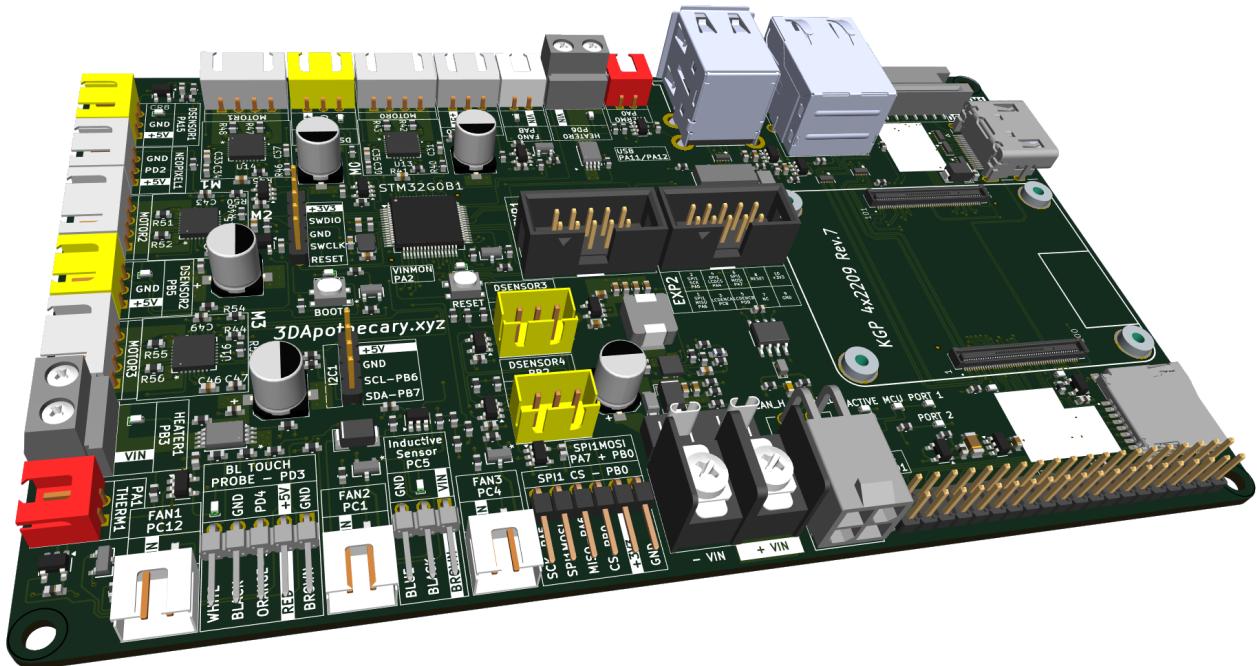


KGP 4x2209 User Manual



The KGP 4x2209 is a Klipper focused, feature rich, cost effective, easy to use 3D printer main controller board for beginners and experts

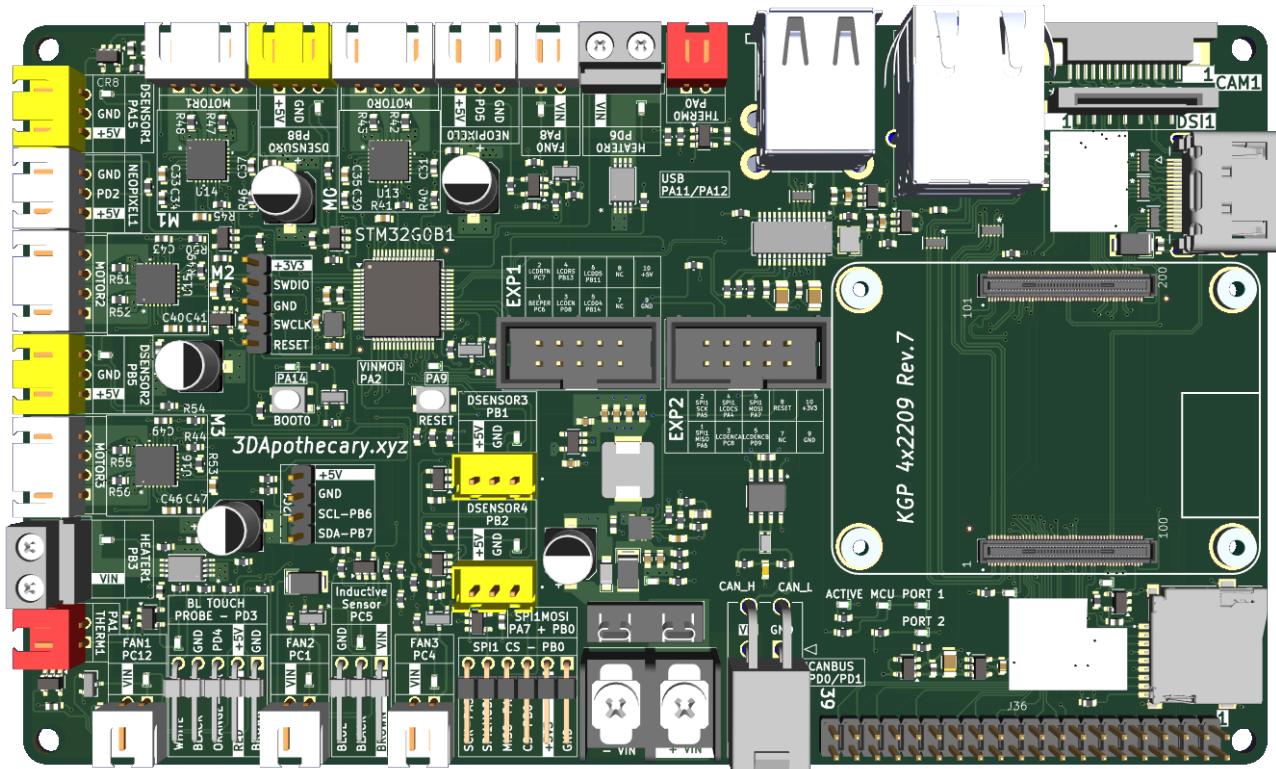
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The KGP 4x2209

The KGP 4x2209 was designed for 3D printers requiring four stepper motors with the option of adding a CAN Bus device to a 3D printer. The board is fast to set up, using a Raspberry Pi CM4, or equivalent form factor, Single Board Computer (SBC) to provide a complete Klipper 3D printer solution.



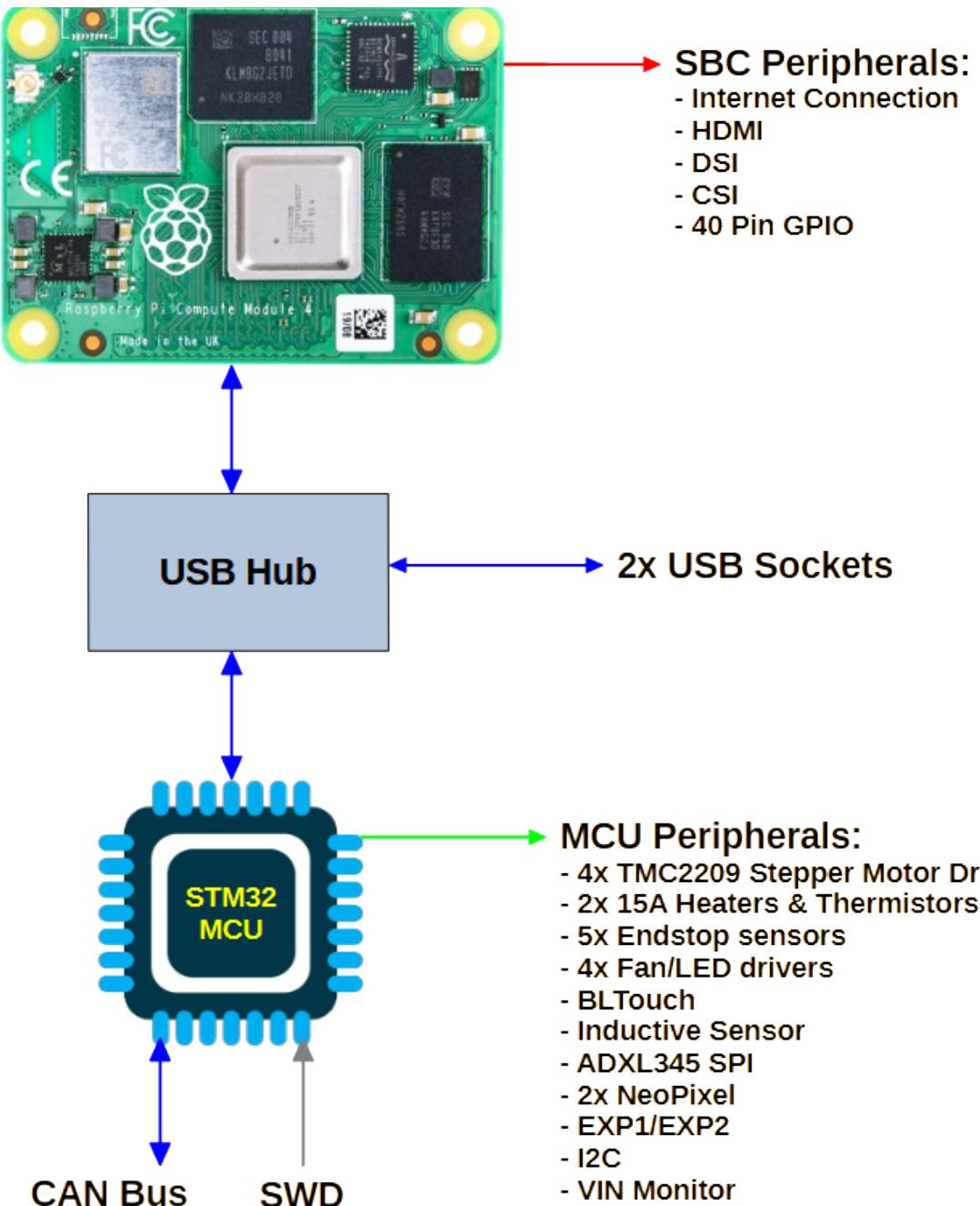
The philosophy behind the was to make 3D Printer wiring, configuration and operation as fast and intuitive as possible. Connectors are color coded as well as having pinout information on the PCB's silkscreen. Multiple indicator LEDs makes set up and testing of a 3D printer as painless as possible. There are no jumpers on the KGP 4x2209 for setting different operating options. All these features minimizes the opportunities for error and makes configuring the KGP 4x2209 trouble free.

Orthogonality

The KGP 4x2209 was designed to take advantage of Klipper's flexibility in selection of devices for use in a 3D Printer. This means, that unlike most other main controller boards for 3D printers, the KGP 4x2209 does not have predefined functions for different features (like specifying that a specific stepper motor driver is for the X axis). This allows greater flexibility in deciding how to best incorporate the KGP 4x2209 in a 3D printer as well as optimize wiring according to the situation.

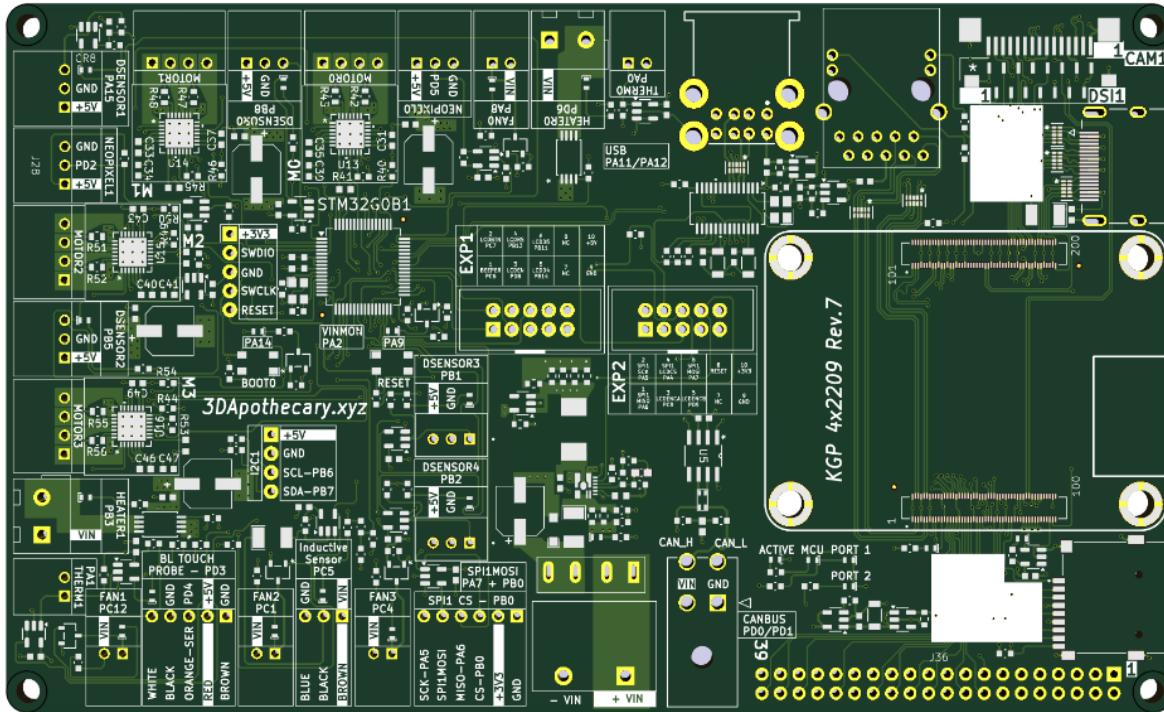
System Overview & Feature Set

The KGP 4x2209 consists of two processors connected through USB. This USB connection is from the two 100 pin connectors the CM4 form factor SBC is plugged into. The connection allows the SBC to act as the Klipper "Host" which uses USB to communicate with the KGP 4x2209's MCU that provides interfaces to standard 3D printer peripherals as shown in the diagram below.



Board Pinout

All the topside connectors on the KGP 4x2209 have their functions and connector numbers along with pinouts printed on the silkscreen with the exception of the stepper motor driver connectors.



MOTOR0
EN-PC9
DIR-PA10
STEP-PB15
DIAG-PB4
UART-PC15

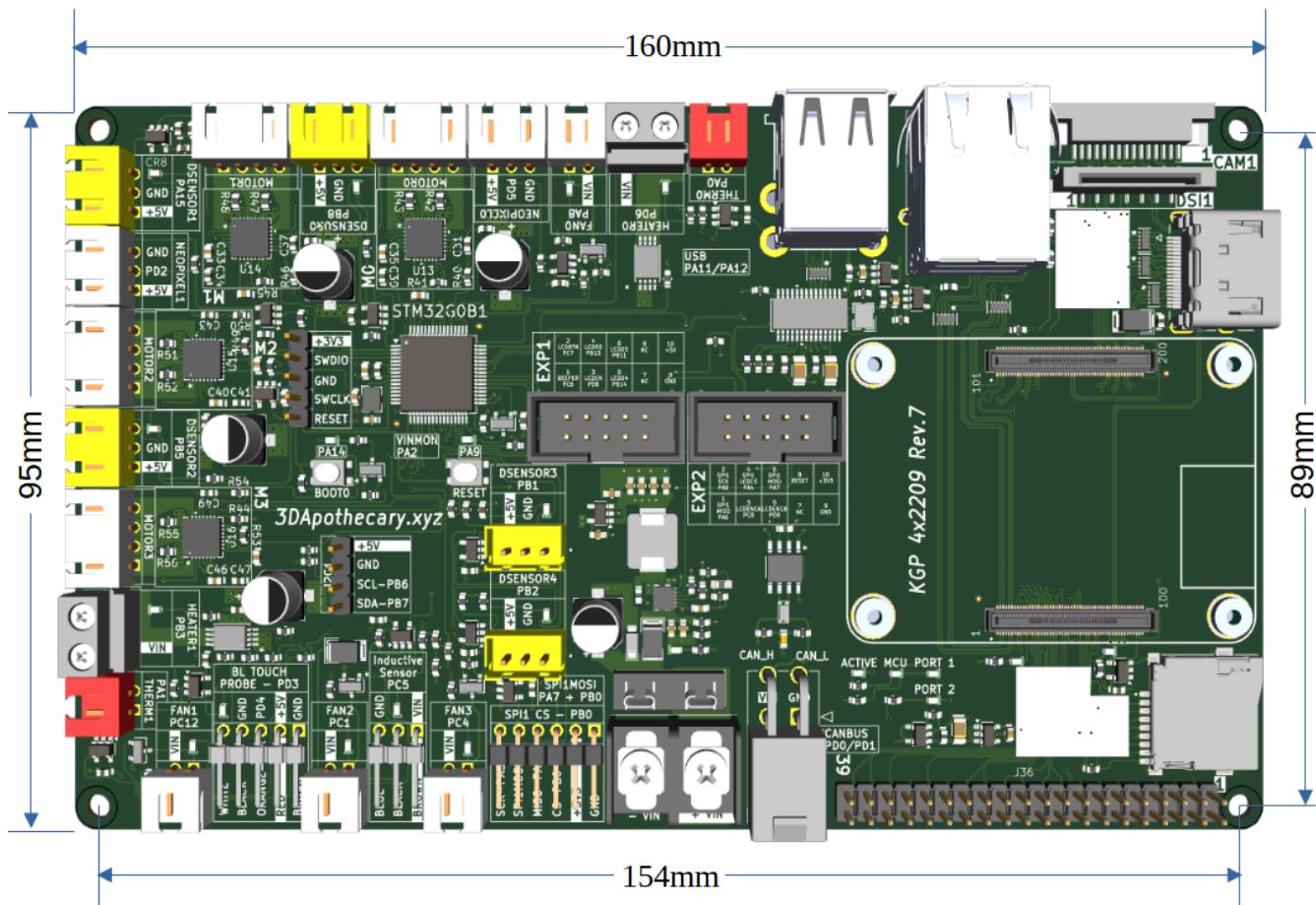
MOTOR1
EN-PB9
DIR-PC11
STEP-PC10
DIAG-PC13
UART-PC15

MOTOR2
EN-PC14
DIR-PA13
STEP-PA3
DIAG-PC0
UART-PC15

While the stepper motor connectors are labelled on the topside silkscreen, the MCU pin connections are printed on the backside silkscreen.

The interface and connector specifications with pinout information are presented in more detail in SBC Peripherals.

Board Dimensions



Adherence to 3D Printer Standards

3D Printers, like many other electronic products, has evolved a set of standards when it comes to connectors, logic levels and communications protocols. These standards range from hard, established standards (USB for example) to de facto ones covering many similar devices (for example, endstop sensors) to manufacturer specific connections and interfaces (like the Antclabs BLTouch).

The KGP 4x2209 was designed to follow the established 3D printer electronics standards as much as possible. The board has been tested with a wide variety of different devices (many of which are noted in this document). At a high level, the KGP 4x2209 follows these standard rules:

- Published standards are followed explicitly
- 5V logic levels are the default used for digital input/output
- Header pin spacing is 0.1" (2.54mm)
- Shrouded connectors follow established product conventions for part form factor and pinouts
- Specific hardware device interfaces use the logic levels and pinouts required by the specific device

Due to the plethora of products that are designed for use in 3D printers, it is expected that some devices will not follow the standards and expectations used in the development of the KGP 4x2209. Support is available through the noted internet communities as well as through the 3DApothecary.xyz GitHub page but it is impossible to guarantee that all devices will work with the KGP 42209 without hardware and/or software modification.

SSH Terminal Commands

Commands to be input into the Direct Console Interface or through the SSH Terminal will be in:

MonoSpace with border

Critical, Warning and Note

In this document, important information is highlighted by the use of the following prefix words:

CRITICAL: Actions will result to damage to the KGP 4x2209 or other hardware

WARNING: Actions may result in problems with hardware, OS & Klipper, Printer Operation

NOTE: Information for the user for better operation or to avoid pitfalls later

Operating Conditions

Parameter	Conditions/Comments	Value	Units
Operating Input Voltage (VIN)	NOTE: 24V Recommended for best quality stepper driver waveforms	12 - 24	Volts(V)
Maximum VIN	CRITICAL: Exceeding this value will damage the power management system and stepper motor drivers	28	V
Minimum VIN	NOTE: Stepper driver waveforms will be severely degraded at less than 12V resulting in noisy, uneven operation	6	V
Quiescent Current	KGP 4x2209 with Raspberry Pi CM4	0.12	Amps(A)
Maximum Recommended Device 5V Current Draw	WARNING: The 5V supply powers the SBC, the MCU and various peripheral devices. The total current drawn by additional devices, including displays, cameras and LEDs, must not exceed the value given here else the +5V power supply will shut down	3	Amps(A)
Expected, Nominal Input Current	Assumed system configuration: <ul style="list-style-type: none"> Raspberry Pi CM4 with DSI Display Heated bed Extruder 4x Stepper motors 3x Endstop Sensors 4x Fans 	15	A
Absolute Maximum Input Current	Same configuration as above but with additional peripherals including: <ul style="list-style-type: none"> CAN Bus toolhead controller with extruder heater and stepper motor driver Multiple LED strips for printer lighting NeoPixel strings CRITICAL: Exceeding this will result in damage to the PCB	20	A
Minimum Internally Measured Operating Temperature	As measured by MCU and SBC. Limited by power management system Component surface and ambient air temperature may be different	15	Celcius(C)
Maximum Internally Measured Operating Temperature	As measured by MCU and SBC. MCU temperature affected by stepper motor drivers Component surface and ambient air temperature may be different	65	Celcius(C)

Functional Test

Each KGP 4x2209 is rigorously tested to ensure that it will work to specifications.

