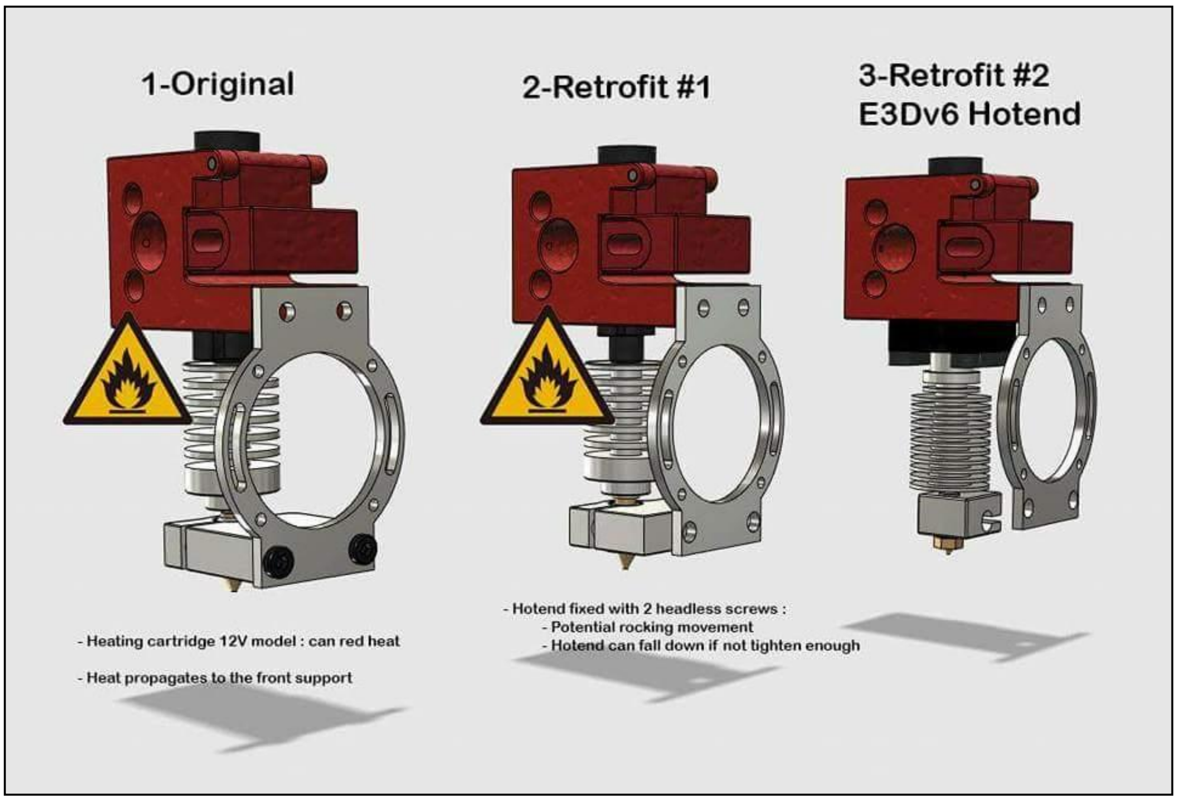
10.1 Hot-end

10.1.1 Hot-end Versions

The latest version V3 (as of Sep-2016) come with a **cloned** E3D-V6 (Retrofit #2) hot-end unit. Previous versions of hot-ends are prone to cause problems and will be swapped by TEVO if you open a support ticket. For Hot-end V3 refer to Section-4.6.

Caution

Versions V1 (Original) & V2 (Retrofit #1) are obsolete and should not be used, as they may pose a safety/fire hazard. Only V3 (Retrofit #2) should be used.

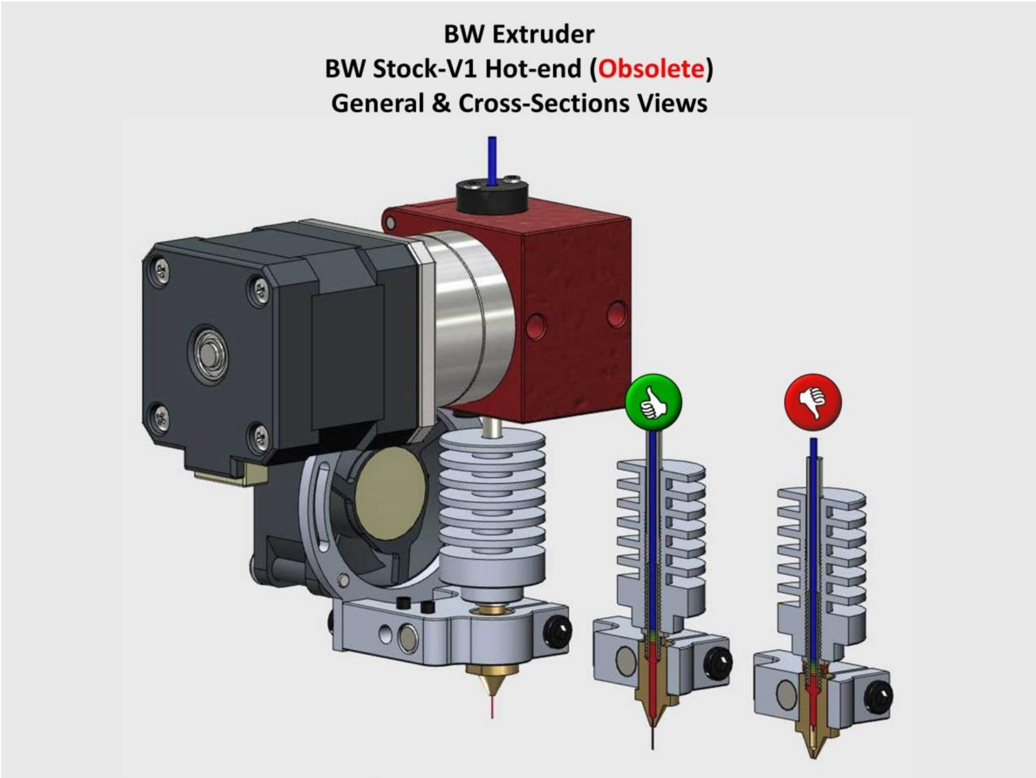


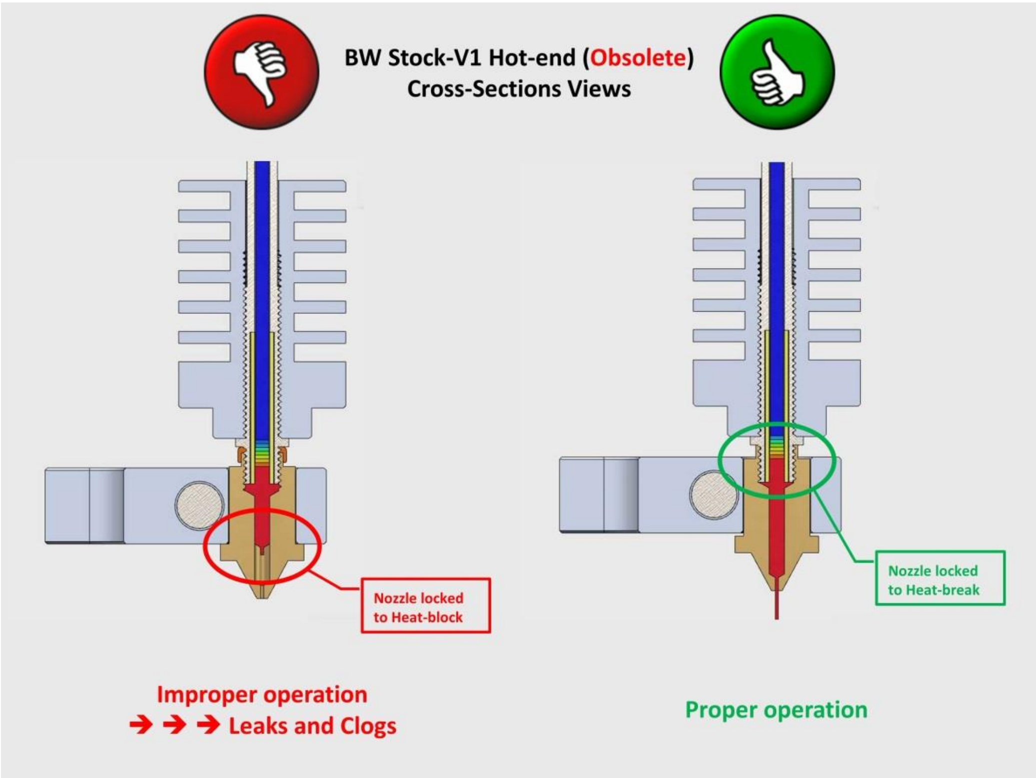
As it comes from TEVO, the nozzle sits against the heat-block, not the heat-break, thus may cause leakage of filament above the heat-block.

Caution

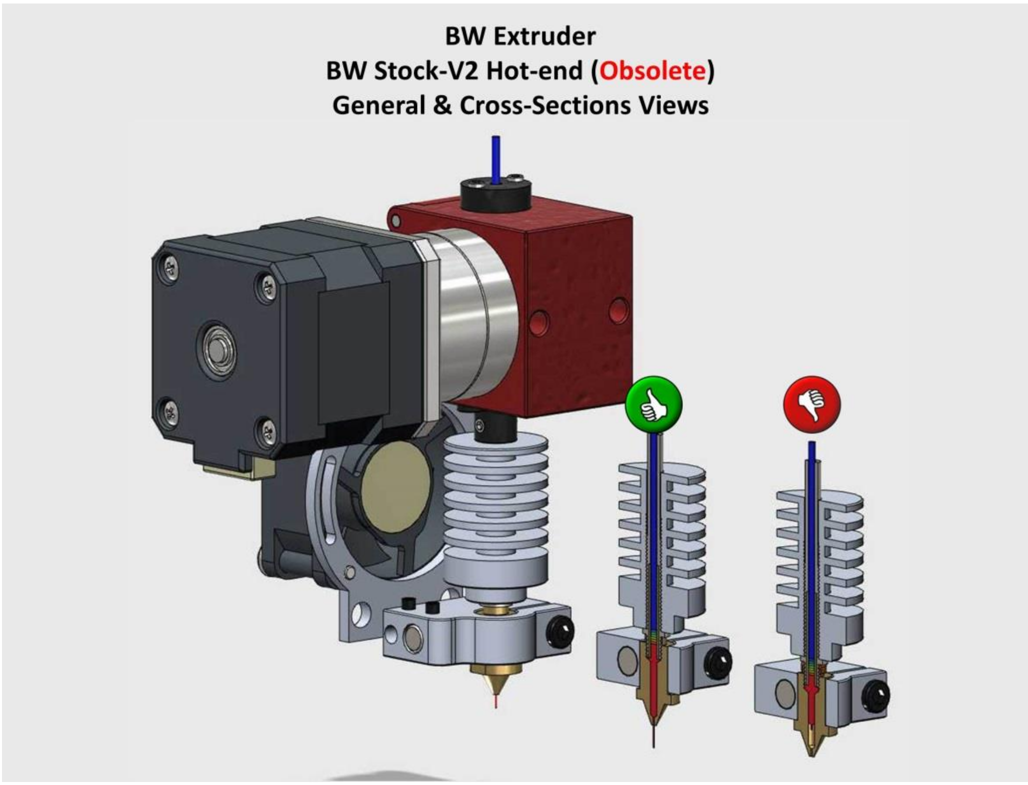
Before use, it is advised to check that the nozzle is locked against the heat-break, as shown in the following illustrations. Current heat-blocks are equipped with white paste. Take care if/when you disassemble it to remove the stuff. Be careful with tools when you remove the nozzle or heat-break.

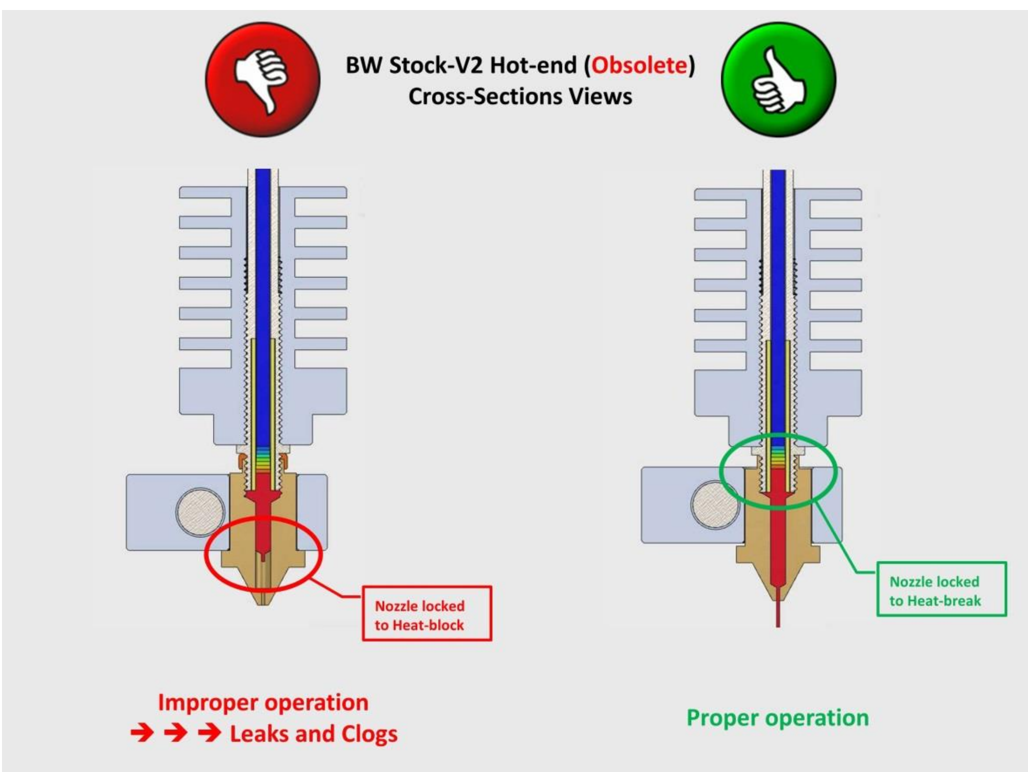
The following illustrations show the stock V1 hot-end, which was originally shipped to about 200 customers. **The V1 is obsolete**.



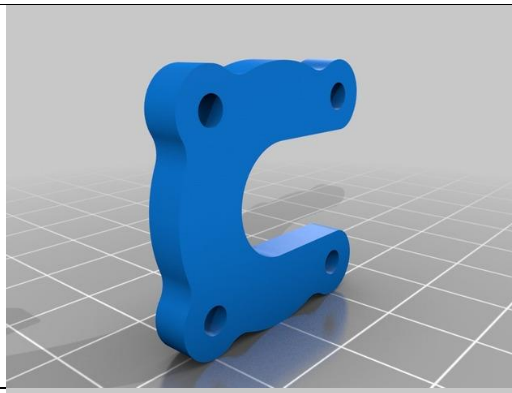
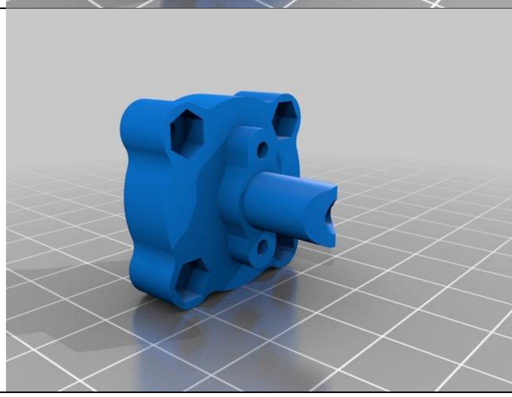


The following illustrations show the stock V2 hot-end, which was shipped as retrofit #1 to about 200 customers who initially received V1, as well as to new customers. **The V2 is obsolete**.





10.1.2 Converting to V3 Hot-end

 	For those who have the V1 and V2 hot-end unit and want to convert to the V3 version, they need to add two spacers. They can be found here: **http://www.thingiverse.com/thing:1708185** With the new machines after Sep-2016, the spacers come with the kit.

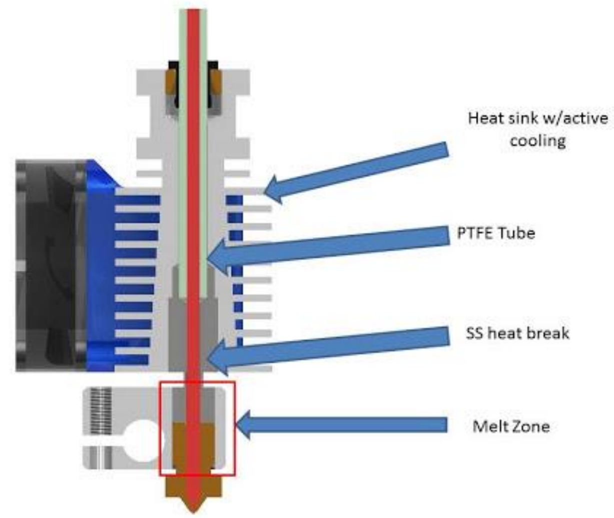
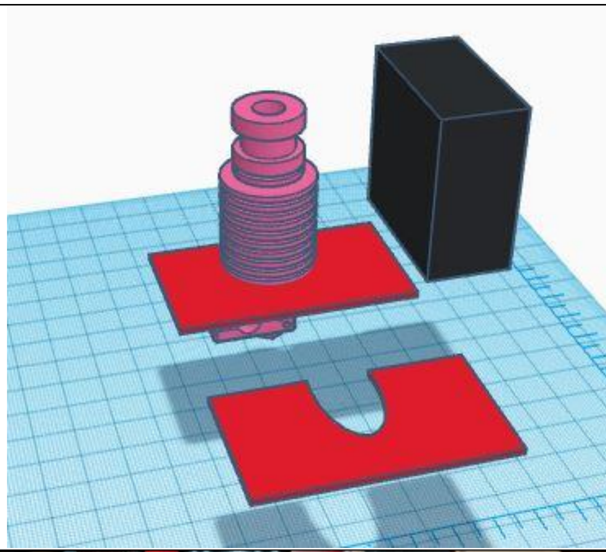
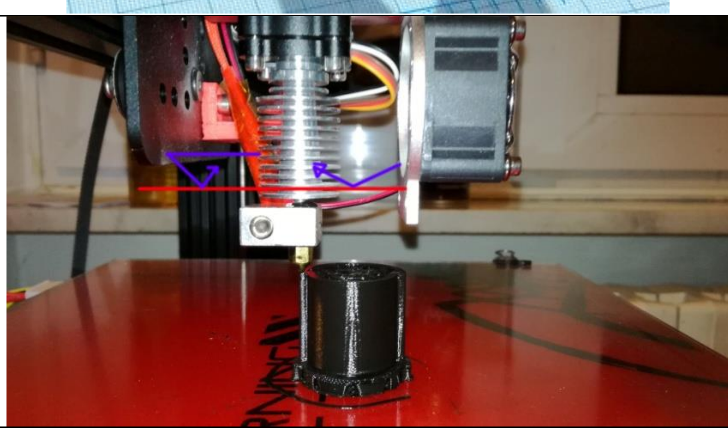
10.1.3 Warm up time

Warm up time of the hot-end from 20 to 245 degrees Celsius should take less than 2 minutes. If it takes much longer, there might be 2 classes of issues. For the Thermal class, please read on the following section. For the Electrical class, please check the appropriate **Control Board** section.

Warning
High Temp, don’t touch with bare hands!

Warning
High Voltage, don’t touch with bare hands!

10.1.4 Hot-end can’t go higher than 180 Degrees-C

<table>
<tr>
<td>
</td>
<td>You only want to cool the cool zone. With current BW design with the E3D V6 clone and stock fan set up the fan is blowing on the cooling heatsink and also on other parts. The cool zone is not separated. The Melt/HOT ZONE needs to be isolated from any cooling. When it is cooled to much by filament/object coolers your hot zone will cool down making the temp unstable and you need more power to get it higher and stable. PID tuning is a fine tuning aid not a solution for bad air flow compensation. Picture shows original E3D V6 heater unit. The BW clone unit has PTFE in the Melt Zone too!!! Maximum temp is 250 degrees Celsius.</td>
</tr>
<tr>
<td>
</td>
<td>When you build the kit and start the first print and your heater can not reach higher temps than 180 degrees, or PID tuning at higher temps fail. It might that the fan is also blowing on the nozzle part of the heater, cooling it down. Cut a playing card with a slot and place the card or any thin cardboard in between the two lowest slots/fin of the aluminum cooling cylinder. Take care the cardboard does not touch the lower hot part. As the picture shows the cool air is blocked and can’t reach the nozzle area.

Then print the air duct like this:
http://www.thingiverse.com/thing:1937278</td>
</tr>
</table>

10.1.5 Thermistor

With your kit you receive two items as a gift.

One item is an extra thermistor for the hot-end heat-block.
This thermistor is a 100Kohm NTC resistor with beta of 3950 PPM/degree-C. (PPM=Parts Per Million)
This thermistor is encapsulated inside a tiny glass bulb.

FW configuration: **Up to RC8 V3:** "**Configuration.h**" file should be:
#define TEMP_SENSOR_0 11 (**for E_0 extruder**)
#define TEMP_SENSOR_1 11 (**for E_1 extruder**)

FW configuration: **As of RC8 V3.2:** "**Configuration_xxxx.h**" file, see **Section 11.1.3**, should be:
#define TEMP_SENSOR_0 127 (**for E_0 extruder**)
#define TEMP_SENSOR_1 127 (**for E_1 extruder**)

Please note
This thermistor can't be used on the heat-bed, as is, since the heat-bed uses an SMD type thermistor. If you need to use it for the heat-bed, refer to Section 10.2.3 for instructions.

10.1.6 Heat-break (New section)

Please note

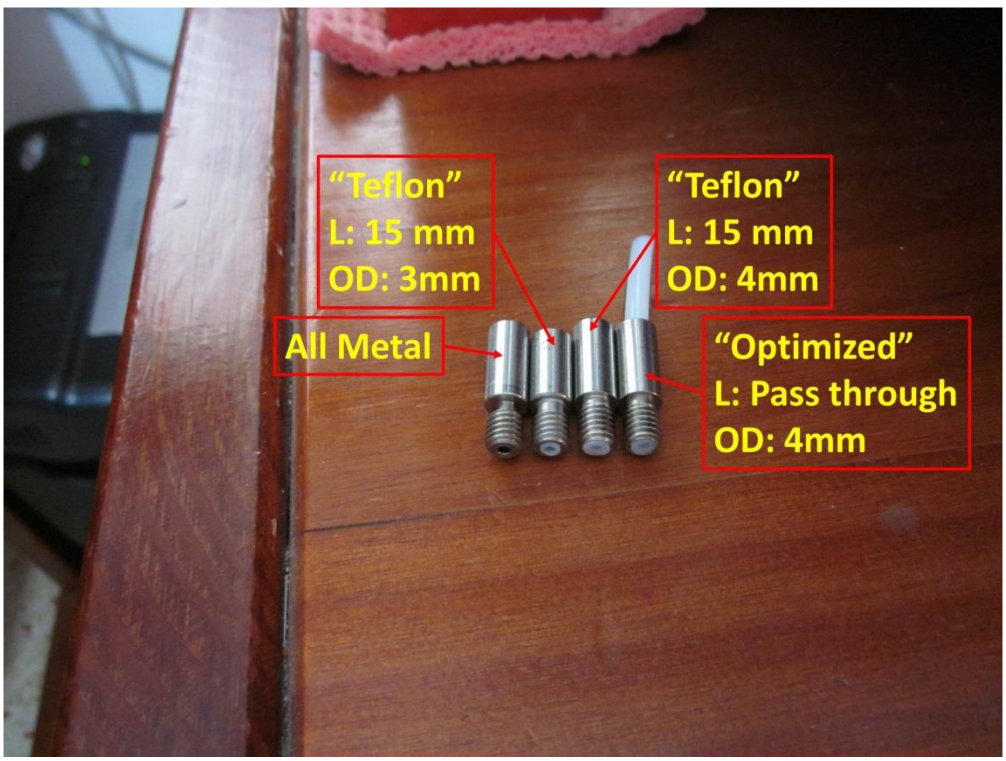
The following pictures show the Kraken type heat-breaks, whereas only the heat-block side is threaded and heat-sink side is smooth. However the same discussion applies to the E3D-V6 type, whereas both sides of the heat-break are threaded.

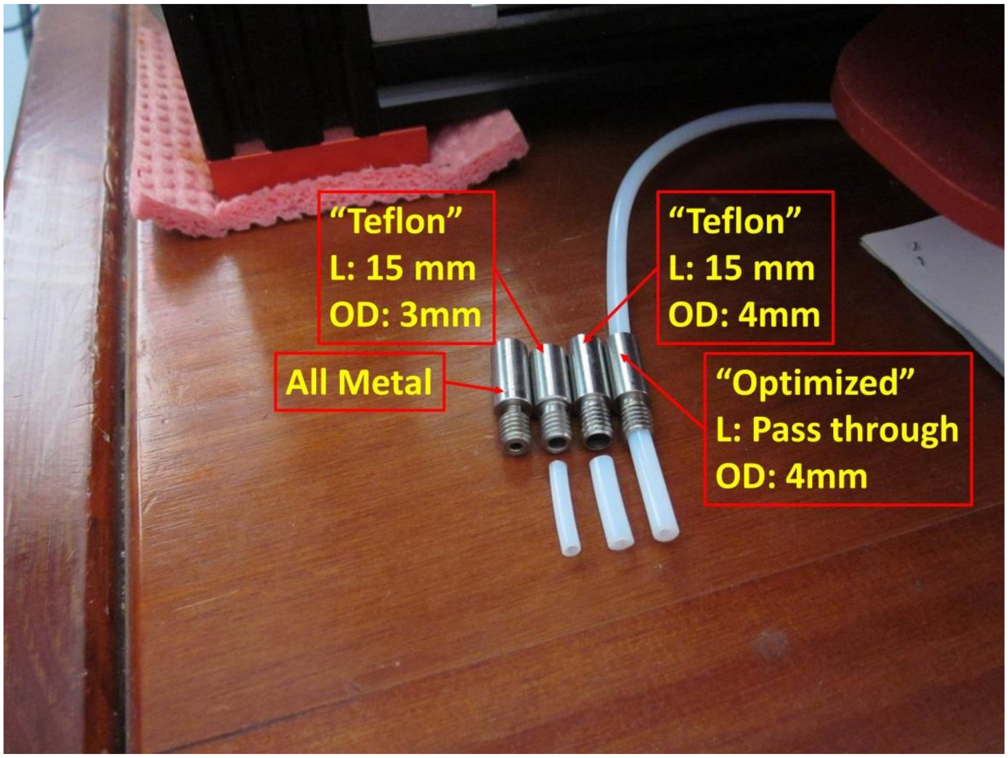
There is a new variation in the clone space, designated here as “Teflon”, 15mm long, 4mm OD, which does not necessarily correspond to the seller information.

Therefore if you are ordering a replacement part, you should make sure you are ordering what you want by having specific instructions to the seller.

The following pictures show how these heat-breaks look when the PTFE liners/Bowden-tube are inside and outside of the heat-breaks.

The pictures are followed by explanations about the 4 variations which currently exist on the market place.





1) The "All metal" type is **NOT** recommended as in most clones the 2 mm bore is not concentric with the nozzle bore. The resultant "step" at the interface, between the nozzle & the heat-break, will cause a clog within 5 minutes to few hours.

Please note
If you are printing with exotic high-temp filament, e.g. CF, meaning that you must use an "all metal" heat-break, you should opt for a genuine E3D.

2) The "Teflon", 15mm long, 3mm OD PTFE liner type, was the Tarantula heat-break that has been shipped at the beginning. **If you are using a low temp filament, e.g. PLA, e.g. ABS, this is the recommended type**, as it will not clog. As a matter of fact, few members of the community are using these for the last 18 months non-stop and they keep running.

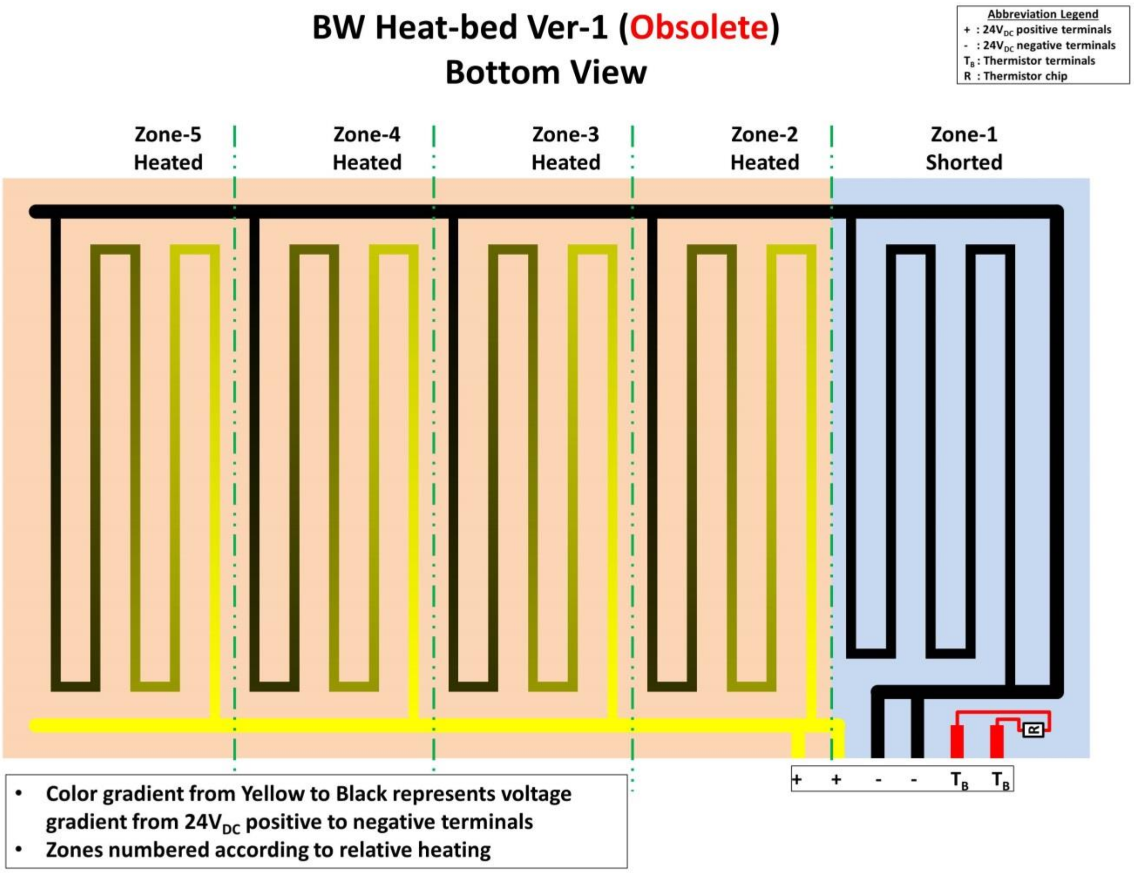
3) The "Teflon", 15mm long, 4mm OD PTFE liner type, is the new kid in the neighborhood. It will not clog, however it is **NOT** recommended as it is mechanically weak at the M6 thread zone, and tends to break easily.

