

Ender 5 Plus Upgrade to SKR 1.4 Turbo Board

An upgrade of the standard Creality board to the Big Tree Tech SKR 1.4 Turbo board, and change the display to the BTT TFT35 (3.5") E3 V3.0 display.

This upgrade was so we could replace the standard board (we suspect an issue on the board with the stepper driver for the extruder, and this is the second board already with the same problem!) and have quiet steppers that also supported some of the advanced features (such as Linear Advance).

This is quite an involved upgrade, but not too difficult, just take your time and go carefully. The biggest problem we had doing this was figuring out the changes in some of the connectors between Creality's connectors and the pins on the SKR 1.4 board.

This information is **NOT** a "how-to" or a guide, this is general information so that people who are looking to do these upgrades have some information specific to the Ender 5 Plus. We struggled to find such information for this printer using the SKR 1.4 boards and displays, so are happy to share our experiences.

Use this information at your own risk!! I highly recommend reading through this whole document before you start your upgrade!

Resources

Parts used:

- BTT SKR 1.4 Turbo board.
- BTT TMC2209 V1.2 drivers (you need 4 drivers for a standard Ender 5 Plus, we got 5 so we have a spare).
- BTT TFT35 E3 V3.0 LCD Display (you could also use the TFT35 V3.0 display, it is exactly the same except the shape of the LCD and position of the dial).
- Board mounting bracket printed beforehand (<https://www.thingiverse.com/thing:4251738>).
- Display mount printed beforehand (<https://github.com/bgdog1/3dPrinterCase> and <https://www.thingiverse.com/thing:4153419>).

We purchased from Amazon (to ensure shipping is safe and quick to South Africa).

Note:

- Mounting holes do not line up with original board in original case, thus you need an adapter plate.
- LCD does not fit in the original case, so you need a mounting (there are mounts for this display that attach to the original case).

Final Configuration:

- TMC2209 drivers in UART mode, with the diag pin cut, so not using sensor-less homing (i.e. using the standard end-stop switches).
- BL Touch (v3.1) fully working. **NB:** If you want to use sensor-less homing, this will not work on the Z-axis, please see the section below on the BL Touch.
- Display working in both “touch screen” mode and “marlin” mode (you can change between the modes at any time). There are some minor problems related to display firmware, with the version of firmware used at the time of this build.
- Using original case (for now) with mounting adapters etc.
- Using Cheetah 5 firmware (at the time version 1.3.4) for SKR 1.4 Turbo board. **NB:** This firmware does not work with the stock Ender 5 Plus display.
- Using BTT TFT35 V3 firmware for display (at the time version V3.0.25.3).
- Direct Drive Extruder (previously done mod) using the Micro Swiss direct drive and Micro Swiss hot-end (this requires some mechanical changes to fit it correctly which ends up with needing to invert the x-axis stepper direction in configurations).
- Hero-Me Gen 3 fan ducts replacement (Ender 3 variant due to the Micro Swiss direct drive upgrade as well, mod done previously).
- Awesomely quiet steppers now!!! – just need to do the fans next and then we’ll have a really quiet machine.
- We did encounter a problem I think is related to EMI noise on the cabling due to how they are routed, discussed later in this document along with how it was fixed in the Issues section.

Current Issues after Upgrade:

These are mostly firmware issues encountered on the versions at install time, which hopefully BTT or the community will fix in time, or I might give it a go when I have some time.

- Display dial does not select mode when changing between touch screen and marlin modes, you have to touch the screen on the option you want.
- The bed levelling option to select which corner (so you can do the manual adjustments for the corners), does not take the head to the correct positions!
- Dial knob LED colour not working properly (this is a known problem in the issues on their GitHub repository).