The functional test (detailed here <https://github.com/3dApothecary-xyz/FunctionalTest/tree/main>) carries out various tests of the active hardware built into the KGP 4x2209 including:

- SBC and Micro SD Card connectors
- SBC 40 pin header
- Ethernet RJ45 operation
- USB subsystem and USB A sockets
- HDMI operation
- MCU clocking and Flash programming/updating
- SWD header
- CAN Bus interface
- Heater drivers and thermistor interfaces
- VIN monitor
- TMC2209 stepper motor driver operation including communications and sensorless homing
- Endstop sensors
- Fan drivers
- NeoPixel interfaces
- BLTouch interface
- ADXL345/SPI interface
- Inductive sensor interface

During the testing, the KGP 4x2209's power management system current loads is varied.

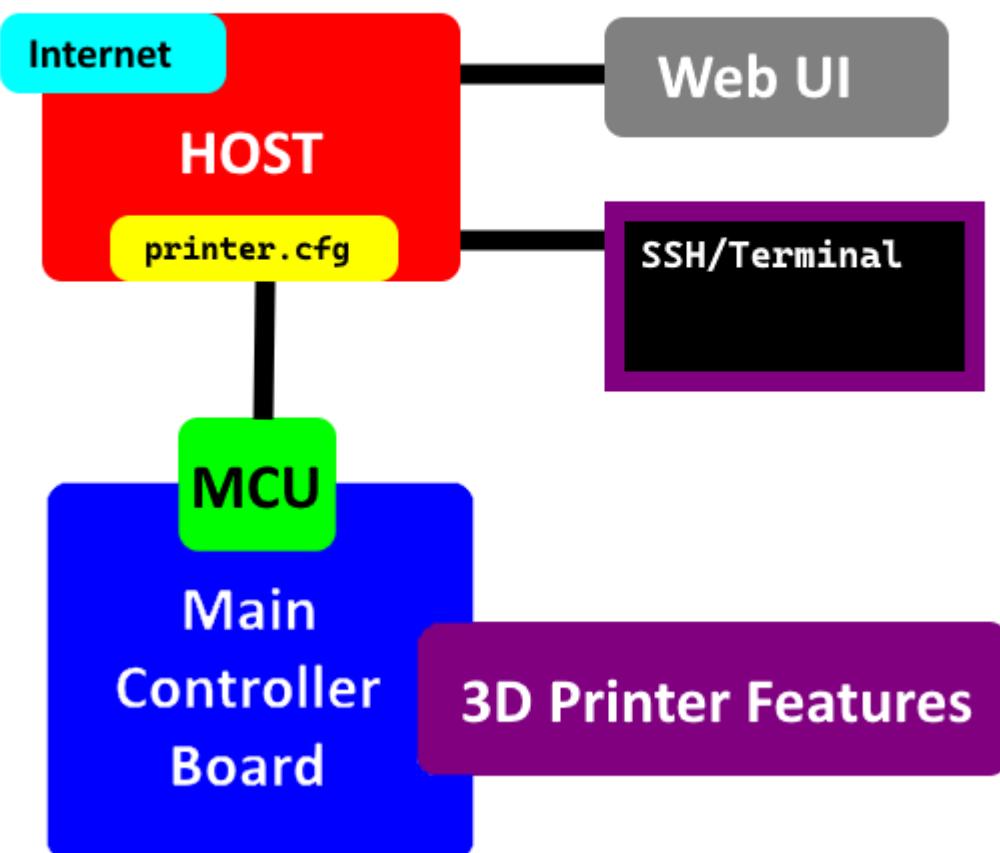
NOTE: Katapult is loaded into the KGP 4x2209's MCU and is used to load test firmware .bin files using the processes presented in "Manually Flushing Firmware & Making the Host-MCU Connection". When the test is complete, the KGP 4x2209 MCU's Flash memory above Katapult is erased, ensuring that Katapult will be active for first user power up.

Klipper Introduction

Klipper is an open source software suite that manages 3D printer operation and provides user interface(s) to allow control over the 3D printing process. While Klipper itself is quite complex, with many different options, it is well organized, fast and powerful. The software itself is easy to use with excellent on line support from a committed user base. The KGP 4x2209 was created to make the Klipper and, by extension, the 3D printing process easier and more efficient.

At a high level, Klipper can be drawn as:

Klipper Block Diagram



The “Host” is a Debian Based Linux system with the Raspberry Pi and similar devices being the most popular choices for this function. This document will refer to the software executing on the Host as

“Klipper” but it really consists of several interlinked applications that will be discussed briefly in this document. The first important aspect to note is that Klipper is Internet connected. This results in simple and intuitive 3D printer operation, including G-Code files without having to take SD Cards or USB Thumb drives to the printer as well as the ability to access the printer remotely.

The second aspect of the Host block in the diagram above to note is the “printer.cfg” which is a file which defines the method of communicating with the main controller board as well as how the different 3D printer features built into it are configured for use as a 3D printer. Unlike older approaches to 3D printer software, the printer.cfg allows easy changing and updating of the printer configuration without having to rebuild the firmware in the “Main Controller Board”.

For loading Klipper and some configuration work, a command line interface (the host “SSH/Terminal” block in the diagram above) is used. This interface can be an HDMI monitor and USB keyboard, a Raspberry Pi DSI touch screen LCD display or an SSH terminal window on a remote PC.

The Main Controller Board has an “MCU” which is loaded with Klipper firmware and communicates with the Host. The communications media can be either is USB or “UART”. Communications between the Host and the MCU have to be consistent and of good quality. As well as communicating with the Host, the MCU controls and monitors the 3D printer features.

Marlin

As noted throughout this document, the KGP 4x2209 was designed for specifically for Klipper. There is no plan for creating Marlin firmware images at this time but if any become available, they will be downloadable from the KGP 4x2209’s GitHub page.

NOTE: There are two hardware features that are typically found in 3D printer main controller boards that are not present on the KGP 4x2209: EEPROM and an MCU SD card socket. Currently, Marlin does not enable the EEPROM for storing printer settings by default. The MCU SD card socket is used for loading and storing model G-Code files which means that if Marlin, or any other 3D printer firmware that requires SD Card G-Code storage, will have to run Octoprint as a printer controller for loading G-Code files.

KGP 4x2209 Setup

The KGP 4x2209 setup is simpler with fewer options that can complicate and introduce errors compared to other 3D printer main controller boards. This is due to four factors, the first being the elimination of all switches and user programmable jumpers. The second is avoiding labelling interfaces to be used for specific functions in the 3D printer (like "Stepper X" for a specific driver) which takes advantage of Klipper's ability to configure the system to the user's needs. The third is a rigid philosophy of understanding the requirements of 3D printers running Klipper and working to optimize the functionality required. The final factor is the labelling of connector pins and providing status LEDs to minimize the need for referencing documentation during the setup, configuring and debugging a 3D printer application. These four factors are implicit in the following instructions and serve to make setting up a KGP 4x2209 main controller board in a 3D printer fast, intuitive and problem free.

The KGP 4x2209 setup process consists of:

1. Determining how the KGP 4x2209 and its host will communicate with the Internet
2. Imaging the Operating System for the SBC Micro SD Card
3. Attaching the SBC to the KGP 4x2209 along with the Operating System Micro SD Card
4. Connecting power to the KGP 4x2209
5. Accessing the SBC
6. Loading Klipper Software
7. Flashing the KGP 4x2209's MCU
8. Loading the Klipper printer.cfg file and establishing a connection between the SBC and the KGP 4x2209's MCU
9. Installing the KGP 4x2209 into the 3D printer
10. Finalizing 3D printer wiring to the KGP 4x2209 and verifying that things are working correctly

Internet Connections

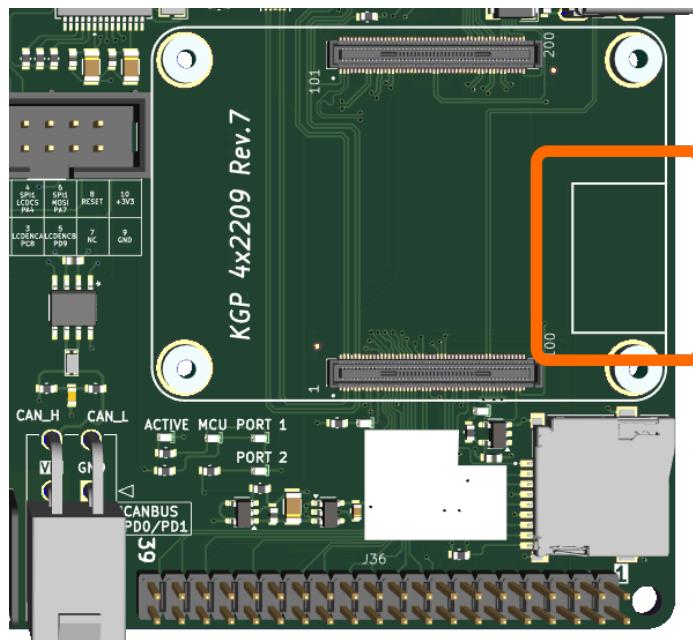
An internet connection is absolutely required for use with the KGP 4x2209. It is required for loading Klipper software as well as providing an interface to the web based 3D printer control panel. There are three methods for connecting the KGP 4x2209 and its host to the Internet and the selection of which method to use will influence where the KGP 4x2209 is located within the 3D printer.

- A direct Ethernet connection using the RJ45 connector built into the KGP 4x2209. This is a 1Gbs connection and is the most reliable way of connecting the 3D printer to the Internet.
- All CM4 form factor SBCs with WiFi capability have an SMA connector for an external WiFi antenna like:



The connector location is specific to different SBCs and can be found in the SBC's documentation. The style of WiFi antenna shown in the photograph above requires that a hole be drilled in the 3D printer's case.

- Some SBCs, like the Raspberry Pi CM4/CM5 have a built in WiFi Antenna that can be used if the KGP 4x2209 is mounted outside the printer or if the printer has a non-metal case. The CM4/CM5 require that the mounting PCB has no metal in the antenna's area and this portion of the KGP 4x2209 has no traces or metal voltage planes in this area:

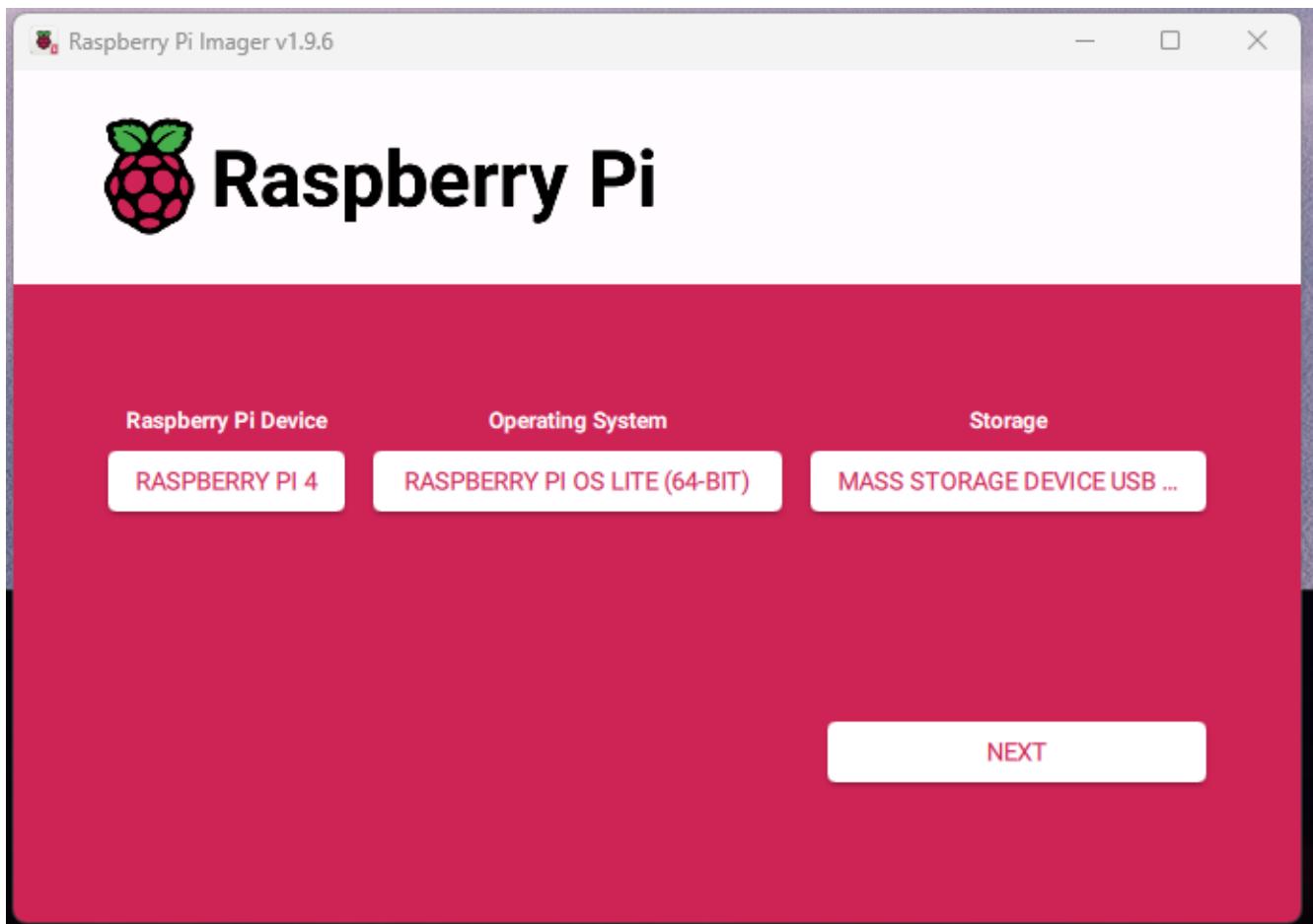


NOTE: If using the internal antenna of the SBC, there can be no metal case or structural elements near the marked keep out area and the 3D printer's case should be a non-metallic material.

Raspberry Pi CM4/CM5 Micro SD Card Imaging

Imaging an SD Card for a Raspberry Pi CM4/CM5 is very straightforward with all the configuration options taking place in the “Raspberry Pi Imager” application which works on Windows, Mac and Linux systems. The link for downloading Raspberry Pi Imager can be found in “Useful Links” at the end of this document.

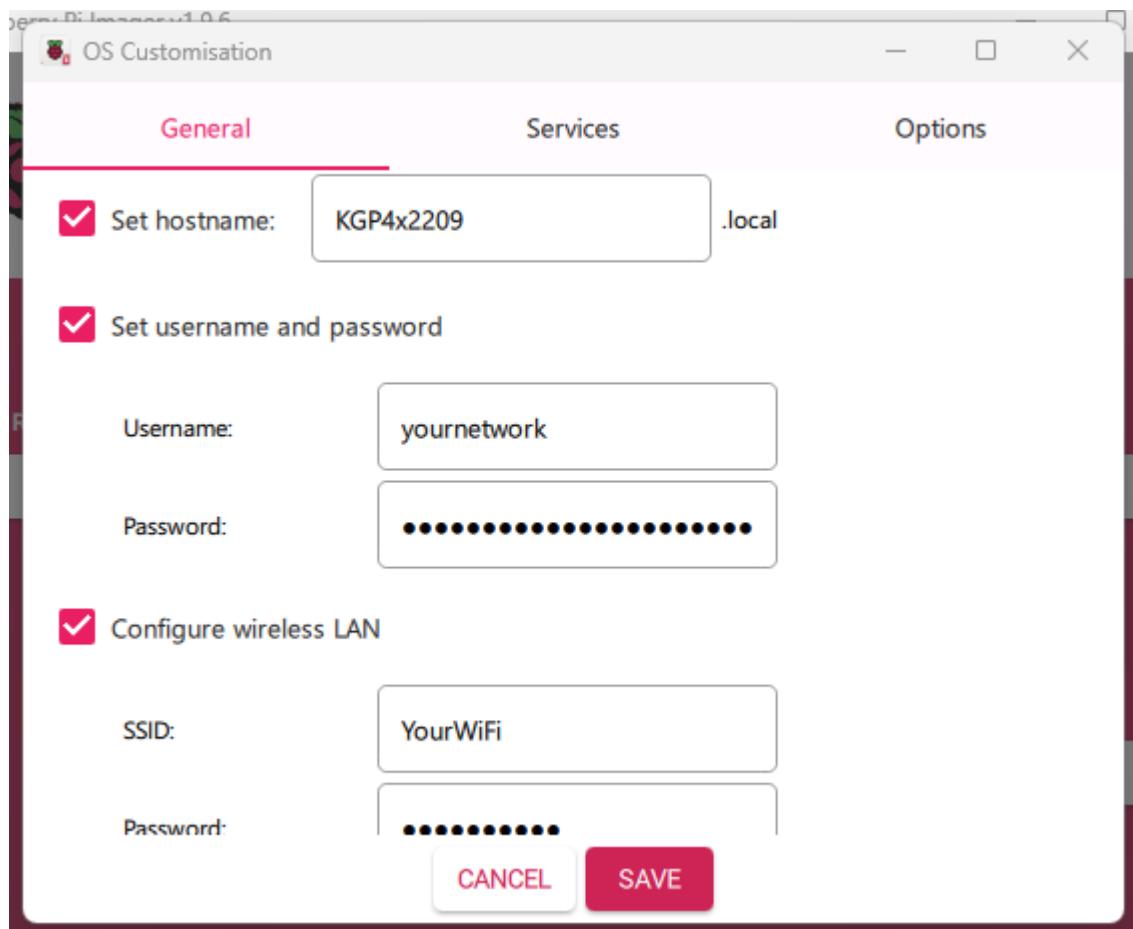
With Raspberry Pi Imager installed, started up with an SD Card inserted in the computer, select the SBC “device” to be used followed by the Operating System and the SD Card as shown in the screenshot below.



For this example, a “Raspberry Pi 4” was selected as the Raspberry Pi CM4 is part of this family (the Raspberry Pi CM5 is part of the “Raspberry Pi 5” family of devices). The “LITE” version of the 64bit Raspberry Pi was selected as this provides the full operating system but does not include the main GUI, which is not required for 3D printer or Klipper operation.

NOTE: There are Raspberry Pi OS images available on Raspberry Pi Imager which incorporate Klipper, seemingly eliminating the need to carry out the loading steps presented below. While these images can be used, it should be noted, that they contain additional applications and utilities that can cause problems when running a 3D printer. For this reason, it is recommended that when first creating a Raspberry PI OS image that the “LITE” version of the basic operating system is selected.

“Next” is clicked on followed by “EDIT SETTINGS” where the “hostname” of the KGP 4x2209’s Host will be used, followed by a username/password and an optional WiFi SSID and password. The hostname, username and username password are all required and will be used to access the Host for loading and configuring Klipper. If a WiFi connection is not selected, an Ethernet connection to the KGP 4x2209 will be required.



With the information entered, click on “SAVE”, followed by “YES” when asked “Would you like to apply OS customisation settings?” and then click on “YES” when asked if it is okay to erase the data on the SD Card.

Once this is done, it will take between ten and fifteen minutes for the SD Card to be imaged.

Other SBC Micro SD Card Imaging

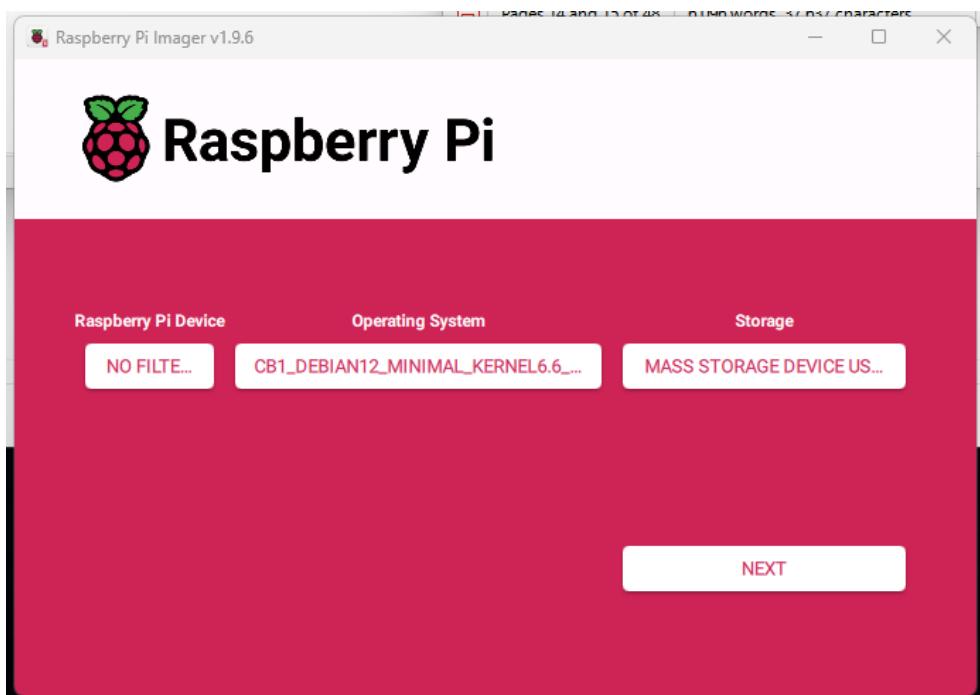
While Raspberry Pi provides OS images that are constantly updated along with a polished process for customizing the SD Card image, other SBCs do not have the resources to provide this level of support. This can make it problematic to find a prebuilt OS that is suitable for using with Klipper and the KGP 4x2209.

The selected OS image should be built from at least Linux kernel 6.6 and have Debian 12 (which has the code name “Bookworm”). Earlier versions of these softwares will result in Klipper instabilities and possible errors during printing. When looking at the manufacturer’s OS image, note the date of release and search the Internet for known problems (especially with working with Klipper). In some cases, the best OS image for a specific SBC will be made by third parties. As in the case of the Raspberry Pi OS, the “minimum” version of the SBC’s operating system should be selected to avoid loading the GUI which will probably not be required.