4) The "Teflon" 4mm OD pass-through type, aka "optimized" type at the Ali stores, has been shipped with the Tarantula for some time in the past. I don't know what the current status is. However it is **NOT** recommended due to 2 reasons: A) It will break easily like #3 above, and B) it will clog, as the molten filament pressure "pushes up" the Bowden tube, thus creating a 4mm diameter space between the nozzle and the heat-break. You would need a high quality Bowden press-fit coupler to prevent this, which is probably not the case with the clones.

10.2 Heat-bed

10.2.1 Heat-bed versions

Heat-bed V1 has design flaw, whereas Zone-1 is shorted thus not heating. The thermistor is at the un-heated zone; therefore temperature readings are completely wrong. If you happen to have this version, you should replace it.

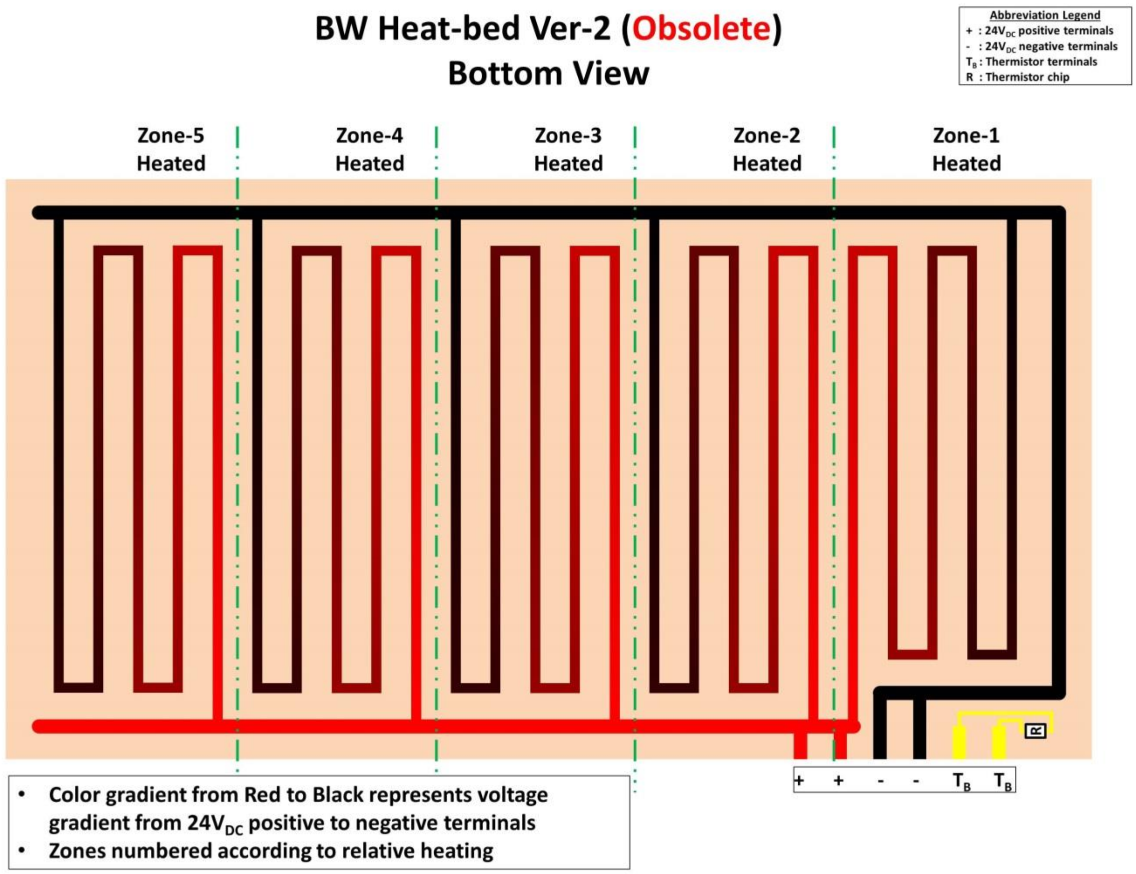


Heat-bed Ver-2 is a corrected version. It has successive less heating as moving away from the feeding point, and has the thermistor at the hottest, however no significant issues reported by using it.

Please note

V1 & V2 have had the SAME pinout. Only the colors of the cable wires are different. (+) lines are Red and Thermistor lines are Yellow.

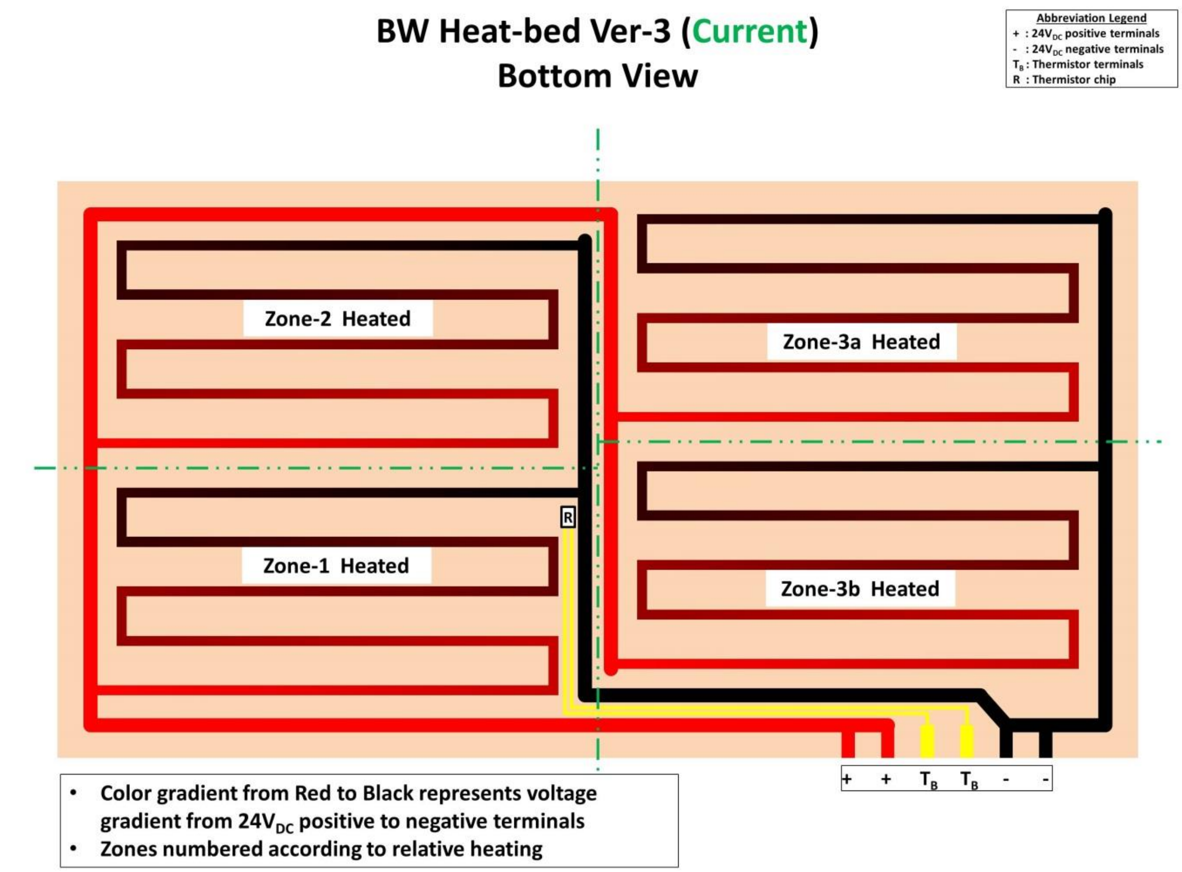
Therefore cables of V1 & V2 are interchangeable, as you can't plug the thermistor plug into the heat-bed connector, regardless of the color.



Heat-bed V3 is a new design which is much better, as the thermistor is at the center, and zones 2, 3a &3b are heating about the same, whereas zone 1 is heating a bit more.

Warning

When replacing either V1 or V2 heat-beds with the new V3, you MUST replace the cable as well! Using either V1 or V2 cables with the V3 bed would destroy your MKS controller!!! (It will inject +24VDC to the thermistor port of the controller chip)



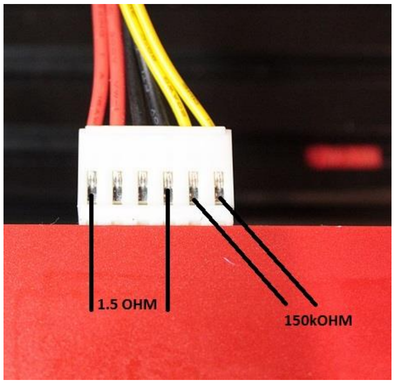
Heat-bed V4

Please note

Although it was not officially confirmed by TEVO, heat-bed V4 is the same as V3 as far as electrical design is concerned, with the addition of a thermal insulator on the bottom side.

It has 4 heating quadrants, thermistor chip located at the center of the bed, and connector wire colors as shown in the above V3 illustration.

10.2.2 Heat-bed Wiring & Resistance Values



Warning:
There are 3 bed versions on the field. You must determine your version before connecting, as V3 is not backward compatible with either V2 or V1

Ohmic values of the heat-bed when connector is removed.

Refer to the table below for thermistor wire color, thermistor position on the connector, and nominal resistance of the bed Vs the version.

Values might vary according to batch. Thermistor resistance value should be between 90 and 150 KOhms.

Please note
For heat-bed connection diagrams, refer to Section 7.10.

Thermistor pin locations are given, when viewed from the TOP of the bed !!!

Ver	Date	Nominal bed (Ohm)	Nominal bed (A)	Thermistor pins	Thermistor wire color
V1	Introduction	1.6	15	Right	Red
V2	Oct-2016	1.6	15	Right	Yellow
V3	01-Jan-2017	2.0	12	Center	Yellow
V4	Feb-2017 ??	2.0	12	Center	Yellow

10.2.3 Thermistor (Revised section)

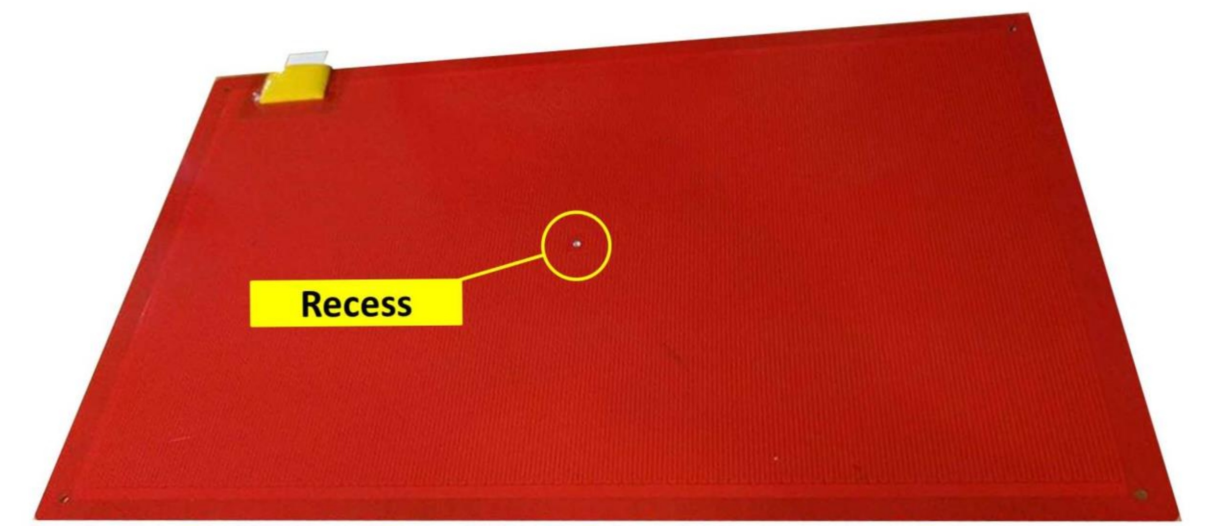
The heat-bed thermistor is a 100Kohm NTC SMD chip resistor with beta of 3950 PPM/degree-C. It is soldered to the bottom of the heat-bed, and covered with a thermal insulation pad and Kapton tape, to keep it at the heat-bed temperature, which prevents erroneous readings.

Heat-bed V1

As shown in Section 10.2.1, the thermistor is placed in a non-heated zone, therefore the reading is completely wrong. If you are still using this version, you should attach the gift thermistor to the recess at the center of the bed, which is shown in the following picture, and cover it with insulation pad and Kapton tape. Then connect it directly to the T_B connector on the MKS-Gen, by replacing the **Red wires** stock connection which is shown in **Section 7.10.1**.

FW configuration: **Up to RC8 V3:** "**Configuration.h**" file should be:
#define TEMP_SENSOR_BED 11

FW configuration: **As of RC8 V3.2:** "**Configuration_xxxx.h**" file, see **Section 11.1.3**, should be:
#define TEMP_SENSOR_BED 11

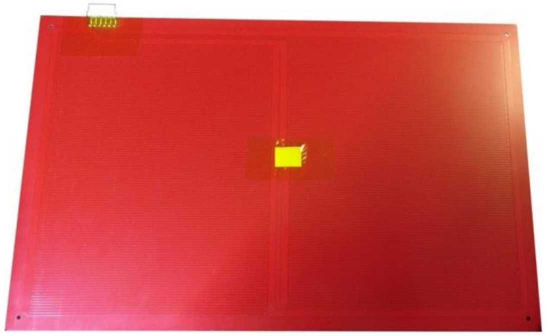


Heat-bed V2

As shown in Section 10.2.1, the thermistor is placed at the heat-bed's edge, therefore the reading is wrong. If you are still using this version and you want a better performance, you can attach the gift thermistor to the recess at the center of the bed, which is shown in the following picture, and cover it with insulation pad and Kapton tape. Then connect it directly to the T_B connector on the MKS-Gen, by replacing the **Yellow wires** stock connection which is shown in **Section 7.10.2**.

FW configuration: **Up to RC8 V3:** "**Configuration.h**" file should be:
#define TEMP_SENSOR_BED 11

FW configuration: **As of RC8 V3.2:** "**Configuration_xxxx.h**" file, see **Section 11.1.3**, should be:
#define TEMP_SENSOR_BED 11



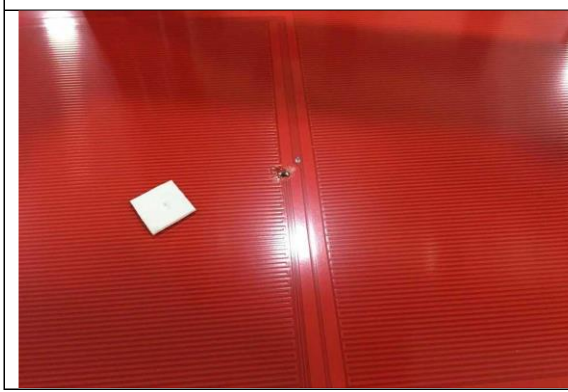
Heat-bed V3

If you are having this heat-bed version, just leave its thermistor alone. All reports up until now indicate that this version functions properly.

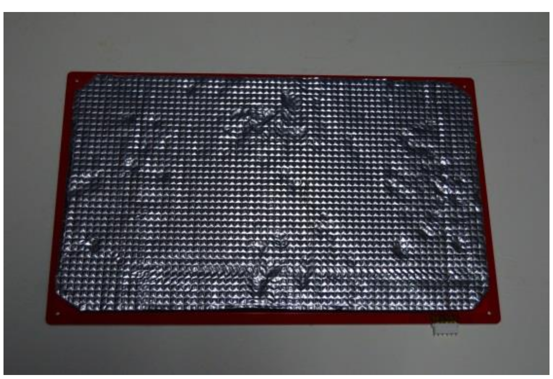
FW configuration: **Up to RC8 V3:** "**Configuration.h**" file.

As of RC8 V3.2: "**Configuration_xxxx.h**" file, see **Section 11.1.3**, should have:

#define TEMP_SENSOR_BED 11



And certainly don't peel off the thermal insulation pad, as this will cause erroneous readings.



Heat-bed V4

Please note

Although it was not officially confirmed by TEVO, heat-bed V4 is the same as V3 as far as electrical design is concerned, with the following mechanical/thermal changes:

1) Addition of a thermal insulation on the bottom side, which is made of PET foam (PolyEthylene Terephthalate), covered with an Aluminum foil.

2) The thermistor is a glass bulb type, like the hot-end thermistor shown in Section 10.1.5, and placed in the recess at the center of the heat-bed, as shown in the above V1 & V2 illustrations.

10.2.4 Glass printing surface

To have a flat printing surface you can use a 250x400 mm –3 or 4mm thick regular window glass plate. No need for expensive Borosilicate or Tempered glass. Avoid the use of binder clamps/clips to mount the glass plate to the heat-bed. You can use tape to attach it to the heat-bed at the sides or use 0.5 mm silicone thermal pads in between.

Caution: Glass may shatter if hit by the hot-end. Use care when calibrating the Z-homing.

This prevents the glass plate to move but allows expansion of the glass and gives easy placing. Larger pads are advised if you regularly need to lift the glass plate. You can use **Auqanett** hairspray or **3Dlac**, or **Magigoo** for correct bonding of the first layer.

Warning: Never apply aerosol based sprays on a heated heat-bed while hot to prevent explosion of the gasses.

Other option is to clean the glass with Isopropyl 96% alcohol or Windex window cleaner. Use a razor blade to clean the surface first. Let the alcohol or fluid evaporate first!

Warning: Never apply alcohol based fluids on a heated heat-bed while hot.

Due to the thickness of the glass plate you need to preheat the heat-bed longer so the glass plate can receive the radiation heat from the heat-bed to overcome the airgap. Approx. 5 minutes extra heat up time is recommended. Larger pads 50x50 mm transduce the heat quicker. A full heat-bed is preferable equipped with 12 pads of 50 x 50 mm.

eBay link…………

10.2.5 Warm up time

Warm up time of the heat-bed from 20 to 80 degrees Celsius takes ~3 minutes. If it takes much longer, check the appropriate **Control Board** section.

Caution: Temp higher than 60 C may cause burns !

Warning: High Voltage, don't touch with bare hands!

11 FW

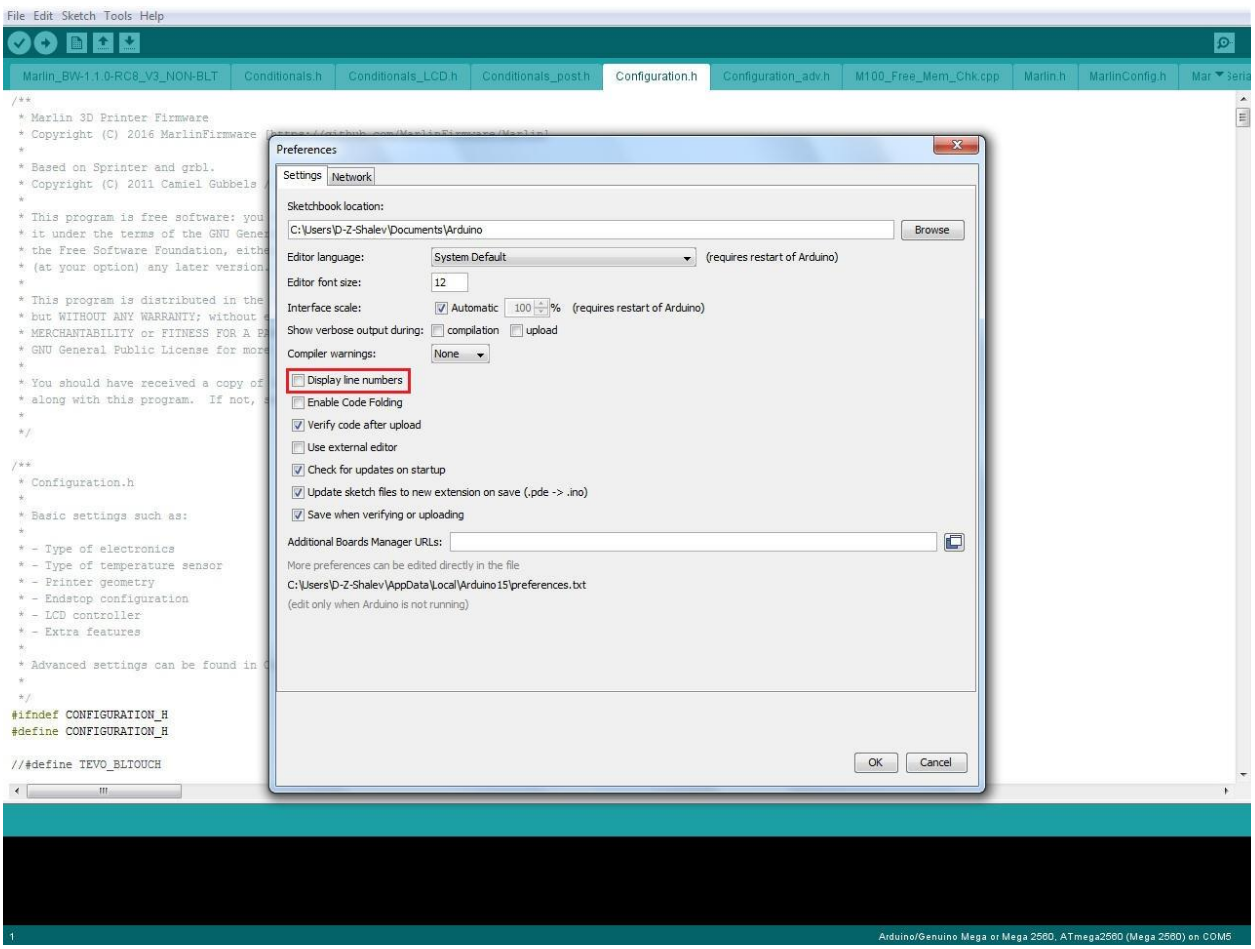
11.1 FW Variants

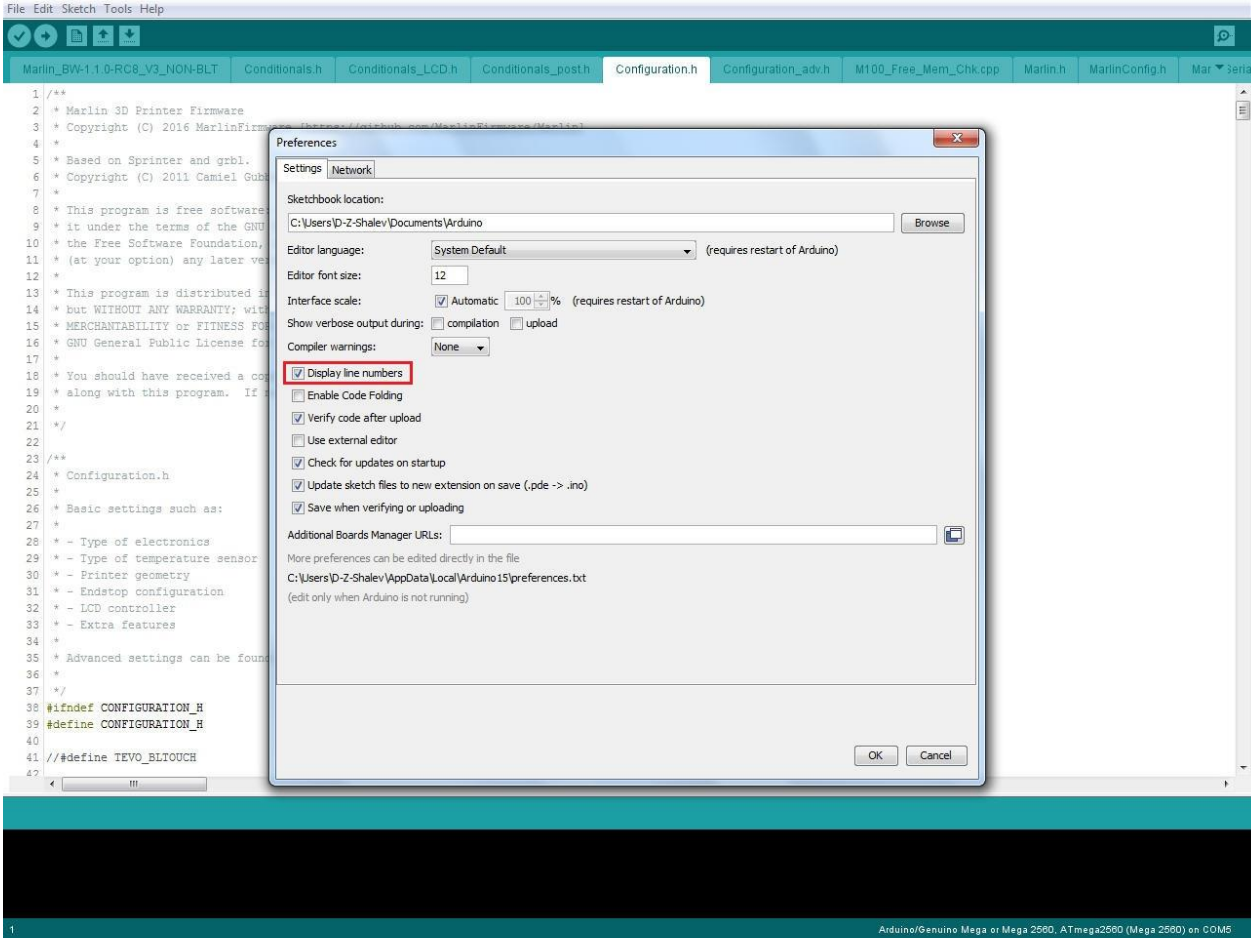
TEVO delivers two Black Widow variants, the stock and the BLT option. BW community has evolved these, as well as adding more variants as required. The following sections detail the various FW variants.

In the Marlin Github repository, line numbers are shown. You may want to enable the line numbers in the Arduino FW interface. In order to do so, you need to click "**Ctrl+Comma**" to open the "**Preferences**" window, and tick the "**Display line numbers**" box, as shown in the following figures.

Please note

If you know the line number and want to jump to it, you should click "Ctrl+L". If you don't know the line number, you should search the appropriate strings by clicking "Ctrl+F".




File Edit Sketch Tools Help
Marlin_BW-1.1.0-RC8_V3_NON-BLT
Conditionals.h
Conditionals_LCD.h
Conditionals_post.h
Configuration.h
Configuration_adv.h
M100_Free_Mem_Chk.cpp
Marlin.h
MarlinConfig.h
Preferences
Settings
Network
Sketchbook location:
C:\Users\D-Z-Shalev\Documents\Arduino
Browse
Editor language:
System Default
(requires restart of Arduino)
Editor font size:
12
Interface scale:
Automatic
100
%
(requires restart of Arduino)
Show verbose output during:
compilation
upload
Compiler warnings:
None
Display line numbers
Enable Code Folding
Verify code after upload
Use external editor
Check for updates on startup
Update sketch files to new extension on save (.pde -> .ino)
Save when verifying or uploading
Additional Boards Manager URLs:
More preferences can be edited directly in the file
C:\Users\D-Z-Shalev\AppData\Local\Arduino15\preferences.txt
(edit only when Arduino is not running)
OK
Cancel
Arduino/Genuino Mega or Mega 2560, ATmega2560 (Mega 2560) on COM5

Caution

Up to Marlin RC8 V3, all settings like E-Steps, PID, stepper motor direction & pin-assignments are done in either the "Configuration.h" and/or the "Configuration_adv.h" files as appropriate.

As of Marlin RC8 V3.2 these settings need to be done in either the "Configuration_xxxx.h" and/or the "Configuration_adv_xxxx.h" files respectively, whereas "xxxx" currently stands for either STOCK or BLT or PROX. See Section 11.1.3.

11.1.1 Stock (Non-BLT)

This machine is equipped with Marlin RC7 firmware. At power up it will show the TEVO logo. The machine can be used without any firmware modification to start printing. If you are a newbie to 3D printing buy this version. Manual bed leveling on the Black Widow is easy and only needs to be done once a week maximum due to the stable framework but depending on your printing needs. This version uses the original proximity/inductive Z-min stop! When the machine is working and calibrated you can print the BL-Touch mount first if needed. You **cannot mix** firmware using the BL-Touch and the inductive Z-min endstop! It is one or the other. If you want to upgrade to the latest RC8 firmware, it can be found under the Community FW section below, under **STOCK FW**.

11.1.2 BLT Option (Duplicate 2 of 2)

This machine is equipped with Marlin RC7 BL-Touch firmware. At power up it will show the TEVO and BL-Touch logo. **Up to Mar-2017, this option did not come with a mounting bracket for the BLT sensor!!! Therefore the machine could not be used for printing with BLT when assembly is done.** If you have an older machine and would like to overcome this problem, you need someone to print for you a BLT mounting bracket. This can also be done by a local 3D print-service/hub.
Or you have to downgrade the firmware first to **STOCK FW**, **and use the stock proximity/inductive Z – min endstop first.**
Therefore this machine/BL-Touch combo is not recommended for newbie 3D printing. The BL-Touch can be purchased later and installed if needed.

Please note

As of Apr-2017, TEVO is providing a metal BLT mounting bracket, shown below, when ordering the BW with the BLT option. Therefore it is possible to print upon finishing the assembly using the stock BLT FW. However it is highly recommended to upgrade to the latest RC8 community BLT FW, in order to have all the Marlin/community updates/bug-fixes.

11.1.3 Community FW by Rob Mendon

As of Marlin 1.1.0 RC8 V3.2 the BW FW is built in a modular fashion, i.e. there is a central **Configuration.h** and **Configuration_adv.h** files which are used to choose one of the specific configuration files. These specific files are named **Configuration_xxxx.h** and **Configuration_adv_xxxx.h** respectively, whereas **xxxx** is per the table below.

There are currently 3 configurations corresponding to the 3 FW variants. In the future, as the community needs evolve, more configurations will be added in the same modular fashion.

The rationale behind this is the need to add more basic configurations for the community on one hand, and on the other hand to prevent complex if/then/else statements in which one error would break the whole system. In the modular design, if a new added variant is not working, it does not impact the previous proven variants.

The following table summarizes the FW variants.

Please note
The FW assumes stock BW components, i.e. DRV8825 stepper drivers and geared extruder. If you are using a different setup, you should update the appropriate parameters, e.g. E-Steps, e.g. stepper direction, in YOUR SPECIFIC CONFIGURATION FILE per the table below, as explained elsewhere in this guide.