Manuals:

The manuals for the board and display can be found at:

- SKR 1.4 Boards (**NB:** for some strange reason they have put the 1.4 boards under the 1.3 boards repository, but in its own “BTT SKR 1.4”) folder: <https://github.com/bigtreetech/BIGTREETECH-SKR-V1.3>

- TFT35 V3 Display: <https://github.com/bigtreotech/BIGTREETECH-TFT35-V3.0>
- TFT35 E3 V3 Display: <https://github.com/bigtreotech/BTT-TFT35-E3-V3.0>
- BTT TMC2209 Driver: The instructions on what to do with the drivers is in the manual for the SKR 1.4 board, but for the advanced people if you need more information or the schematics then BTT does have a repository on GitHub with that information.

The BTT repositories do have extensive information, including the board pinouts and other information. Sometimes the information is not quite that clear (maybe translation issues) but overall, the needed information is there.

Firmware:

You need to be comfortable with downloading, changing and compiling the board firmware! However, we used the Cheetah 5 firmware, which has a really good walkthrough on how to do this and they have made it really easy to setup your printer in the configuration with specific instructions on what to do where. They also have good support available. So overall this is fairly easy using the Cheetah 5 firmware and if you're not familiar with the firmware compiling process, you'll learn the basics quite easily by following their instructions.

The display is fairly easy to update using the SD card, and BTT provides the relevant files with instructions on their GitHub site.

- Cheetah 5 website: <https://kay3d.com/pages/kay3d-cheetah-5-firmware>
- BTT TFT35 GitHub for display (NB: The firmware for both the standard TFT35 V3 and TVT35 E3 V3 is the same): <https://github.com/bigtreotech/BIGTREETECH-TouchScreenFirmware>

See the "Firmware Configuration" section later in this document regarding changes done in the firmware for the board, for the Ender 5 Plus.

Installation

SKR 1.4 Turbo Board and TMC2209 Drivers:

- Install the heatsinks on the drivers (if not already done).
- Configure the board jumpers for the drivers. We used UART mode. The instructions for this are in the SKR 1.4 manual (section IV, point 3.2).
- Configure your drivers as per the manual, as we wanted to use the original end-stop switches and not use sensor-less homing, this meant cutting the diag pin on the drivers.
- Install the drivers into the board, be careful and ensure you have the correct orientation.
- You only need drivers for the first 4 slots (X, Y, Z axis's and E Extruder), from the left with the stepper connectors at the top (so as it is shown in the manual). If you have an additional extruder, then you will also need the 5th driver for E1.

Wiring Connections:

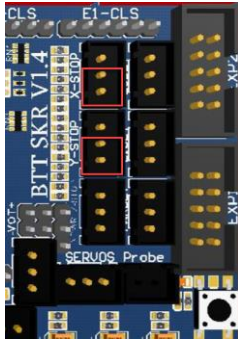
I highly recommend that you change the cables from the original board to the new board one-by-one so that you do not make any mistakes. If all your cables are clearly marked (which is not really the case with the original stock printer) then should have no problem.

We unplugged everything from the cables on the outside of the power supply/main board case so we could work with the inside more easily (by putting it on a different table upside down). Check your cables are marked, if not then mark which cable goes where!

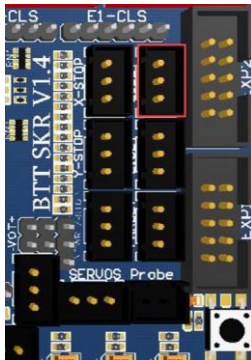
You can remove the display and its cable from the main board to start with, so you have space. You can also install the display mount holding part in the hole where the display was.