NOTE: The OS Image may be compressed. If it has a file extension of “.zip”, “.rar” or other compressed file format, it needs to be expanded. The proper extension for an OS image is “.img” or “.img.xz”.

While there are various tools for loading the OS image onto a Micro SD Card, it is recommended that Raspberry Pi Imager (the same tools presented in the previous section) is used as it is available on all platforms, is reliable, fast and easy to use.

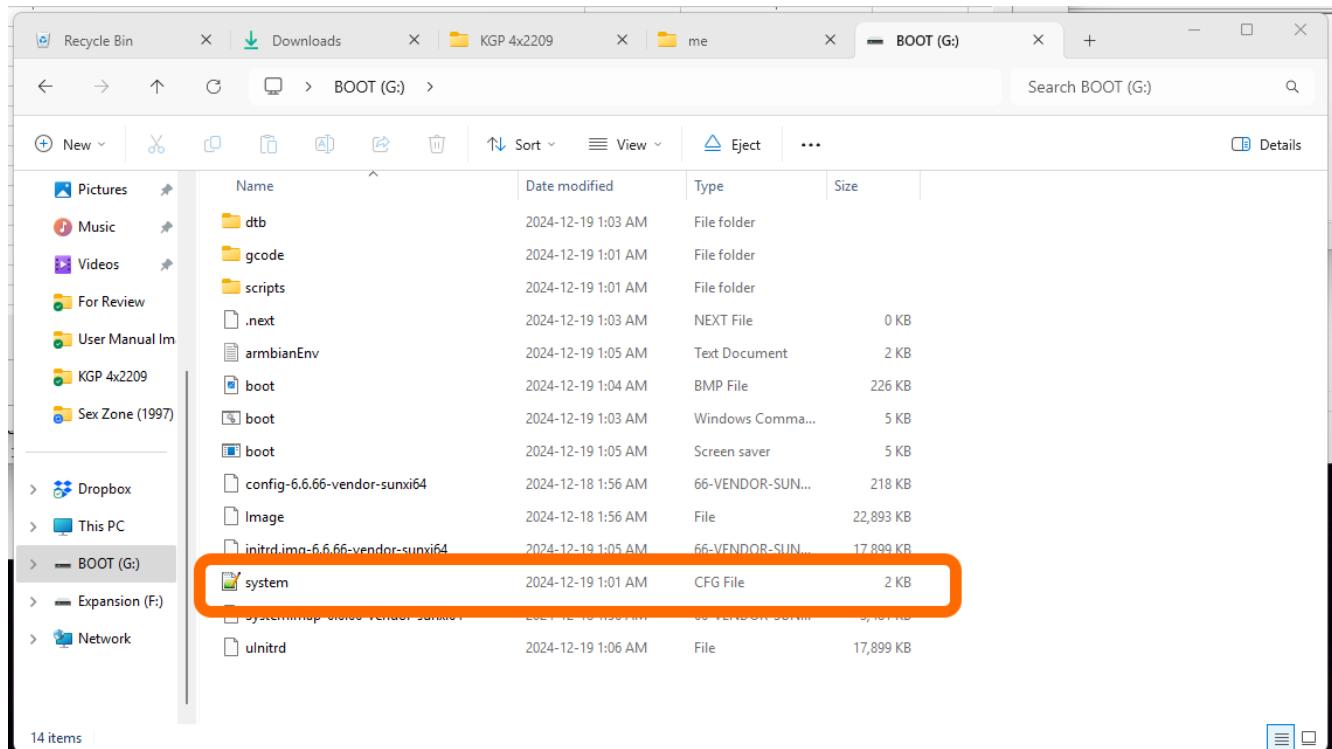
Once Raspberry Pi Imager is installed, start the application and select “NO FILTER” for the “Raspberry Pi Device”, the downloaded (and optionally expanded) OS image is selected under “Operating System” (after first clicking on “User Custom”). Finally, the target Mini SD Card is selected under “Storage” as shown below:



When the OS Image and destination Micro SD Card are selected, click on “NEXT” followed by “NO” for “Would you like to apply OS customisation settings” on the next window that pops up and then “YES” to “Are you sure you want to continue?” to load the OS Image onto the Micro SD Card.

Depending on the OS selected, there may be the opportunity to specify the hostname, username and network SSID and password (if using WiFi with the host) before the SBC is booted with the Micro SD Card OS image. This will be spelled out in the information regarding the OS image.

In the case of the BTT CB1 and CB2 SBCs, after loading the OS Image, pull the SD Card out of the computer that is running Raspberry Pi Imager and then plug it back in. This will cause the SD Card to be recognized as a storage device, typically with the name “BOOT”. Open up File Explorer (or Finder in MacOS or File Window in Linux) and select the BOOT device and look for the “system.cfg” file:



Open the “system.cfg” file in NotePad or some other text editor and look for the commented out lines with “hostname” as well as “WIFI_SSD” and “WIFI_PASSWD”, uncomment them (by deleting the “#” character at the start of the line) and add the appropriate information for the printer and where it is working. The following screenshot shows the location of these parameters:

```
1  #-----#
2  check_interval=5      # Cycle to detect whether wifi is connected, time 5s
3
4  eth=eno0            # Ethernet card device number
5  wlan=wlan0          # Wireless NIC device number
6
7  #hostname="BIGTREETECH-CB1"
8
9  ######
10 # System time zone setting, default Time zone: Etc/UTC (UTC, +0000)
11 # More settable time zones can be viewed by running the command: timedatectl list-timezones
12 #TimeZone="Asia/Shanghai"
13
14 #####
15 ## klipperScreen Target Screen
16 ## ks_src: "HDMI-1", "TFT35"
17 #ks_src="HDMI-1"
18
19 ## ks_angle: Rotation angle
20 ##      normal: 0; inverted: 180;
21 ##      left: 90; right: 270;
22 #ks_angle="normal"
23
24 #####
25 ## wifi name
26 #WIFI_SSID="ZYIPTest"
27 ## wifi password
28 #WIFI_PASSWD="12345678"
29
30 #####
31 # BTT-PAD7 (ON/OFF)
32 BTT_PAD7="OFF"
33 # touch vibration effects
34 TOUCH_VIBRATION="OFF"
35 # touch sound effects
36 TOUCH_SOUND="OFF"
37 # Automatic brightness adjustment
38 AUTO_BRIGHTNESS="OFF"
39 #####
40
```

NOTE: This process does not include the username and password, which will have to be entered when the SBC is first powered up with a console or SSH terminal window which is discussed below. The process for entering this information, like setting the hostname and WIFI SSID information, varies between SBCs as well as OS images and it is important to understand the process before selecting the OS image and using it.

SBCs with eMMC

The KGP 4x2209 is designed for SBC operation with an SD Card and does not provide an interface for loading built in eMMC memory. This was done to simplify the set up and operation of the KGP 4x2209 along with the understanding that very few users use the more expensive SBCs with built in eMMC.

If an SBC with eMMC is to be used with the KGP 4x2209, then the SBC's eMMC will have to loaded with the appropriate OS using a tool like the Raspberry Pi Compute Module 4 IO Board. Once this is

done, the SBC can be installed into the KGP 4x2209 and Klipper loaded using the following instructions. Installing an SD Card in this case is not required.

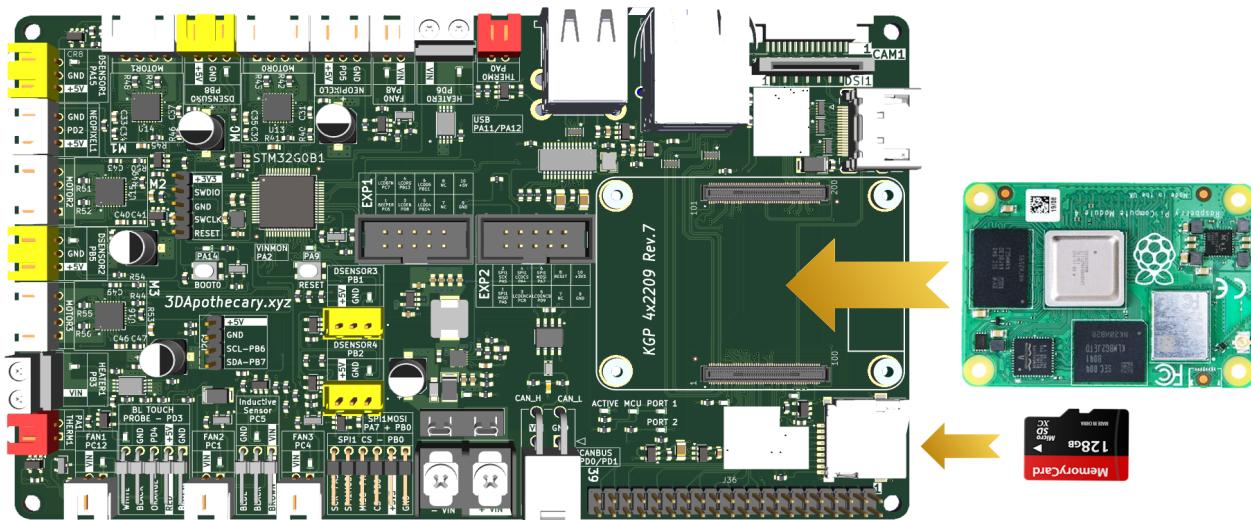
NOTE: As discussed above, a minimum of 32GB is recommended for proper Klipper operation allowing for extra space for G-Code files as well as any additional applications and utilities. 16GB may be sufficient for systems with no added system features.

WARNING: 8GB does not provide sufficient space to run Klipper successfully.

SBC Installation

NOTE: It is recommended that the first operation performed on the KGP 4x2209 is to install the CM4 form factor SBC along with a micro SD Card imaged with the SBC's operating system. This is done before connecting any wires to the KGP 4x2209.

The CM4 form Factor is plugged into the two 100 pin connectors as shown in the diagram below. The orientation shown is for the Raspberry Pi CM4; other SBCs may have their silkscreen text and graphics in a different orientation. When installing the SBC, the mounting holes on the SBC must line up with the mounting posts on the PCB.

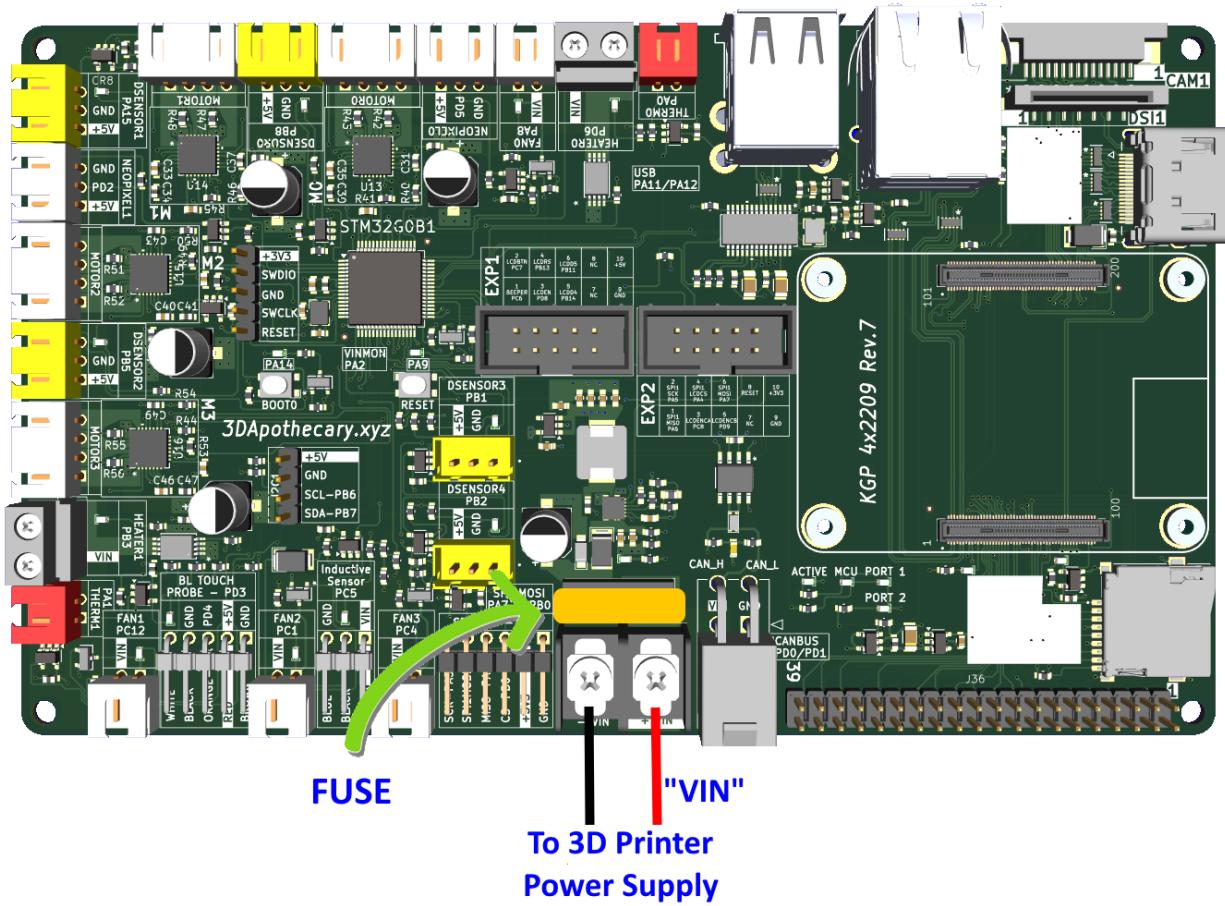


As noted in the diagram above, the imaged Micro SD Card is also installed at this time.

If there is a heatsink available for the SBC, it is to be installed before fastening the SBC to the KGP 4x2209 using the corner screws.

Power Connections

With the SBC and Micro SD Card installed, the power supply can be connected as shown in the image below:

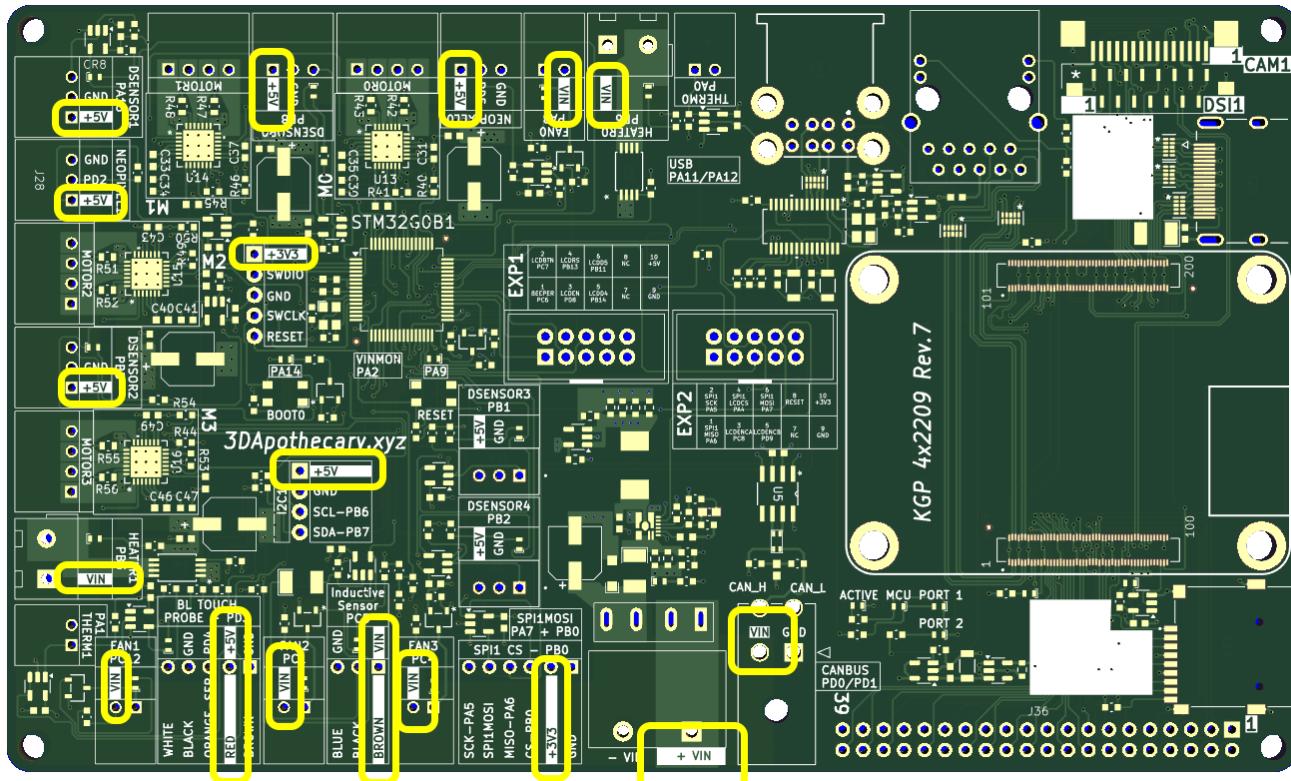


The positive power line (usually marked as "+V" or "V+" on the power power supply) is connected to the screw terminal marked "+ VIN" – the term "VIN" is used with the KGP 4x2209 to indicate positive input power and is tied directly to the "+ VIN" screw terminal through the FUSE. Negative power (usually marked as "-V" or "V-" on the power supply) is connected to the screw terminal marked "- VIN". It is recommended that tradition is followed and the positive power line is red while the negative power line is black.

For safety, power wiring should be stranded 14 AWG (2.1mm²) or thicker to accommodate the expected current loads when the 3D printer's heaters and stepper motors are active.

CRITICAL: The Fuse that comes with the KGP 4x2209 is a 20A automotive “Mini Fuse”. Fuses with larger current ratings greater than 20A MUST not be used with the KGP 4x2209 and the minimum recommended value is 15A.

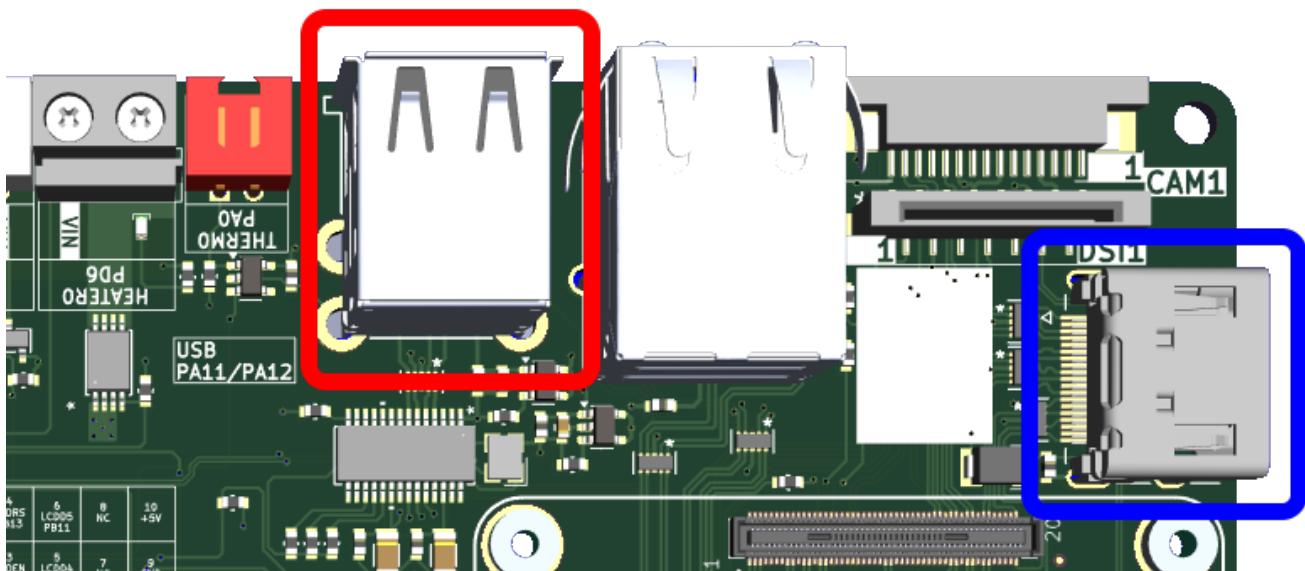
NOTE: All Positive Voltage Power Connections are marked on the PCB using reversed silkscreen text as shown in the yellow rounded rectangles in the bare PCB image shown below:



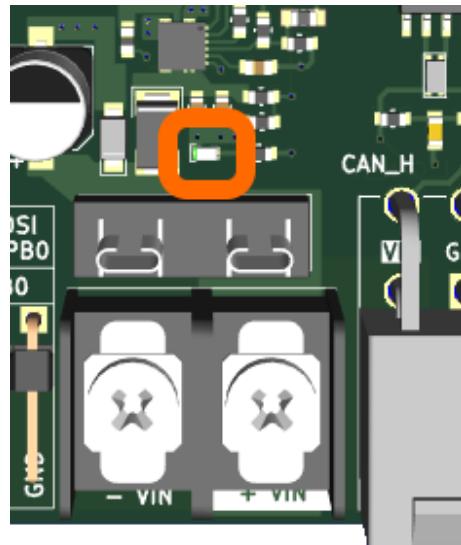
KGP 4x2209 First Power Up

It is recommended that when the KGP 4x2209 is powered up for the first time that it is done outside the printer, ideally on a bench. The reason for this is two fold, to allow a direct console interface to provide network and configuration information not available when the OS Image was made and secondly, to allow easy monitoring of the status LEDs built into the KGP 4x2209.