Name of FW variant	Auto Bed leveling (xxxx)	Configuration_xxxx.h Specific file	Configuration_adv_xxxx.h Specific file	Links to RC8 V4 FW variants
STOCK FW	None (STOCK)	Configuration_STOCK.h	Configuration_adv_STOCK.h	**STOCK**
BLT FW	BL-Touch (BLT)	Configuration_BLT.h	Configuration_adv_BLT.h	**BLT**
PROX FW	Proximity sensors (PROX)	Configuration_PROX.h	Configuration_adv_PROX.h	**PROX**

11.2 USB Drivers (Duplicate 1 of 2)

If you install the Arduino IDE then the USB drivers are installed automatically for Windows and Macintosh OS (Operating System).

The separate USB driver for the MKS V1.3 and V1.4 control board can be downloaded from the FTDI (Future Technology Devices International) site.
The machine uses a Windows VCP (Virtual Com Port) RS232.
Marlin uses by standard a baud rate of 250,000 bps.
If you need to set a baud rate use AUTO or select 250,000 for any PC related communication.

http://www.ftdichip.com/Drivers/VCP.htm

Choose the correct operating system!

http://www.ftdichip.com/Support/Documents/AppNotes/AN_119_FTDI_Drivers_Installation_Guide_for_Windows7.pdf

11.3 Arduino firmware upgrade / downgrade

Caution
Before uploading a new FW into the controller; make sure you have copied all configuration changes you have done in your current version's configuration.

Each new upload overrides all configuration parameters!!!

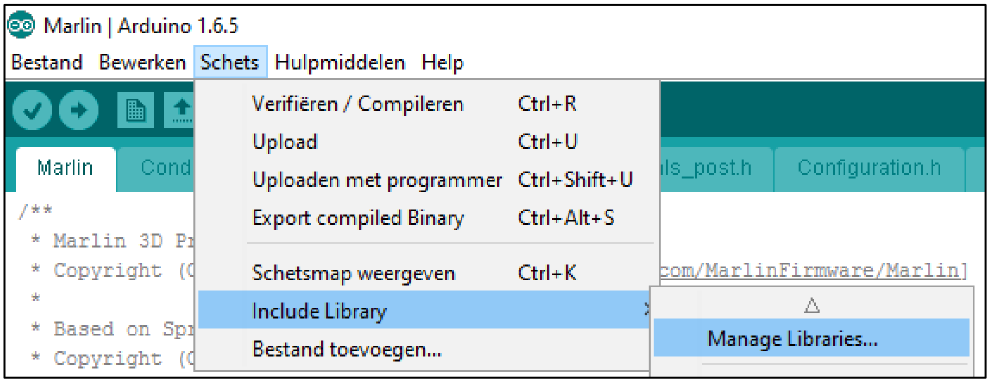
For uploading firmware (machine control settings) you need to install Arduino software. Arduino is free full function software to perform this firmware upgrade. Version 1.6.12 is OK and tested on Windows 10. **https://www.arduino.cc/en/Main/Software**

!------------------------ If the U8glib is not installed correctly you get compilation errors -----------------!

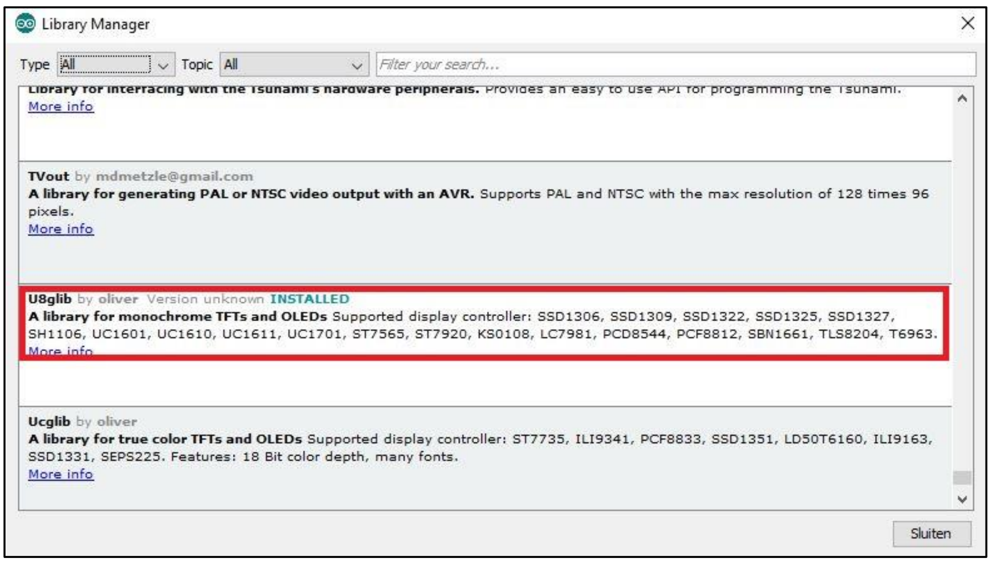
If you download the Arduino IDE file you have to unzip it first in a separate directory. If you do not, not all the files will show up. Then open Marlin.ino by double click from the Marlin folder.

Marlin.h	12-11-2016 04:47	H-bestand	15 kB
Marlin	12-11-2016 04:47	Arduino file	3 kB
Marlin_main.cpp	12-11-2016 04:47	CPP-bestand	314 kB

If Arduino is installed open the Marlin.ino from the downloaded file, inside Arduino click Sketch > Include Library > Manage Libraries.



In the "filter your search" box, type U8glib. When the U8glib shows up, click on Install.



Make sure all other programs that can communicate with the com port like Pronterface, Repetier or Simplify3D need to be closed while uploading.

For how to upload machine firmware you can use **this video** **as a guide**. Use Mega 2560 as board in Arduino IDE. You have to choose only different files to upload from the file section, do not use other Marlin files. Do not use servo port 4 for connecting BL-Touch as shown in the video but **servo port 1**.

For Black Widow (Stock without BL-Touch) >>> **STOCK FW**

For Black Widow (with BL-Touch) >>> **BLT FW**

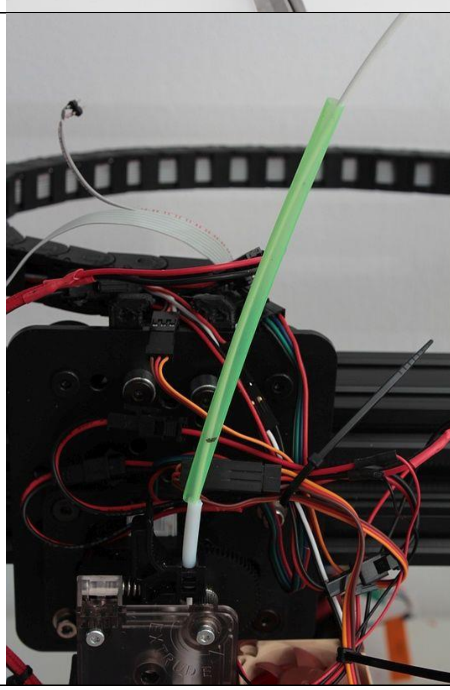
For Black Widow (with Inductive/Capacitive Proximity sensor) >>> **PROX FW**

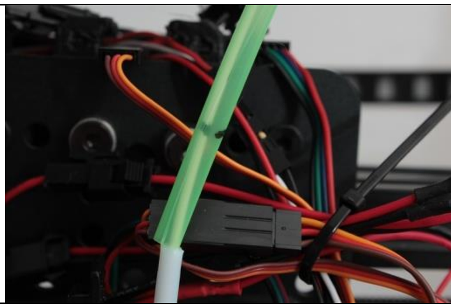
All settings like E-Steps, PID, stepper motor direction & pin-assignment need to be done in the appropriate configuration files, as described in Section 11.1.3. Once you change a setting, you have to upload the changes.

11.4 PID Tuning

To optimize the heating of the heater and heat-bed you can perform a so called PID tuning. By default the PID tuning for both the hot-end heater and the heat-bed are **ON**. Only do PID heater tuning with a proper hot-end fan duct mounted, or using means to prevent hot-end over-cooling, as depicted in the section titled: **Hot-end can't go higher than 180 Degrees-C**. **Please note** **As of Marlin RC8 V3.2 FW, the default hot-end thermistor table in the FW has been changed, to track more accurately the hot-end temp. Therefore after upgrading to V3.2 or later revision, it is recommended to perform PID tuning in order to have the correct PID coefficients.**	**http://reprap.org/wiki/PID_Tuning** **https://www.youtube.com/watch?v=APzJfYAgFkQ** **https://www.youtube.com/watch?v=dU2S1heu3XU**

11.5 E-Steps Tuning for 0.4mm Nozzle

	Take a drinking straw (preferable transparent or translucent) and cut it to a 120 mm length.
	At a 20 mm distance from the bottom put a line mark on the drinking straw.
	With a scissor slice over the full length the drinking straw open.
	Slide the drinking straw over the filament and place it on top of the extruder unit. With a thin felt marker, mark the filament at the top of the drinking straw. Use a contrasting felt marker compared to the filament you going to use. Issue the following G-code in a G-code terminal like Pronterface, Octoprint, Repetier G91 G1 E100 F100 G90 This will transport 100 mm filament at a low speed. Follow the mark on the filament and also check if the feeding is in regular motion to detect possible irregular feeding.

	When the transport is ready measure the distance compared to the 20 mm mark. If you are above the 20 mm mark (less than 100 mm feed) raise the E step value If you are below the 20 mm mark (more than 100 mm feed) lower the E step value Regular E step value for a 0.4 mm nozzle is between 865 to 935.

Change the value in the Marlin FW:
Up to RC8 V3: "**Configuration.h**" file.
As of RC8 V3.2: "**Configuration_xxxx.h**" file, see **Section 11.1.3**.

In the line: #define DEFAULT_AXIS_STEPS_PER_UNIT {160,160,3200,935}
change last value and upload the new value as firmware to the machine.

Or use the LCD control panel and go to:
1) >control>motion>E-Steps/mm and adjust the value required (press the knob to accept new value).
2) >control>store memory (press knob to save values to EEPROM)

Or you can send G-code commands from Pronterface or other utility:
1) M92 X?? Y?? Z?? E??. Fill in the value you like to be used at the question marks.
2) M500. To finish the sequence. This saves the values in the EEPROM.

Remove the drinking straw when ready. ☺

A video for guidance can be viewed here:
https://www.youtube.com/watch?v=JZGdMc2ebPo

11.6 Pin Assignment – MKS Gen V1.3/V1.4

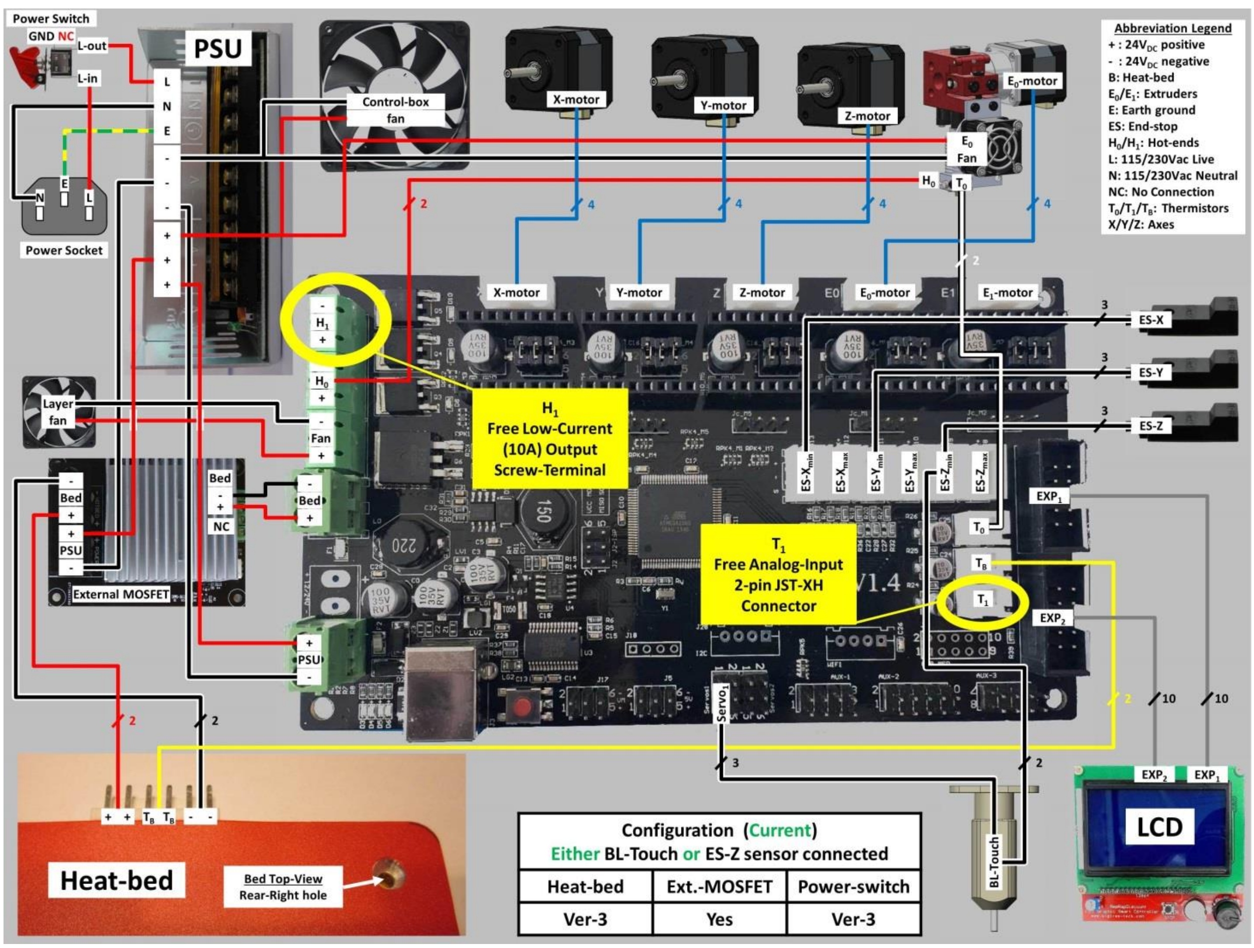
If your MKS Gen V 1.3 or V 1.4 board has problems with certain outputs or inputs, we can use the free available connections and change the pin assignments of the appropriate headers.

The MKS-Gen V1.3/V1.4 is equipped with only one free output screw-terminal, called **H_1** as depicted in the picture below.

The MKS-Gen V1.3/V1.4 is also equipped with only one free input, 2-pin JST-XH connector, called **T_1** as depicted in the picture below.

Please note
The pin assignments shown in the following sections are only valid for the Marlin RC8 V3 FW. Line numbers in the following pictures are as follows: RC8 V3: "Configuration_adv.h" file. As of RC8 V3.2: "Configuration_adv_xxxx.h" file, see Section 11.1.3. For Marlin RC8 V3.2 and up, click "Ctrl+F" to find the strings.

Please note
Lower Marlin RC8 versions are not supported by the section.suite, which is about to discontinue at the beginning of 2017.



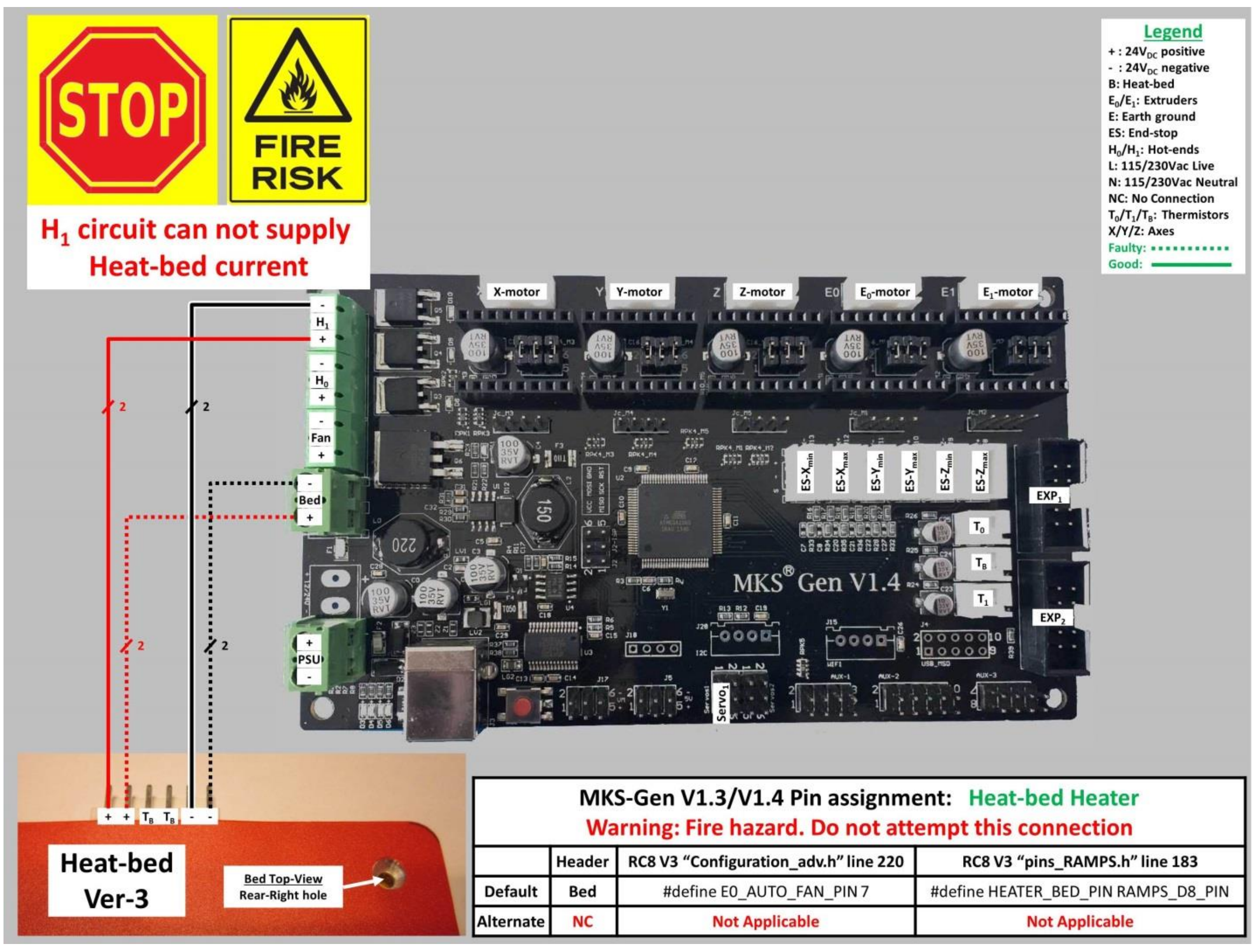
11.6.1 Heat-bed Heater

There is **only one** high-current (20A) output screw-terminal on the controller board, labeled "Bed", which is suitable for the heat-bed heater.

Therefore if it is faulty, you **can't directly drive** the heat-bed using any other low-current (10A) output screw-terminal, as shown in the 1st picture.

However, you **can indirectly control** the heat-bed, by using either an External Heatbed Driver (external MOSFET), as shown in the 2nd picture, or an SSR (not shown), controlled by the H_1 Low-current (10A) output screw-terminal.

Please note
The following pictures are in hi-res. In the PDF document, you should zoom to 200%-300% in order to see the fine details.



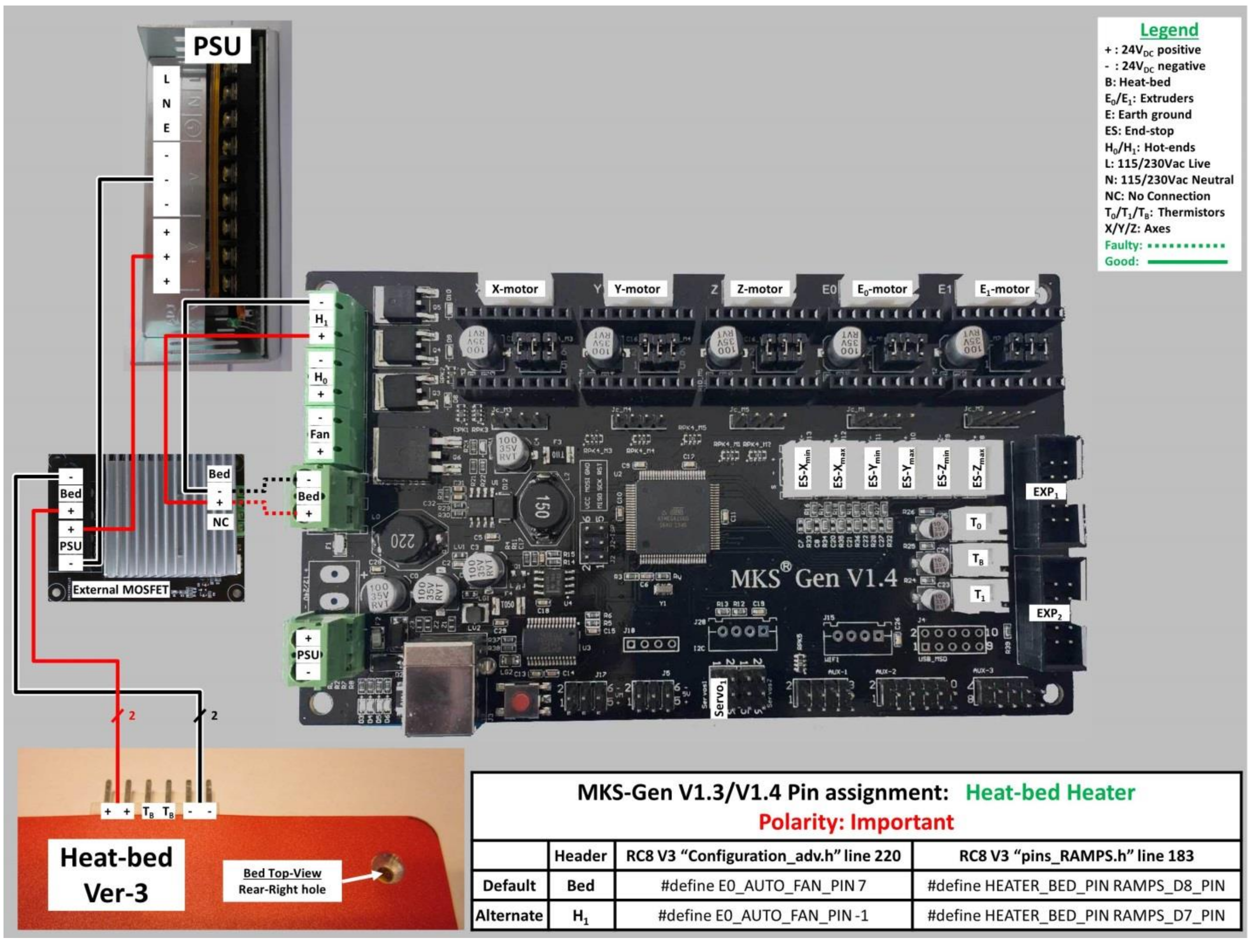
Re-routing the heat-bed heater control, from the "**Bed**" connection to the "**H_1**" connection:

<u>Please note</u>

1) As depicted by the legend, the dotted line represents the FAULTY default connection. The solid line represents an ALTERNATE connection. The table shows the default and alternate header names and pin assignments.

<u>2) External Heatbed Driver (external MOSFET) is shown in the picture. If your setup is fitted with an SSR (not shown), dotted and solid lines from the SSR's control input to the MKS-Gen terminals are the same. Detailed picture with an SSR can be found in Section 7.10.7 of this guide.</u>

<u>3)</u> Line numbers in the above picture are as follows: For RC8 V3: "Configuration_adv.h" file. As of RC8 V3.2: "Configuration_adv_xxxx.h" file, see <u>Section 11.1.3</u>. For Marlin RC8 V3.2 and up, click "Ctrl+F" to find the strings.



MKS-Gen V1.3/V1.4 Pin assignment: Heat-bed Heater
Polarity: Important

	Header	RC8 V3 "Configuration_adv.h" line 220	RC8 V3 "pins_RAMPS.h" line 183
Default	Bed	#define E0_AUTO_FAN_PIN 7	#define HEATER_BED_PIN RAMPS_D8_PIN
Alternate	H_1	#define E0_AUTO_FAN_PIN -1	#define HEATER_BED_PIN RAMPS_D7_PIN

<u>Please note</u>

Line numbers in the above picture are as follows: For RC8 V3: "Configuration_adv.h" file. As of RC8 V3.2: "Configuration_adv_xxxx.h" file, see <u>Section 11.1.3</u>. For Marlin RC8 V3.2 and up, click "Ctrl+F" to find the strings.

11.6.2 Part/Layer Cooling Fan

The stock BW is equipped with 40mm heat-sink fan, which cools the hot-end's heat-sink, and is connected permanently to 24VDC via connectored cable running through the drag-chain. **This heat-sink fan must be running as long as there is power to the BW**.

If you like to cool the object you need to add a part/layer fan near the nozzle. This layer fan and its mounting/duct are not standard and need to be made separately. You can find appropriate solutions in section 4.7.

For the layer fan you need to add wires into the drag chain.

The wires, in correct polarity, should be connected to the green screw terminal on the MKS-Gen v1.3/ V1.4, that has the name "**Fan**", see the following picture for the **default** connection.

If this connection is not working for any reason, then follow the **alternate** connection to the "**H_1**" screw terminal, and re-assign the FW pins, as shown in the following picture.

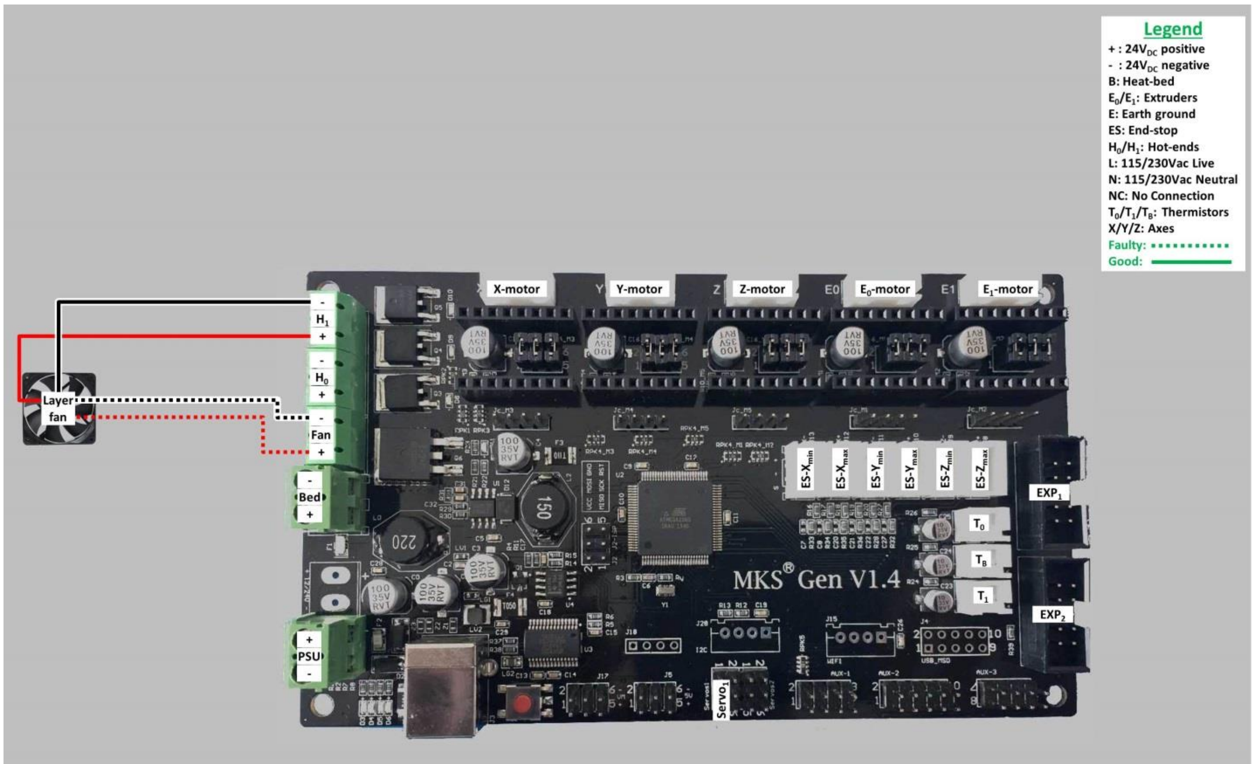
The layer fan port can be controlled through either of the following:

- Machine LCD.
- Slicer code.
- Control program like Repetier.
- G-code commands.

The G-code command to control the layer fan speed from 0 to 100% is M106 Sxxx, whereas "xxx" is the PWM value (0-255), and whereas the zero value (S0) turn off the fan.

Re-routing the layer fan control, from the "**Fan**" connection to the "**H_1**" connection:

Please note
As depicted by the legend, the dotted line represents the FAULTY default connection. The solid line represents an ALTERNATE connection. The table shows the default and alternate header names and pin assignments.