- The SKR 1.4 board connections are displayed in the manual in section IV, point 2.
- However, we also used the SKR 1.4 PIN manual (in the GitHub repository), as this actually shows the connectors properly along with which is positive and negative for the cables!
- Leave the BL Touch until last (see section below), but you can unplug it from the original board so it is out of the way (the cables are clearly colour coded).
- POWER goes to DCIN (DC 24v Power), they are even in the same location on both boards. **NB:** Make sure you have positive (red) and negative (black) correct!!!
- HOT BED goes to BED (Bed Heater power). **NB:** Make sure you have positive and negative the correct way around, On the SKR 1.4 board for some reason they are the opposite way around to the other connectors!
- HEATER0 goes to HE0 (Hot End Power), check which one you take out of negative(-) to put in negative and which one you took out of positive(+) to put in positive (on our printer, both cables were red).
- TB goes to TB (Thermistor for the bed).
- TH1 goes to TH0 (Thermistor for the Hot End).
- FAN (for the part cooling fan – which on ours is a yellow and blue cable) goes to FAN0. **NB:** On the SKR 1.4 Board FAN0 is the PWM fan, which means it is speed adjustable, the other fan connectors are just always on!
- The two remaining fans, one for the hot end and one for the case can go to FAN1 and FAN3 (or FAN2 depending on your wiring layout).
- The stepper motors all go to the relative positions (be careful as on ours the end stop switches connectors for X and Y is part of the same cable). X goes to XM, Y goes YM, the 2 Z steppers (Z0 and Z1 – which are vertically inline on the original Creality board) go to ZMA and ZMB. E0 goes to E0M.
- The end-stops are a little tricky! They go to the relative places, but on the Creality the cables have a 2-pin connector and on the SKR 1.4 board the connectors are for a 3-pin cable! The end-stop cables go to the bottom 2 pins on the board, so this means you have to shave/cut-off one of the guide tabs on the cable connector so it fits into the board connector properly.

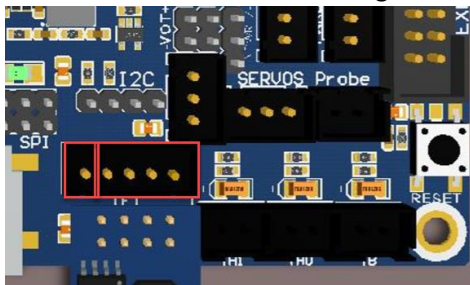
X stop goes to X-STOP, y stop goes to Y-STOP.



- The filament run-out sensor (which on our printer is a red, black and yellow cable) has a 3-pin connector and simply plugs into the E0DET connector (next to the X-STOP).



- The cables for the BTT TFT35 V3 display are fairly straight forward. The two ribbon cables go from EXP1 to EXP1 and EXP2 to EXP2. The other cable is the serial cable and this goes from TFT (using the 4-pin with 1-pin sperate connectors) on the board to RS232 on the display (with the notched connector end). However, the single loose sperate pin goes on the LEFT on the board (this is the RESET Pin). Be careful when putting the cable into the connector on the board, as it is not a notched connector and can go in either way around. Make sure the end with the single loose connector is on the left.



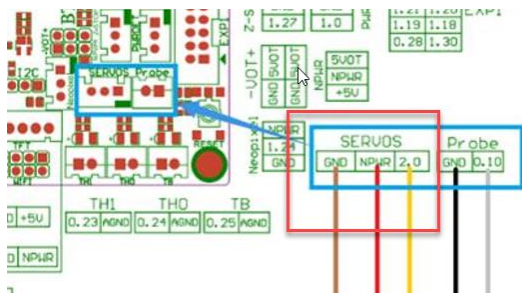
- You can now mount the board, or finish the BL Touch cables (next section) and then mount the board, which ever is easier for you.

BL Touch:

The Ender 5 Plus has a BL Touch v3.1 (well ours did) which is great, but needs some changes to work on the SKR 1.4 Turbo board (and probably the same for the normal SKR 1.4 board as the pinouts are the same).