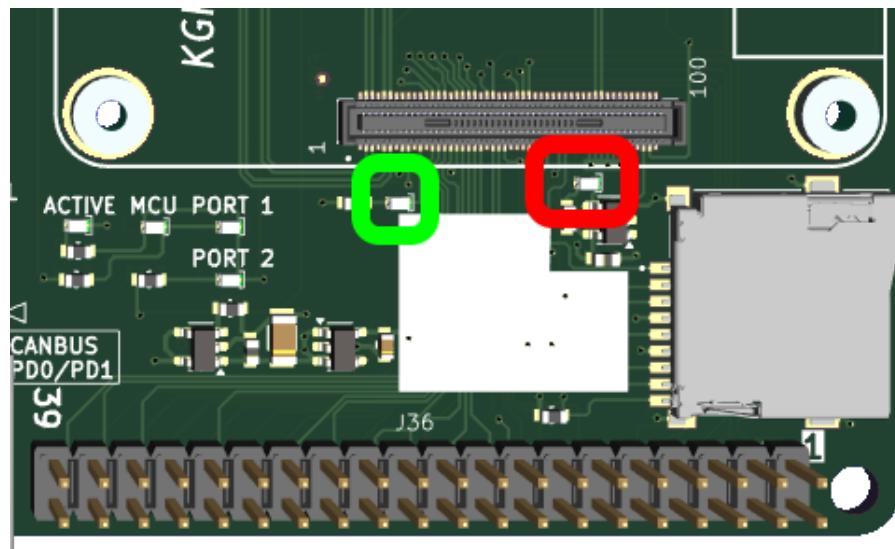
If a Raspberry Pi CM4 or CM5 is used as the host, the hostname, username and WiFi network information (if required) was entered into the configuration before the SD Card is imaged eliminating the need for the direct console interface. Similarly, if a BTT CB1 or CB2 is used and the “system.cfg” file is updated with the hostname along with, if required, the WiFi SSD and password, then there is also no need for the direct connection. Otherwise, a USB Keyboard (red rounded rectangle in the image below) will have to be plugged into the KGP 4x2209’s USB port and an HDMI monitor capable of 1080p will have to be plugged into the KGP 4x2209’s HDMI connector (blue rounded rectangle):



With these connections made, power can be applied to the KGP 4x2209. The white “Power On” LED is located by the fuse holder as shown in the diagram below. This LED lights when the KGP 4x2209’s 5V power supply is active. When first powering up the KGP 4x2209, this LED should be checked to ensure that power is available to the host SBC.



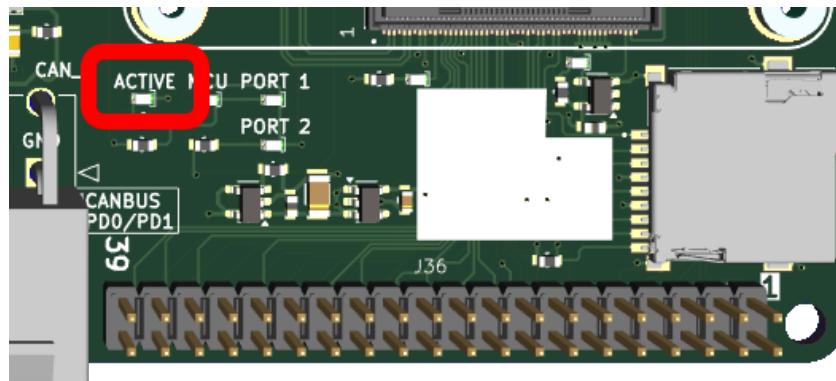
As the KGP 4x2209 powers up, two other LEDs should be monitored. The first is a Green LED that should start flashing a few seconds after power is applied (and the white LED noted above is lit). The purpose of this LED is to indicate that the SBC is up, running and loading the operating system from the Mini SD Card. The behavior of this LED is specific to the host's SBC hardware and the operating system used.



The red LED is a Power On confirmation for the CM4/CM5 and will be on solidly as long as power is applied. This LED may behave differently in other SBCs.

When the operating system installation process is complete, the green LED will settle into a regular pattern (generally flashing at a regular interval that is described in the operating system's documentation) and red "ACTIVE" LED will light indicating that the host is ready to communicate with

other devices over USB. If a direct console interface is used, either the “PORT 1” or “PORT 2” LED will light, indicating that the USB Keyboard is recognized by the host and is ready to use.



Direct Console Interface Parameter Setup

As noted above, this step is required if the Micro SD Card operating system image does not have the hostname or username specified or if a WiFi Internet connection is to be used and there was no facility for specifying the network SSID and password.

During the first power up cycle, the HDMI will become a flurry of information scrolling down as the operating system configures itself and then stops at an initial login. This process typically takes about five minutes. The required login information will be provided in the OS image documentation.

Once login is successful, then the hostname will have to be specified for the host followed by the username and any WiFi SSID information. The instructions for setting the hostname and WiFi parameters are usually, but not always, included in the OS image instructions and are typical Linux commands. If they are not provided in the operating system documentation, then user groups for the SBC will need to be queried.

With this information in place, the host should be powered down by following the process:

1. Execute the command `sudo shutdown now`
2. Disconnect the USB keyboard and HDMI monitor unless they are to be used when the printer is in operation
3. Restore power to the KGP 4x2209

NOTE: Using a USB keyboard and HDMI monitor does not eliminate the need for an internet connection. The Internet connection is required for downloading and installing Klipper and other software as well as enabling the use of the web user interface.

SSH Terminal

With the hostname, username and optional WiFi network definitions made, either through the Raspberry Pi Imager or using the Direct Console Interface now test the network connection by making an “SSH” connection to the KGP 4x2209 and its host on your Windows, Mac or Linux computer. While the operations described in this and the following sections can be done in Direct Console mode, it is recommended to use SSH to confirm that there is working a network connection to the KGP 4x2209.

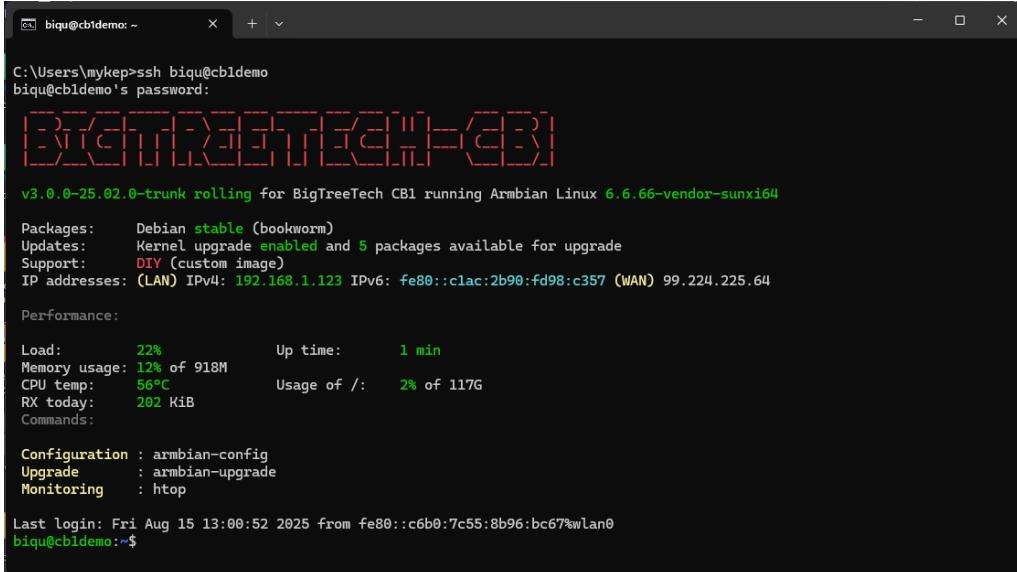
NOTE: The computer running the SSH Terminal **MUST** be on the same network as the SBC.

For Windows PCs, open a “Command Prompt” while for Macs and Linux open a “Terminal” window. This action is actually the same for all the different systems, it opens a character based user interface that allows direct access to different applications and resources.

NOTE: In some online instructions for setting up Klipper onto a main controller board, PuTTY, Tera Term or some other terminal emulator applications are used but they are no longer required in modern PC operating systems as the Command Prompt or Terminals provide the ability to SSH into network devices the KGP 4x2209.

To SSH into the KGP 4x2209, the command is `SSH {username}@{hostname}` where “username” and “hostname” was set in Raspberry Pi Imager, manually through the Direct Console Interface or defined by the operating system provider.

After entering the SSH command, enter the username’s password when prompted:



```
biqu@cb1demo: ~
C:\Users\mykep>ssh biqu@cb1demo
biqu@cb1demo's password:
[REDACTED]
v3.0.0-25.02.0-trunk rolling for BigTreeTech CB1 running Armbian Linux 6.6.66--vendor--sunxi64

Packages: Debian stable (bookworm)
Updates: Kernel upgrade enabled and 5 packages available for upgrade
Support: DIY (custom image)
IP addresses: (LAN) IPv4: 192.168.1.123 IPv6: fe80::c1ac:2b90:fd98:c357 (WAN) 99.224.225.64

Performance:

Load: 22% Up time: 1 min
Memory usage: 12% of 918M
CPU temp: 56°C Usage of /: 2% of 117G
RX today: 202 KiB

Commands:

Configuration : armbian-config
Upgrade      : armbian-upgrade
Monitoring    : htop

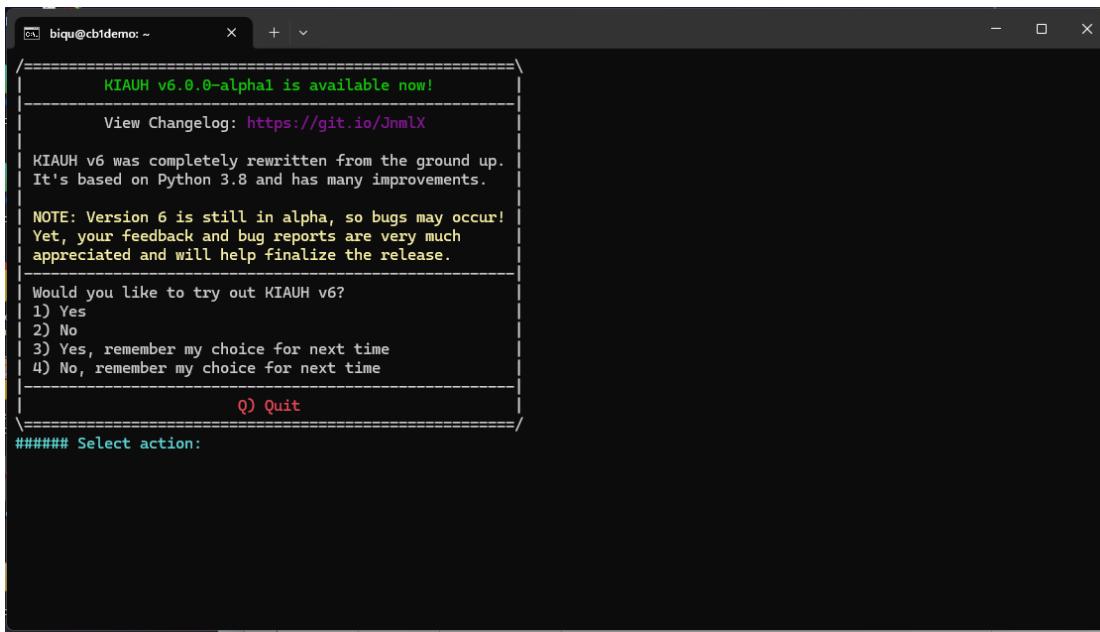
Last login: Fri Aug 15 13:00:52 2025 from fe80::c6b0:7c55:8b96:bc67%wlan0
biqu@cb1demo:~$
```

Klipper Installation

The following commands need to be entered into SSH to update the host and install and connect Klipper. This process will use “KIAUH” which is the Klipper installation tool and is also used for loading Klipper onto the KGP 4x2209. Manual methods for creating and installing firmware on the KGP 4x2209 are presented in “Building & Installing Klipper Firmware” and “Manually Flashing Firmware & Making the Host-MCU Connection”.

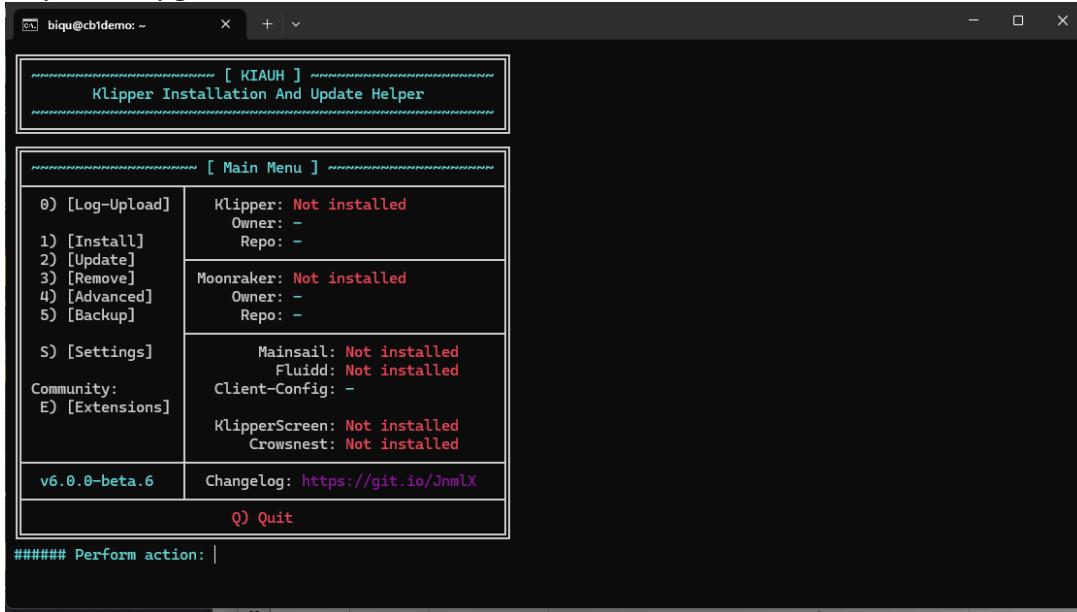
If a CAN device is to be used with the KGP 4x2209, then skip this step and go on to “CAN Bus Wiring and Set Up” and go to the recommended installation instructions.

1. Do any required updates: `sudo apt update`
2. Do any pending upgrades `sudo apt upgrade`
NOTE: The operation of the `upgrade` command will have to monitored and may require responses to configuration questions
3. Install Git for loading Klipper and Katapult `sudo apt-get install git -y`
4. Enter `sudo apt install python3 python3-serial -y`
5. Install KIAUH (Klipper install tool) with:
`git clone https://github.com/dw-0/kiauh.git`
6. Run KIAUH using the command: `./kiauh/kiauh.sh`
 1. If prompted to select KIAUH version 6, enter “3” as this is provides the optimal installation experience:



A screenshot of a terminal window titled "biqu@cb1demo: ~". The window displays the KIAUH v6.0.0-alpha1 installation process. It starts with a message: "KIAUH v6.0.0-alpha1 is available now!". It provides a link to the changelog: "View Changelog: <https://git.io/JmmlX>". It then states: "KIAUH v6 was completely rewritten from the ground up. It's based on Python 3.8 and has many improvements." A note follows: "NOTE: Version 6 is still in alpha, so bugs may occur! Yet, your feedback and bug reports are very much appreciated and will help finalize the release." The user is then prompted: "Would you like to try out KIAUH v6?". Four options are listed: 1) Yes, 2) No, 3) Yes, remember my choice for next time, and 4) No, remember my choice for next time. At the bottom, there is a "Q) Quit" option and a prompt: "##### Select action:".

2. When the “Main Menu” appears, check on required system updates by entering “2” if “9) System” upgrades are available, enter “9”

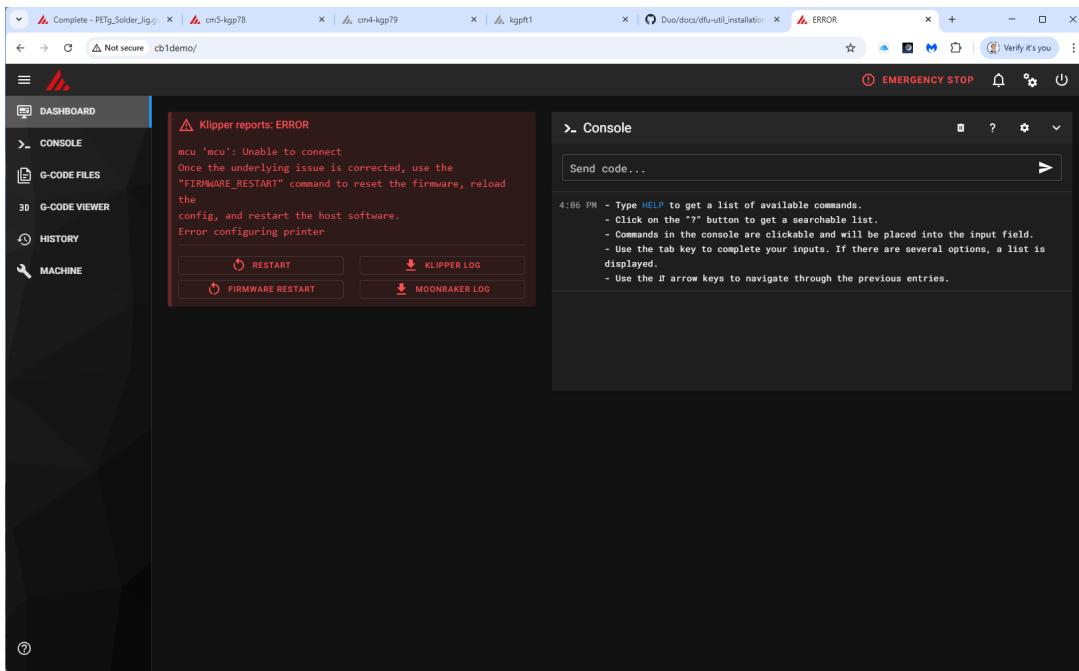


3. When the previous step is complete and the “Update Menu” is displayed or if no system updates are pending, select “B” for “B) << Back”
4. Go to the KIAUH Installation menu. Enter “1” to “1) [Install]”
5. In the “Installation Menu”, enter “1” to Install “1) [Klipper]”. When prompted, select the default options.
6. When the “Installation Menu” returns, enter “2” to Install “2) [Moonraker]”. When prompted, select the default options.
7. When the “Installation Menu” returns, enter “3” to Install “3) [Mainsail]” or enter “3” to Install “4) [Fluiddd]”. When prompted, select the default options.

NOTE: Mainsail and Fluiddd and Klipper Web 3D printer user interfaces for control and will be the primary method used to interface with the 3D printer. Mainsail is more popular but Fluiddd has a large user base and good support.

NOTE: Octoprint is also an option for controlling a 3D printer using the KGP 4x2209 and host but requires a different set up process

8. At this point of the installation, Klipper and its web interface are fully installed. To verify the installation, enter “<http://hostname>” into a browser window on the PC that is being used to install Klipper where “hostname” is the hostname selected for the SBC. There will be an error displayed as the connection between the host and KGP 4x2209’s MCU has not yet been made.



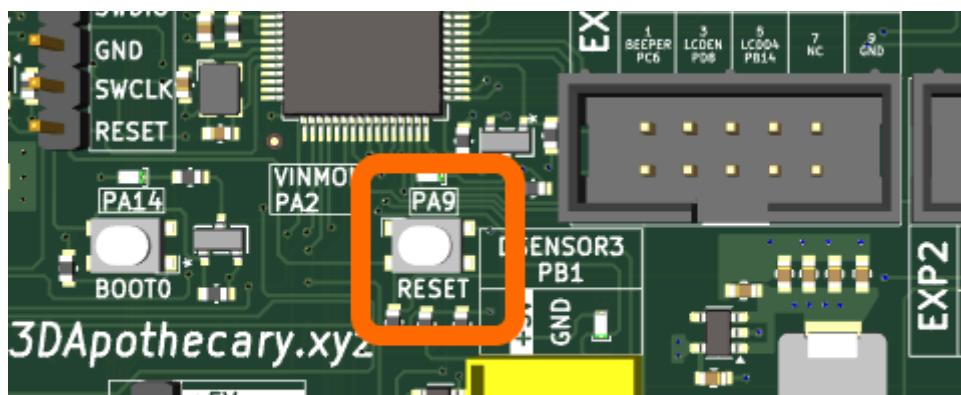
Do not close the web browser window if Klipper is to be installed in the KGP 4x2209 using the process given in the next section.

Building & Installing Klipper Firmware

The process described here is for building and installing Klipper firmware into the KGP 4x2209’s microcontroller (MCU) using KIAUH and the Katapult bootloader. The KGP 4x2209 has a ST Microelectronics STM32G0B1 MCU which has its own Flash memory which needs to be loaded with the Klipper 3D printer firmware in order for the Klipper software running on the host to communicate with the MCU and run 3D printer operations. The Katapult bootloader is a program that provides a standard interface to load firmware onto the MCU without requiring specialized equipment. The process required for building and installing Klipper firmware will take less than five minutes and is quite straightforward.