MKS-Gen V1.3/V1.4 Pin assignment: Layer Fan
Polarity: Important

	Header	RC8 V3 "Configuration_adv.h" line 220	RC8 V3 "pins_RAMPS.h" line 182
Default	Fan	#define E0_AUTO_FAN_PIN 7	#define FAN_PIN RAMPS_D9_PIN
Alternate	H_1	#define E0_AUTO_FAN_PIN -1	#define FAN_PIN RAMPS_D7_PIN

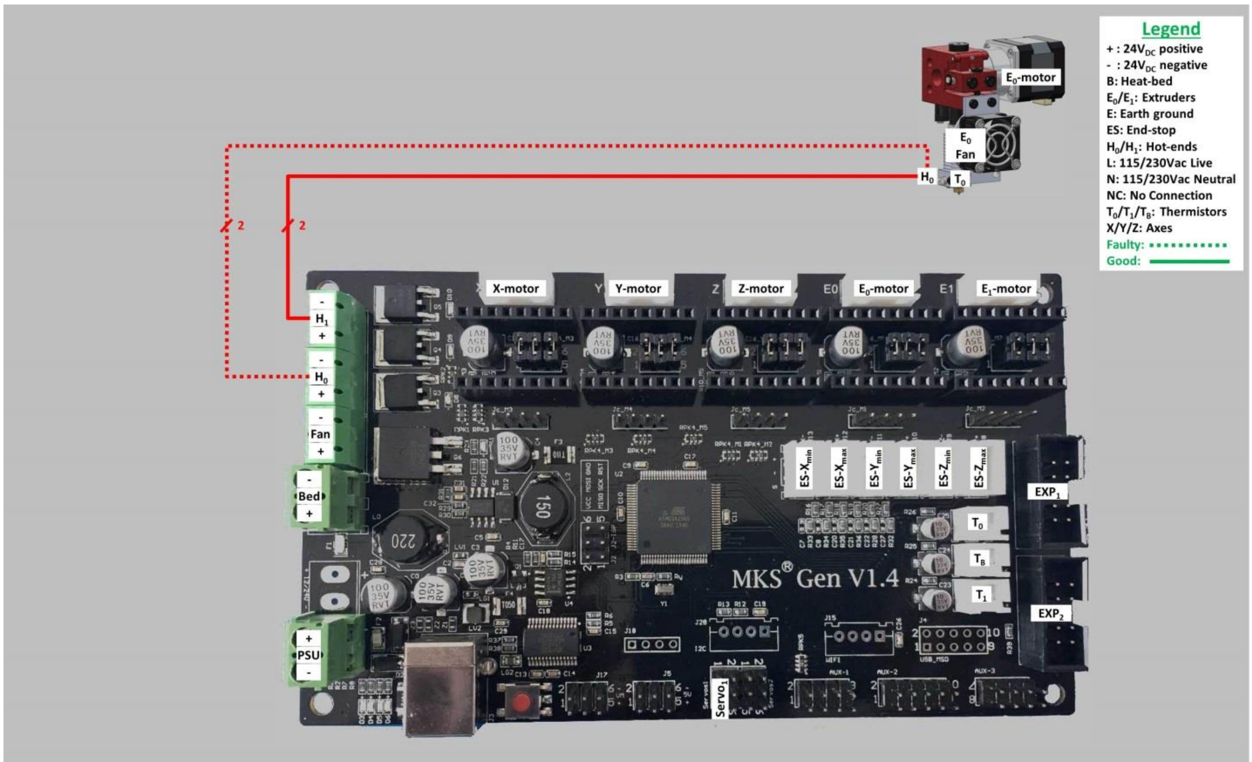
Please note
Line numbers in the above picture are as follows: For RC8 V3: "Configuration_adv.h" file. As of RC8 V3.2: "Configuration_adv_xxxx.h" file, see Section 11.1.3. For Marlin RC8 V3.2 and up, click "Ctrl+F" to find the strings.

11.6.3 Hot-end Heater

Re-routing the hot-end heater control, from the "H_0" connection to the "H_1" connection:

Please note

As depicted by the legend, the dotted line represents the FAULTY default connection. The solid line represents an ALTERNATE connection. The table shows the default and alternate header names and pin assignments.



MKS-Gen V1.3/V1.4 Pin assignment: Hot-end Heater Polarity: Unimportant			
	Header	RC8 V3 "Configuration_adv.h" line 220	RC8 V3 "pins_RAMPS.h" line 165
Default	H_0	#define E0_AUTO_FAN_PIN 7	#define HEATER_0_PIN RAMPS_D10_PIN
Alternate	H_1	#define E0_AUTO_FAN_PIN -1	#define HEATER_0_PIN RAMPS_D7_PIN

Please note

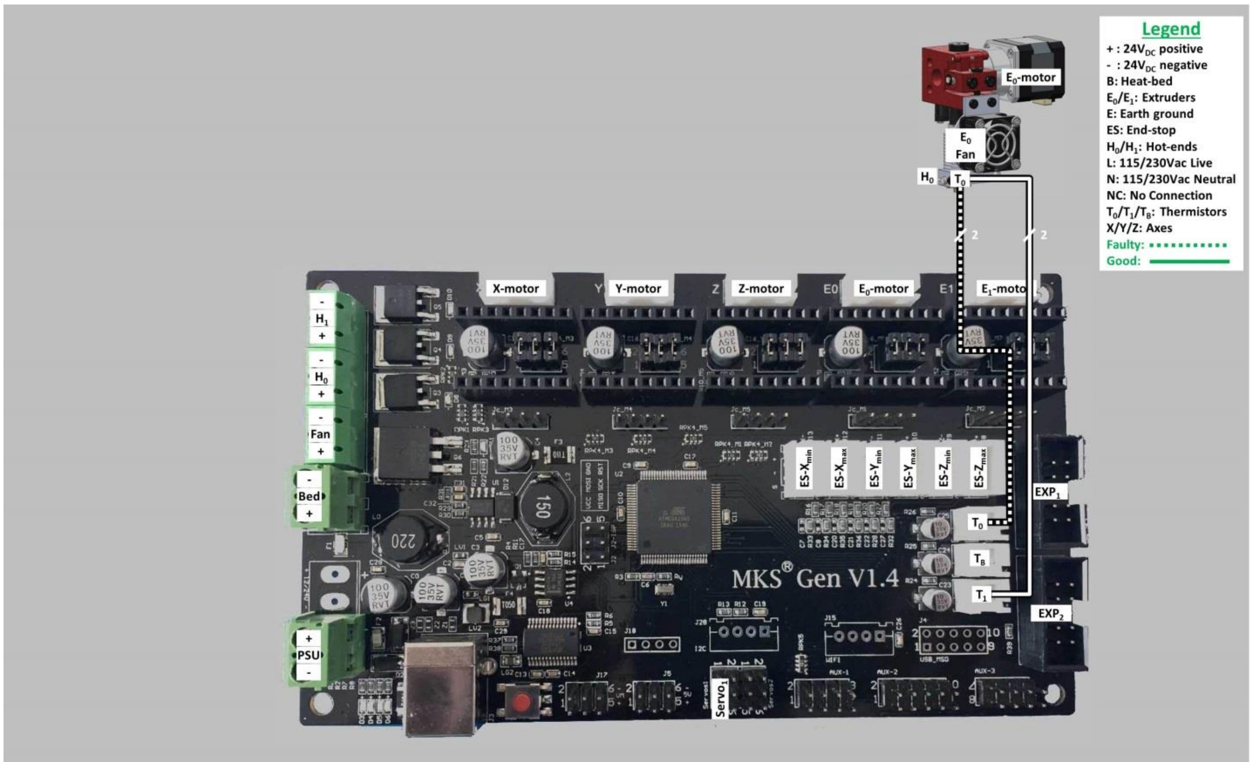
Line numbers in the above picture are as follows: For RC8 V3: "Configuration_adv.h" file. As of RC8 V3.2: "Configuration_adv_xxxx.h" file, see <u>Section 11.1.3</u>. For Marlin RC8 V3.2 and up, click "Ctrl+F" to find the strings.

11.6.4 Hot-end Thermistor

Re-routing the hot-end thermistor input, from the “T_0” connection to the “T_1” connection:

Please note

As depicted by the legend, the dotted line represents the FAULTY default connection. The solid line represents an ALTERNATE connection. The table shows the default and alternate header names and pin assignments.



MKS-Gen V1.3/V1.4 Pin assignment: Hot-end Thermistor Polarity: Unimportant		
	Header	RC8 V3 “pins_RAMPS.h” line 121
Default	T_0	#define TEMP_0_PIN 13
Alternate	T_1	#define TEMP_0_PIN 15

Please note

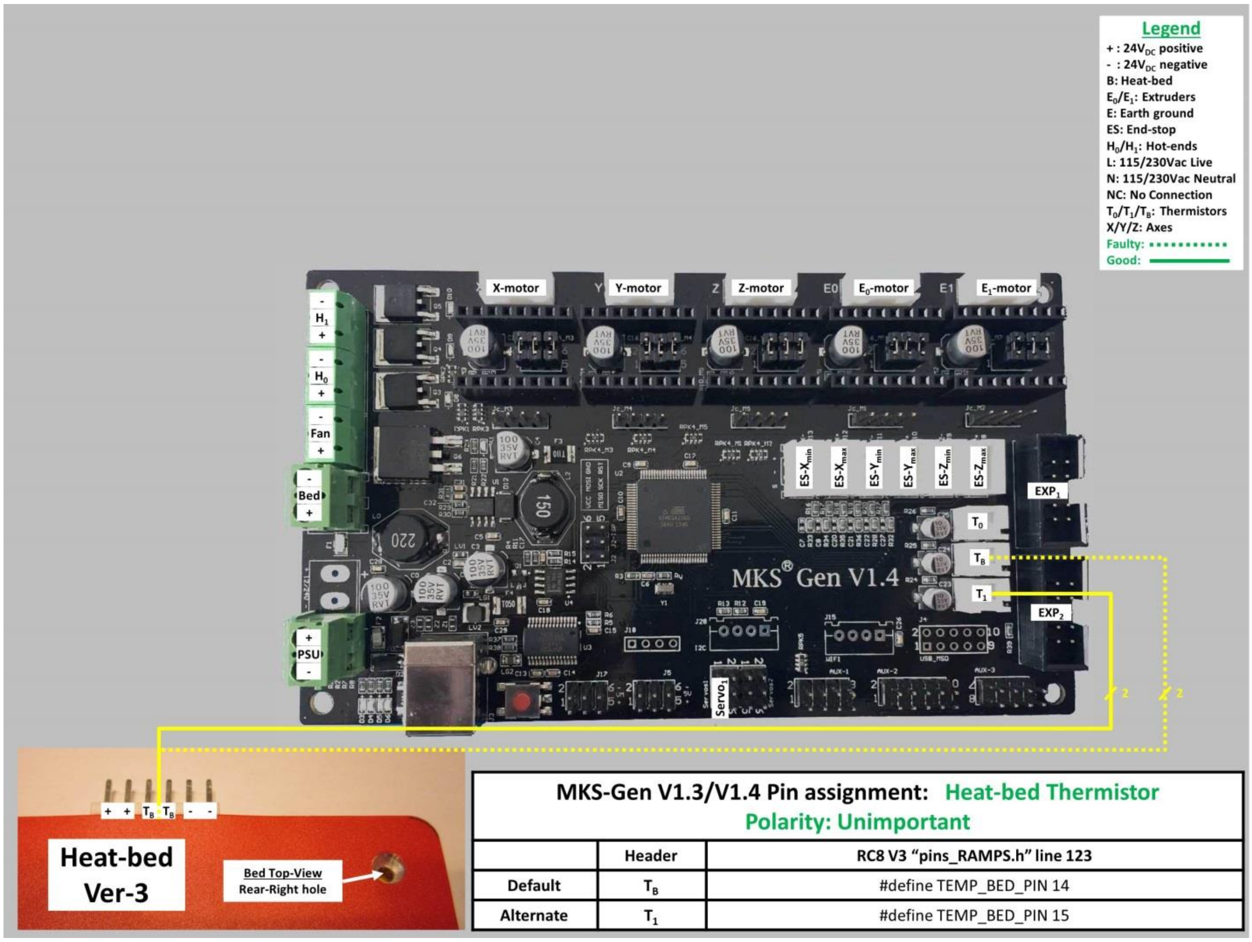
Line numbers in the above picture are as follows: For RC8 V3: “Configuration_adv.h” file. As of RC8 V3.2: “Configuration_adv_xxxx.h” file, see Section 11.1.3. For Marlin RC8 V3.2 and up, click “Ctrl+F” to find the strings.

11.6.5 Heat-bed thermistor

Re-routing the heat-bed thermistor input, from the “T_B” connection to the “T_1” connection:

Please note

As depicted by the legend, the dotted line represents the FAULTY default connection. The solid line represents an ALTERNATE connection. The table shows the default and alternate header names and pin assignments.



MKS-Gen V1.3/V1.4 Pin assignment: Heat-bed Thermistor
Polarity: Unimportant

	Header	RC8 V3 “pins_RAMPS.h” line 123
Default	T_B	#define TEMP_BED_PIN 14
Alternate	T_1	#define TEMP_BED_PIN 15

Please note

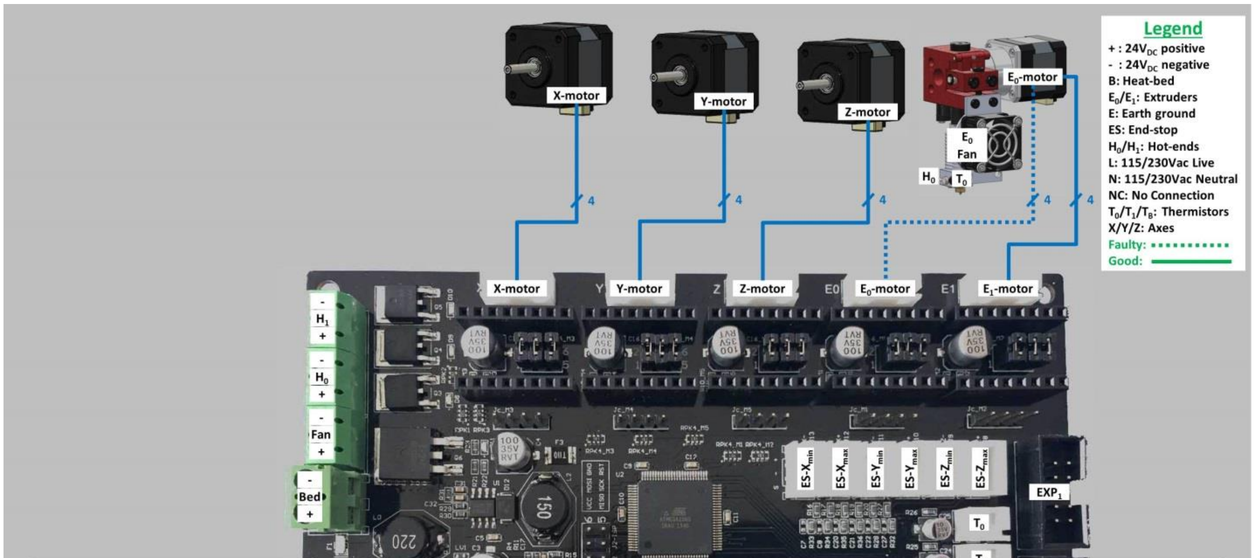
Line numbers in the above picture are as follows: For RC8 V3: “Configuration_adv.h” file. As of RC8 V3.2: “Configuration_adv_xxxx.h” file, see Section 11.1.3. For Marlin RC8 V3.2 and up, click “Ctrl+F” to find the strings.

11.6.6 Stepper Motors

Re-routing a motor control, from the **default** connection to the "**E_1-motor**" connection:

Please note

As depicted by the legend, the dotted line represents the FAULTY default connection. The solid line represents an ALTERNATE connection. The table shows the default and alternate header names and pin assignments.



MKS-Gen V1.3/V1.4 Pin assignment: Motors

		X-Axis (Not Shown) RC8 V3 "pins_RAMPS.h" Lines: 93-96	Y-Axis (Not Shown) RC8 V3 "pins_RAMPS.h" Lines: 98-101	Z-Axis (Not Shown) RC8 V3 "pins_RAMPS.h" Lines: 103-106	E-Axis (Shown) RC8 V3 "pins_RAMPS.h" Lines: 108-111
Default	Header	X-motor	Y-motor	Z-motor	E_0-motor
	Code	#define X_STEP_PIN 54 #define X_DIR_PIN 55 #define X_ENABLE_PIN 38 #define X_CS_PIN 53	#define Y_STEP_PIN 60 #define Y_DIR_PIN 61 #define Y_ENABLE_PIN 56 #define Y_CS_PIN 49	#define Z_STEP_PIN 46 #define Z_DIR_PIN 48 #define Z_ENABLE_PIN 62 #define Z_CS_PIN 40	#define E0_STEP_PIN 26 #define E0_DIR_PIN 28 #define E0_ENABLE_PIN 24 #define E0_CS_PIN 42
Alternate	Header	E_1-motor	E_1-motor	E_1-motor	E_1-motor
	Code	#define X_STEP_PIN 36 #define X_DIR_PIN 34 #define X_ENABLE_PIN 30 #define X_CS_PIN 44	#define Y_STEP_PIN 36 #define Y_DIR_PIN 34 #define Y_ENABLE_PIN 30 #define Y_CS_PIN 44	#define Z_STEP_PIN 36 #define Z_DIR_PIN 34 #define Z_ENABLE_PIN 30 #define Z_CS_PIN 44	#define E0_STEP_PIN 36 #define E0_DIR_PIN 34 #define E0_ENABLE_PIN 30 #define E0_CS_PIN 44

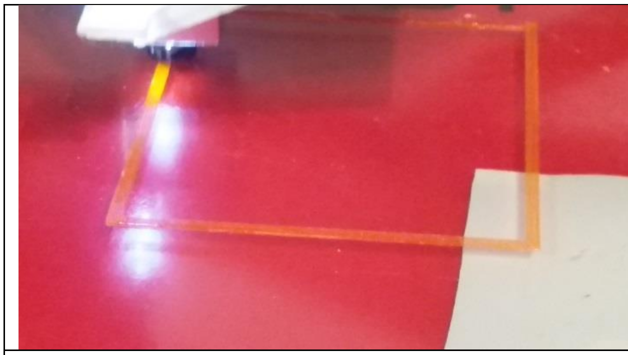
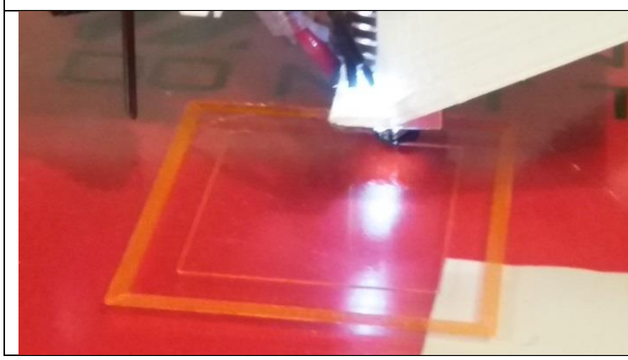
Please note

Line numbers in the above picture are as follows: For RC8 V3: "Configuration_adv.h" file. As of RC8 V3.2: "Configuration_adv_xxxx.h" file, see <u>Section 11.1.3</u>. For Marlin RC8 V3.2 and up, click "Ctrl+F" to find the strings.

11.7 Babystep & Live Adjust

As of Marlin RC8 V3.2 FW for the BW, the main menu structure has an added function during a print called "Live adjust Z" when using ABL. For a Non-ABL operation, the function remains "Babystep Z". When in idle mode these functions are not available.

When do you use these functions?
If you start a print job, that for example contains a skirt around the object, and while printing this layer you notice that the layer height is incorrect, then you can use either the "**Babystep Z**" or "**Live adjust Z**" function to correct it **on the fly**, as shown in the following table.

	Adjusting the Z-offset, by using the "**Babystep Z**" or "**Live adjust Z**" as appropriate (see next tables), during the skirt phase.
	1st layer of the object already having the proper Z-offset. **Please note** **It is recommended to use this function only for the 1st layer, to prevent the nozzle knocking off the already laid down layers, and/or creating gaps between layers.**

The following tables show the FW variants and their respective LCD screen captures.

FW Variant	LCD Screens	Notes
STOCK FW	  	"**Babystep Z**" is a function for adjusting the Z offset height, while printing with **Non-ABL**, in steps of 0.001 mm up or down. In the **STOCK FW** variant, the Z offset is not stored in the EEPROM, either when the print job is done, or when you exit the menu option.

<table>
<tr><th>FW Variant</th><th>LCD Screens</th><th>Notes</th></tr>
<tr><td rowspan="2">BLT FW & PROX FW</td><td>
</td><td rowspan="2">"Live adjust Z" is a function for adjusting the Z offset height, while printing with ABL, in steps of 0.001 mm up or down.

In the BLT FW or PROX FW variants, the Z offset is stored in the EEPROM upon exit of the menu option.</td></tr>
<tr><td>
</td></tr>
</table>

12 SW (Software)

12.1 USB Drivers (Duplicate 2 of 2)

If you install the Arduino IDE then the USB drivers are installed automatically for Windows and Macintosh OS (Operating System).

The separate USB driver for the MKS V1.3 and V1.4 control board can be downloaded from the FTDI (Future Technology Devices International) site.
The machine uses a Windows VCP (Virtual Com Port) RS232.
Marlin uses by standard a baud rate of 250,000 bps.
If you need to set a baud rate use AUTO or select 250,000 for any PC related communication.

http://www.ftdichip.com/Drivers/VCP.htm

Choose the correct operating system!

http://www.ftdichip.com/Support/Documents/AppNotes/AN_119_FTDI_Drivers_Installation_Guide_for_Windows7.pdf

12.2 Slicer

12.2.1 Cura (Freeware) (Revised section)

TEVO machines do not come with any driver/slicer or other machine related software supplied. For slicing (**preparing a file and printing a *.stl file**) you can use Cura which is developed by Ultimaker, and has several versions available. Version 15.04.6 is the last non-beta version of the 1st generation of Cura. This is full function free software with full slicing and printing capabilities through USB. Use this as standard slicing software for the first prints you make.

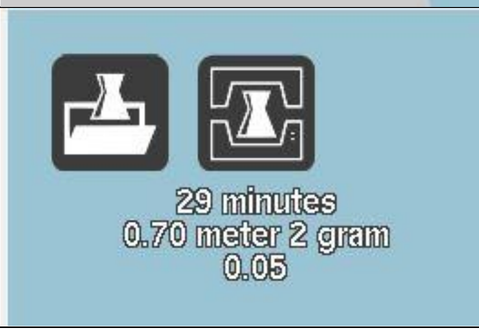
If you are an experienced user, you may use the 2nd generation of Cura, the Cura 2.X versions, which are more advanced than the 1st generation with additional features. However if you are a newbie, do not use any of the Beta versions, as these are intended for experienced users.

The following link is for all Cura versions: **https://ultimaker.com/en/products/cura-software/list**

The following paragraphs will add detailed information regarding the two generations.

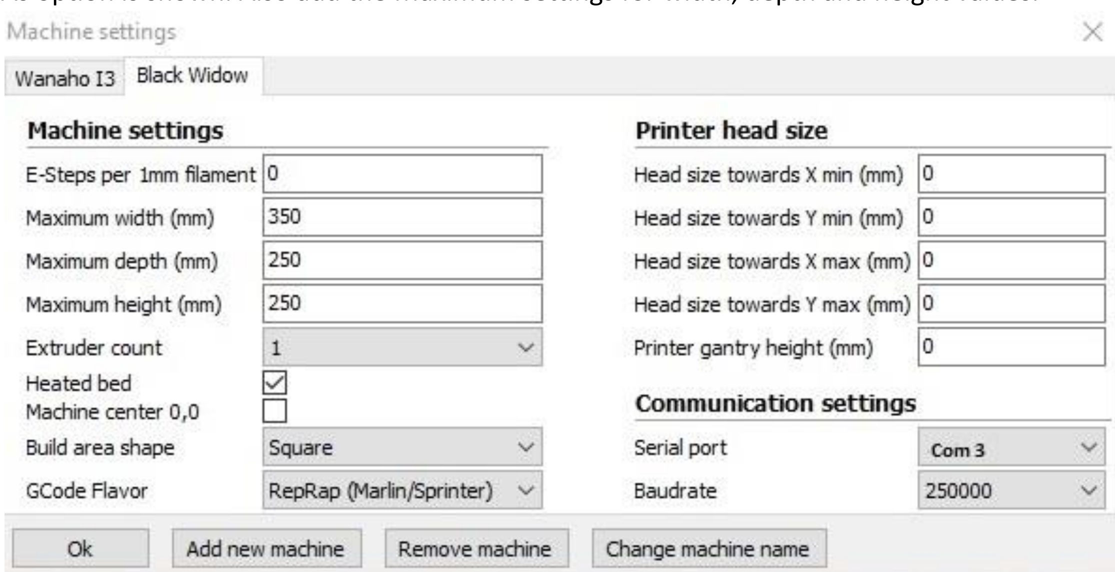
1st generation: Cura 15.04.6
For starters we advise to use the 15.04.6 version.

You can also print using this version by USB (printing by USB is not advised for long prints).
For long prints save your G-code file to a SD card and print from there.

	If the printer is not recognized by Cura the print function option is not available and only the SAVE icon is shown.
	If the printer is recognized by Cura the print function option is shown.

To make the print function available you have to set the com-port and baud rate manually. In the machines setting screen select the correct com-port and baud rate from the Communications settings drop-down menu's.
Com-port (Serial-Port) > select the correct com-port **not** AUTO
Baud-rate > 250000

As option is shown. Also add the Maximum settings for width, depth and height values.

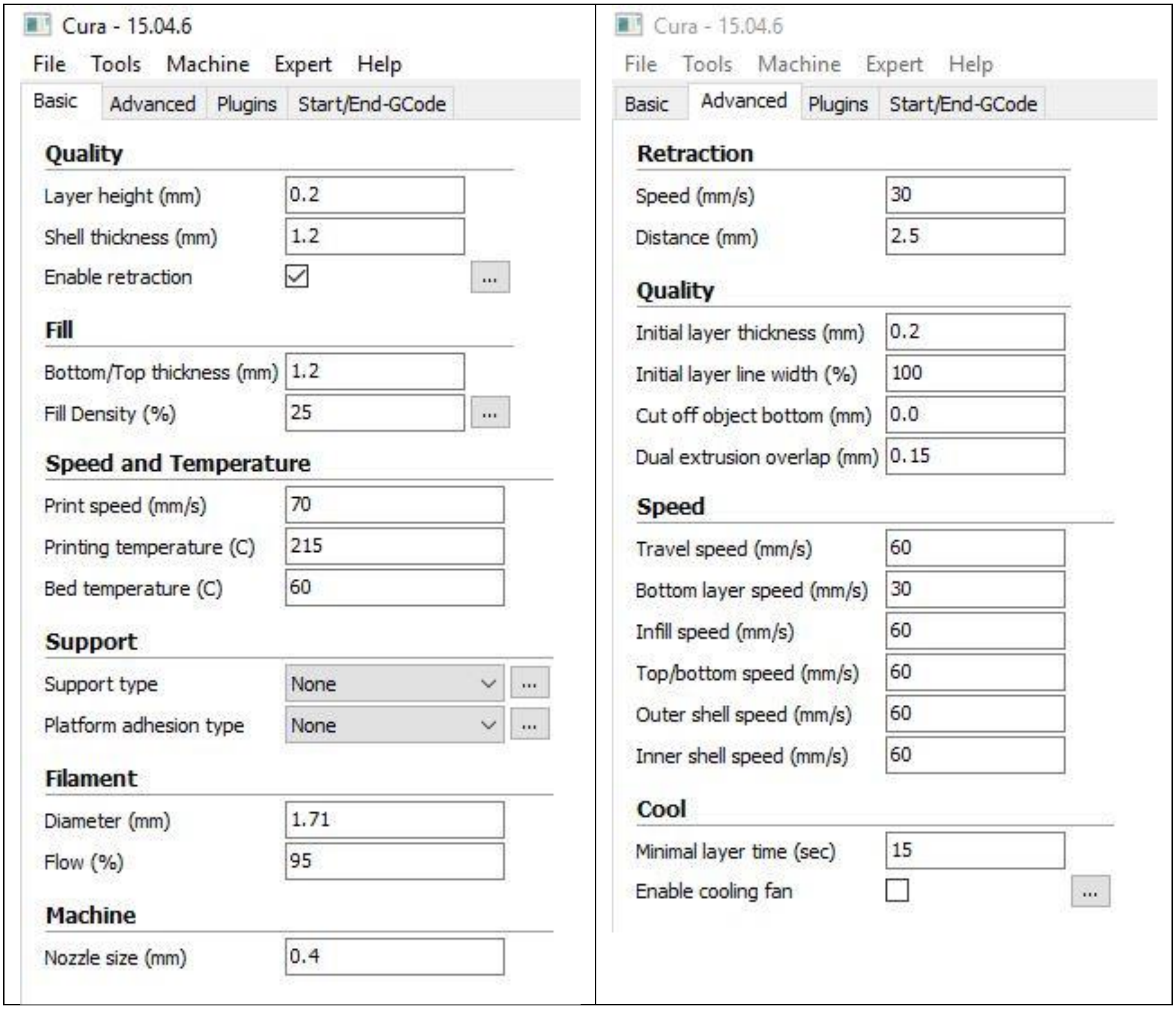


Some starter filament settings for Cura 15.x.x for the Black Widow can be downloaded.
They are the profiles which you can import and start with tweaking them for the best result with

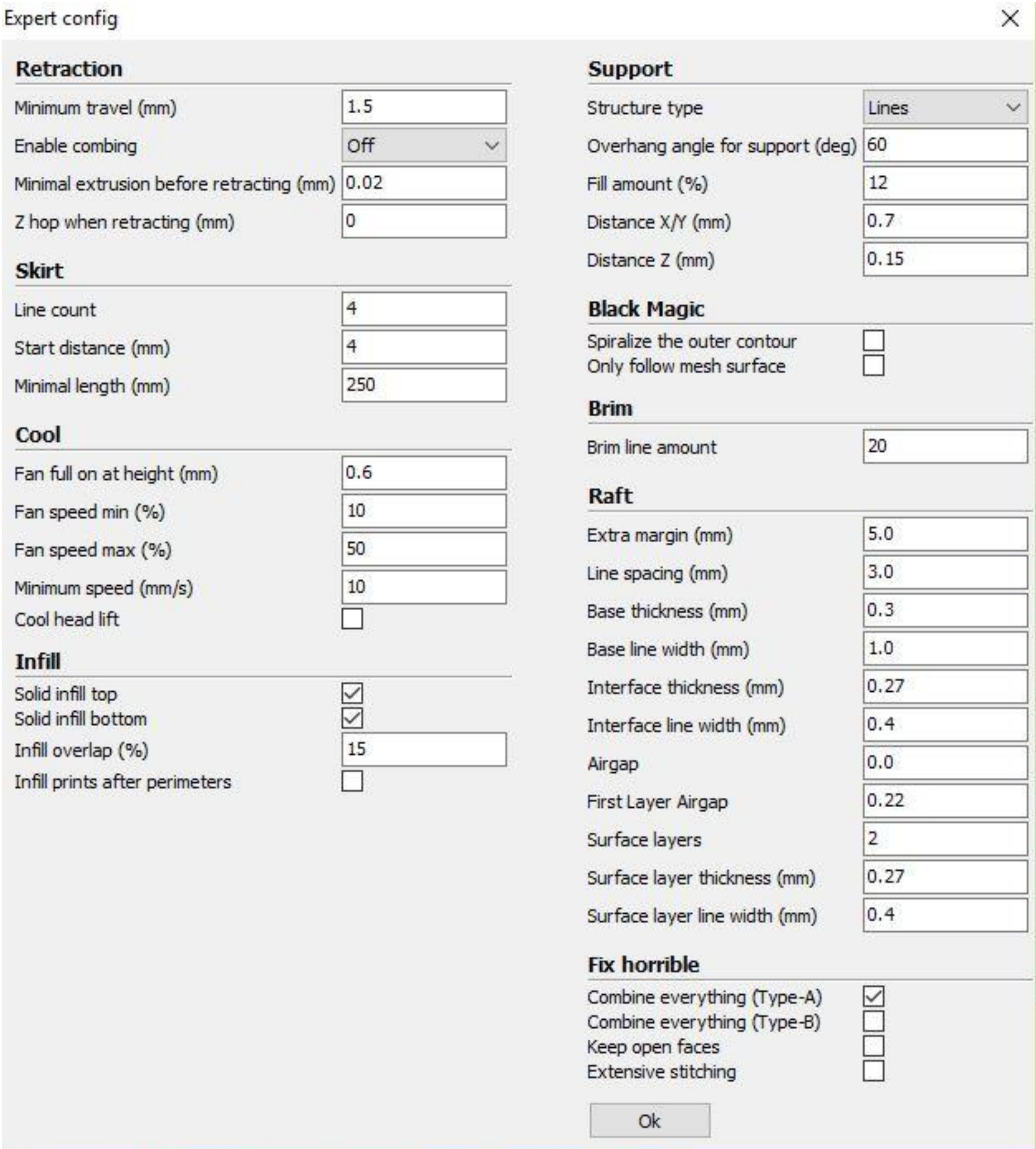
your own machine and filament. Take care they are general profiles and might give different results than others.