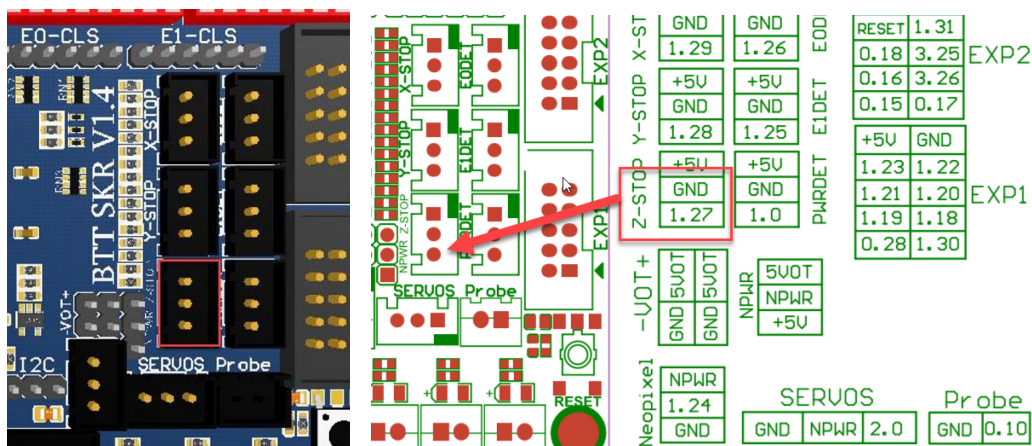
The connectors are not correct so need to be adjusted. The BL Touch has 2 connectors, one with 3 wires (brown, red, yellow/orange) and one with 2 wires (black, white).

The SKR 1.4 manual has the correct order for which wires need to go to which pins. On our BL Touch we had to swap the brown and red wires as on the 3-pin connector they were not correct to match the connector for the board. So, check yours and make sure it matches what is in the manual (highlighted in the red box below).



Once you have done this you can plug the 3-pin connector in on the board as per the manual (section IV, point 4).

However, we found that most firmware currently has some problems using the dedicated probe connector on the board for the BL Touch, so we used the Z-STOP connection on the board for the probe black and white cable. There is another problem in that the Z-STOP connector on the board is a 3-pin, and the cable is a 2-pin, so you have to shave/cut-off that one tab so that the cable plug goes into the board connection. BUT we discovered that looking at the pinout that the cables are the wrong way around!! So, you have to also swap the two cables around. In other words, the black cable must go to the middle pin on the Z-STOP and the white cable to the bottom pin on the Z-STOP!



NB: This will NOT work if you are using sensor-less homing!! So, you will need to research how to make that work, or make sure you cut the diag pin on the driver for the Z axis.

Finally

You should have no more cables on the original board, and everything should be plugged in to the new SKR board. Double check everything and mount the board if you have not done so yet.

Firmware Installation

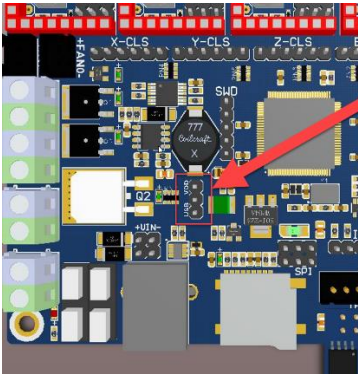
I am not going to detail the steps here, you will need to follow the relevant instructions for the board and display (links provided in first section above), these are just some notes.

Installing Firmware

The installation for both board and display is fairly straight forward. You simply copy the required files to a SD Card (Micro SD for the board, ours came with one), plug it in and then power on.

What I did once everything was plugged in to the board, was to not plug all the motors etc. in, but with the case open, and display connected to the board, I used the laptop (or computer) USB to power on the board.

To do this, you need to change the jumper on the board for power, to the USB power mode (by default it should be on VDD). This is in section II in the manual.



Then you simply plug the provided USB cable in to the board and laptop/computer and it should all power on (including the display). Wait a few moments and the “printer not ready” message should go away on the display.

If this is all working, then you can apply the display firmware (if you want to update it) by putting in the SD Card with the correct files on it (as per instructions from the BTT GitHub page) in to the display SD Card slot, and resetting it (or remove the USB to your laptop/computer and plug in again). The display firmware does take some time, but does display the progress on the display.

I then repeated, but with the MicroSD on the board and applied the Cheetah 5 firmware for the board. Note: The update is quite quick so you don’t really notice it has updated, but you will see the Cheetah 5 logo come up on the display once the board starts up. When it shows the menu, then the “printer not ready” message should go away quite quickly.