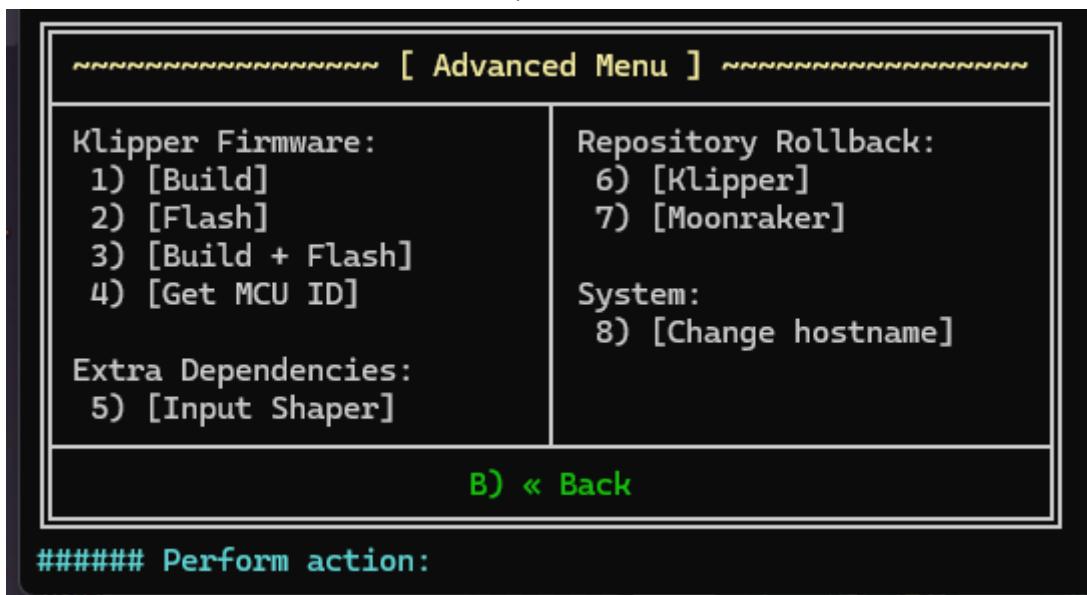
When Katapult is active (such as when there is no firmware loaded) the orange LED above the “RESET” button in the middle of the KGP 4x2209 will be flashing at a regular rate. If the LED is not flashing, then Katapult can be activated by pressing the “RESET” button twice within one second. After doing this, the LED will be flashing and Katapult is active and ready to install new firmware. This can be done

at any time, such as to upgrade the firmware or replace the Klipper firmware so that the CAN Bus interface built into the KGP 4x2209 can be used.

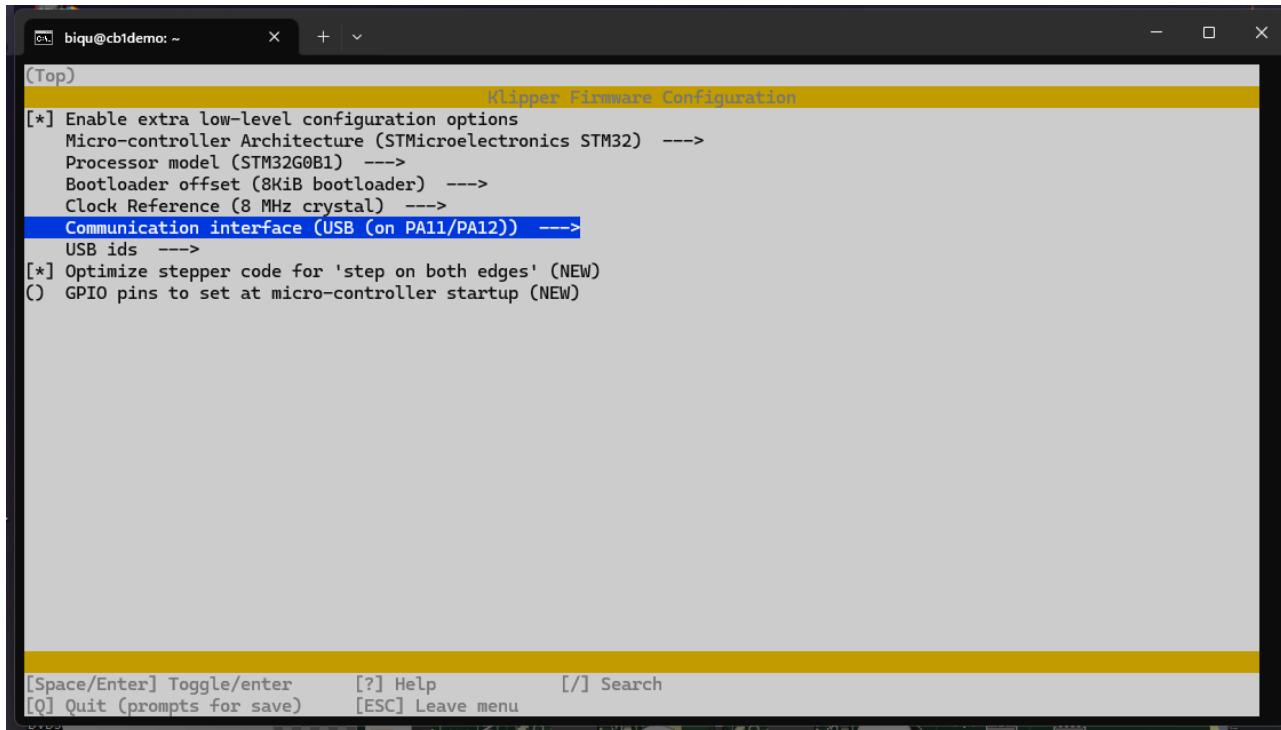


With the Katapult bootloader active (and the orange LED flashing), the following steps are followed in KIAUH to build and install Klipper firmware into the KGP 4x2209:

1. If KIAUH is not active, start it with the SSH command: `./kiauh/kiauh.sh`
2. If the KIAUH “Main Menu” is not active (as if left in the “Installation Menu” from the previous section), enter “B” until the “Main Menu” appears.
3. In the KIAUH “Main Menu”, enter “4” for “4) [Advanced]”
4. In the “Advanced Menu”, enter “1” for “1) [Build]”

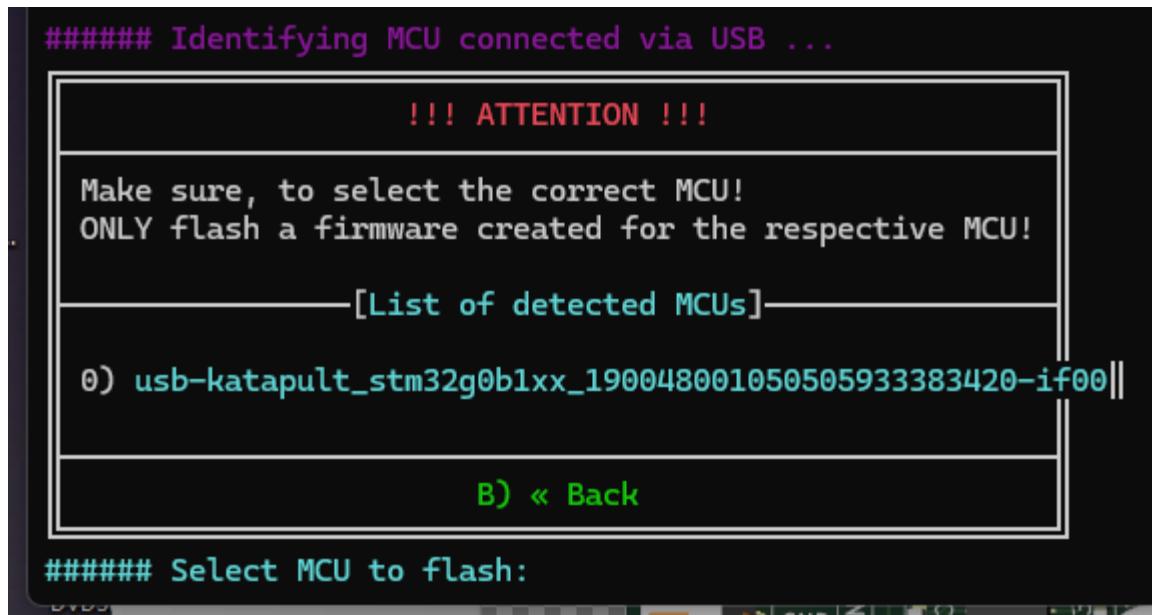


5. The “1) [Build]” selection will bring up the “Klipper Firmware Configuration” menu and make the following changes to the base configuration that is presented:
 1. “Enable extra low-level configuration options
 2. “Micro-controller Architecture” as “STMicroelectronics STM32”
 3. “Processor Model” as “STM32G0B1”

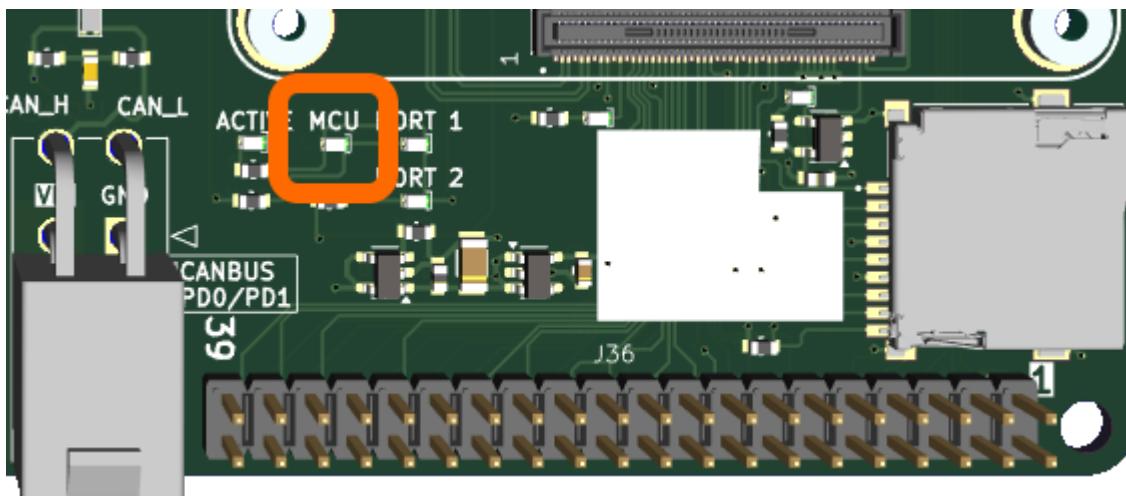


6. When the configuration is set, Enter “Q” followed by “Y”. After doing this, the Klipper firmware build will start automatically and return to the “Advanced Menu” when the build is complete. There may be a prompt to save the configuration information for later builds.
7. With the firmware built, select “2” for “2) [Flash]”
 1. Enter “1” for the “Regular flashing method”
 2. Enter “1” for “make flash (default)”
 3. Enter “1” to select “1) USB”

- With this information, there will be a prompt requesting which MCU to Flash. Enter “0” as there will only be one device.



- There will be a review of the Flashing information, enter “Y” to start the Flashing process
- The flashing process will take a few seconds and will return to the “MCU Flash Menu”
NOTE: The orange LED by the RESET button will stop flashing and turn off. The “MCU” LED will light. These two changes in LED states indicates that the MCU is running the Klipper firmware.



- Enter “B” to return to the “Advanced Menu”.

To provide a Klipper connection between the host and the KGP 4x2209's MCU, the MCU's serial device identifier is needed. To get this and enter it into Klipper's "printer.cfg" file, following steps are carried out.

1. In the "Advanced Menu", enter "4" to "4) [Get MCU ID]"
2. Enter "1" for "1) USB" which will return the MCU id:

```

Make sure that the controller board is connected now!

How is the controller board connected to the host?

1) USB
2) UART
3) USB (DFU mode)
4) USB (RP2040 mode)

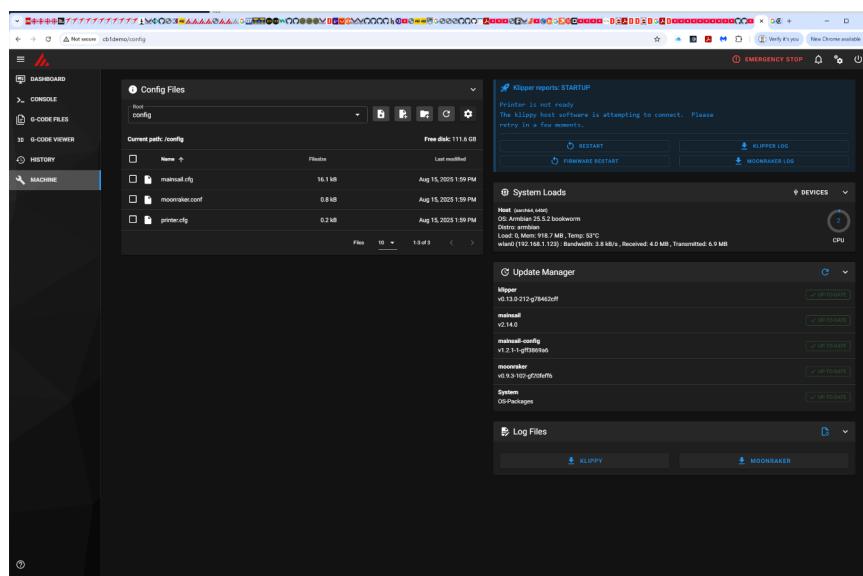
B) << Back   H) Help [?]

#####
Select connection type: 1

#####
Identifying MCU connected via USB ...
The following MCUs were found:
● MCU #0: /dev/serial/by-id/usb-Klipper_stm32g0b1xx_190048001050505933383420-if00

```

3. Using the computer's mouse, highlight the string after "MCU #0:" and press Ctrl-C ("Command-C" for Macs) to copy the ID into they computer's clipboard.
4. Going to the web page that was created by Mainsail or Fluidd (and opened up in the previous section), click on the "MACHINE" vertical tab.



The “MACHINE” page (which shows as “hostname/config” in the browser’s navigation bar) provides access to the configuration files used in Klipper to specify the 3D printer configuration as well as provide a dashboard of the software versions running on the

5. In the “MACHINE” page, click on “printer.cfg”, which is the 3D printer configuration file and an editor will come up. Paste the MCU ID that was copied in the SSH terminal after the “serial:” statement in the printer.cfg file (make sure that the “/dev/serial/by-id?” string isn’t repeated). Along with that, enter in the following statements:

```
[temperature_sensor mcu_temp]
sensor_type: temperature_mcu
```

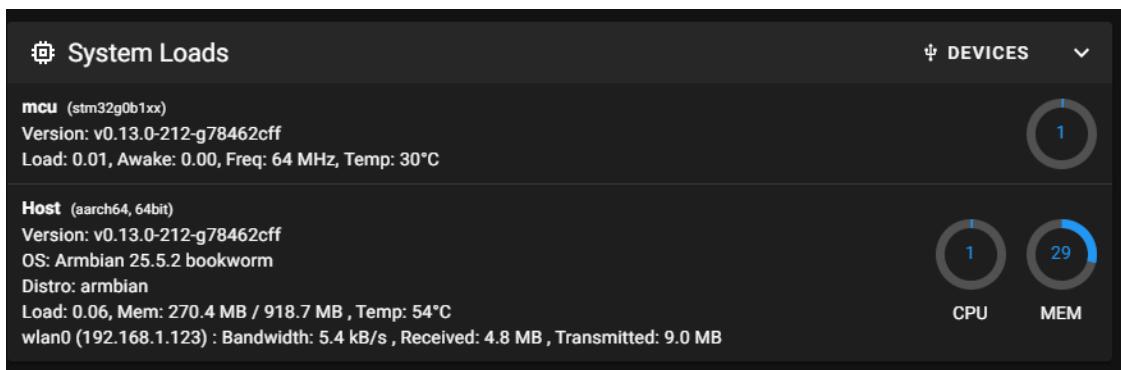
```
[temperature_sensor cm4]
sensor_type: temperature_host
```

The resulting printer.cfg file will look like:

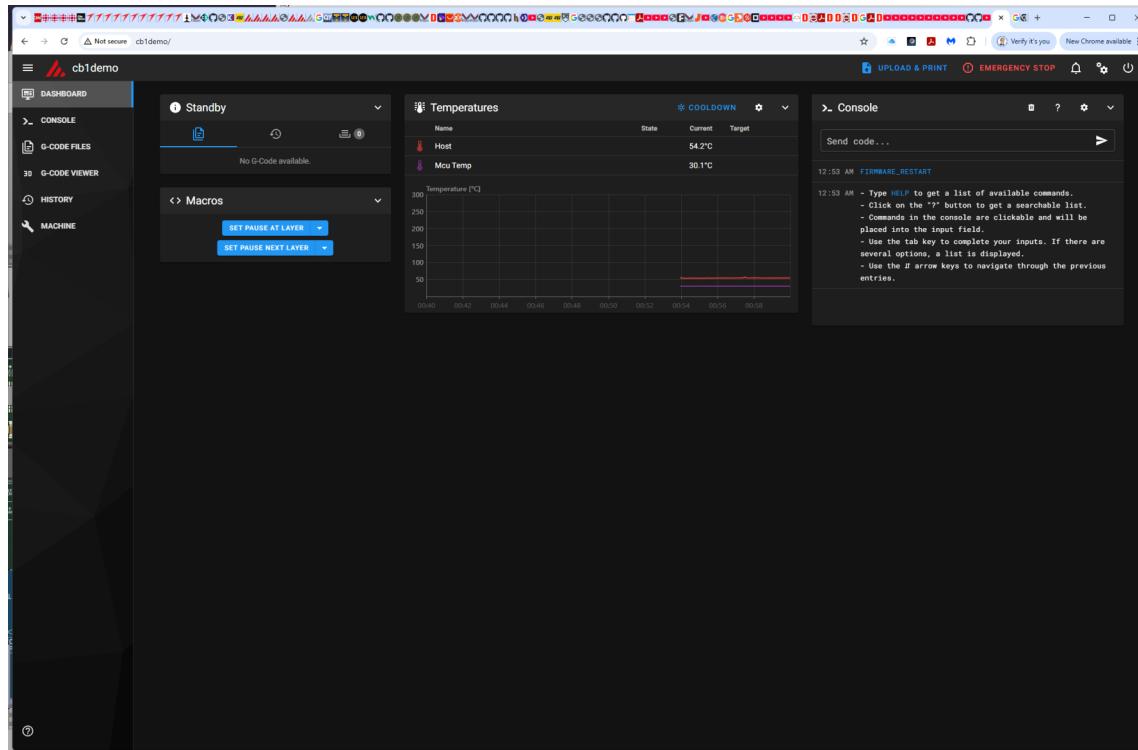
```
printer.cfg *

1 [include mainsail.cfg]
2 [mcu]
3 serial: /dev/serial/by-id/usb-Klipper_stm32g0b1xx_190048001050505933383420-if00
4
5 [temperature_sensor mcu_temp]
6 sensor_type: temperature_mcu
7
8 [temperature_sensor host]
9 sensor_type: temperature_host
10
11 [virtual_sdcard]
12 path: /home/biqu/printer_data/gcodes
13 on_error_gcode: CANCEL_PRINT
14
15 [printer]
16 kinematics: none
17 max_velocity: 1000
18 max_accel: 1000
19
```

6. Click on “SAVE & RESTART” in the upper right hand corner. This will save the updated printer.cfg file and prompt Klipper to restart.
7. The “MACHINE” page will reappear and, after a few seconds, the “Error” or “Not Ready” message in the top right corner will be replaced with the status information regarding the host and KGP 4x2209’s MCU that looks like:



- Clicking on the “DASHBOARD” vertical tab will display the current status of the Klipper system as well as displaying the current internal temperatures of the host’s CPU and the KGP 4x2209’s MCU:



- Go back to the SSH Terminal running KIAUH and enter the “B” command (“B) << Back”) until the “Main Menu” is reached and then enter “Q” for “Q) Quit1” to end the application.
- To leave the SSH session, use the “logout” command

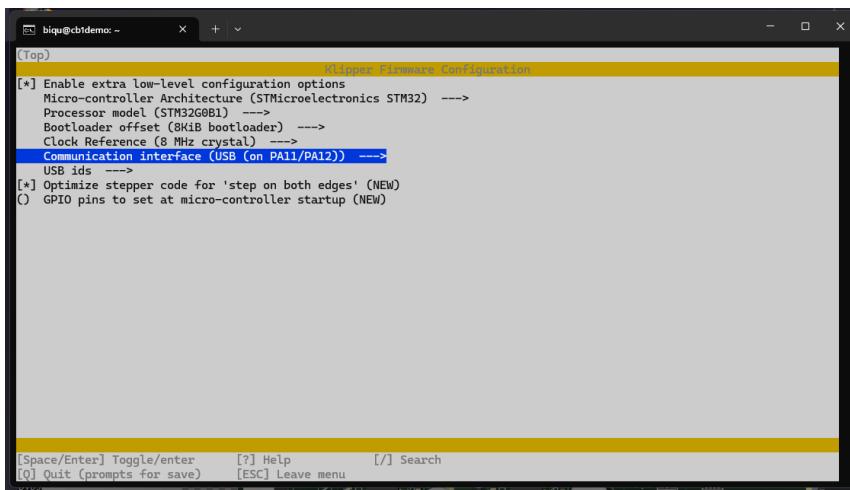
That's it, the host and KGP 4x2209's MCU are loaded with Klipper and communicating.

The next steps will be to power down the KGP 4x2209 (using the power icon in the top left corner of the web page followed by turning off the power supply) and then wiring the KGP 4x2209 into a 3D printer and updating the printer.cfg file with the appropriate information.