[Sample PLA profile]
[Sample PETG profile]

Below you see the two tabs, Basic and Advanced that carry the most settings you might like to change.



In the Expert tab there are some more settings but if you use one of the two sample profiles as starter you do need to change their things.


Expert config
Retraction
Minimum travel (mm)
1.5
Enable combing
Off
Minimal extrusion before retracting (mm)
0.02
Z hop when retracting (mm)
0
Skirt
Line count
4
Start distance (mm)
4
Minimal length (mm)
250
Cool
Fan full on at height (mm)
0.6
Fan speed min (%)
10
Fan speed max (%)
50
Minimum speed (mm/s)
10
Cool head lift
Infill
Solid infill top
Solid infill bottom
Infill overlap (%)
15
Infill prints after perimeters
Support
Structure type
Lines
Overhang angle for support (deg)
60
Fill amount (%)
12
Distance X/Y (mm)
0.7
Distance Z (mm)
0.15
Black Magic
Spiralize the outer contour
Only follow mesh surface
Brim
Brim line amount
20
Raft
Extra margin (mm)
5.0
Line spacing (mm)
3.0
Base thickness (mm)
0.3
Base line width (mm)
1.0
Interface thickness (mm)
0.27
Interface line width (mm)
0.4
Airgap
0.0
First Layer Airgap
0.22
Surface layers
2
Surface layer thickness (mm)
0.27
Surface layer line width (mm)
0.4
Fix horrible
Combine everything (Type-A)
Combine everything (Type-B)
Keep open faces
Extensive stitching
Ok

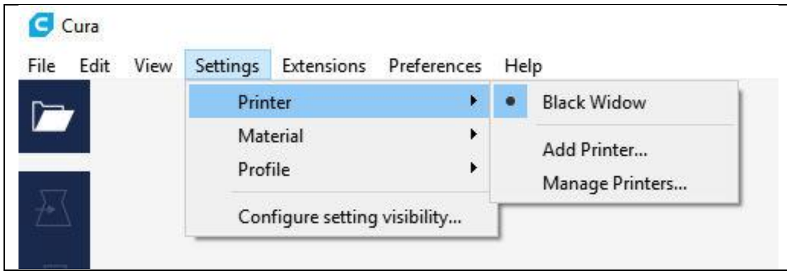
2nd generation: Cura 2.3 through 2.5

These versions have a new user interface and look, and can be used but used to have bugs and were Beta test editions only.

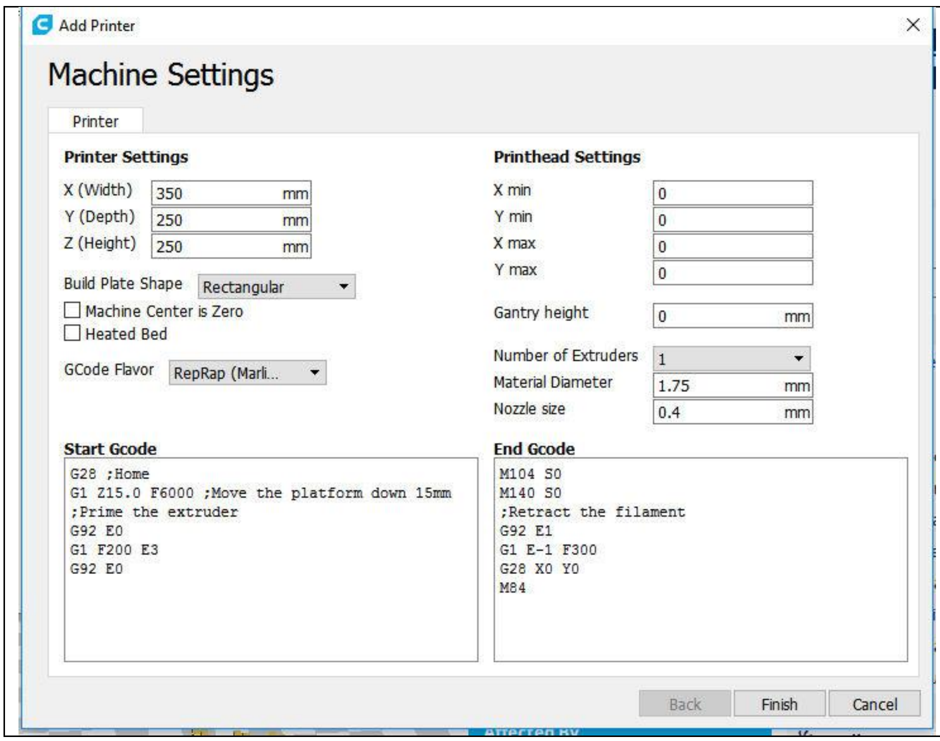
Cura 2.6.2

At the time of writing, Jul-2017, the newest version is 2.6.2 and this is a full release. We cannot go into the full workings but there is a comprehensive manual. By accessing menu items you can set the printer and print options as per the Cura 15.04.6 above.

A huge range of extra settings are available but in essence, it works exactly like 15.04.6 version.

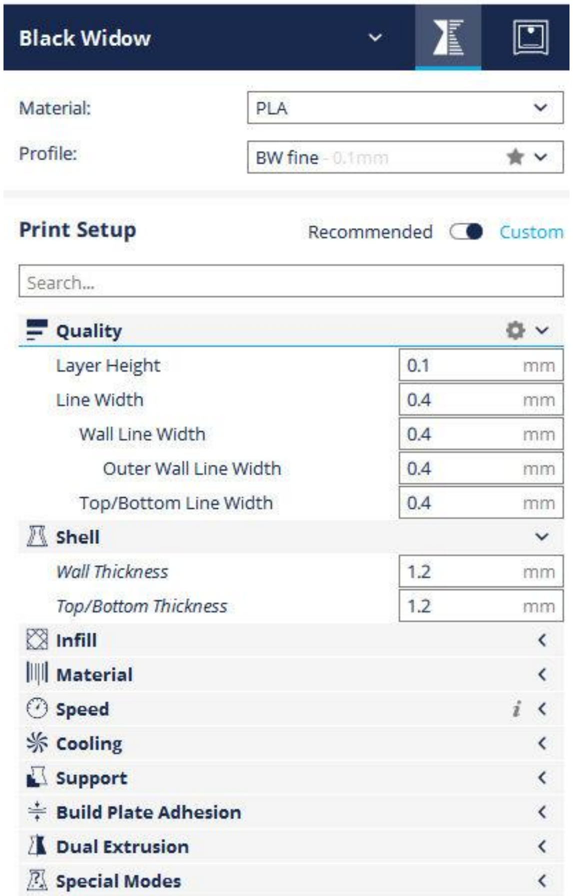


The main drop down menu selection has changed however all the main settings are still available, some like the view options have moved to a drop down menu.



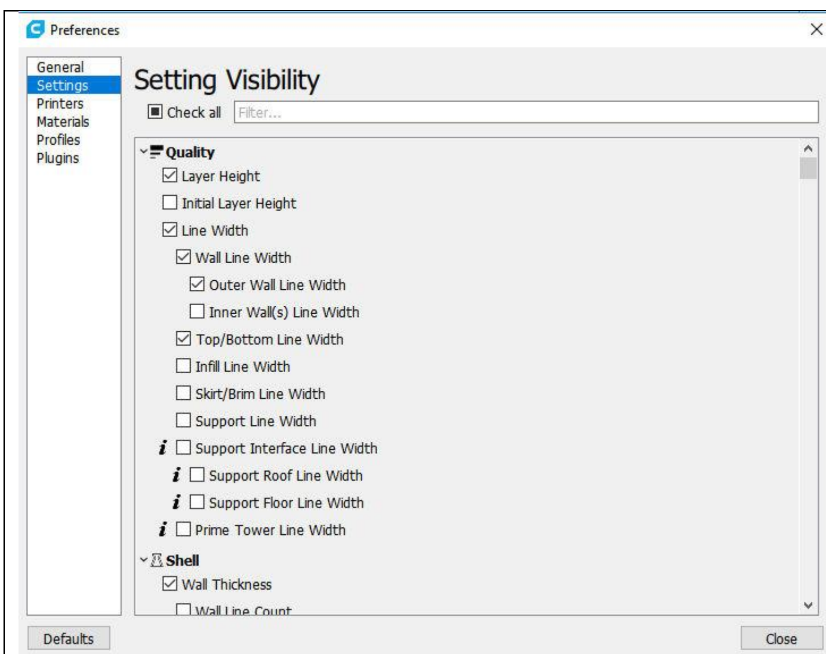
As with Cura 15.04.6 above you need to first add your printer using the Add Printer menu item, then choose Custom and click Add Printer, this will bring up the Machine Settings Screen .

Copy the Start and End G code into this window as well. Click finish. Now go to Settings/Printers/Manage Printers, her you will be able to rename your printer.

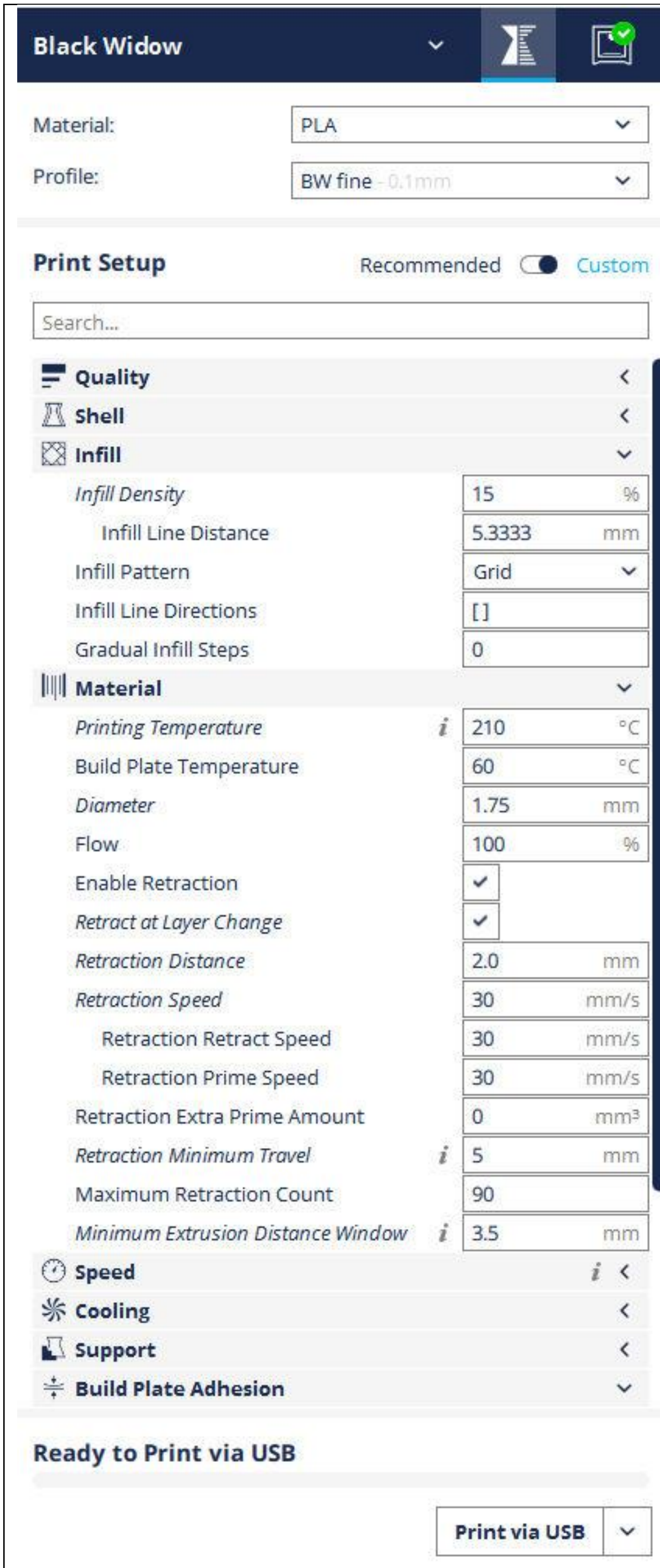


This version of Cura has a number of built in print profiles, unfortunately none of these work with the Black Widow straight from the box. The best option is to take one of these profiles and modify it.

So select your printer, select a base profile and then click the button top left of the image from recommended to custom, this reveals the detail settings menu(s) as in the picture below.



Clicking an arrowhead will open the menu where the basic settings will be shown. If you hover your mouse over a settings line then a gear shape will appear. Clicking the gear shape will bring up a further screen that allows you to set the visibility of other options.



Clicking in a box will set/reset the visibility of that option in the Print setup screen, You will initially be shown to the option set you clicked but you can scroll up/down or choose other settings from here. Hovering over an item will give you a short form of what it does. Hovering over an I will give more information. Use this screen to make the advanced and expert settings from above visible. Close the screen and then you will be able to set those options in the print set up screen.

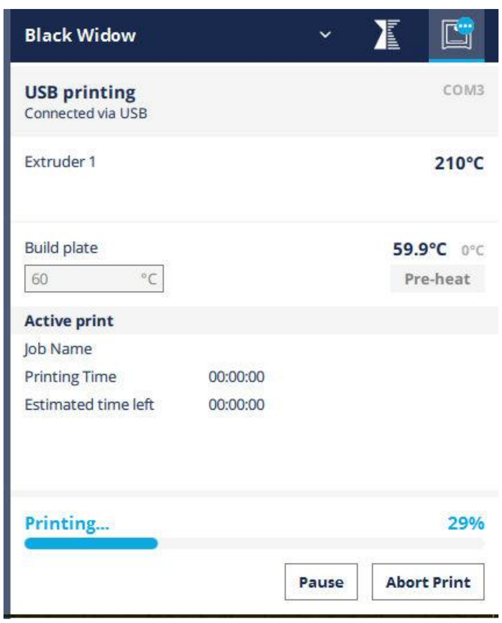
Network Connection

There are no network settings in Cura 2.6.2, it will automatically detect a printer. It does have firmware update functionality but it is better to use Arduino for that.

As indicated above there are no accessible network settings within Cura 2.6.2. In order to connect it to a printer you must connect the printer with the USB cable then fully power it up BEFORE running Cura. Once the printer is ready run Cura 2.6.2 and the printer will automatically connect. Once connected the double square on the top right of the window will have a green tick in it.

In the picture you will see that the box on bottom right contains “Print via USB” The down arrow to the right is used to change the print mode. Other options are “Save File” and “Save to SD” The down arrow is only present when there is an object on the bed!

Once the green tick is present and you can initiate prints. If you attempt to print over usb when there is no connected printer the USB interface screen will show that no printer is connected - there is no way out of this other than to kill Cura.



In some circumstances (e.g. sometimes after another application has used the usb) then you will have to kill Cura, go to system settings/devices/device manager, expand the USM tab right click the USB(com x) and disable it. Once disabled re-enable using the same process.

When printing the USB Printing monitor panel will appear on the right side of the window and the rest of the window will be greyed out. The information provided is very basic and no adjustments can be made via this panel.

Once the print has finished you will have to restart Cura to return to the set up. If you abort a print then you are returned to the set up screens

These issues have been reported as has the lack of any manual connection ability.

Start G-code for Cura 1st & 2nd generations

```
M280 P0 S160 ; Release BL-Touch alarm before each print
G21 ;metric values
G90 ;absolute positioning
M82 ;set extruder to absolute mode
M107 ;start with the fan off
G28;move X/Y/Z to min end stops
;G29 ; uncomment this line when BL-Touch is used
G1 Z15.0 F9000 ;move the platform down 15mm
G92 E0 ;zero the extruded length
G1 F200 E3 ;extrude 3mm of feed stock
G92 E0 ;zero the extruded length again
G1 F9000 ; Put printing message on LCD screen  M 117 Printing...
```

End G-code for Cura 1st & 2nd generations

```
M104 S0 ;extruder heater off
M140 S0 ;heated bed heater off
G91 ;relative positioning // Do not remove this line
G1 E-1 F300  ;retract the filament a bit before lifting the nozzle, to release some of the pressure
G1 Z+0.5 E-5 ;move Z up a bit and retract filament even more
G90 ;absolute positioning
G1 X328 Y250 ;move X to the right and the bed to the front for easy object removal
M84 ;steppers off
```

12.2.2 Slic3R (Freeware)

Slic3r is another freeware slicer, which some experts claim that is better than Cura.

The SW & manual can be found here: http://slic3r.org/

12.2.3 Simplify3D

Simplify3D, or S3D in short, is a paid for slicer. It is considered by most experts to be the best slicer, and can be purchased for 149USD here: https://www.simplify3d.com/

12.3 Design

12.3.1 Tinkercad (Freeware)

For designing simple 3D objects you can use Autodesk's Tinkercad. This is a free full function online software, which can be found here: **https://www.tinkercad.com**

12.3.2 123D App Suite (Freeware)

If you would like to design offline, a good free package is the Autodesk's 123D design suite which consists of several standalone applications, which can be found here: **http://www.123dapp.com/**

The design package is 123D Design, which is part of this suite.

Please note
This suite is about to discontinue at the beginning of 2017.

12.3.3 Netfabb

Netfabb is a paid application (3-years free for students). It is considered to be one of the best apps for checking and repairing your STL files, prior to sending them to the printer, which can be found here: **https://www.netfabb.com/**

It is a good practice, and highly recommended, to repair each STL file prior to sending it to the slicer, even if the file is coming from a known good source. There are many defects which seem legitimate to the slicer, and you will probably find them when the print is done.

12.4 Control

Please note

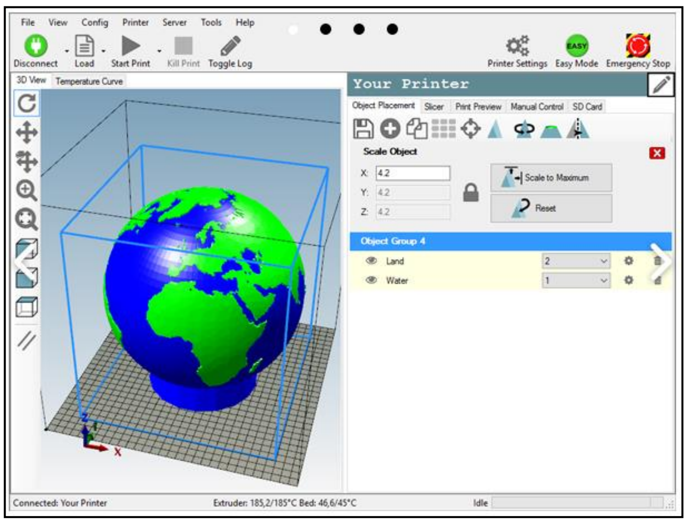
The Extruder (E0) motor can only be tested if the hot-end is above 170 degrees Celsius. This is to prevent grinding of the filament when the heater is not warm enough to melt the filament.

To control the machines XY and Z axes, both of the following programs can be used.

If you need to set a baud rate use AUTO or select 250,000 for any PC related communication.

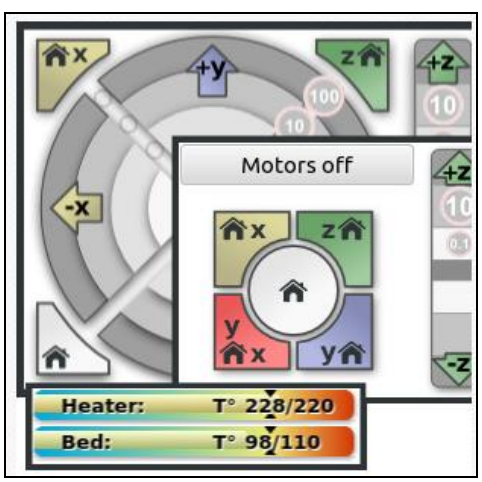
12.4.1 Repetier-Host (Open Source)

Repetier-host (can slice by itself as stand alone, or slice in conjunction with multiple other slicers)



12.4.2 Pronterface (Open Source)

Pronterface (can't slice by itself as stand alone, however can slice in conjunction with **Slic3r**)



12.4.3 G-Codes

A comprehensive list of G-codes and M-codes can be found the **RepRap wiki page**.

13 Annexes

13.1 Glossary of Terms & Abbreviations

13.1.1 Terms

Heat-bed, also known as Heatbed or Hotbed.

Heat-block, also known as Heatblock, or Heater-block, or Heater.

Heat-break, also known as Heatbreak, or Throat, or heater-tube

Heat-Cartridge, also known as Heater. Please note the ambiguity with Heat-block.

Heat-sink, also known as Heatsink.

Hot-end, also known as Hotend.

RS232: Serial communication standard.

Temp: Temperature.

13.1.2 Abbreviations

ABL: Auto Bed Leveling

AC/DC: Alternating Current / Direct Current

ASIC: Application Specific Integrated Circuit

AWG: American Wire Gauge

BLT: Bed Level Touch (BL-Touch)

BW: Black Widow

BWCG (Black Widow Community Guide)

CCA (Copper Clad Aluminum)

DIY: Do It Yourself

EEPROM: Electrically Erasable Programmable Read Only Memory

EHD: External Heat-bed Driver

EMI: Electro-Magnetic Interference

FTDI: Future Technology Devices International

FW: Firmware

ID: Inside Diameter

LCD: Liquid Crystal Display

LED: Light Emitting Diode

MOSFET: Metal Oxide Semiconductor Field Effect Transistor

NC: Normally Closed

NO: Normally Opened

NTC: Negative Temperature Coefficient

OB: OpenBuilds

OD: Outside Diameter

OS: Operating System

PC: Personal Computer

PID: Proportional Integral Derivative

POM: Poly-Oxy-Methylene

PPM: Parts Per Million

PSU: Power Supply Unit

PTFE: Poly-Tetra-Fluoro-Ethylene (Teflon)

PVC (Poly Vinyl Chloride)

PWM: Pulse Width Modulation

QC: Quality Control

SD: Secure Digital

SMD: Surface Mount Device

SPST: Single Pole Single Throw

SSR: Solid State Relay

SW: Software

TBA: To Be Added

TOC: Table of Contents

USB: Universal Serial Bus

VAC: Volt Alternating Current

VCP: Virtual Com Port

VDC: Volt Direct Current

13.2 BW Square & Parallel Rev – 1.0 by Doron Shalev

13.2.1 Proper disclosure

I was TEVO's beta tester for the Black Widow 3D printer; however TEVO has neither approved nor endorsed this document.

Therefore following this document is on your own responsibility and risk.

13.2.2 Acknowledgments

I would like to thank Bruce Walker, Laurent Paillard & Jari Tulilahti, for their help in reviewing, proofing and providing constructive comments which are embedded in this document.

13.2.3 Introduction

This is one of the most important procedures a BW builder would face in order to assure high quality prints.

Hereinafter, the assembly comprising the two 2040 extrusions and the small wheel carriages will be called: "The X-Gantry".

Each of the leadscrews is constrained at 3 points: The top and bottom bearings, and the ACME nut, which is part of the X-Gantry. The X-Gantry has a fixed length during Z-travel.

The two issues this procedure is dealing with are:

A) Any deviation of the leadscrews out of parallelism will cause them to bend along the travel of the X-Gantry.

B) Any deviation of the ACME nut's threaded hole from the straight line path, from the center of the bottom bearing to the center of the top bearing, will cause the leadscrew to bend as the ACME nut travels up and down the leadscrew.

The way of dealing with this issue is by transforming the 3-point constraint system into a 2-point constraint system. The bottom bearing serves as the pivot point of the straight line, and the ACME nut serves as the tuning point of the straight line. The top bearing hole, which has no bearing during the tuning process, serves as a reference point showing that the 3rd point on the straight line has arrived to the proper position, i.e. centered in the hole.

Please note

Throughout this document, extrusions will be identified by their overall cross section dimensions, i.e. 2040 is 20mm by 40mm, 2080 is 20mm by 80mm, and 4080 is 40mm by 80 mm. The 4080 extrusions are also called C-Beams, as their cross section shape resembles the letter "C".

13.2.4 Personal note

I do believe that this C-Beam Dual-Z system has great potential which can be realized only if adjusted properly.
I also do realize that the following procedure is tedious, and some folks would like to take shortcuts. However until an Oldham Coupler for the BW will be available, an almost perfectly square and parallel printer is a must for best results.
Such a coupler is currently under development and would render this procedure obsolete in most cases.

Doron Shalev
Nov-2016

13.2.5 Procedure Steps

13.2.5.1 Step-01: Initial assembly-1

Assemble the small wheel carriages as per Fig. 1-1a & 1-1b. Make sure your small wheel carriages are running smoothly on the 4080 C-beams, **without** any wobble or bumping.

Please note:

The figure shows the stack-up of the wheel as per the manual. You may use a different stack-up in order to prevent wheel lock up and “sand” feeling, as well as to prevent possible scratching of the C-Beams. This may result in different dimensions, however the following procedure will take care of that.

Hereinafter, the figures will show the stock stack-up only.

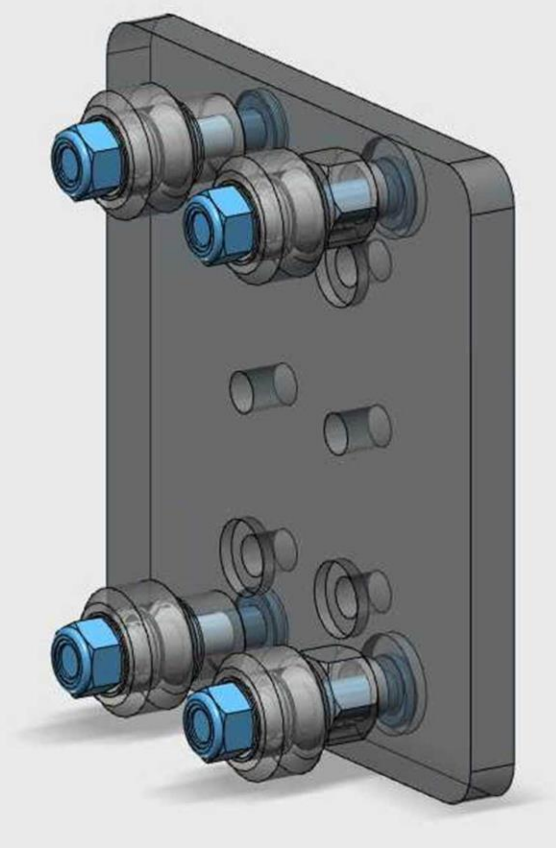


Fig. 1-1a

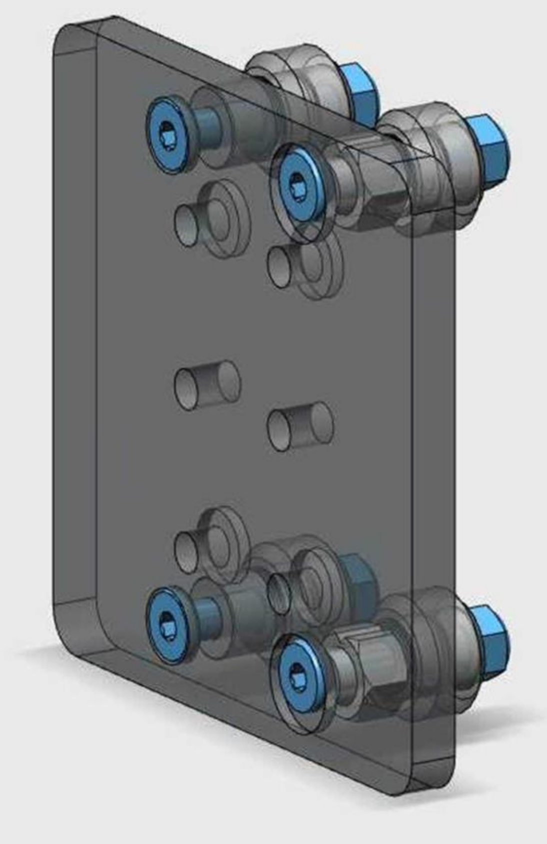


Fig. 1-1b

13.2.5.2 Step-02: Initial assembly-2

Assemble the frame and the X-Gantry as per Fig. 2-1 or 2-2. **Use no shims** between the two 2040 extrusions, and the small wheel carriages. Make sure the X-Gantry is running smoothly on the 4080 C-beams, **without** any stops and/or bumping.

Please note

You may be using the stock L-brackets as shown in Detail 2-1a, or cast corner brackets as shown in Detail 2-2a, which is recommended for long term stability of the frame.
Unless the procedure is different, hereinafter the figures will show the cast corner bracket version only.