NB: After updating the firmware on the board, you should perform the “Initialize EEPROM” option (it is in the menus on the display). Sometimes you will see a message on the display about an “Err: EEPROM Ver”, this will fix that message as well.

At this point you are ready to re-assemble your printer and plug in everything.

NB: Once you have removed the USB cable to your laptop/computer, change the jumper on the board back to VDD for the power options!!

Display Firmware

This is straight forward and I just used the files provided.

There are some minor issues, and I’ll keep an eye on the BTT GitHub to see when they are fixed and then update the display firmware accordingly.

SKR 1.4 Turbo Board Firmware – Using Cheetah 5

I really like the Cheetah 5 firmware; they have put in a lot of work on it and it has some nice features. They also have good support. It is also very easy to setup.

Here are some notes for changes I did during the setup:

- In the `printer_def.h` file:
 - o I changed their bed sizes for the Ender 5 Plus section back to the standard size of 350 x 350 (`X_BED_SIZE` and `Y_BED_SIZE`).
 - o I changed my `INVERT_X_DIR` to false – this is because our printer has a direct drive mod that inverts the X-axis direction, so this should not be needed unless you have done a similar mod.
- In the `Configuration.h` file:
 - o Follow the setup steps as documented in their instructions for your printer setup! Below are some notes for some items.
 - o Use the `REPRAP_DISCOUNT_FULL_GRAPHIC_SMART_CONTROLLER` option if you are using the TFT35 V3 display, it seems to work well and works in both touch screen and marlin modes.
 - o Enable `Auto_bed_level`
 - o Enable both `BLTOUCH_v3_v3_1` and `BLTOUCH`
 - o I'm using `Herome_fanduct_40105015` as we have that mod installed.
 - o Enable `FILAMENT_RUNOUT_SENSOR`
 - o I changed `HEATER_0_MAXTEMP` to 300, because that's what we prefer.
- In the `Configuration_adv.h` file:
 - o I enabled `EMERGENCY_PARSER` as the display was complaining it was off.

Then compile and apply to the board!

I have done some more minor changes since and will probably continue to tweak the printer as we go along. I have my config on GitHub which can be found here: https://github.com/cyberaxcess/Cheetah5/tree/E5PLUS_SKR14_TURBO if you would like to see how I run the board. However, be careful as we have mods installed so it will probably not work on your printer, especially as the X-Axis is inverted in my config!!

My changes are in the `E5PLUS_SKR14_TURBO` branch of the repository.

Issues:

Homing Problem, suspect related to EMI Noise

We had an issue initially where the printer would not home properly. It would start the process and then stop as if the Y-Axis end-stop was triggered. It would happen when the head was at random places and we switched on the printer and then performed the homing function. It seemed to happen more when the Y had a longer way to travel (i.e. in the front half of the bed). After a lot of head scratching and working with the Cheetah 5 support (and using one of their community member's config who has the same setup), I did manage to solve it.

What I did was to get the Tiny Machines (InsanityAutomation repository using the CrealityDwin_2.0 branch on GitHub) firmware working, but didn't like how the BL Touch was behaving. I then got the BTT firmware (from their GitHub repository) configured and working on the printer, with everything working as expected. So, I then worked my way through the code and compared the default Marlin BTT code configuration to the Cheetah 5 configurations. I eventually discovered an option that was enabled in the Tiny Machines code and the BTT code, but disabled in the Cheetah 5 code.

I enabled this option in Cheetah 5, tested on the printer and homing then behaved as expected!! So, problem solved, or is it...

The option is to enable: `#define ENDSTOP_NOISE_THRESHOLD 2`

This is related to EMI noise and is a software filter for it. I thus suspect that somehow the Y-Axis end stop is falsely triggering when it shouldn't, and this could possibly be due to the way the cables are running (as they run right past the power supply) in the case. This is how they run originally as provided by Creality.

I will revisit this setting when we have changed the case (future planned mod) and can re-run the cables a bit better and away from the power supply.

If you have this same problem, then enable this setting, otherwise leave it off. The Marlin page does not recommend using this setting unless you have to!