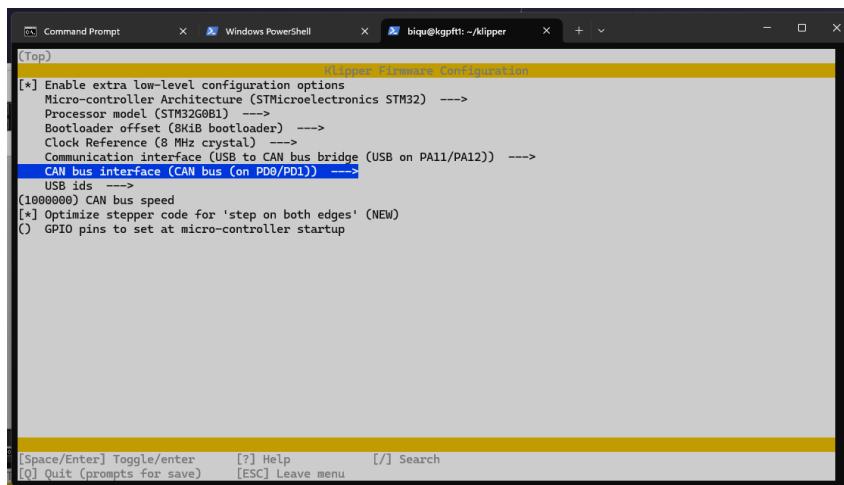
Building Klipper Updates

The following steps are used to build Klipper manually, as in the case where an updated version of Klipper is available. Notification of the updated version will be presented in the Web user interface and updates to the host software can be done there. Updates to the KGP 4x2209 MCU's firmware is done using the following steps:

1. SSH into the host as described above.
2. Go to the Klipper folder using the command `cd ~/klipper`
3. Start the Klipper configuration utility using the command `make menuconfig`
4. When menuconfig starts, put in the same information as used before:
 1. If there is **NO** CAN Bus connection, use:



2. If there **IS** a CAN Bus connection, use:



5. Exit menuconfig by entering “Q” followed by “Y”
6. Clear the previous make information using the command `make clean`
7. Build the new firmware using the command `make`

NOTE: The KGP 4x2209 menuconfig options presented above are for use with Katapult. If DFU Mode is to be used, then the firmware must be built with “No Bootloader” selected.

Manually Flashing Firmware & Making the Host-MCU Connection

In “Building & Installing Klipper Firmware”, Klipper was flashed into the KGP 4x2209’s MCU as part of the initial setup process. Over the course of the life of the KGP 4x2209, the MCU will be updated multiple times. The contents of the MCU’s Flash memory can be completely rewritten or the space not used by Katapult can be overwritten using the host SBC attached to the KGP 4x2209. Along with using the SBC for updating the MCU’s Flash memory, access to the MCU’s SWD port is provided to allow a commercial programmer/debugger, like the STMicroelectronics’ STLink, access to the MCU, its Flash memory and Option Bytes, used to configure the MCU.

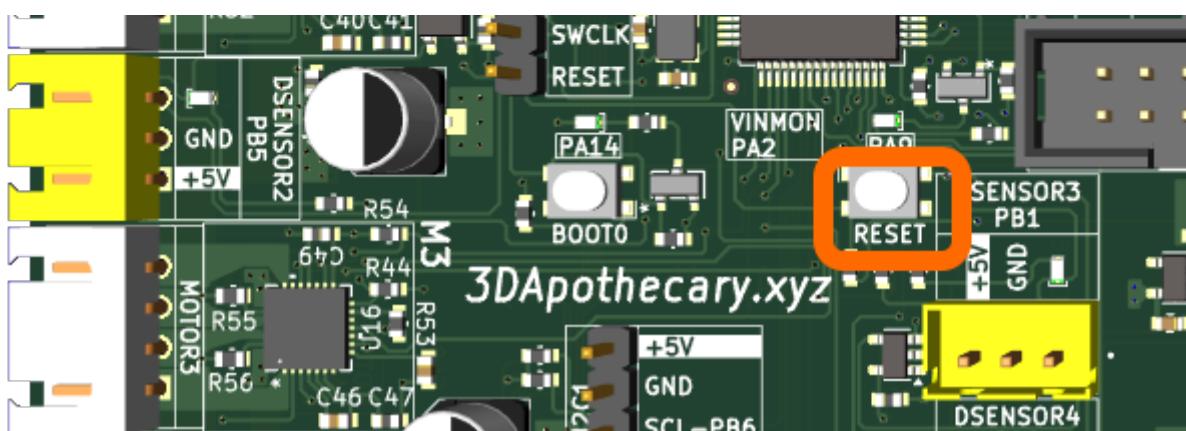
NOTE: Updating the KGP 4x2209’s MCU requires physical access to the KGP 4x209 board. It is recommended that the simple circuitry described to be sections below be added to the 3D printer.

Katapult

As noted in “Building & Installing Klipper Firmware”, the KGP 4x2209 comes with the Katapult bootloader installed. This allows fast and easy updating of the MCU using a firmware image stored on the host SBC.

To Flash new firmware into the MCU, the follow steps are used:

1. Login to the KGP 4x2209’s host SSH
2. Execute `sudo reboot now`
3. The KGP 4x2209’s “RESET” button is pressed twice in one second:



4. After the RESET button is pressed twice, the orange LED above the RESET button will start flashing, indicating that Katapult is active
5. Wait two or three minutes before logging into the KGP 4x2209's host SSH
6. Enter the command `ls /dev/serial/by-id`

```
biqu@kgpf3:~ $ ls /dev/serial/by-id
usb-katapult_stm32g0b1xx_1A0044001050505933383420-if00
biqu@kgpf3:~ $
```

7. If the `ls /dev/serial/by-id` command returns the following, restart the process from step 2.

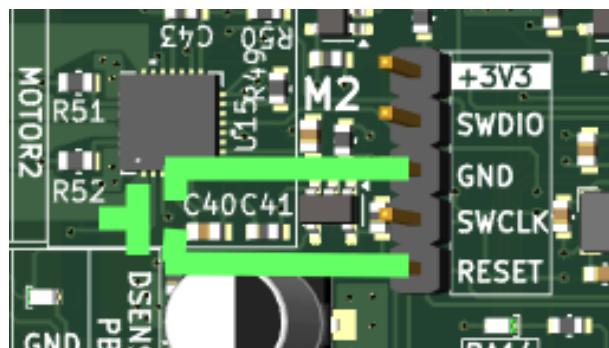
```
biqu@kgpf3:~ $ ls /dev/serial/by-id
ls: cannot access '/dev/serial/by-id': No such file or directory
biqu@kgpf3:~ $
```

8. Copy the serial ID from the previous step
9. Enter the following command to load the firmware after adding the USB ID where noted and, if required, changing the firmware to be loaded into the KGP 4x2209's MCU: `python3`

```
~/katapult/scripts/flashtool.py -f ~/klipper/klipper.bin -d
/dev/serial/by-id/{USB ID FOUND PREVIOUSLY}
```

NOTE: If Katapult is started accidentally, execution can be returned to the Klipper firmware by pressing the “RESET” button once.

Once the KGP 4x2209 is installed into a 3D printer, it can be inconvenient to access it for updating the firmware. A momentary on switch connected between the “RESET” and “GND” pins of the SWD Header can be used to activate Katapult in the KGP 4x2209’s MCU:



DFU Mode

DFU Mode provides a method of overwriting the entire contents of the KGP 4x2209's MCU, allowing the replacement/upgrade of Katapult installing firmware that does not need a bootloader.

NOTE: DFU Mode is best used when there has been a problem with an MCU Flash update using Katapult with unexpected results that do not change, even with generally not required can be entered at any time is a feature built into the KGP 4x2209's MCU that allows all the contents of its Flash to be overwritten.

DFU Mode is actually bootloader code stored in the read only memory of the KGP 4x2209's MCU that is entered by use of a special reset sequence. To enter DFU Mode and download new firmware, the following sequence of operations is used:

1. Login to the KGP 4x2209's host SSH
2. Press and hold the "BOOT0" button on the KGP 4x2209 (which will light the green LED by the "BOOT0" button) and then press and release the "RESET" button followed by releasing the "BOOT0" Button.



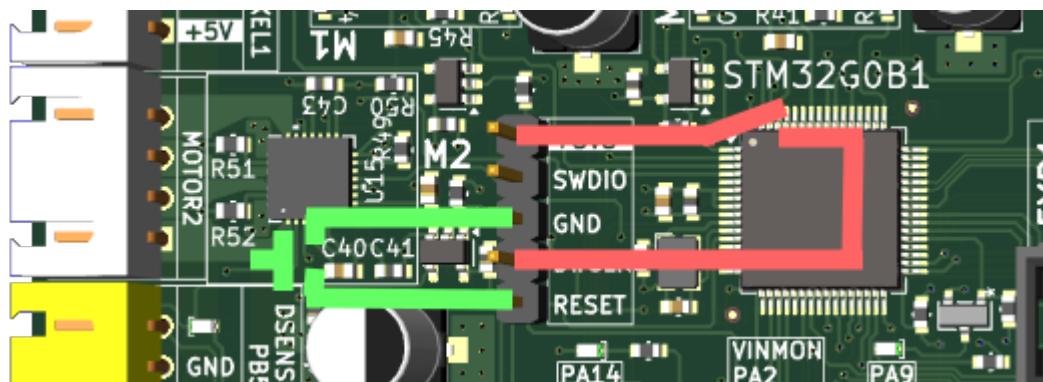
3. Upon completion of this button press sequence, the orange LED above the "RESET" button will light and remain on without flashing.
4. Check that the host is recognizing that the KGP 4x209's MCU is in DFU Mode by executing the command `lsusb`. When the MCU is in DFU Mode, it will have an id of `0483:df11` as shown below:

```
biqu@kgpft3:~ $ lsusb
Bus 001 Device 004: ID 0483:df11 STMicroelectronics STM Device in DFU Mode
Bus 001 Device 002: ID 1a40:0101 Terminus Technology Inc. Hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
biqu@kgpft3:~ $
```

5. Flash the new firmware into the KGP 4x2209's MCU using the command (specifying the location of the .bin file to load into the MCU):
- ```
sudo dfu-util -a 0 -D ~/BIN FILE
TO LOAD INTO MCU} --dfuse-address 0x08000000:force:mass-
erase:leave -d 0483:df11
```

**NOTE:** If DFU Mode is started accidentally, execution can be returned to the Klipper firmware by pressing the “RESET” button once.

The KGP 4x2209's MCU can be reset into DFU Mode by adding an SPST switch between the “SWCLK” and “+3V3” pins of the SWD header along with a momentary on switch between “RESET” and “GND” (the same as enabling Katapult).



## CAN Bus Wiring and Set Up

The IEEE CAN Bus Protocol (ISO 11898) is an excellent method for adding additional hardware to a 3D printer using the KGP 4x2209 built in hardware, in the form of an electrical interface and connector (“Molex Mini-Fit CAN Connector”). CAN Bus is very commonly used in cars and, in recent years, has become very popular in 3D printers running Klipper. The most common application for CAN Bus devices in a 3D printer is for “toolhead” (also known as the “hot end” or “extruder”) controllers, which drastically cuts down on the number of wires that run from the KGP 4x2209, making a more reliable system with a lighter wiring connection.

Another benefit for using a CAN Bus toolhead controller with the KGP 4x2209 is that on a “bedslinger” type 3D printer, a second Z axis stepper motor (using the one freed up by moving the extruder stepper motor driver to the toolhead controller) can be added to the printer’s configuration, giving the printer Klipper “Z Tilt” ([https://www.klipper3d.org/Config\\_Reference.html?h=z\\_tilt#z\\_tilt](https://www.klipper3d.org/Config_Reference.html?h=z_tilt#z_tilt)) capability, eliminating the need for manually levelling the printer bed.

Recommended cabling for the CAN Bus is the Tensility 30-02482 or 30-02483 four conductor cable with twisted pair wires for the “CAN H” and “CAN L” signals and thicker cables for VIN and GND. Due to the number of cabling and toolhead controller options, the explicit instructions on wiring the CAN

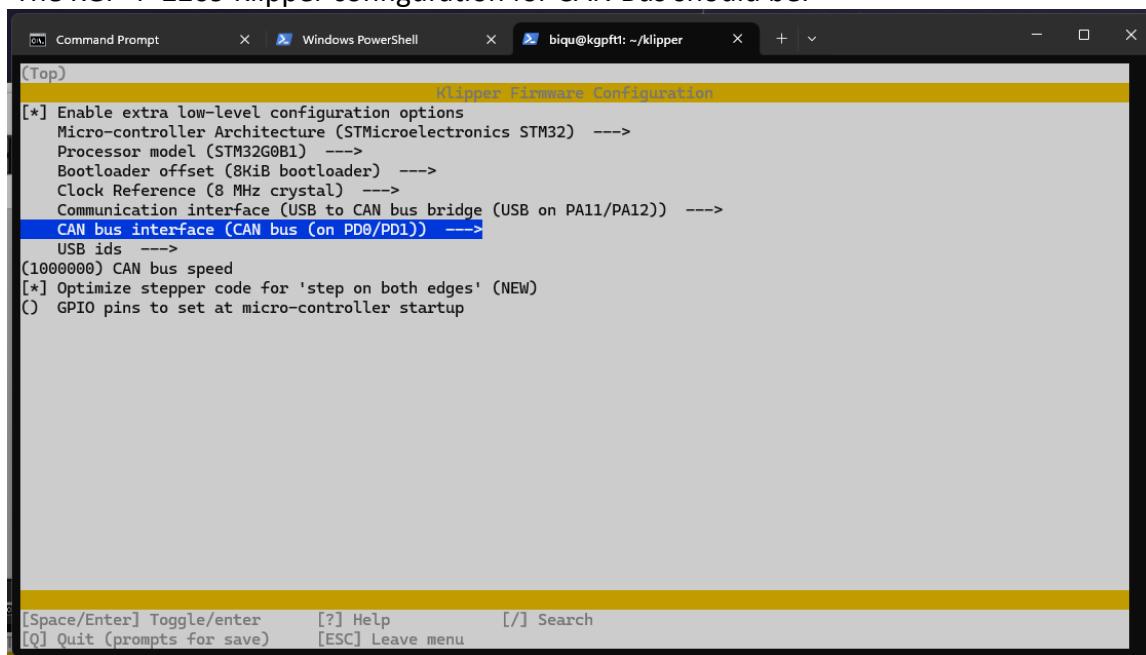
Bus cannot be provided here; the toolhead and other CAN connector device manufacturers will provide device specific connector and wiring information.

**NOTE:** The KGP 4x2209's CAN interface has a 120Ω terminating resistor built in, meaning that the KGP 4x2209 **MUST** be at one of the ends of the CAN bus. This is explained in CAN Bus documentation.

To implement CAN Bus on Klipper with the KGP 4x2209, the Micro SD Card will have to be imaged with additional commands, utilities and configuration information that is outlined in the excellent "Esoterical CANBus Guide" (<https://canbus.esoterical.online/>).

The process described here should be followed explicitly with the following deviations:

1. As noted above, the KGP 4x2209 comes with Katapult preloaded on the board. This means that the steps for loading Katapult onto the "Mainboard" (the term used to describe the KGP 4x2209 in the Esoterical instructions) can be ignored as loading Katapult will be redundant.  
  
**NOTE:** Katapult must still be loaded into the system as it will be required for the toolhead controller.
2. The KGP 4x2209 Klipper configuration for CAN Bus should be:



```
Command Prompt X Windows PowerShell X biqu@kgpf1t: ~/klipper X + -
(Top) Klipper Firmware Configuration
[*] Enable extra low-level configuration options
 Micro-controller Architecture (STMicroelectronics STM32) --->
 Processor model (STM32G0B1) --->
 Bootloader offset (8KiB bootloader) --->
 Clock Reference (8 MHz crystal) --->
 Communication interface (USB to CAN bus bridge (USB on PA11/PA12)) --->
 CAN bus interface (CAN bus (on PD0/PD1)) --->
 USB ids --->
 (1000000) CAN bus speed
[*] Optimize stepper code for 'step on both edges' (NEW)
() GPIO pins to set at micro-controller startup

[Space/Enter] Toggle/enter [?] Help [/] Search
[Q] Quit (prompts for save) [ESC] Leave menu
```

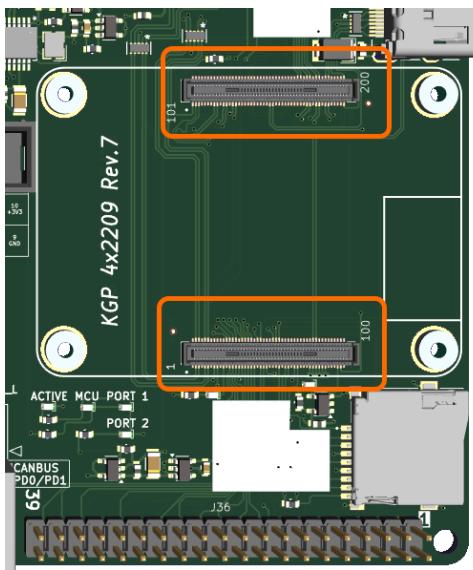
## Peripheral Interfaces

In this section, the different device interfaces available on the KGP 4x2209 are discussed. An image of the peripheral interface is included in the description along with the nearest corner to make location as easy as possible.

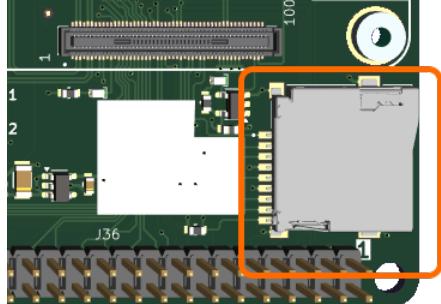
### SBC Peripherals

While the references to the Klipper host Single Board Computer (SBC) is generally “CM4” as a reference to the Raspberry Pi CM4 in other documentation, including schematics, the KGP 4x2209 was designed for SBCs that use the CM4 form factor as discussed in Other SBC Micro SD Card Imaging.

### SBC Mounting Sockets

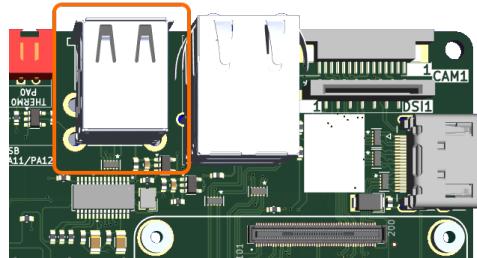
|                                                                                                                                            |                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Designator(s): J32, J33                                                                                                                    | Color: Grey                                                                         |
| MCU Pins: N/A                                                                                                                              |                                                                                     |
| Power: N/A                                                                                                                                 |                                                                                     |
| ESD Protection: None                                                                                                                       |                                                                                     |
| LED Indicators: CR24, CR28                                                                                                                 |                                                                                     |
| PN: DF40C-100DS-0.4V(51)                                                                                                                   |                                                                                     |
| The SBC must be installed in the mounting sockets before power is applied to the KGP 4x2209.                                               |  |
| After mounting, it is recommended that the SBC is secured in the mounting sockets by use of the M2.5 screws, included with the KGP 4x2209. |                                                                                     |
| <b>CRITICAL: Under NO Circumstances is the SBC to be Removed from the Mounting Sockets while Power is Applied</b>                          |                                                                                     |

## Micro SD Card Socket

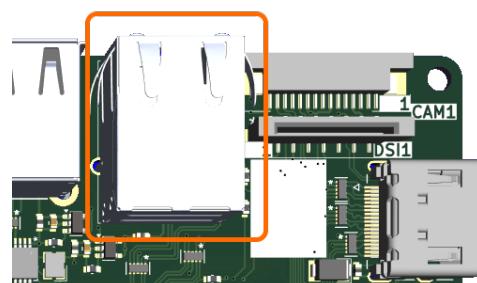
|                                                                                                                                                                                                                                  |                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Designator(s): J38                                                                                                                                                                                                               | Color: Metal                                                                       |
| MCU Pins: N/A                                                                                                                                                                                                                    |                                                                                    |
| Power: N/A                                                                                                                                                                                                                       |                                                                                    |
| ESD Protection: Moderate                                                                                                                                                                                                         |                                                                                    |
| LED Indicators: None                                                                                                                                                                                                             |                                                                                    |
| PN: TF PUSH                                                                                                                                                                                                                      |                                                                                    |
| The Micro SD Card holds the SBC Operating System, Klipper image, downloaded G-Code files and user specific applications. The imaged SD Card must be placed in the socket before applying power.                                  |  |
| <b>WARNING:</b> Removal of the SD Card while the KGP 4x2209 is operating will halt operation of the host and may leave the SD Card in a state that will not allow resumption of operation, requiring the SD Card to be reimaged. |                                                                                    |

**Dual Stacked USB A Connector**

|                                                                                                               |              |
|---------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J35                                                                                            | Color: Metal |
| MCU Pins: N/A                                                                                                 |              |
| Power: 5V, 0.5A available in both USB Sockets                                                                 |              |
| ESD Protection: Hot Pluggable                                                                                 |              |
| LED Indicators: CR20 - Yellow, CR21 – Yellow, CR22 – Yellow, CR23 - Red                                       |              |
| PN: USB1035-GF-P-0-B-B                                                                                        |              |
| The stacked USB connector provides two USB A 2.0 connectors for accessories like keyboards, mice and cameras. |              |

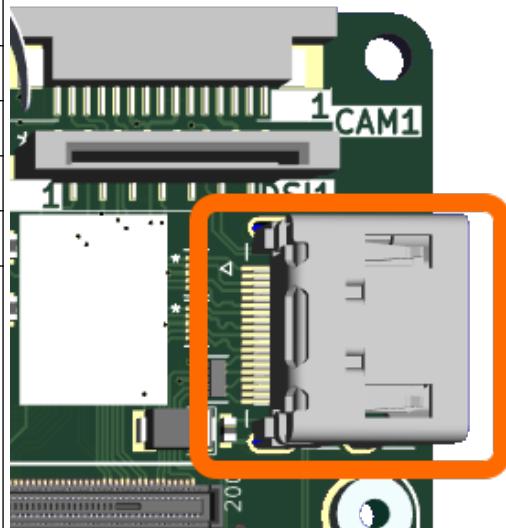
**RJ45 Ethernet Connector**

|                                                                                                       |              |
|-------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J34                                                                                    | Color: Metal |
| MCU Pins: N/A                                                                                         |              |
| Power: N/A                                                                                            |              |
| ESD Protection: Hot Pluggable                                                                         |              |
| LED Indicators: Built into J34. Yellow – High Speed, Green – Connection                               |              |
| PN: RJMG201K21120FR                                                                                   |              |
| The Ethernet connector provides internet and network connections if WiFi is not available to the SBC. |              |