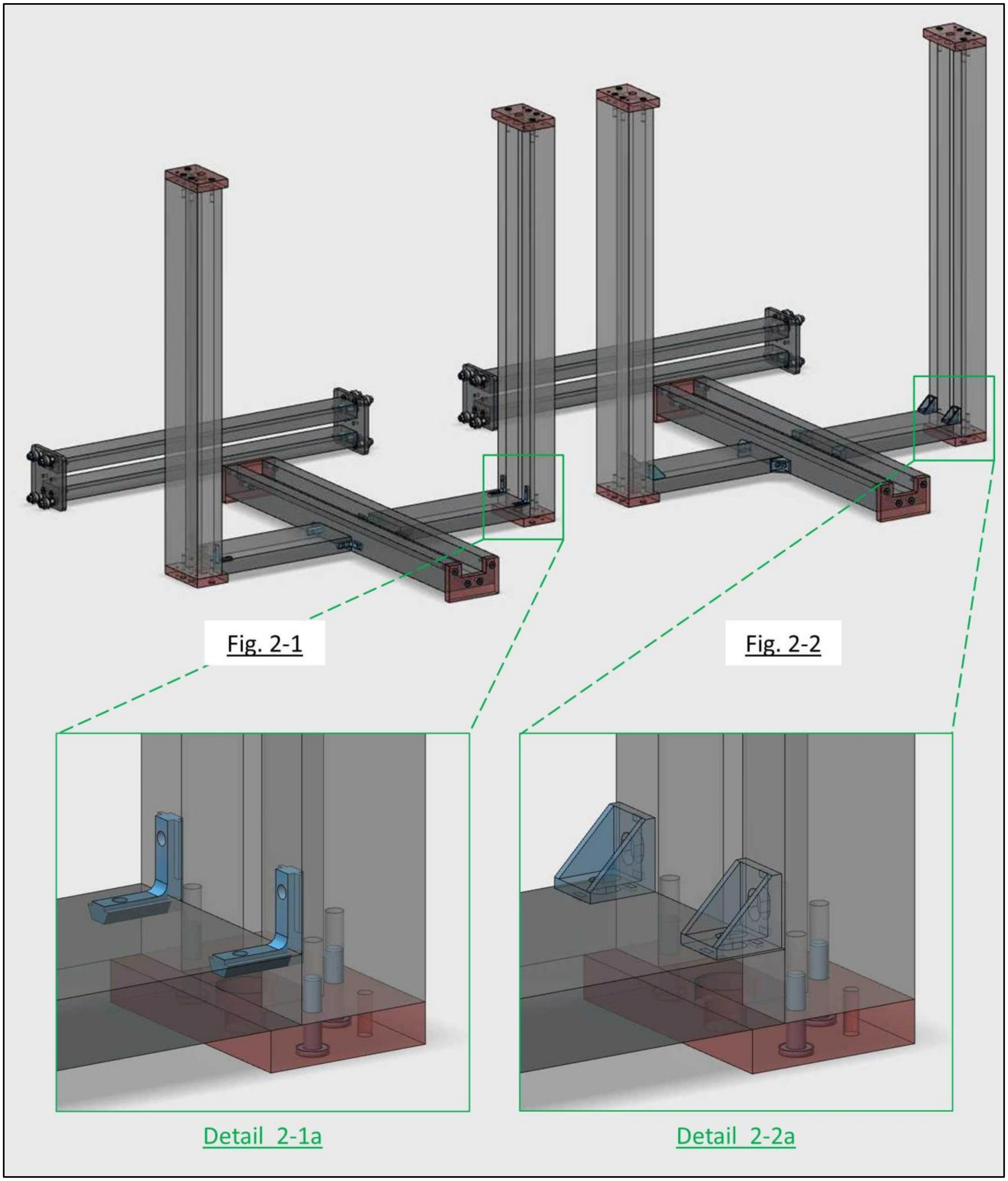


Fig. 2-1
Fig. 2-2
Detail 2-1a
Detail 2-2a

13.2.5.3 Step-03: Leadscrew initial inspection

Ensure your leadscrews are not bent by rolling them on a flat surface. If there is significant wobble, straighten or replace the leadscrews.

During the procedure and after assembling the leadscrews, you'll be referred to the appendix for leadscrew final inspection.

13.2.5.4 Step-04: Determine the shape of your frame

Ideally, the end to end distance of the two vertical 4080 C-beams should be X_1; regardless the position of the X-Gantry, as shown in figures 3-1 through 3-3.
In practice, due to changes in the small wheel assembly stack, and manufacturing tolerances, there are variations on the X_1 & X_2 lengths.
When the X-Gantry is at the lowest position, the frame may look diverging at the top, as shown in figures 4-1 & 4-2, or may look converging at the top, as shown in figures 5-1 & 5-2.
A mere 1mm at the bottom, can manifest as 5mm at the top due to the height of the frame and the angles involved.
Divergence may be caused by the following scenarios:

a. 2040 extrusions of the X-Gantry are **longer** than necessary. In this case Δ_2=+1mm, and Δ_1=+5mm as shown in Fig. 4-1.
b. Lower 2080 extrusions are **shorter** than necessary. In this case -Δ_2=-1mm, and Δ_1=+5mm as shown in Fig. 4-2.

Convergence may be caused by the following scenarios:

a. 2040 extrusions of the X-Gantry are **shorter** than necessary. In this case -Δ_2=-1mm, and -Δ_1=-5mm as shown in Fig. 5-1.
b. Lower 2080 extrusions are **longer** than necessary. In this case Δ_2=+1mm, and -Δ_1=-5mm as shown in Fig. 5-2.

Please note
The Δ sign means "Delta", which denotes the difference between 2 quantities.
Hereinafter it will denote the difference between 2 dimensions.

Please note
Divergence and convergence angles have been exaggerated in the figures to enhance clarity.

Please note
There may be combinations of the above (a) & (b) scenarios, i.e. either both are shorter, or both are longer. The final result may be either divergence or convergence, which will determine the corrective action in this procedure.

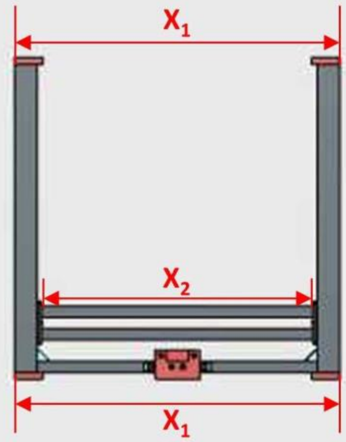


Fig. 3-1

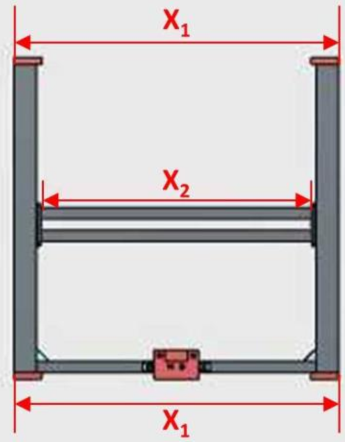


Fig. 3-2

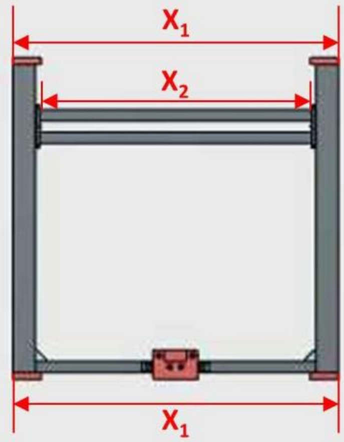


Fig. 3-3

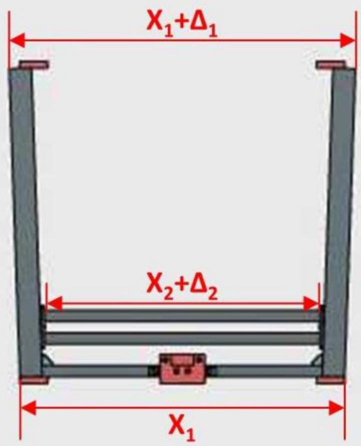


Fig. 4-1

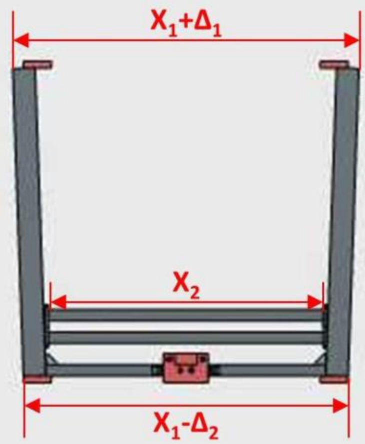


Fig. 4-2

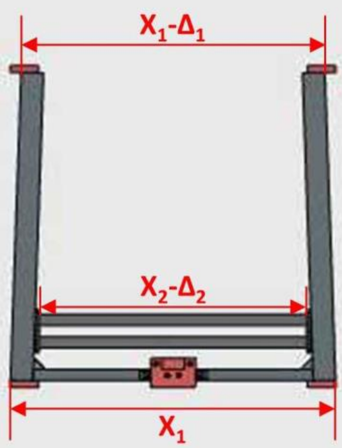


Fig. 5-1

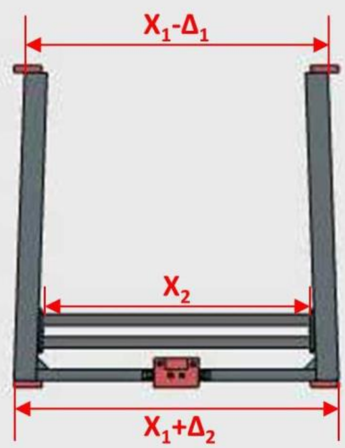


Fig. 5-2

13.2.5.5 Step-05: Divergence corrective action

Add a shim between each of the 2080 & the 4080 extrusions.

If your initial frame looks like figures 4-1 or 4-2, then after inserting the shim it should look like figures 6-1 or 6-2 respectively.

If you are using the stock L-brackets, the shim goes into the gap between the 2080 and 4080 extrusions as shown in Detail-1 Option-a of figures 6-1 & 6-2.

If you are using a casted corner brackets, the shim would be a large washer, between the bracket and the 4080 extrusion, as shown in Detail-1 Option-b of figures 6-1 & 6-2, which will leave a gap between the 2080 & 4080 extrusions.

Please note

Δ_2 should be determined from Fig. 4-1 or Fig. 4-2, according to your case, according to the following formula: $\Delta_2 \approx \Delta_1/5$.

Please note

Make sure that the end to end distance at the top of the 4080 extrusions remains constant throughout the travel of the X-Gantry.

It should be $X_1 + \Delta_2$ if your case is per figures 4-1 & 6-1.

It should be X_1 if your case is per figures 4-2 & 6-2.

Please note

If the gap width Δ_2 does not correspond to a shim that you have on hand, you may "lock the gap" using only the brackets. There is at least one BW printer assembled this way with the cast corner brackets. I am not sure that this is feasible with the stock L-brackets, however you may try.

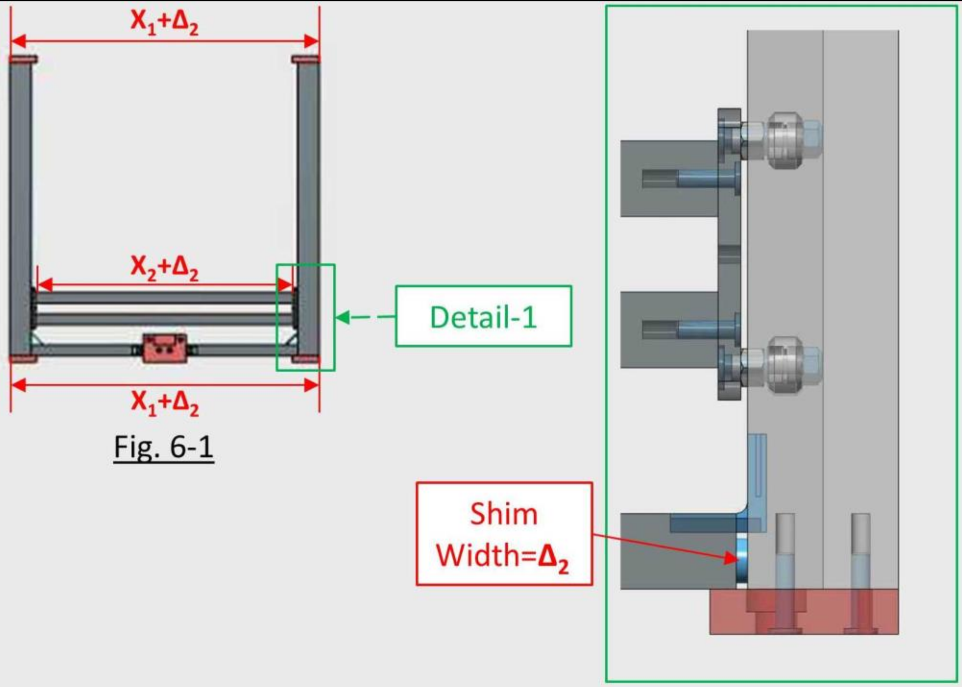


Fig. 6-1

Detail-1, Option-a: Stock L-brackets

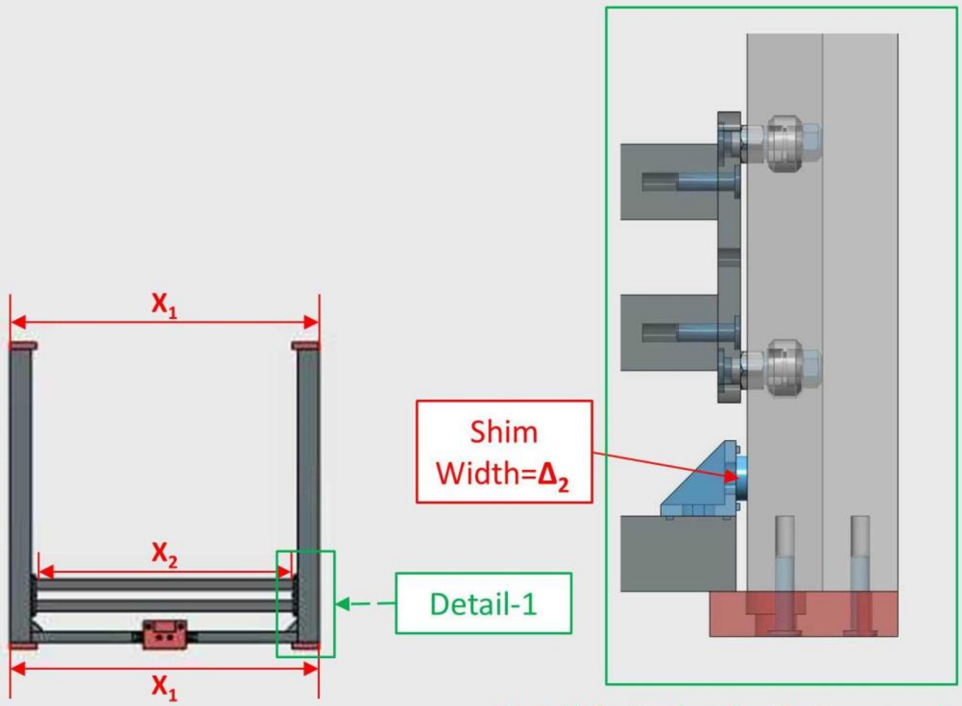


Fig. 6-2

Detail-1, Option-b: Cast corner brackets

13.2.5.6 Step-06: Convergence corrective action

Add shim between each of the 2040 extrusions, and small wheel carriage, of the X-Gantry.

If your initial frame looks like figures 5-1 or 5-2, then after inserting the shim it should look like figures 7-1 or 7-2 respectively.

The shim would be a large washer as shown in Detail-1 of figures 7-1 & 7-2.

Please note

Δ_2 should be determined from Fig. 5-1 or Fig. 5-2, according to your case, according to the following formula: $\Delta_2 \approx \Delta_1/5$.

Please note

Make sure that the end to end distance at the top of the 4080 extrusions remains constant throughout the travel of the X-Gantry.
It should be X_1 if your case is per figures 5-1 & 7-1.
It should be $X_1 + \Delta_2$ if your case is per figures 5-2 & 7-2.

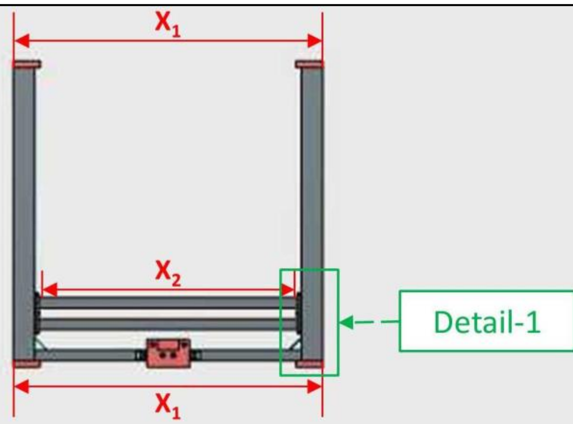
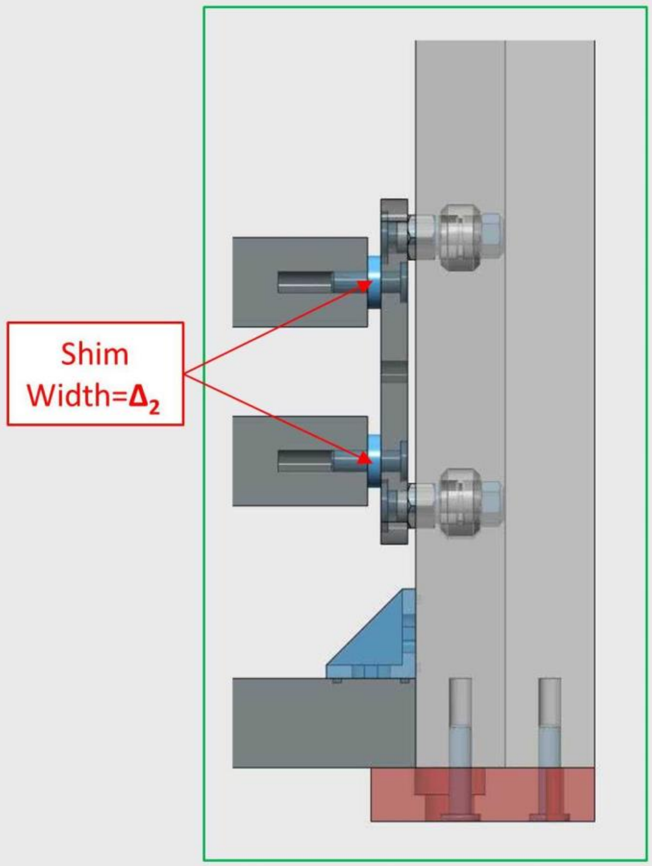


Fig. 7-1



Detail-1

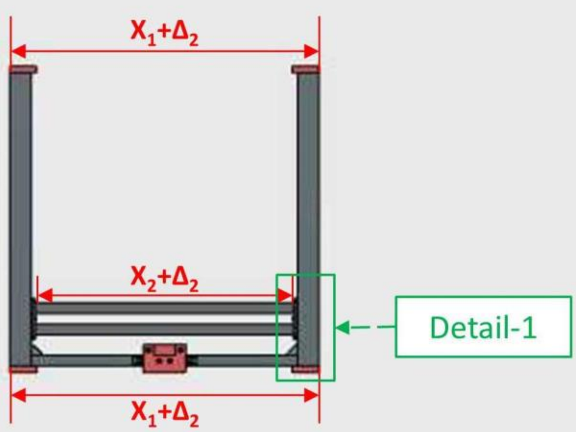


Fig. 7-2

13.2.5.7 Step-07: Verify the frame

Temporarily assemble the top 2080 extrusion.
Watch the gap between the top 2080 extrusion and the 4080 C-Beam.
You should verify that the top 2080 extrusion does not deform the frame!

There are 3 possible scenarios:

A) There is a positive gap.
Prepare shims with width equal to the gap, to be assembled at the **top joint**, similarly to what you have done for the lower joint in Step-05.
In this case your final frame would have **two** places with shims. At the bottom joint, and at the top joint.

B) There is a zero gap.
You are lucky.
Go to Step-08.
In this case your final frame would have **one** place with shims. At either the bottom joint, or at the X-Gantry.

C) There is a negative gap, i.e. the top 2080 extrusion is pushing on the 4080 C-Beams.
Prepare shims with width equal to the gap, to be assembled at **both** the **bottom joint**, similarly to what you have done in Step-05, **and** at the **X-Gantry** similarly to what you have done in Step-06.
This would be equivalent to scenario (B) i.e. zero gap, however in this case your final frame would have **two** places with shims. At the bottom joint, and at the X-Gantry.

Please note
In scenario (C), due to real world constrains you may only find standard shims that would give you combinations that would lead to scenario (A) rather than (B), i.e. positive gap rather than zero gap.
In this case your final frame would have Three places with shims. At the bottom joint, at the X-Gantry, and at the top joint.

13.2.5.8 Step-08: Measure the gap between the leadscrew and the small wheel carriage

Now that the 4080 C-beams are parallel, it's time to measure the gap between the leadscrew and the small wheel plate, as shown in Fig. 8-1.

Assemble the leadscrews and install bearings and collars at **both** the top & bottom end plates, as shown in Fig. 8-1, Details-1&3.

The ACME nut is not installed, as shown in Fig. 8-1 Detail-2, in order to maintain a 2-point constraint system, and determine the position of the leadscrew relative to the small wheel carriage.

The gap X_3, should be constant at 5.4 mm nominal, throughout the X-Gantry travel.

If it is not, there are 2 possible causes:

A) The leadscrew is bent/crooked.

Please refer to Step-03.

B) The leadscrew is not parallel to the 4080 C-beam.

Please continue with this procedure.

To determine which case you are dealing with, please refer to the Appendix.

Please note

Fig. 8-2 is the same as Fig. 8-1, whereas the 4080 C-Beam extrusion is hidden to enhance clarity.

Please note

This step should be done for each leadscrew independently.

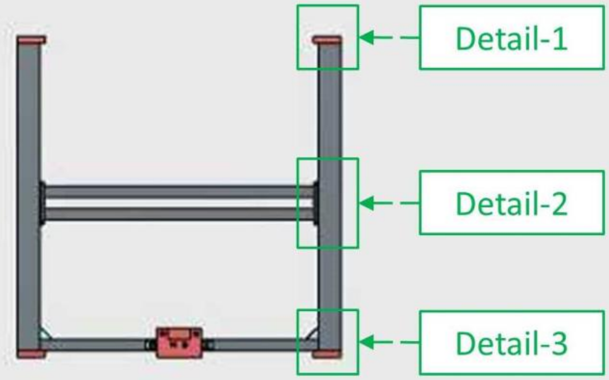
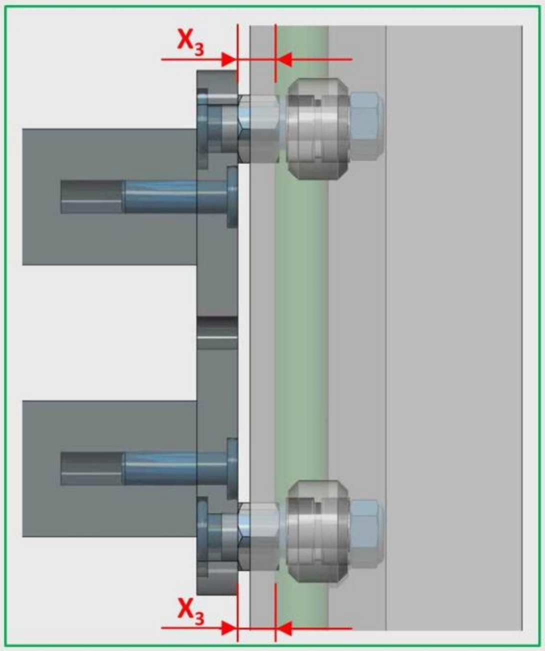
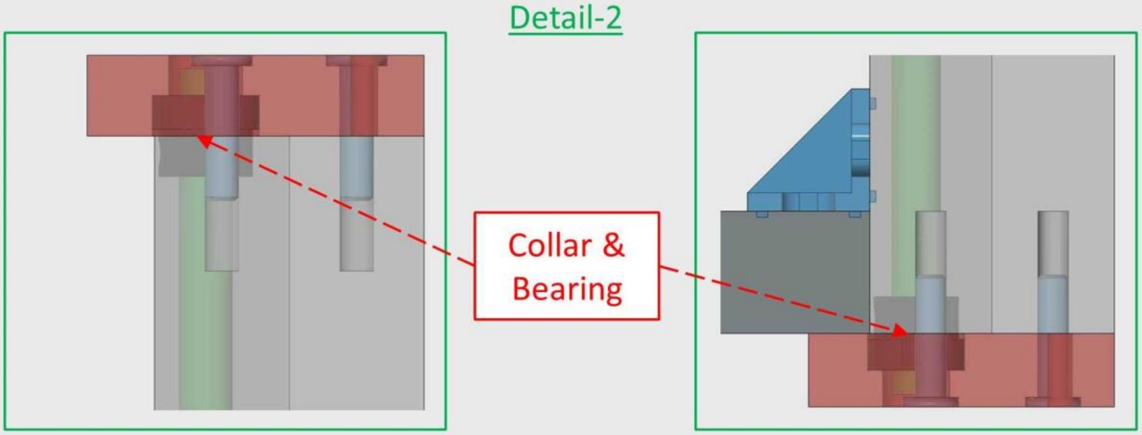


Fig. 8-1



Detail-2



Detail-1 Detail-3

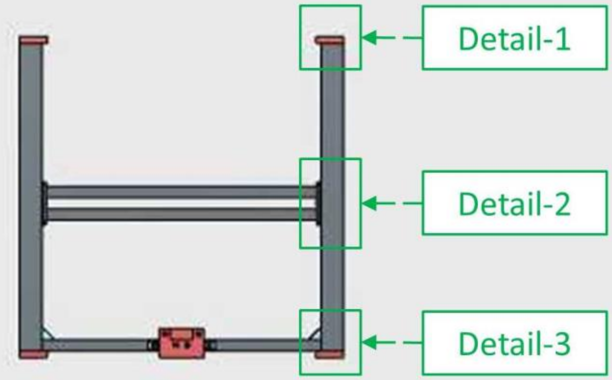
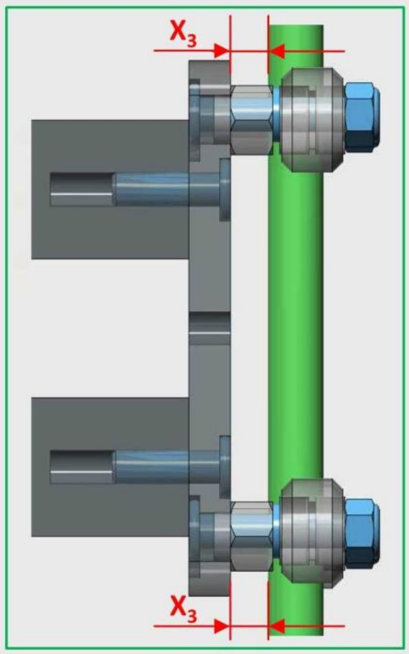
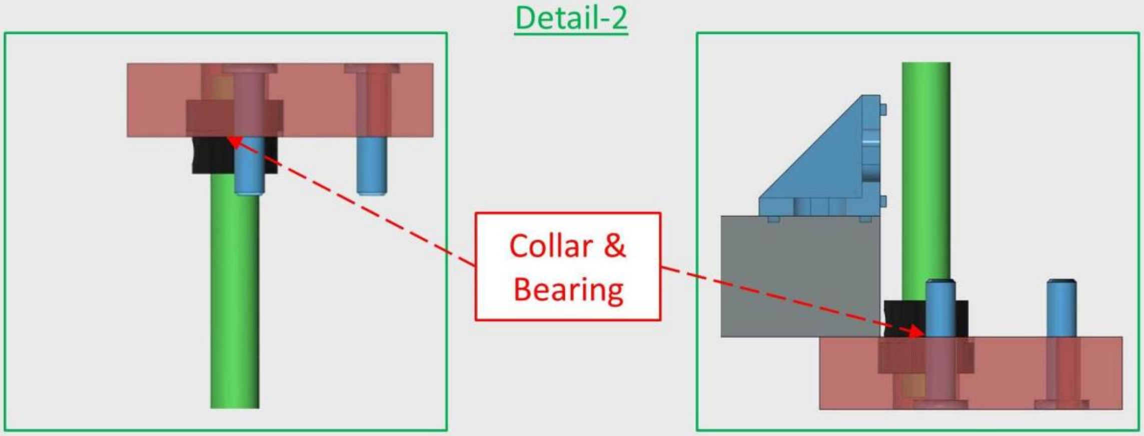


Fig. 8-2



Detail-2



Detail-1 Detail-3

13.2.5.9 Step-09: Parallel the leadscrews in the X-Z plane

The previous steps ensured that the 4080 C-Beam extrusions are parallel. Therefore in order to ensure that both leadscrews are parallel, each of them should be parallel to its corresponding 4080 C-Beam extrusion.

Assemble the X-Gantry, the leadscrews, the ACME nut, the collars and the **bottom only bearing**, as shown in Fig. 9-1 and associated side-view details.

The top bearing is not installed, in order to maintain a 2-point constraint system, and determine the position of the leadscrew relative to the hole of the top bearing.

The X-Gantry should be at the **lowest position**, to enhance the sensitivity of the adjustment.

Per the gap measured in the previous step (Step-08), and the dimensions of the POM/Brass ACME (POM: Poly-Oxy-Methylene) nut supplied with your kit, you can determine the needed spacer width between the ACME nut and the small wheel plate:
POM ACME nut: **Spacer=Gap (mm)**.
Brass ACME nut: **Spacer=Gap-3.5 (mm).**

The leadscrew should remain centered within +/- 0.1 mm inside the top bearing hole, relative to the X direction, during the whole travel of the X-Gantry.

Please note
The 4080 C-Beam extrusion is hidden in the figures to enhance clarity.

Please note
If your actual gap is less than the width of the supplied spacer, you may sand down the supplied spacer 0.05 mm at a time, until the top of the leadscrew is at dead-center relative to the top bearing hole. Remember that each 0.05 mm at the X-Gantry when it is at the lowest position, manifests as 0.25 mm at the top.
If your actual gap is greater than the width of the supplied spacer, or if you are using the Brass ACME nut, you may need to use combinations of shims in order to get to your target spacer width.

Please note
This step should be done for each leadscrew independently.