**Full Sized HDMI Connector**

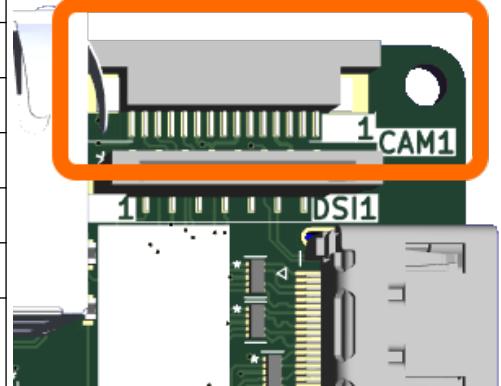
|                                     |              |
|-------------------------------------|--------------|
| Designator(s): J39                  | Color: Metal |
| MCU Pins: N/A                       |              |
| Power: N/A                          |              |
| ESD Protection: Hot Pluggable       |              |
| LED Indicators: None                |              |
| PN: GT-HD001-FNNG0                  |              |
| Wired to the HDMI0 port of the SBC. |              |



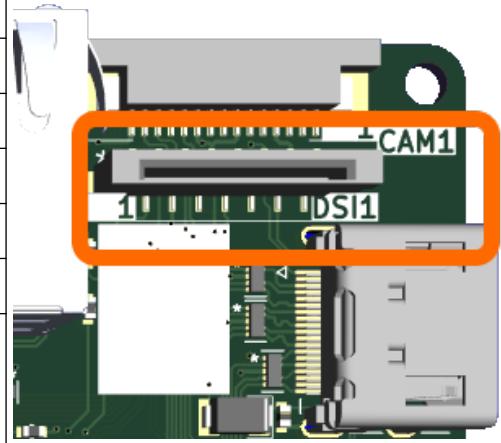
## Raspberry Pi 40 Pin Header

|                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------------------------------------------------|
| Designator(s): J36                                                                                                                                                                                                                                                                                                                                                                                                                       | Color: Painted as in image |  |
| MCU Pins: N/A                                                                                                                                                                                                                                                                                                                                                                                                                            |                            |                                                                                     |
| Power: N/A                                                                                                                                                                                                                                                                                                                                                                                                                               |                            |                                                                                     |
| ESD Protection: None                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |                                                                                     |
| LED Indicators: None                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |                                                                                     |
| PN: 12251220ANG05115001                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |                                                                                     |
| Standard Raspberry Pi 40 pin header. Color coding to the right is used on the 40 pin header used with the KGP 4x2209.                                                                                                                                                                                                                                                                                                                    |                            |                                                                                     |
| <p><b>NOTE:</b> The pins listed in the diagram to the right may not be correct for all SBCs. This includes the alternate functions that are available on a standard Raspberry Pi.</p> <p><b>NOTE:</b> The process for enabling IO pins both for SBC operations as well as Klipper will be different for different SBCs. The process and utilities to enable and access the header pins should be documented by the SBC manufacturer.</p> |                            |                                                                                     |

**Camera CSI Connector**

|                                                                                                                                               |                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Designator(s): J41                                                                                                                            | Color: Tan and Black                                                               |
| MCU Pins: N/A                                                                                                                                 |                                                                                    |
| Power: N/A                                                                                                                                    |                                                                                    |
| ESD Protection: None                                                                                                                          |                                                                                    |
| LED Indicators: None                                                                                                                          |                                                                                    |
| PN: FC10-515DCT-00                                                                                                                            |                                                                                    |
| Standard Raspberry Pi CSI Camera Connector wired as <b>CSI1</b> on the SBC.                                                                   |  |
| <b>NOTE:</b> In testing different SBCs, it was found that several do not have functional CSI ports. This is noted elsewhere in this document. |                                                                                    |
| <b>CRITICAL: Under NO Circumstances is a device connected to the CSI connector is to be Added or Removed while Power is Applied</b>           |                                                                                    |

**Camera DSI Connector**

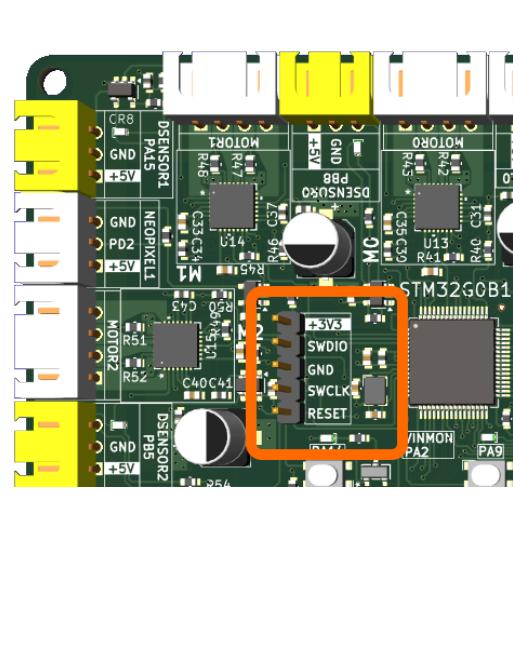
|                                                                                                                                               |                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Designator(s): J23                                                                                                                            | Color: Tan and Black                                                                 |
| MCU Pins: N/A                                                                                                                                 |                                                                                      |
| Power: N/A                                                                                                                                    |                                                                                      |
| ESD Protection: None                                                                                                                          |                                                                                      |
| LED Indicators: None                                                                                                                          |                                                                                      |
| PN: 1.0k-GL-15PB                                                                                                                              |                                                                                      |
| Standard Raspberry Pi CSI Camera Connector wired as <b>DSI1</b> on the SBC.                                                                   |  |
| <b>NOTE:</b> In testing different SBCs, it was found that several do not have functional DSI ports. This is noted elsewhere in this document. |                                                                                      |
| <b>CRITICAL: Under NO Circumstances is a device connected to the DSI connector is to be Added or Removed while Power is Applied</b>           |                                                                                      |

## MCU Interfaces

As noted elsewhere, the MCU interfaces are designed for standard 3D Printer devices. Where the interface can be used for purposes other than

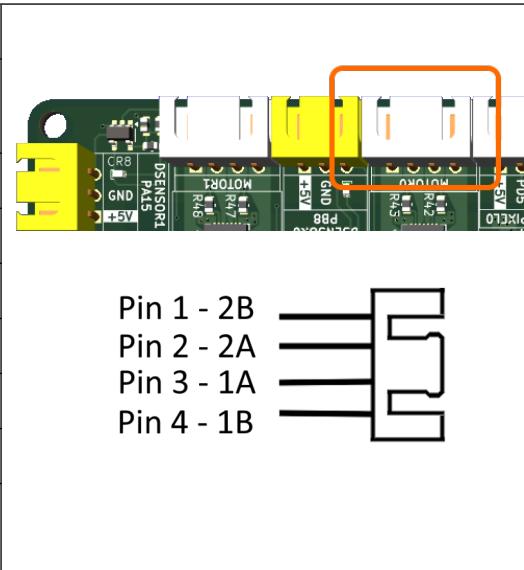
### SWD Header

|                                                                                                                                                        |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J2                                                                                                                                      | Color: Black |
| MCU Pin(s): NRESET, SWDIO, BOOT0/SWCLK                                                                                                                 |              |
| Power: +3.3V                                                                                                                                           |              |
| Logic Level(s): +3.3V                                                                                                                                  |              |
| Signal(s) Direction: Input and Output                                                                                                                  |              |
| ESD Protection: None                                                                                                                                   |              |
| LED Indicators: BOOT0/Status LED: CR4 – Green, DFU Active LED: CR17 - Orange                                                                           |              |
| PN: PH-00759                                                                                                                                           |              |
| Header access to Reset, DFU Mode and SWD debug port.                                                                                                   |              |
| <b>NOTE:</b> SWDIO_TMC2DIR (PA13) is used for Klipper printer operation. BOOT0_SWCLK_LED (PA14), DFULED (PA9) should not be referenced in printer.cfg. |              |



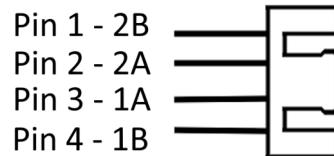
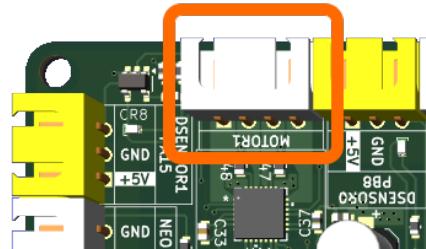
### JST XH 4 Pin MOTOR0 Connector

|                                                                               |              |
|-------------------------------------------------------------------------------|--------------|
| Designator(s): J13                                                            | Color: White |
| MCU Pin(s): EN-PC9, DIR-PA10, STEP-PB15, UART-PC15/Address-0, DIAG-PB4        |              |
| Power: N/A                                                                    |              |
| Logic Level(s): N/A                                                           |              |
| Signal(s) Direction: N/A                                                      |              |
| ESD Protection: Fair                                                          |              |
| LED Indicators: None                                                          |              |
| PN: XH-W-4A                                                                   |              |
| The connector is wired to a TMC2209 stepper motor driver with UART interface. |              |



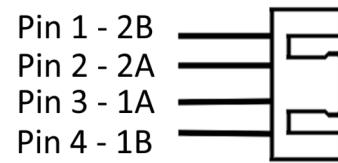
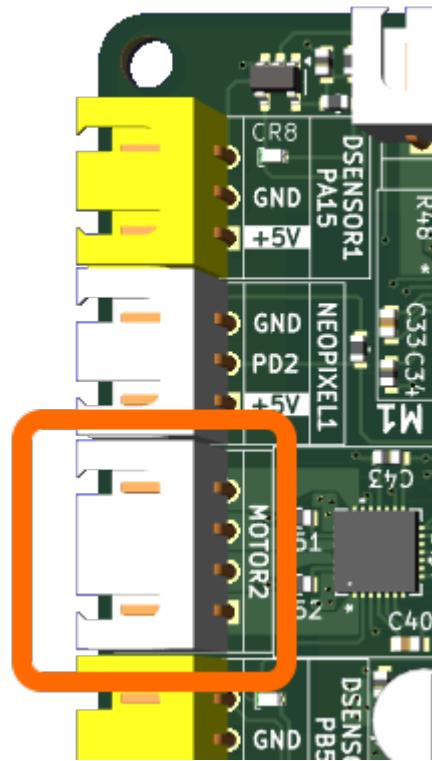
**JST XH 4 Pin MOTOR1 Connector**

|                                                                               |              |
|-------------------------------------------------------------------------------|--------------|
| Designator(s): J25                                                            | Color: White |
| MCU Pin(s): EN-PB9, DIR-PC11, STEP-PC10, UART-PC15/Address-1, DIAG-PC13       |              |
| Power: N/A                                                                    |              |
| Signal(s) Direction: N/A                                                      |              |
| Logic Level(s): N/A                                                           |              |
| ESD Protection: Fair                                                          |              |
| LED Indicators: None                                                          |              |
| PN: XH-W-4A                                                                   |              |
| The connector is wired to a TMC2209 stepper motor driver with UART interface. |              |



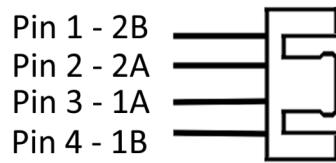
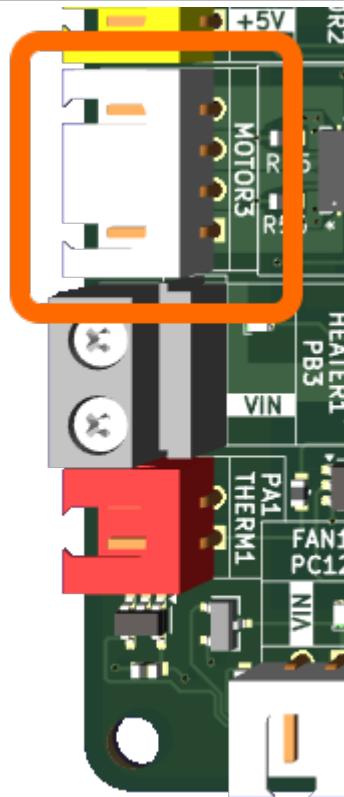
**JST XH 4 Pin MOTOR2 Connector**

|                                                                               |              |
|-------------------------------------------------------------------------------|--------------|
| Designator(s): J26                                                            | Color: White |
| MCU Pin(s): EN-PC14, DIR-PA13, STEP-PA3, UART-PC15/Address-2, DIAG-PC0        |              |
| Power: N/A                                                                    |              |
| Logic Level(s): N/A                                                           |              |
| Signal(s) Direction: N/A                                                      |              |
| ESD Protection: Fair                                                          |              |
| LED Indicators: None                                                          |              |
| PN: XH-W-4A                                                                   |              |
| The connector is wired to a TMC2209 stepper motor driver with UART interface. |              |



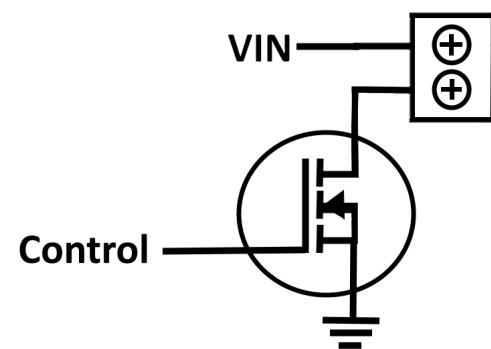
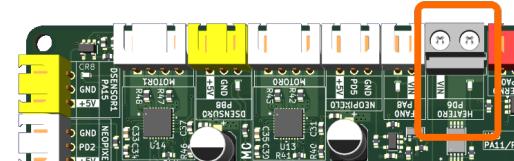
**JST XH 4 Pin MOTOR3 Connector**

|                                                                               |              |
|-------------------------------------------------------------------------------|--------------|
| Designator(s): J27                                                            | Color: White |
| MCU Pin(s): EN-PC2, DIR-PB10, STEP-PB12, UART-PC15/Address-3, DIAG-PC3        |              |
| Power: N/A                                                                    |              |
| Logic Level(s): N/A                                                           |              |
| Signal(s) Direction: N/A                                                      |              |
| ESD Protection: Fair                                                          |              |
| LED Indicators: None                                                          |              |
| PN: XH-W-4A                                                                   |              |
| The connector is wired to a TMC2209 stepper motor driver with UART interface. |              |

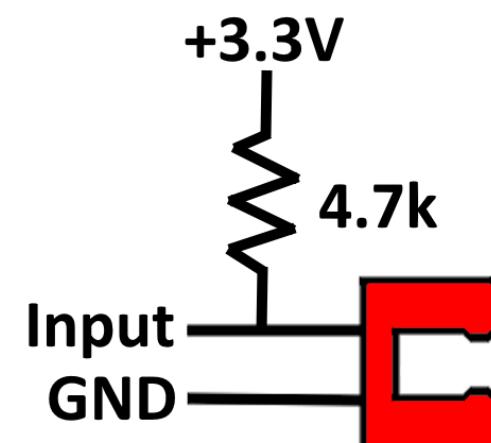
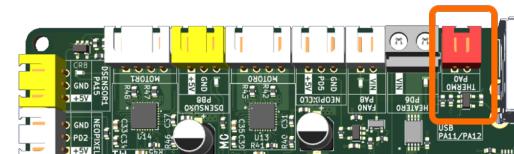


**Screw Terminal HEATER0 Connector**

|                                                                                                                                                                        |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Designator(s): J9                                                                                                                                                      | Color: Grey |
| MCU Pin(s): PD6                                                                                                                                                        |             |
| Power: VIN                                                                                                                                                             |             |
| Logic Level(s): N/A                                                                                                                                                    |             |
| Signal(s) Direction: Output                                                                                                                                            |             |
| ESD Protection: Good                                                                                                                                                   |             |
| LED Indicators: CR5 – Red                                                                                                                                              |             |
| PN: WJ126W-5.0-2P                                                                                                                                                      |             |
| Heater Driver can be used for bed or extruder heaters.<br>Heater Driver can also be used for other devices requiring<br>VIN power including SSRs, fans and LED strips. |             |
| Maximum recommended current draw is 15A                                                                                                                                |             |

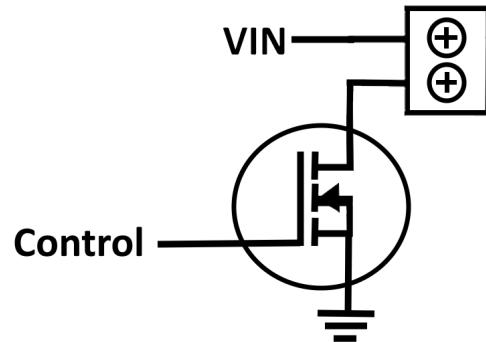
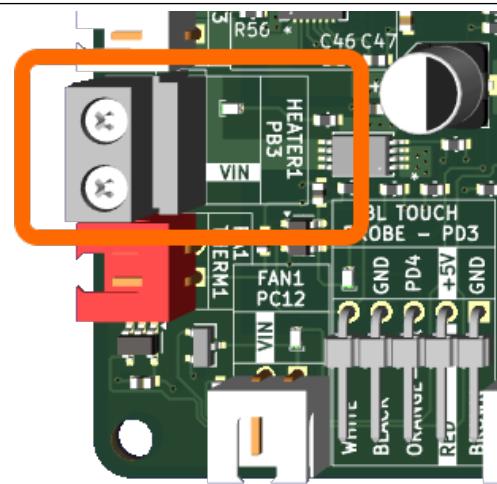
**JST XH 2 Pin THERMO0 Connector**

|                                                             |            |
|-------------------------------------------------------------|------------|
| Designator(s): J8                                           | Color: Red |
| MCU Pin(s): PA0                                             |            |
| Power: N/A                                                  |            |
| Logic Level(s): ADC Port/+3.3V                              |            |
| Signal(s) Direction: Input                                  |            |
| ESD Protection: Good                                        |            |
| LED Indicators: None                                        |            |
| PN: ZX-XH2.54-2PWZ-R                                        |            |
| ADC Input typically used for sensing thermistor resistance. |            |



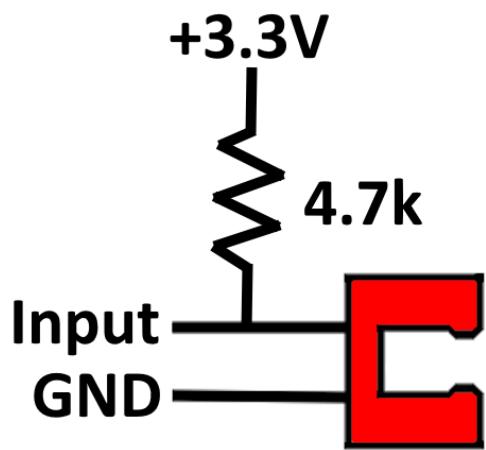
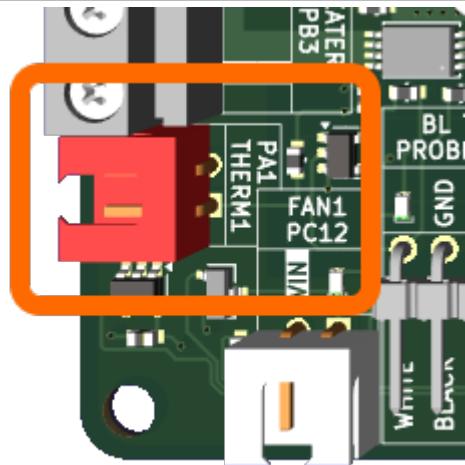
**Screw Terminal HEATER1 Connector**

|                                                                                                                                                                        |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Designator(s): J11                                                                                                                                                     | Color: Grey |
| MCU Pin(s): PB3                                                                                                                                                        |             |
| Power: VIN                                                                                                                                                             |             |
| Logic Level(s): N/A                                                                                                                                                    |             |
| Signal(s) Direction: Output                                                                                                                                            |             |
| ESD Protection: Good                                                                                                                                                   |             |
| LED Indicators: CR6 – Red                                                                                                                                              |             |
| PN: WJ126W-5.0-2P                                                                                                                                                      |             |
| Heater Driver can be used for bed or extruder heaters.<br>Heater Driver can also be used for other devices requiring<br>VIN power including SSRs, fans and LED strips. |             |
| Maximum recommended current draw is 15A                                                                                                                                |             |



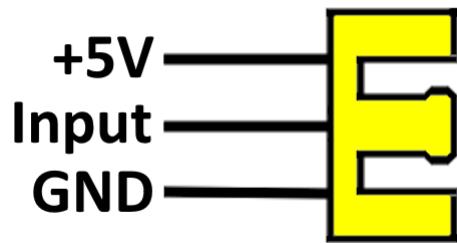
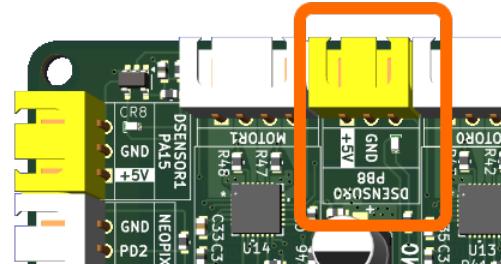
**JST XH 2 Pin THERMO1 Connector**

|                                                             |            |
|-------------------------------------------------------------|------------|
| Designator(s): J10                                          | Color: Red |
| MCU Pin(s): PA1                                             |            |
| Power: N/A                                                  |            |
| Logic Level(s): ADC Port/+3.3V                              |            |
| Signal(s) Direction: Input                                  |            |
| ESD Protection: Good                                        |            |
| LED Indicators: None                                        |            |
| PN: ZX-XH2.54-2PWZ-R                                        |            |
| ADC Input typically used for sensing thermistor resistance. |            |