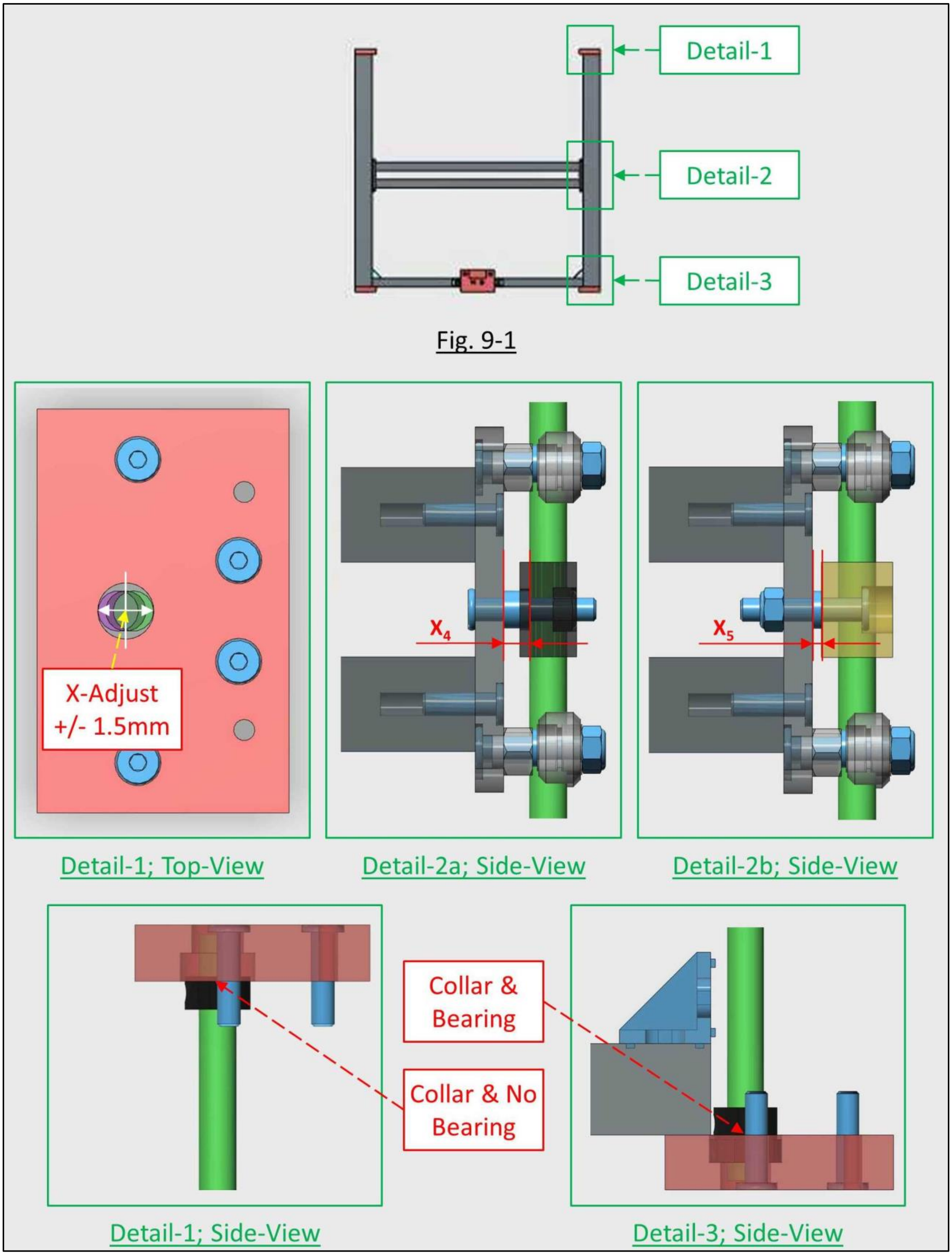

Detail-1
Detail-2
Detail-3
X-Adjust
+/- 1.5mm
X4
X5
Detail-1; Top-View
Detail-2a; Side-View
Detail-2b; Side-View
Collar &
Bearing
Collar & No
Bearing
Detail-1; Side-View
Detail-3; Side-View

Fig. 9-1

13.2.5.10 Step-10: Parallel the leadscrews in the Y-Z plane

Release to POM/Brass ACME nut locking screws and adjust the ACME nut **until the leadscrew is centered, within +/- 0.1 mm, inside the top bearing hole**, as shown in Fig. 10-1, Details-1&2.

The amount of “play” between the ACME nut and the screws is in the order of +/- 0.1 mm, which will result in +/- 0.5 mm movement of the leadscrew relative to the top bearing hole.

The leadscrew should remain centered within +/- 0.1 mm inside the top bearing hole, during the whole travel of the X-Gantry.

Please note

If you are using the supplied POM ACME nut, you may make this adjustment while the X-Gantry is assembled on the 4080 C-beams. The Nylock nuts inside the recesses of the POM ACME nut will “hold” the screws even when not tightened.

Please note

This step should be done for each leadscrew independently.

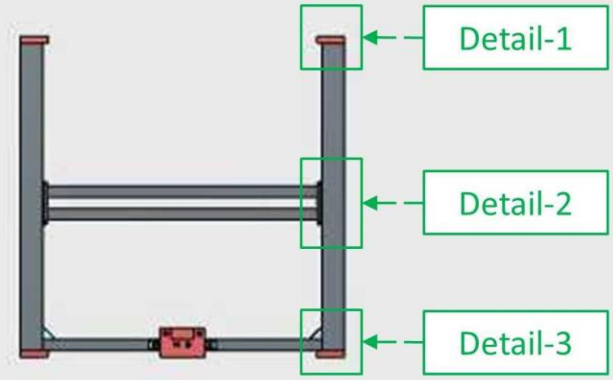
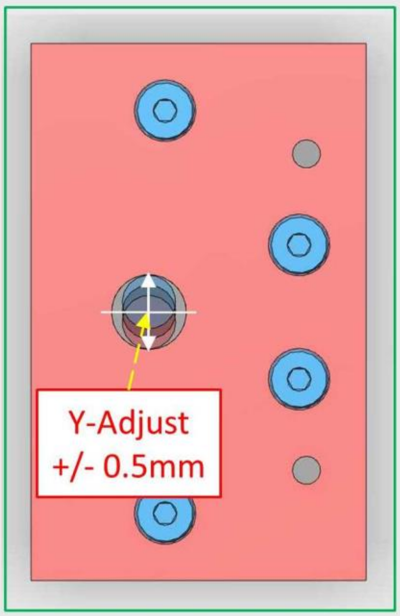
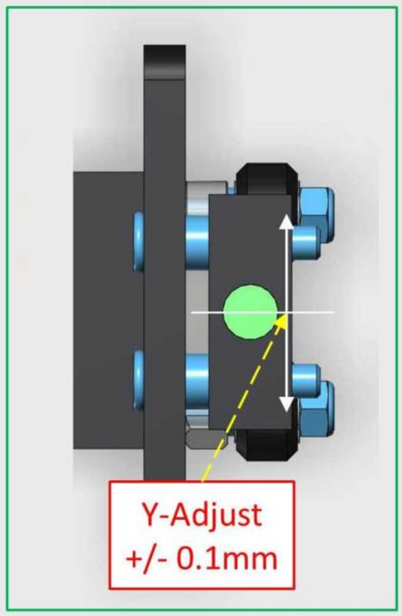


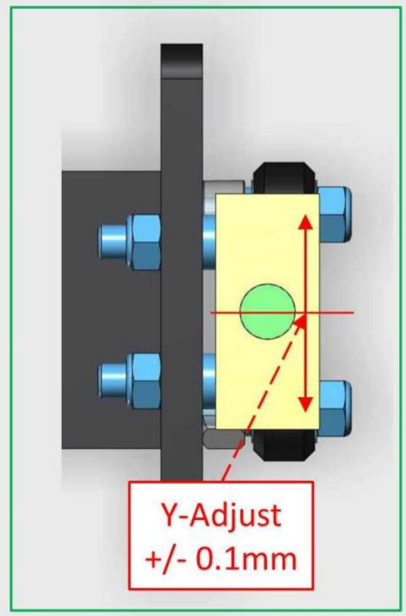
Fig. 10-1



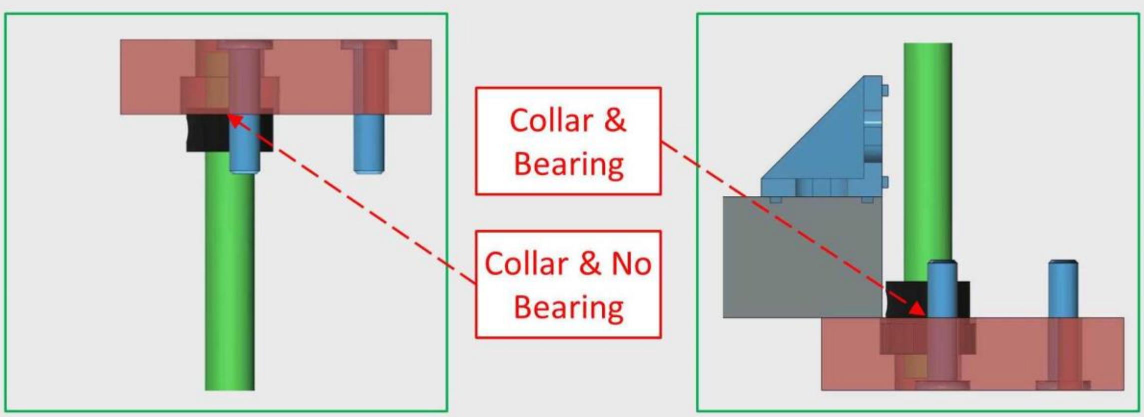
Detail-1; Top-View



Detail-2a; Top-View



Detail-2b; Top-View



Detail-1; Side-View

Detail-3; Side-View

13.2.5.11 Step-11: Finish

At this stage both leadscrews should be centered relative to their respective bearing holes, and this should hold true throughout the travel of the X-Gantry.

You may continue with the build instructions as per the manual.

13.2.6 Appendix

13.2.6.1 Leadscrew final inspection

Assemble the X-Gantry, the leadscrews, the ACME nut, the collars and the **bottom only bearing**, as shown in Fig. A1-1 and associated side-view details.

The X-Gantry should be at the **lowest position**, to enhance the sensitivity of the test.

The top bearing is not installed, in order to maintain a 2-point constraint system, and determine the position of the leadscrew relative to the hole of the top bearing.

Rotate the leadscrew **one turn**, using your fingers, and observe the trace the top of the leadscrew is making inside the top bearing hole.

There are 2 possible scenarios:

A) Leadscrew bent/crooked.
The leadscrew wobbles throughout this rotation, as shown in Fig. A1-1, Detail-1a.

B) Leadscrew not parallel to the frame.
The leadscrew end remains at the same position, throughout this rotation, as shown in Fig. A1-1, Detail-1b through Detail-1d.
It doesn't matter where the tip of the leadscrew is at the beginning of the rotation. What matters is that the tip of the leadscrew remains at the **same point** throughout the full rotation.
The leadscrew is straight, however slanted relative to either the X-Z plane, or the Y-Z plane, or both.

Please note
The 4080 C-Beam extrusion is hidden in the figures to enhance clarity.

Please note
This inspection should be done for each leadscrew independently.

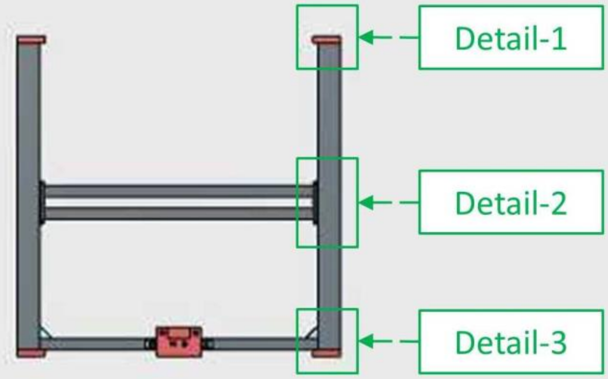
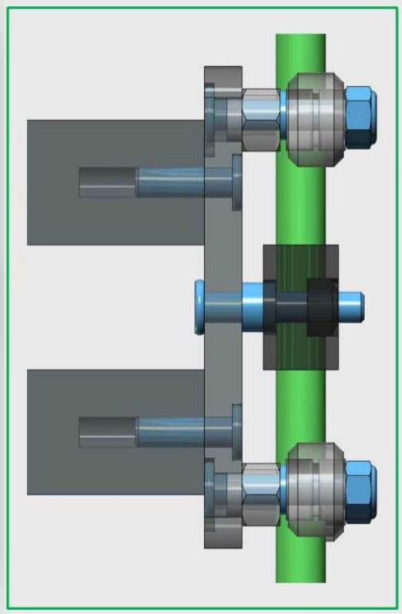
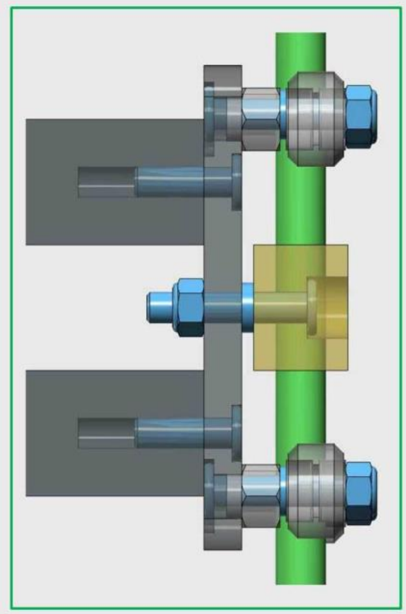


Fig. A1-1

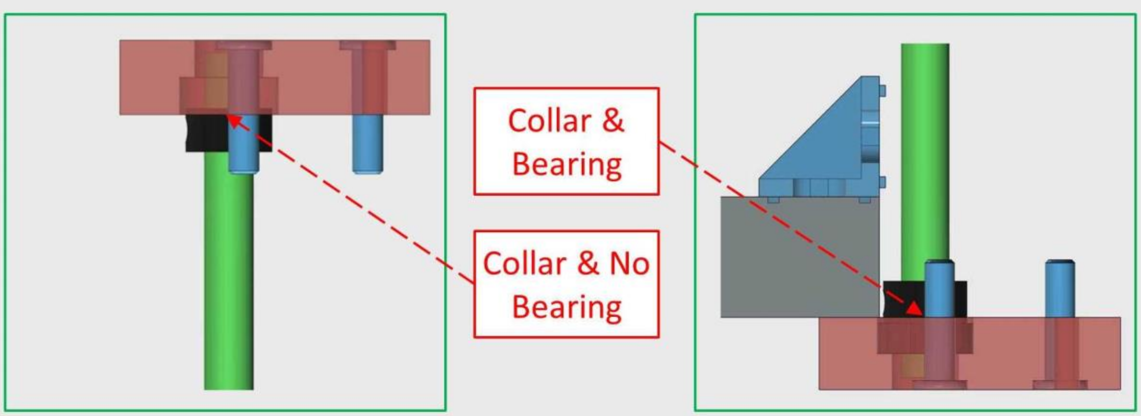
Detail-1a; Top-View



Detail-2a; Side-View



Detail-2b; Side-View



Detail-1; Side-View

Detail-3; Side-View

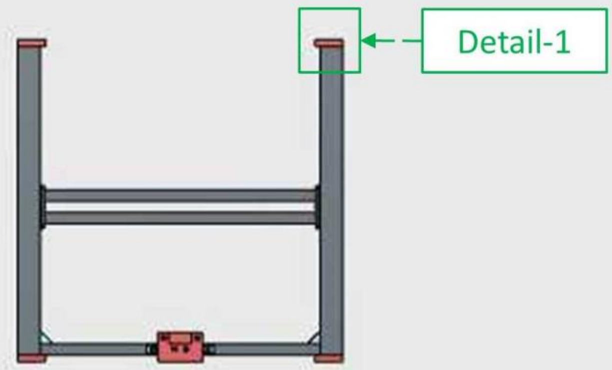


Fig. A1-1

Detail-1b; Top-View

Detail-1c; Top-View

Detail-1d; Top-View

13.2.6.2 Nominal Dimensions

The following are the nominal dimensions referred to in this document. The piece parts supplied with your kit may result different dimensions due to manufacturing tolerances:

Symbol	Description	Nominal (mm)
X_1	Frame width	580.0
X_2	2040 extrusions of the X-Gantry	484.4
X_3	Leadscrew to small wheel plate gap	5.4
X_4	POM ACME block spacer width	5.4
X_5	Brass ACME block spacer width	1.9

13.2.6.3 Dimensional Relations

$X_4=X_3$ (mm)

$X_5=X_3-3.5$ (mm)

$\Delta_2\approx\Delta_1/5$ (mm)

13.3 Heat-bed ABL Instructions

13.3.1 ABL-General

This annex is based off the "**Tevo Tarantula Auto Level Instructions**" document by **Ed Farias** (ArcadEd), and adapted for the Black Widow Community Guide by **Doron Shalev**.

Proximity sensors are devices which can detect an object at a predetermined distance. There are many types of these which include Inductive, Capacitive, Magnetic & Optical. We will concentrate on the Inductive type which can detect metallic objects, and the Capacitive type which can detect non-metallic objects, which are the common types in 3D printing.

The operation principles of these are outside the scope of this guide, and the interested reader is referred to the public domain literature.

These sensors function like mechanical switches and therefore classified as either NC (Normally Closed), or NO (Normally Opened) switches. However since they are implemented electronically, they are also having either a PNP, or an NPN transistor at the output.

Good engineering practice requires that the end-stop circuit would be NC during normal operation, and open when homing or reaching the end-travel. Thus if the switch malfunctions/disconnects, the heat-bed/hot-end would not move, rather than crashing into the end-stop which is the case with NO end-stops. The Marlin FW default is therefore set for NC switches. However TEVO has decided to use end-stops with NO mechanical switches for the Tarantula, and followed with end-stops having Inductive NO/NPN sensors for the BW.

We can't cover all four combinations of sensor output configurations, and will follow the TEVO BW stock, which is the Inductive type GL-8H sensor employing the NO/NPN configuration.

Please note

If you are having either NO/PNP, or NC/NPN or NC/PNP sensor, the following sections WOULD NOT apply. You would need to figure out the proper connection configuration and/or change the FW.

Please note

Official FW version, RC8 Vx.x-PROX where x.x is 3.2 and up, which is suitable for the sensors discussed in this annex, is currently available. Please refer to Section 11.1.3. If you wish to use an earlier version, you can manually configure the FW, as explained in Section 13.3.4 ABL-FW

The following table summarizes the more common sensor types, which have community mountings, as well as FW support.

Please note
The detection range of these sensors is rated from an Iron plate. Since the heat-bed is usually made of Aluminum, and in some installations there are an additional glass and/or other covers, the actual detection range is usually much smaller, and each installation should be checked for compatibility.

For Inductive type over Aluminum, the sensing distances should be multiplied by 0.4 (40%).

<table>
<tr><td>TEVO Tarantula optional ABL sensor.

Sensing distance from an Iron-plate: 4mm.</td><td></td><td>SN04-N Inductive

6-36VDC
3-wire
NO
NPN
200mA</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>
<table>
<tr><th>Type</th><th>Diameter</th><th>Body</th><th></th><th>Sensing Distance Iron plate</th><th></th><th>Supply & Output</th></tr>
<tr><td rowspan="5">LJ</td><td rowspan="2">12: 12mm</td><td rowspan="5">A3: Metal</td><td rowspan="5">-</td><td>4: 4mm</td><td rowspan="5">-</td><td rowspan="5">Z/BX:
6-36VDC
3-wire
NO
NPN
200mA</td></tr>
<tr><td>8: 8mm</td></tr>
<tr><td rowspan="3">18: 18mm</td><td>B: 1-8mm</td></tr>
<tr><td>T: 1-12mm</td></tr>
<tr><td>H: 1-15mm</td></tr>
</table>
</td><td></td><td>LJ-Series Inductive

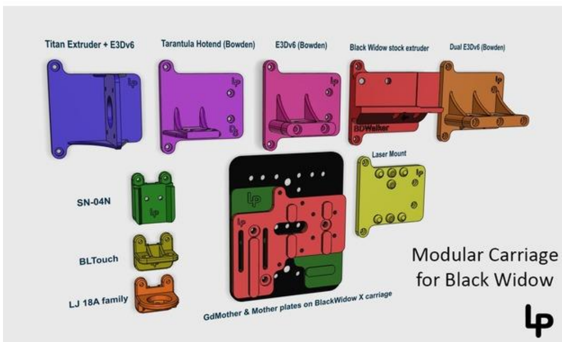
Compatible Devices: Choose one from each column.
e.g. LJ12A3-4-Z/BX</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>
<table>
<tr><th>Type</th><th>Diameter</th><th>Body</th><th></th><th>Sensing Distance Iron plate</th><th></th><th>Supply & Output</th></tr>
<tr><td rowspan="5">LJC</td><td rowspan="2">12: 12mm</td><td rowspan="5">A3: Metal</td><td rowspan="5">-</td><td>4: 4mm</td><td rowspan="5">-</td><td rowspan="5">Z/BX:
6-36VDC
3-wire
NO
NPN
200mA</td></tr>
<tr><td>8: 8mm</td></tr>
<tr><td rowspan="3">18: 18mm</td><td>B: 1-8mm</td></tr>
<tr><td>T: 1-12mm</td></tr>
<tr><td>H: 1-15mm</td></tr>
</table>
</td><td></td><td>LJC-Series Capacitive

Compatible Devices: Choose one from each column.
e.g. LJC18A3-B-Z/BX</td></tr>
</table>

13.3.2 ABL-Mounting

Please note
Regarding the LJ(C)-series, the following mountings include adaptors ONLY for the 18mm diameter bodies. They DO NOT include adaptors for the 12mm diameter bodies. If you have a 12mm body sensor, you would need to design a proper mounting/adaptor.

We recommend using the 18mm versions, as for only 3mm "penalty" in position; you get more than double sensing area, which makes the reading more reliable.

 	A Modular X Carriage which enables you to fit any extruder/hot-end/sensor combination. http://www.thingiverse.com/thing:1829292 Sensor offsets in FW, refer to Section 13.3.4: **Default: X: -40 ; Y: +10** **Titan direct extruder +E3Dv6: X: -40 ; Y: +16**

You want the bottom of the sensor to be slightly higher than the tip of the nozzle, but not too much. 1-2mm is probably good. The goal here is for the sensor to detect the aluminum bed before the nozzle touches it.

Please note
Capacitive sensors have better results with lower sensitivity. That is, you need to reduce the sensitivity so that the trigger point will be as close to the glass plate as possible. In repeatability tests, both the Sigma, and Mean variation over 24 hours improves when you do that. Therefore it is recommended to adjust the sensitivity to 2mm max.

Once the sensor is mounted you will want to remove you current Z end stop that is plugged in the Z- (Zmin) on the PCB, and replace it with the sensor plug, which you have outfitted per the figures below. The sensor will now become your Z end stop. Remember that the sensor can only detect metal in the Inductive case, or some other solid surface in the capacitive case, therefore if it's off the side of the heat-bed when your Z is going down; there is nothing to stop your nozzle from crashing into your heat-bed and doing some damage to other parts.

13.3.3 ABL-Connections

As depicted in Section 13.3.1, these sensors are rated for 6-36V_{DC}. Depending on the vendor, there are variants rated for 10-30V_{DC}.

There is a lot of controversy in the 3DP community at large, regarding whether these sensors can operate off the regulated 5V_{DC}, which is part of the 3-pin Z-end-stop header, or not.

The answer to this is not Black & White, as some YouTubers claim, but rather in the Gray area, and is mainly dependent on the internal implementation of the sensor, which is usually vendor dependent.

Some vendors implement their sensors using discrete components, in order to lower the cost. These sensors would operate off the regulated 5V bus, and even perform well, as evidenced from the optional SN04-N Inductive sensor used on hundreds of TEVO Tarantula printers.

Other vendors implement their sensors using an ASIC (Application Specific Integrated Circuit), which usually contains an internal voltage regulator. These sensors would not operate off the regulated 5V bus, and the only option is to power them from the 12/24V_{DC} bus. This would require some means to reduce the output voltage from 12/24V to 5V in order to prevent controller damage. There are 2 configurations given here for this purpose. One with resistive divider, and one with a switching diode, which is the recommended one, as it can be used “as is” for both 12V and 24V systems.

We would like to have a sensor with readings that are stable both short term and long term.

The long term stability is determined by the “mean” parameter of the repeatability test described in Section 13.3.6.4 . We would like this number to be within 0.1mm over days, in order to have a good 1st layer without re-calibrating the Z-offset too often.

The short term stability is determined by the “sigma”, aka standard deviation parameter of the repeatability test. We would like all measurements to be in an 0.1mm window in order that the mesh is calculated accurately for having a goo 1st layer across the bed. In the empirical sciences the so-called three-sigma rule of thumb expresses a conventional heuristic that "nearly all" values are taken to lie within three standard deviations of the mean, i.e. that it is empirically useful to treat 99.7% probability as "near certainty". Therefore if sigma is better that 0.03mm, then 3-sigma is better than 0.1 mm.

The following table summarizes the results of a full week’s research on the subject. Once you have determined the sensor you actually have, you may follow our recommendations.

	Sensor can operate 0ff 5V	Sensor cannot operate off 5V
How to tell	1) Sensor fed with 5V. 2) LED **lit** when sensor-head touched with a metal object.	1) Sensor fed with 5V. 2) LED **does not lit** when sensor-head touched with a metal object.
Sensor internal implementation	Discrete components.	ASIC
Operation off 5V	1) Trigger threshold: Soft (on-off over 1.0mm). 2) Mean: **Pass**. 3) Sigma: **Pass**. 4) EMI immunity: **High (1)**. 5) EMI filter (4): **Not required**.	**N/A**
Operation off 12/24V	1) Trigger threshold: Hard (on-off over 0.1mm). 2a) Mean (w/o EMI filter): **Marginal**. 2b) Mean (w/ EMI filter): **Pass**. 3a) Sigma (w/o EMI filter): **Fail**. 3b) Sigma (w/ EMI filter): **Pass**. 4) EMI immunity: **Low (2)**. 5) EMI filter (4): **Must**.	1) Trigger threshold: Hard (on-off over 0.1mm). 2a) Mean (w/o EMI filter): **Pass**. 2b) Mean (w/ EMI filter): **Pass**. 3a) Sigma (w/o EMI filter): **Pass**. 3b) Sigma (w/ EMI filter): **Pass**. 4) EMI immunity: **Very high (3)**. 5) EMI filter (4): **Optional**.

Notes regarding EMI filter & immunity:

1) Regulated 5V is confined to the board. Runs to the sensor in a bundled cable with the GND wire. EMI picked on the way having approximately the same magnitude and/or phase on each wire, therefore tends to cancel at the sensor's interface circuitry.

2) 12/24V line runs to the sensor, in part of the way, separately from the GND wire. EMI picked on the way having different magnitude and/or phase on each wire, therefore not canceled at the sensor's interface circuitry.

3) Sensor's onboard ASIC regulator virtually eliminates the EMI picked on the way.

4) Recommended EMI filter is a "clip on" type, capable of housing 2.5 turns of the sensor cable.

Please note
The ABL sensor is mutually exclusive with the stock Zmin end-stop sensor, therefore only one of them can be connected to the controller board, as depicted in the following figures. The ABL sensor will serve for BOTH ABL, and end-stop functionalities, as defined in the FW.

Depending on the vendor, some sensors are equipped with internal pullup resistor, and some are configured as an open collector arrangement, in which the circuit relies on external pullup resistor to function. The way to verify this is by measuring the resistance between the Brown and Black lines. If it reads infinity, then it is an open collector arrangement. If it reads a finite value in the range of KOhms, this value should be used as per the figures. Also if you are using different PSUs to power the heat-bed and the controller, you should use the controller PSU voltage for the calculations.

Caution
In the following figures, it is assumed that MKS-Gen board is used. This board has 4.7KOhm pullup resistors on all X/Y/Z min/max inputs.

If you are using another board with an ATMega 2560 controller, however does not have on-board pullup resistors, you MUST enable the ATMega 2560 internal pullup resistors by the FW. Up to RC8 V3: "Configuration.h" file. As of RC8 V3.2: "Configuration_PROX.h" file, see Section 11.1.3. It should read: #define ENDSTOPPULLUPS (Un-commented). Search the string by clicking "Ctrl+F".

The tables in the following figures provide the values for the four combinations of finite/infinite internal pullup, and 12V/24V PSU. If you are using a different PSU voltage, i.e. cranked-up your 12V or cranked-down your 24V for any reason, the general formula is:

$R_{OUT}=5*R_{IN}/(V_{PSU}-5)$

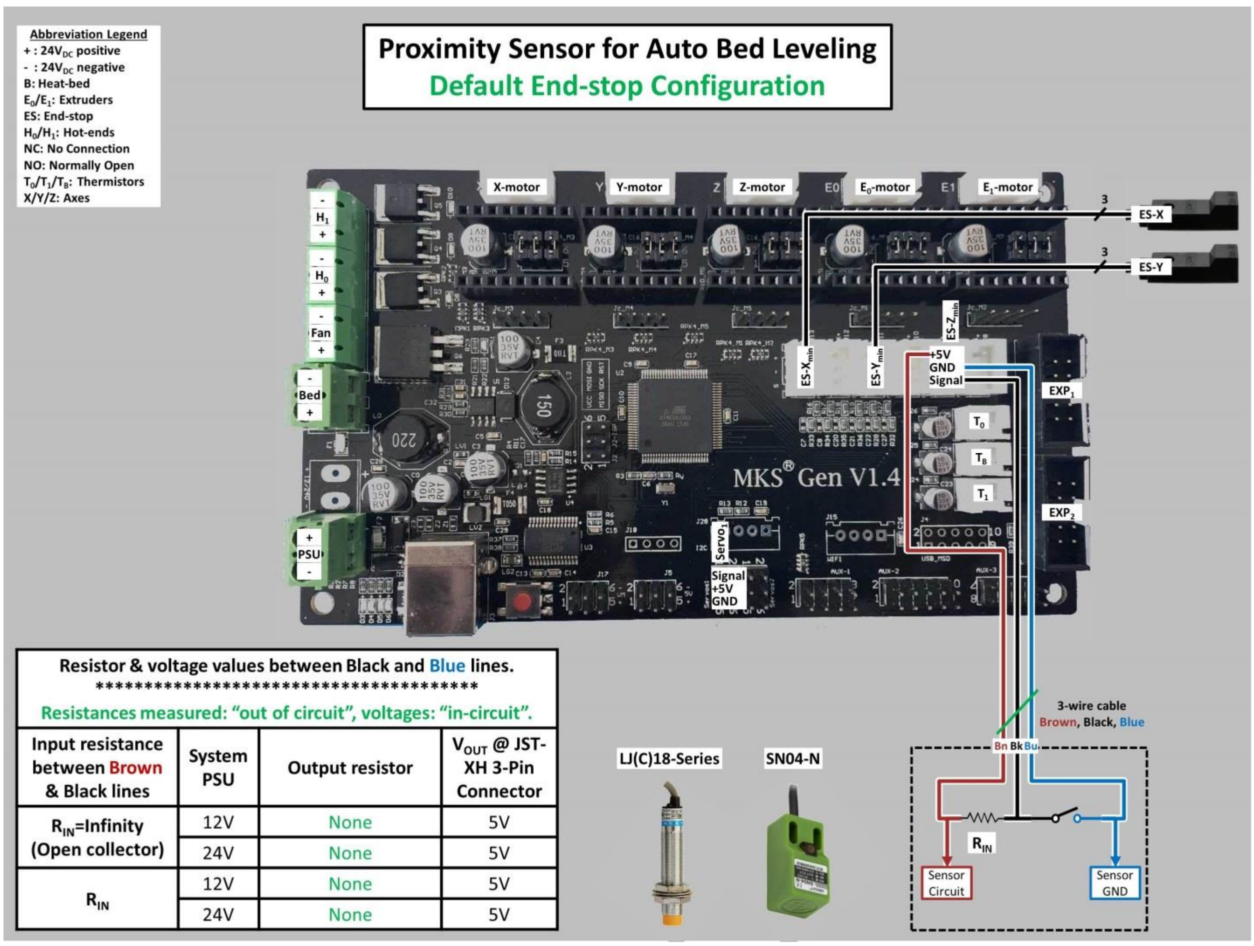
Please note
For the R_{OUT} resistor, you should use the closest standard value which is BELOW the calculated value. This would result in less than 5V, which is safe.

13.3.3.1 Default End-stop Configuration

There is a lot of controversy, whether these sensors which are rated for 6-36VDC, can operate from the 5V regulated bus. This is highly dependent on the sensor's vendor. The high quality sensors are built with a special integrated circuit, which contains an internal regulator for stable operation. These will probably not work off the 5V. However most of the clones are made with discrete components, and would probably work fine off the 5V.

The following figure illustrates the default end-stop configuration, using 5V. There are hundreds of TEVO Tarantulas, if not more, that are using the SN04-N Inductive sensor in this configuration, without any reported issues, as well as numerous LJ(C)18-series sensors.

If you want to be on the safe side, or the following configuration doesn't work for your sensor, you can either use a sensor which was verified to operate at 5V **HERE**, or use the alternate connections shown in the following figures.



Resistor & voltage values between Black and Blue lines.
****
Resistances measured: "out of circuit", voltages: "in-circuit".

Input resistance between Brown & Black lines	System PSU	Output resistor	V_{OUT} @ JST-XH 3-Pin Connector
R_{IN}=Infinity (Open collector)	12V	None	5V
	24V	None	5V
R_{IN}	12V	None	5V
	24V	None	5V

13.3.3.2 Alternate Connection-1: Output Resistive Divider

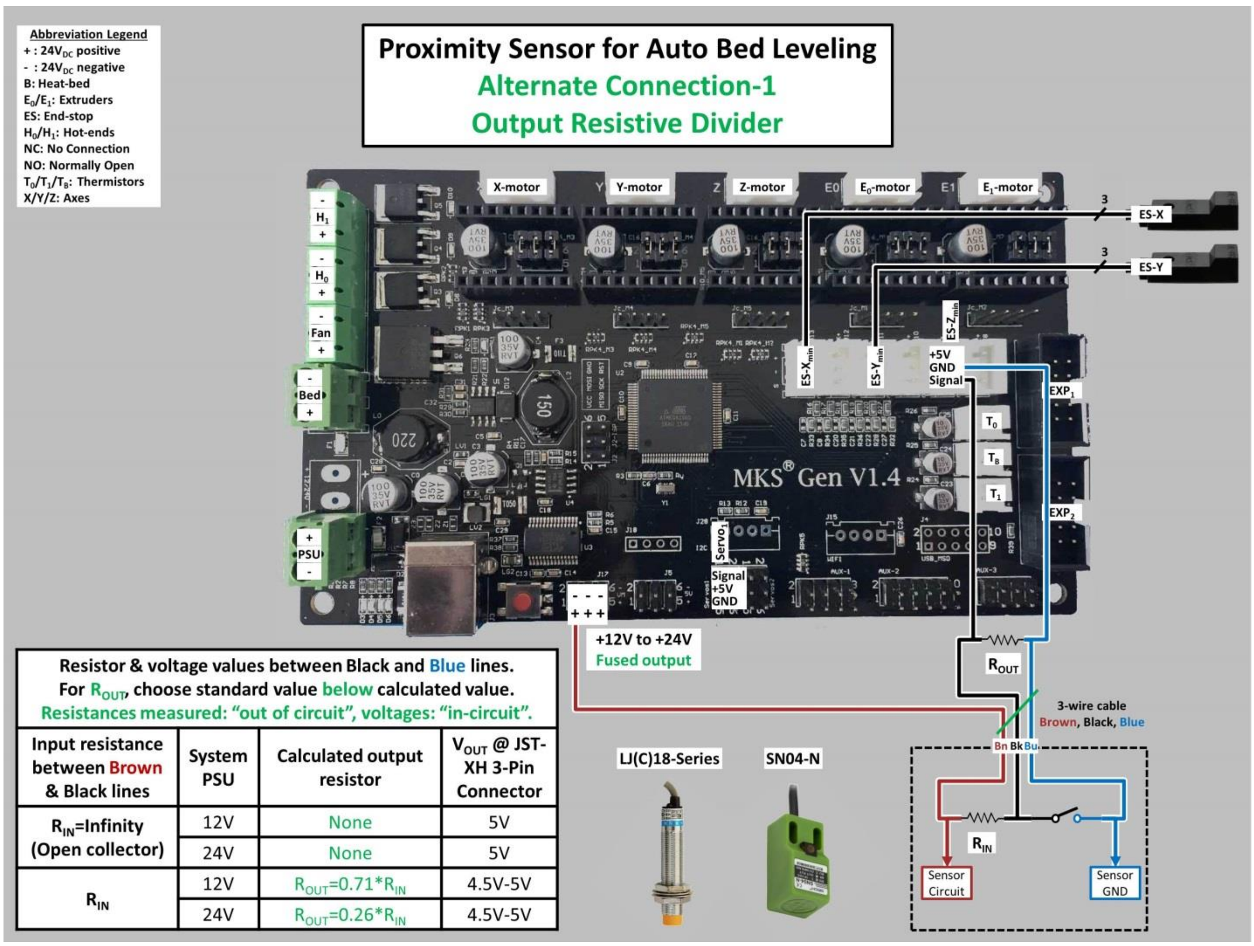
The following figure illustrates two scenarios:

1) There is no internal pullup inside the sensor, i.e. it is configured as “open collector”. The sensor’s output signal line (Black) is pulled to 5V by the MKS-Gen controller’s pullup resistor.

2) There is pullup resistor inside the sensor. The R_{OUT} resistor between the signal (Black line) and GND (Blue line), provide a resistive divider in conjunction with the internal pullup resistor, thus limiting the signal output to 4.5-5V.

Caution

This configuration is highly sensitive to PSU voltage. If you are using neither 12V, nor 24V, you should use the general formula: $R_{OUT}=5*R_{IN}/(V_{PSU}-5)$.



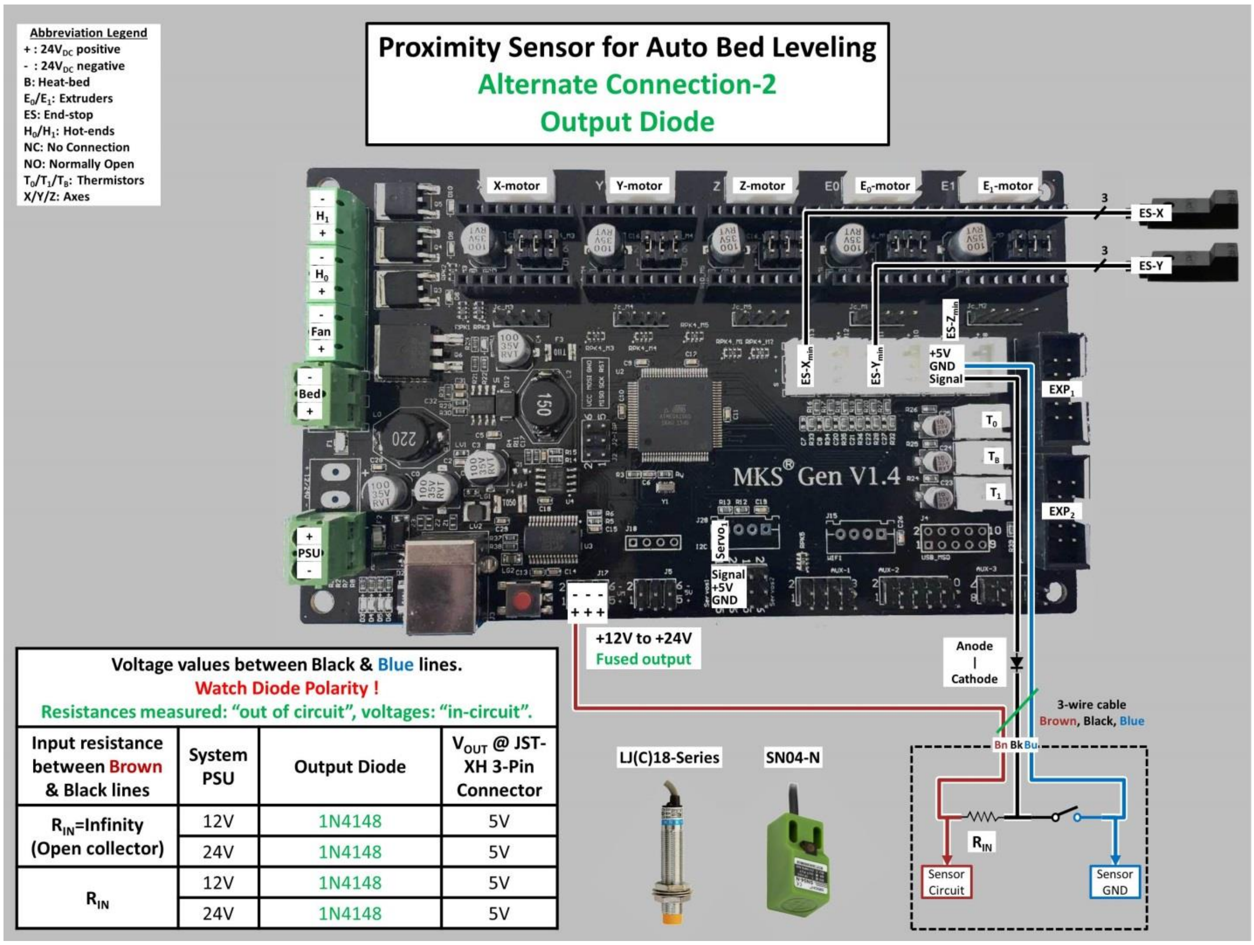
Input resistance between Brown & Black lines	System PSU	Calculated output resistor	V_{OUT} @ JST-XH 3-Pin Connector
R_{IN}=Infinity (Open collector)	12V	None	5V
	24V	None	5V
R_{IN}	12V	$R_{OUT}=0.71*R_{IN}$	4.5V-5V
	24V	$R_{OUT}=0.26*R_{IN}$	4.5V-5V

13.3.3.3 Alternate Connection-2: Output Diode

This configuration is using a switching diode to block the sensor's high voltage. The end-stop is pulled up to 5V by the MKS-Gen pullup resistor, regardless of PSU voltage, or sensor's output configuration.

Caution

This configuration is highly sensitive to diode polarity. If you reverse the polarity as shown, high voltage will be injected into the 5V port of the MKS-Gen controller and destroy it.



Voltage values between Black & Blue lines.
Watch Diode Polarity !
Resistances measured: "out of circuit", voltages: "in-circuit".

Input resistance between Brown & Black lines	System PSU	Output Diode	V_{OUT} @ JST-XH 3-Pin Connector
R_{IN}=Infinity (Open collector)	12V	1N4148	5V
	24V	1N4148	5V
R_{IN}	12V	1N4148	5V
	24V	1N4148	5V

13.3.4 ABL-FW

The following table summarizes the needed changes in the "**Configuration.h**" file **up to RC8 V3 Non-BLT** FW.

Red color represents changed item in the specified line, before the change. **Green color** represents the item after the change.

Please note
As of RC8 V3.2, the ABL's specific "Configuration_PROX.h" file of the PROX FW variant is already pre-configured, see **Section 11.1.3****.**

Please note
Use the latest FW, FW uploading instructions, USB drivers & USB driver's installation instructions, as described in the appropriate sections of this guide.

Please note
Use your specific configuration limits for the "Travel limits after homing".

Caution
Although the bug, which allowed probing outside the limits, has been fixed in RC8 V4, you may need to fine tune these limits to ensure that probing is allways on the bed. When first operating the ABL, be prepared to turn off the master switch, in case you observe that probing is attenmpted ouside the bed !

Please note
EEPROM behavior with regards to ABL is still under investigation. At this point the FW default is maintained.

Change from	Change to	Notes
#define CUSTOM_MACHINE_NAME "Black Widow"	#define CUSTOM_MACHINE_NAME "Black Widow ABL"	Machine name.
#define Z_MIN_PROBE_ENDSTOP_INVERTING false	#define Z_MIN_PROBE_ENDSTOP_INVERTING true	NO/NPN sensor.
//#define FIX_MOUNTED_PROBE	#define FIX_MOUNTED_PROBE	Uncomment to enable sensor.
// Note the following offsets are for the TEVO Black Widow BLTouch probe located	// Note the following offsets are for the ABL BW with stock extruder, and either LJ series Inductive/Capacitive probes,	Sensor offsets.
// here from ANTCLABS the maker of the BLTouch: http://www.thingiverse.com/thing:1761761	// or SN04-N Inductive probe, with mounting brackets here from LP: http://www.thingiverse.com/thing:1829292	
#define X_PROBE_OFFSET_FROM_EXTRUDER 48	#define X_PROBE_OFFSET_FROM_EXTRUDER 40	
#define Y_PROBE_OFFSET_FROM_EXTRUDER -18	#define Y_PROBE_OFFSET_FROM_EXTRUDER -10	
#ifdef TEVO_BLTOUCH	//#ifdef TEVO_BLTOUCH	Comment to enable Repeatability test.
#endif	//#endif	
#ifndef TEVO_BLTOUCH	//#ifndef TEVO_BLTOUCH	Comment to disable Mesh leveling.
#define MESH_BED_LEVELING	//#define MESH_BED_LEVELING	
#endif	//#endif	
#ifdef TEVO_BLTOUCH	//#ifdef TEVO_BLTOUCH	Comment to enable bi-linear leveling.
#endif	//#endif	

13.3.5 ABL-SW

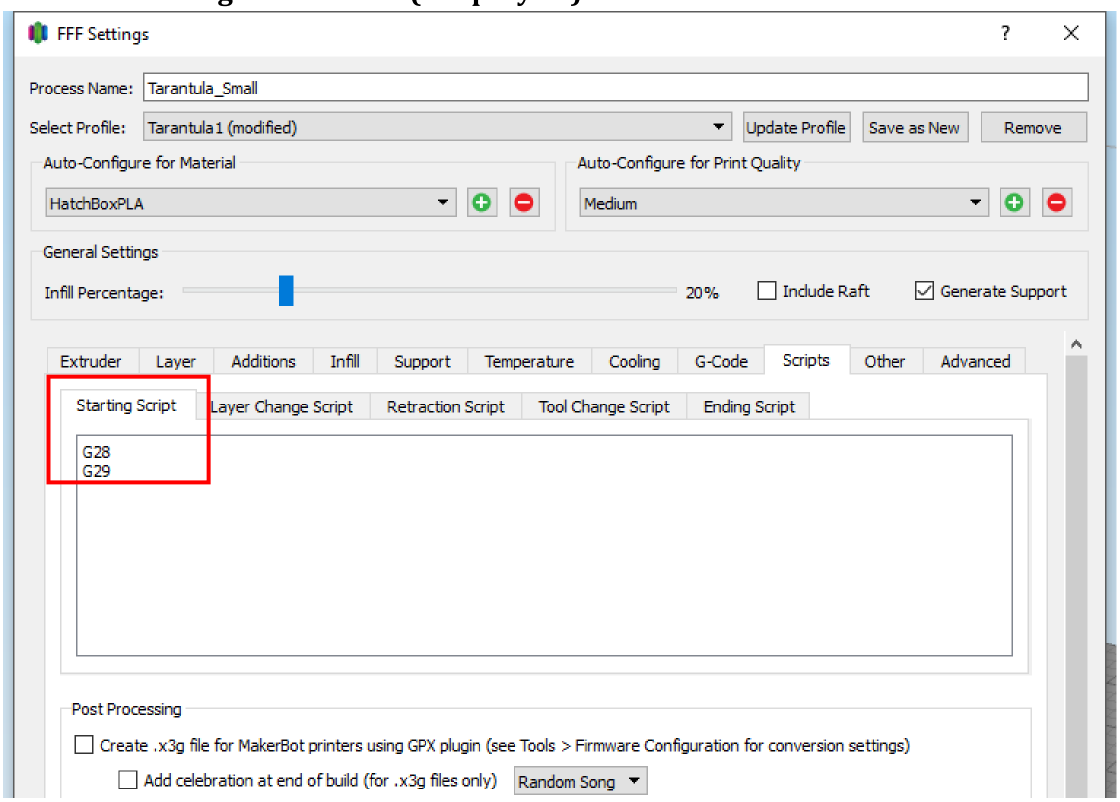
In your slicer there should be a place to put in starting G-Code commands. Here you will put a G28, followed by a G29.

Please note

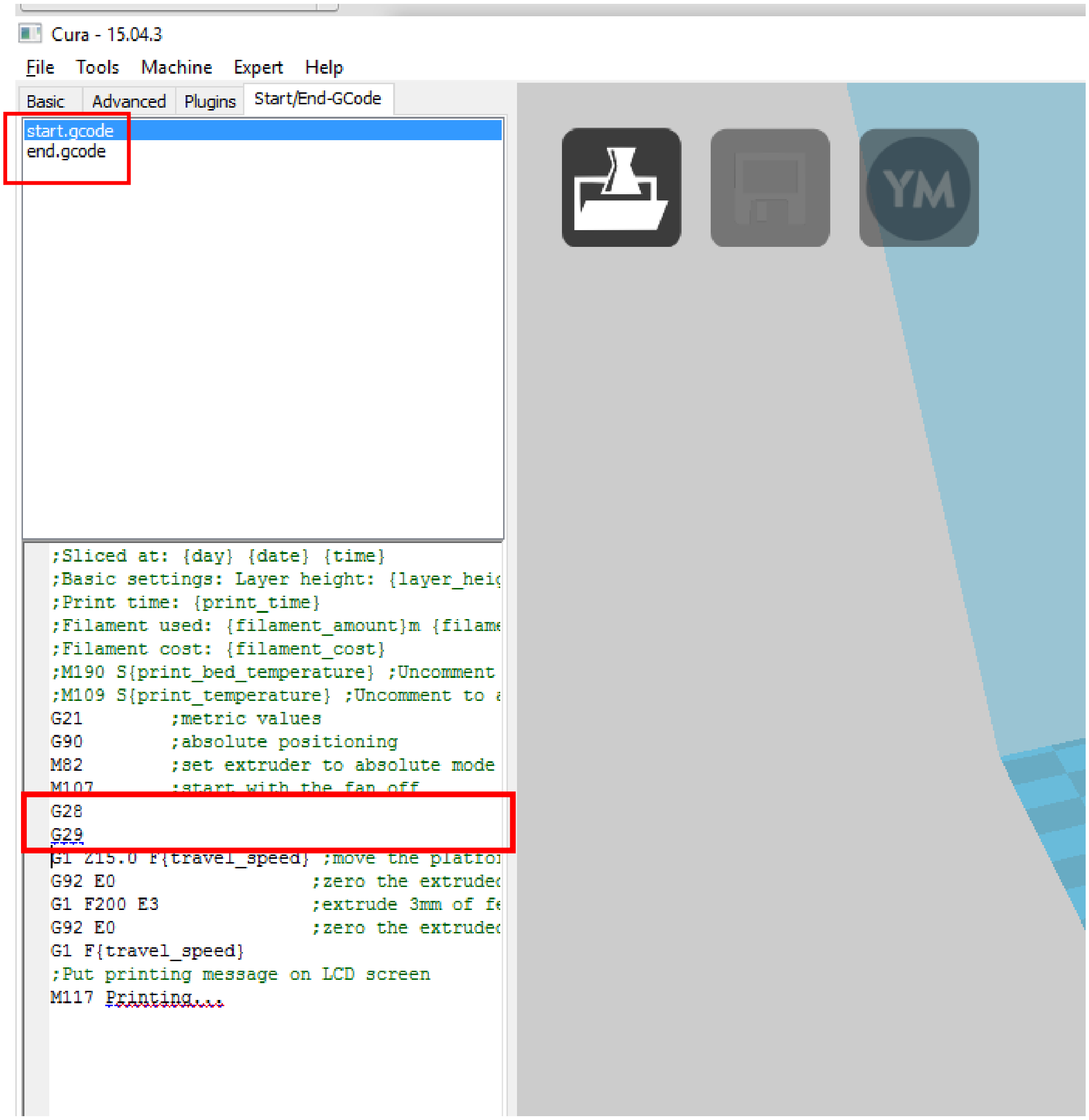
1) "#define ENABLE_LEVELING_FADE_HEIGHT" is enabled in Configuration_PROX.h. This is used by issuing the M-code command M420 Z<height>. If you are having vertical lines in your print due to mesh leveling correction this will help combat this. Using "M420 Z2 for a 2mm fade height, for a fairly leveled heat-bed, has shown good results.

2) You have to make sure to put the M420 Z<height> command BEFORE the home all (G28) and auto level (G29) commands.

13.3.5.1 Starting G-Code: S3D (Simplify3D)



13.3.5.2 Starting G-Code: Cura



13.3.6 ABL-Operation

Now try a print. Obviously this first time the nozzle will probably be too high since you started with a Z probe offset of 0 in the firmware under the "@section probes" section. There are a few ways to get this perfect. One way is by changing the number in the firmware, re uploading and trying again.

Another way is using the slicer programs which sometimes have Z offset setting. This is nice therefore you don't have to keep uploading firmware to find the perfect value.

13.3.6.1 Z-Offset: FW

In "**Configuration_PROX.h**" file, you should change:

"#define Z_PROBE_OFFSET_FROM_EXTRUDER **0**" to

"#define Z_PROBE_OFFSET_FROM_EXTRUDER **-0.5**", and then increase the negative number by -0.1mm i.e. -0.6, -0.7, etc. until you get your perfect 1st layer.

Please note
The Z-offsets in the FW are NEGATIVE.

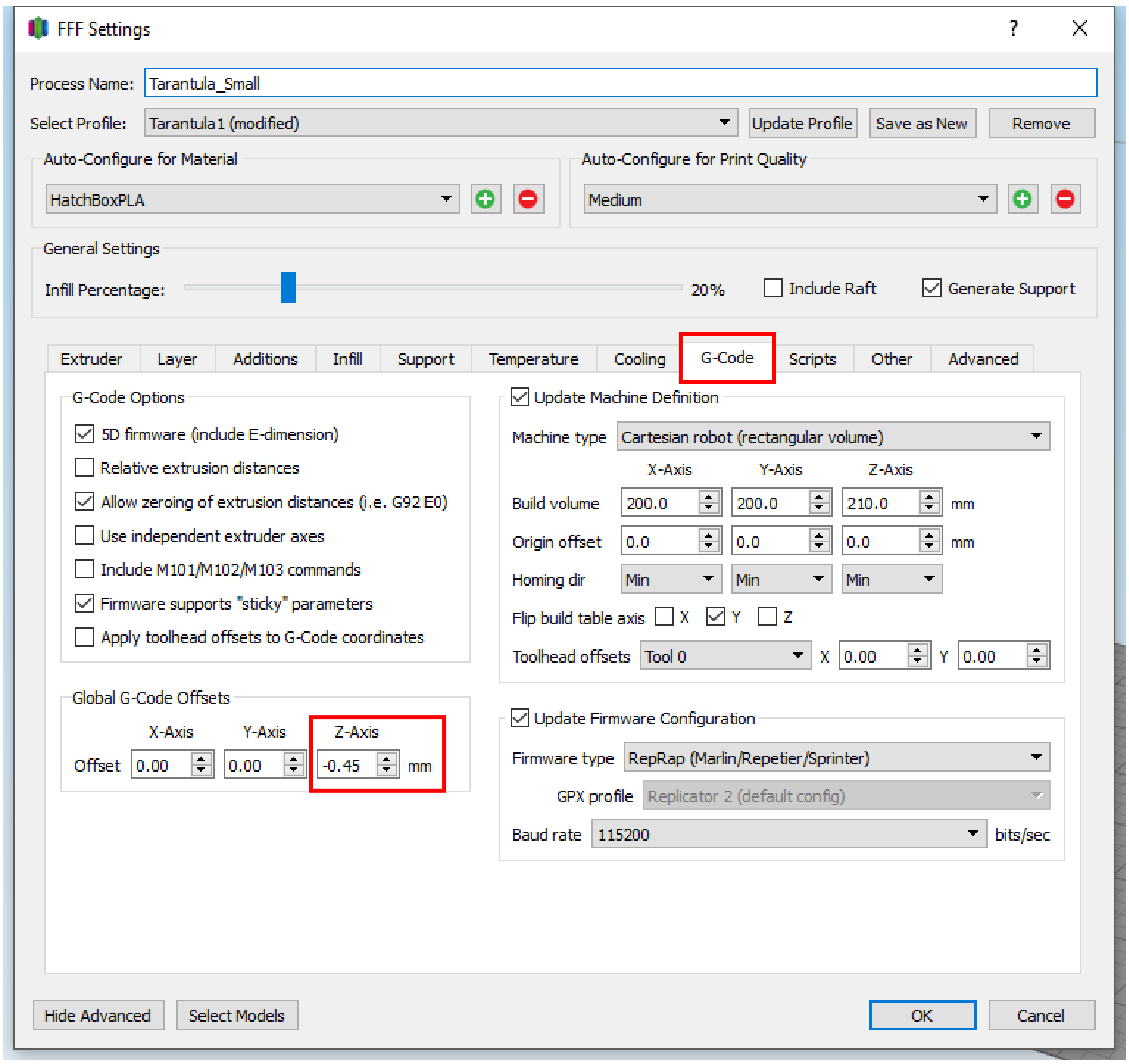
13.3.6.2 Z-Offset: S3D

You should start with a small negative value, e.g. -0.45 as shown in the following example, and then increase the negative number by -0.1mm i.e. -0.55, -0.65, etc. until you get your perfect 1st layer.

Please note

1) The Z-offsets in S3D are NEGATIVE.

2) It is recommended that after the final value have been found, this value should be written in the FW, and the slicer reset to zero. Small changes due to different bed temperatures for different filaments should be set via the slicer's menu, as you have done before.



13.3.6.3 Z-Offset: Cura

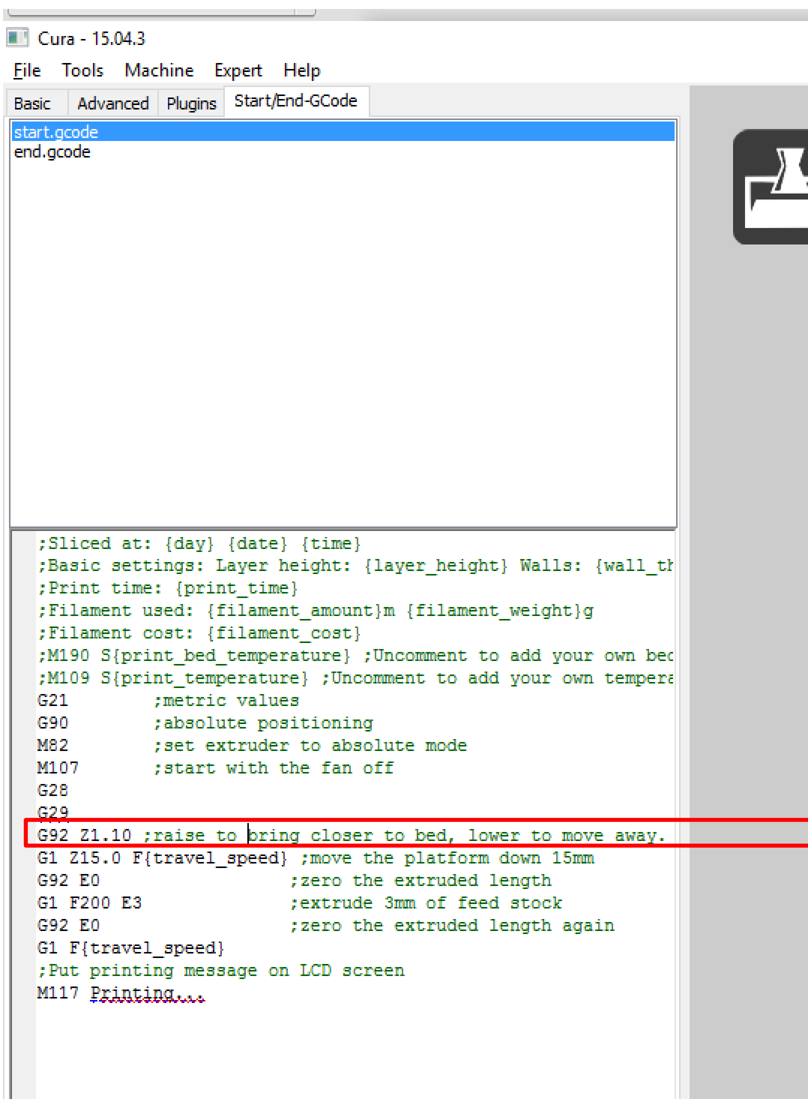
In Cura you can set the Z offset in the start G-Code section. This same idea should work for other slicers as well. The G92 is your offset command, therefore you can do something like G92 Z1.10, as shown in the following example, to create an offset of 1.1mm. Then increase the number by 0.1mm i.e. 1.20, 1.30, etc. until you get your perfect 1st layer.

Please note

1) You have to make sure to put the G92 Z<height> command AFTER the home all (G28) and auto level (G29) commands.

2) The Z-offsets in Cura are POSITIVE.

3) It is recommended that after the final value have been found, this value should be written in the FW, and the slicer reset to zero. Small changes due to different bed temperatures for different filaments should be set via the slicer's menu, as you have done before.



13.3.6.4 Repeatability Test

If you have enabled this feature in the FW, as explained in Section 13.3.4, The M-code for repeatability test is M48. The following command should perform 50 tests at X=100, Y=100 and do pseudo-random move of the head between each test:

M48 P50 X100 Y100 V2 E L2

If you want the test repeated 10 times at the center of the bed, and have some more information use the following short command:

M48 V3 E L2

Please note
V4 will give you the maximum information, however may clutter your screen.

The standard deviation of this test ("sigma") should be **BETTER THAN 0.03mm**.

If it doesn't, then the sensor isn't operating properly. Do the following in order to determine the root-cause:

1) If you are using an adjustable sensor type, try to increase/decrease the sensitivity, and repeat the test.

2) If you are using glass or other removable sheets over the heat-bed, remove them for the test, and repeat the test. If this helps, you need to use a higher detection range sensor.

3) If you are using the default end-stop connection, try using one of the two alternate connections, and repeat the test.

If all the above failed, and your standard deviation is still above 0.03mm, than your sensor is faulty.

Please note
The test should be done when the heat-bed and hot-end are at their nominal temperatures, e.g. for PLA: 60C for the heat-bed & 210C for the hot-end.

Please note
The test should be repeated after 24 hours. The "mean" parameter should be within 0.1 mm, otherwise your 1st layer would be laid wrong.

13.3.7 ABL-Conclusion

That's it. You should have all tools and knowledge you need to get going with the auto leveling feature of your Black Widow using the proximity sensor and the Marlin firmware.

Good luck and happy printing!