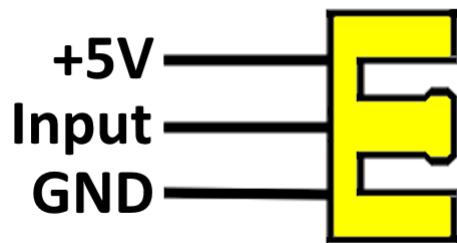
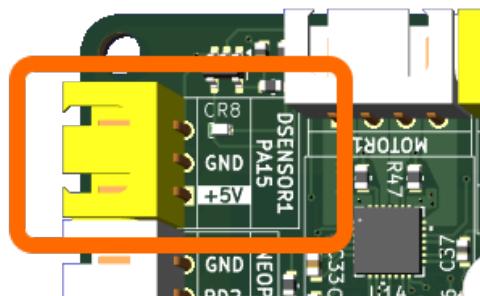


**JST XH 3 Pin DSENSOR0 Connector**

|                                                                                                                                                                         |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Designator(s): J12                                                                                                                                                      | Color: Yellow |
| MCU Pin(s): PB8                                                                                                                                                         |               |
| Power: +5V                                                                                                                                                              |               |
| Logic Level(s): 5V                                                                                                                                                      |               |
| Signal(s) Direction: Input                                                                                                                                              |               |
| ESD Protection: Good                                                                                                                                                    |               |
| LED Indicators: CR7 – Yellow                                                                                                                                            |               |
| PN: ZX-XH2.54-3PWZ-Y                                                                                                                                                    |               |
| 5V Logic Digital Input with Yellow LED Indicator. Tested with various physical switch endstops as well as 5V Inductive Sensors, filament presence and movement sensors. |               |
| Connector can be used for unswitched 5V power to Fans, LEDs, etc.                                                                                                       |               |

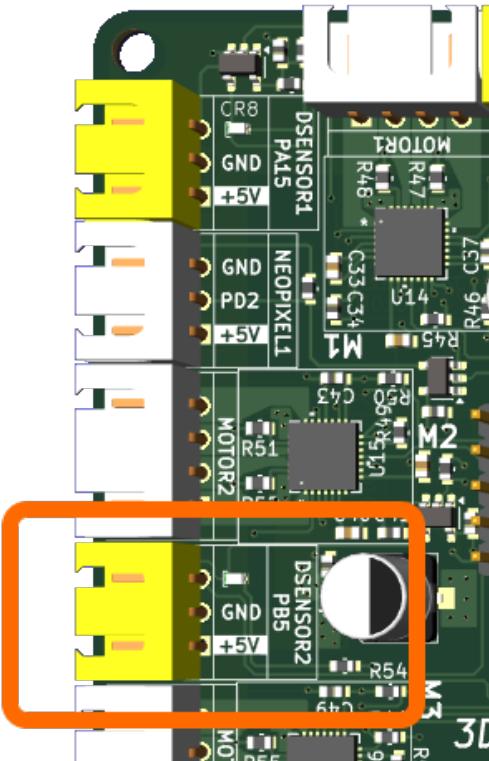
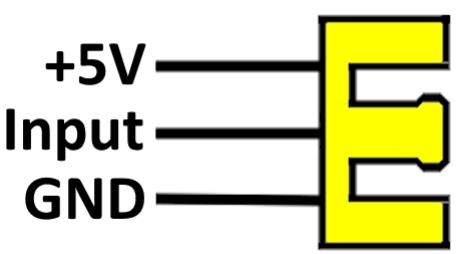
**JST XH 3 Pin DSENSOR1 Connector**

|                                                                                                                                                                         |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Designator(s): J15                                                                                                                                                      | Color: Yellow |
| MCU Pin(s): PA15                                                                                                                                                        |               |
| Power: +5V                                                                                                                                                              |               |
| Logic Level(s): 5V                                                                                                                                                      |               |
| Signal(s) Direction: Input                                                                                                                                              |               |
| ESD Protection: Good                                                                                                                                                    |               |
| LED Indicators: CR8 – Yellow                                                                                                                                            |               |
| PN: ZX-XH2.54-3PWZ-Y                                                                                                                                                    |               |
| 5V Logic Digital Input with Yellow LED Indicator. Tested with various physical switch endstops as well as 5V Inductive Sensors, filament presence and movement sensors. |               |
| Connector can be used for unswitched 5V power to Fans, LEDs, etc.                                                                                                       |               |



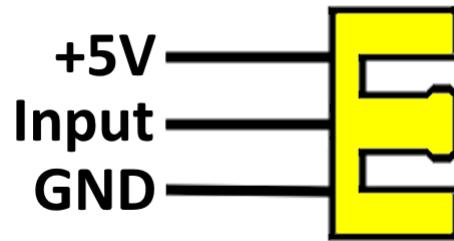
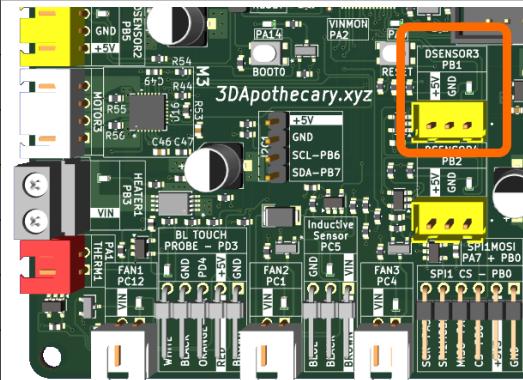
**JST XH 3 Pin DSENSOR2 Connector**

|                                                                                                                                                                         |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Designator(s): J14                                                                                                                                                      | Color: Yellow |
| MCU Pin(s): PB5                                                                                                                                                         |               |
| Power: +5V                                                                                                                                                              |               |
| Logic Level(s): 5V                                                                                                                                                      |               |
| Signal(s) Direction: Input                                                                                                                                              |               |
| ESD Protection: Good                                                                                                                                                    |               |
| LED Indicators: CR9 – Yellow                                                                                                                                            |               |
| PN: ZX-XH2.54-3PWZ-Y                                                                                                                                                    |               |
| 5V Logic Digital Input with Yellow LED Indicator. Tested with various physical switch endstops as well as 5V Inductive Sensors, filament presence and movement sensors. |               |
| Connector can be used for unswitched 5V power to Fans, LEDs, etc.                                                                                                       |               |

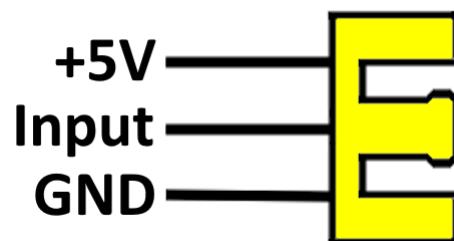
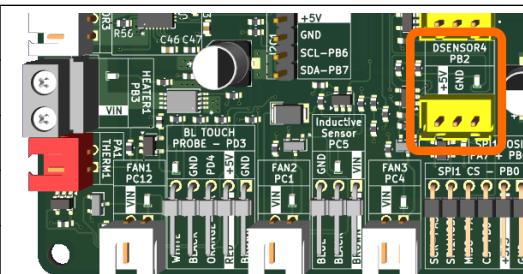



**JST XH 3 Pin DSENSOR3 Connector**

|                                                                                                                                                                         |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Designator(s): J29                                                                                                                                                      | Color: Yellow |
| MCU Pin(s): PB1                                                                                                                                                         |               |
| Power: +5V                                                                                                                                                              |               |
| Logic Level(s): 5V                                                                                                                                                      |               |
| Signal(s) Direction: Input                                                                                                                                              |               |
| ESD Protection: Good                                                                                                                                                    |               |
| LED Indicators: CR18 – Yellow                                                                                                                                           |               |
| PN: ZX-XH2.54-3PWZ-Y                                                                                                                                                    |               |
| 5V Logic Digital Input with Yellow LED Indicator. Tested with various physical switch endstops as well as 5V Inductive Sensors, filament presence and movement sensors. |               |
| Connector can be used for unswitched 5V power to Fans, LEDs, etc.                                                                                                       |               |

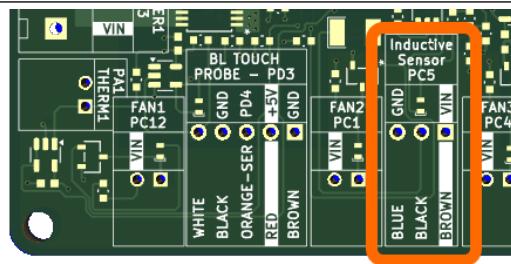
**JST XH 3 Pin DSENSOR4 Connector**

|                                                                                                                                                                         |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Designator(s): J30                                                                                                                                                      | Color: Yellow |
| MCU Pin(s): PB2                                                                                                                                                         |               |
| Power: +5V                                                                                                                                                              |               |
| Logic Level(s): 5V                                                                                                                                                      |               |
| Signal(s) Direction: Input                                                                                                                                              |               |
| ESD Protection: Good                                                                                                                                                    |               |
| LED Indicators: CR19 – Yellow                                                                                                                                           |               |
| PN: ZX-XH2.54-3PWZ-Y                                                                                                                                                    |               |
| 5V Logic Digital Input with Yellow LED Indicator. Tested with various physical switch endstops as well as 5V Inductive Sensors, filament presence and movement sensors. |               |
| Connector can be used for unswitched 5V power to Fans, LEDs, etc.                                                                                                       |               |



## Inductive Sensor Header

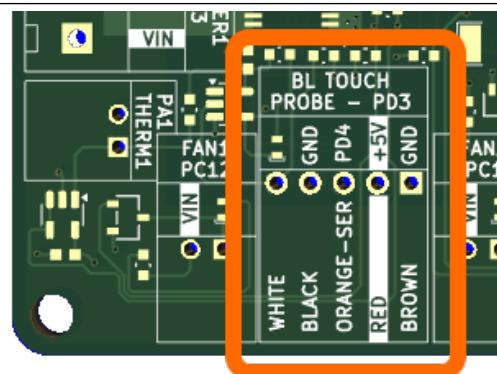
|                                                                                                                                                                                                                                |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J17                                                                                                                                                                                                             | Color: Black |
| MCU Pin(s): PC5                                                                                                                                                                                                                |              |
| Power: VIN                                                                                                                                                                                                                     |              |
| Logic Level(s): VIN                                                                                                                                                                                                            |              |
| Signal(s) Direction: Input                                                                                                                                                                                                     |              |
| ESD Protection: Good                                                                                                                                                                                                           |              |
| LED Indicators: CR10 – Yellow                                                                                                                                                                                                  |              |
| PN: P125-1103A0BR138A1                                                                                                                                                                                                         |              |
| Header for Inductive Z Axis sensors like the Omron TL-Q5MC2-Z Inductive Probe. There is an internal 10k pullup on the "Input" pin so the header will work with sensors with push-pull drivers or open drain/collector outputs. |              |
| <b>NOTE:</b> This header is designed for sensors that work at VIN and not +5V or +3.3V                                                                                                                                         |              |
| <b>NOTE:</b> Colors on PCB silkscreen are standard wire colors for this type of inductive probe                                                                                                                                |              |



**GND** —————  
**Input** —————  
**VIN** —————

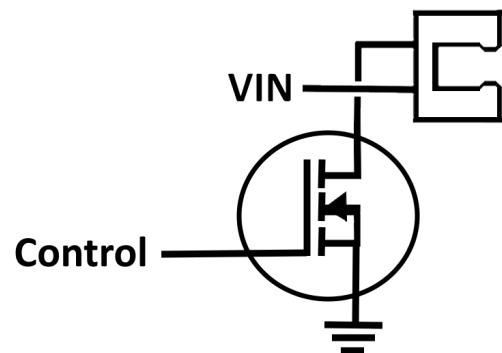
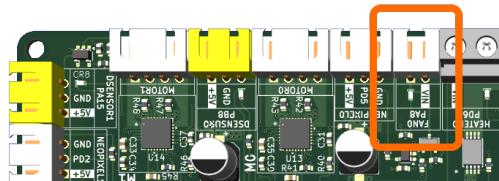
## BLTouch Header

|                                                                                                                                                                     |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J18                                                                                                                                                  | Color: Black |
| MCU Pin(s): PD4-SERVO, PD3-PROBE                                                                                                                                    |              |
| Power: +5V                                                                                                                                                          |              |
| Logic Level(s): +3.3V                                                                                                                                               |              |
| Signal(s) Direction: PD4-Input/Ouput, PD3-Input                                                                                                                     |              |
| ESD Protection: None                                                                                                                                                |              |
| LED Indicators: CR12 – Yellow                                                                                                                                       |              |
| PN: P125-1105A0BR138A1                                                                                                                                              |              |
| Header for Antclabs BLTouch Z-Axis endstop sensor and similar products. There is a 10k pull up on the PROBE pin and the SERVO pin is connected directly to the MCU. |              |
| <b>NOTE:</b> Activating the Antclabs BLTouch “5V Logic Mode” is not required with the KGP 4x2209.                                                                   |              |
| <b>NOTE:</b> Colors on PCB silkscreen are wire colors for the Antclabs BLTouch. Wiring colors may vary with similar products.                                       |              |



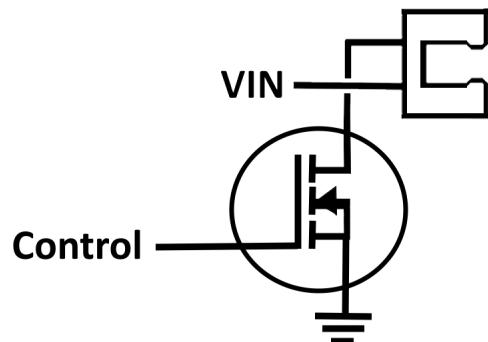
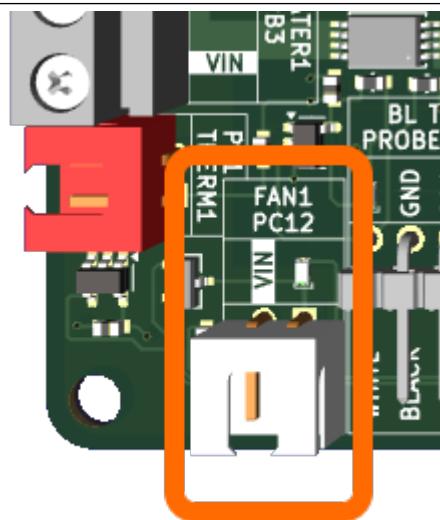
**JST XH 2 Pin FAN0 Connector**

|                                                                                           |              |
|-------------------------------------------------------------------------------------------|--------------|
| Designator(s): J19                                                                        | Color: White |
| MCU Pin(s): PA8                                                                           |              |
| Power: VIN                                                                                |              |
| Logic Level(s): N/A                                                                       |              |
| Signal(s) Direction: Output                                                               |              |
| ESD Protection: Good                                                                      |              |
| LED Indicators: CR13 – Blue                                                               |              |
| PN: XH-W-2A                                                                               |              |
| Fan can also be used for other devices requiring VIN power including LED strips and SSRs. |              |
| Maximum recommended current draw is 500mA                                                 |              |



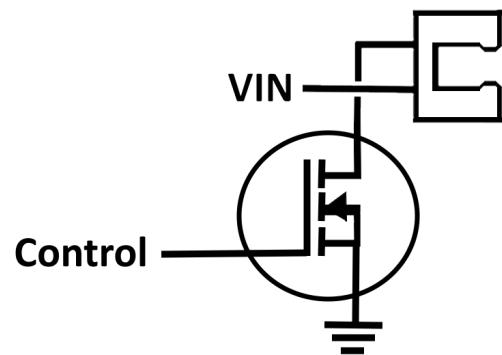
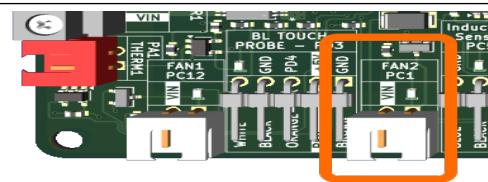
**JST XH 2 Pin FAN1 Connector**

|                                                                                           |              |
|-------------------------------------------------------------------------------------------|--------------|
| Designator(s): J20                                                                        | Color: White |
| MCU Pin(s): PPC12                                                                         |              |
| Power: VIN                                                                                |              |
| Logic Level(s): N/A                                                                       |              |
| Signal(s) Direction: Output                                                               |              |
| ESD Protection: Good                                                                      |              |
| LED Indicators: CR14 – Blue                                                               |              |
| PN: XH-W-2A                                                                               |              |
| Fan can also be used for other devices requiring VIN power including LED strips and SSRs. |              |
| Maximum recommended current draw is 500mA                                                 |              |

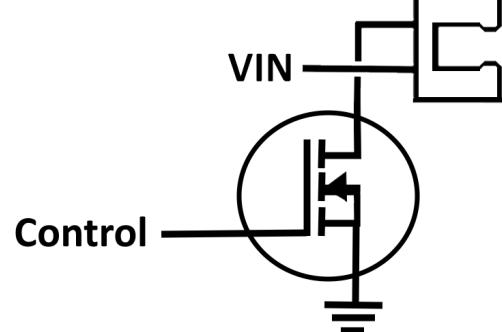
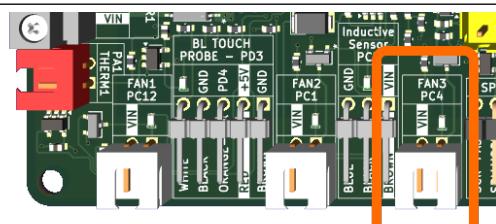


**JST XH 2 Pin FAN2 Connector**

|                                                                                           |              |
|-------------------------------------------------------------------------------------------|--------------|
| Designator(s): J21                                                                        | Color: White |
| MCU Pin(s): PC1                                                                           |              |
| Power: VIN                                                                                |              |
| Logic Level(s): N/A                                                                       |              |
| Signal(s) Direction: Output                                                               |              |
| ESD Protection: Good                                                                      |              |
| LED Indicators: CR15 – Blue                                                               |              |
| PN: XH-W-2A                                                                               |              |
| Fan can also be used for other devices requiring VIN power including LED strips and SSRs. |              |
| Maximum recommended current draw is 500mA                                                 |              |

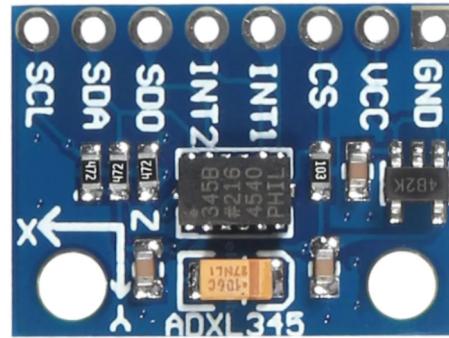
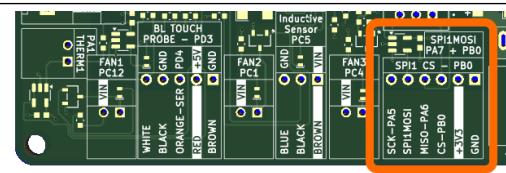
**JST XH 2 Pin FAN3 Connector**

|                                                                                           |              |
|-------------------------------------------------------------------------------------------|--------------|
| Designator(s): J22                                                                        | Color: White |
| MCU Pin(s): PC4                                                                           |              |
| Power: VIN                                                                                |              |
| Logic Level(s): N/A                                                                       |              |
| Signal(s) Direction: Output                                                               |              |
| ESD Protection: Good                                                                      |              |
| LED Indicators: CR16 – Blue                                                               |              |
| PN: XH-W-2A                                                                               |              |
| Fan can also be used for other devices requiring VIN power including LED strips and SSRs. |              |
| Maximum recommended current draw is 500mA                                                 |              |



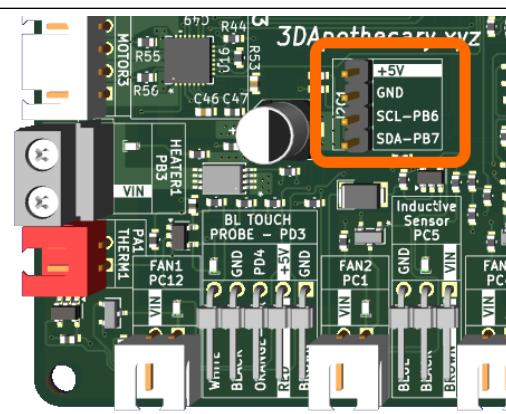
## SPI Header

|                                                                                                                                                                                                             |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J5                                                                                                                                                                                           | Color: Black |
| MCU Pin(s): PA5-SPISCK, PA6-MISO, PA7-MOSI with Note, PB0-ADXLCS                                                                                                                                            |              |
| Power: +3.3V                                                                                                                                                                                                |              |
| Logic Level(s): 3.3V                                                                                                                                                                                        |              |
| Signal(s) Direction: Input/Output with Note                                                                                                                                                                 |              |
| ESD Protection: None                                                                                                                                                                                        |              |
| LED Indicators: None                                                                                                                                                                                        |              |
| PN: P125-1106A0BR138A1                                                                                                                                                                                      |              |
| Direct Connection to MCU SPI1 bus or IO Pins. Pin ordering allows for simple wiring to ADXL345 Inductive Sensor PCB.                                                                                        |              |
| When wiring an ADXL345 PCB, like the one to the right, the two middle "INT#" pins are left unconnected.                                                                                                     |              |
| <b>NOTE:</b> The SPI header IO Pins can be used for other purposes but note that the "MOSI" pin is PA7 logically ORed with PB0 to allow SPI operation with EXP1/EXP2 as recommended in ADXL345's datasheet. |              |



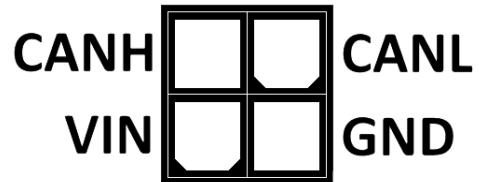
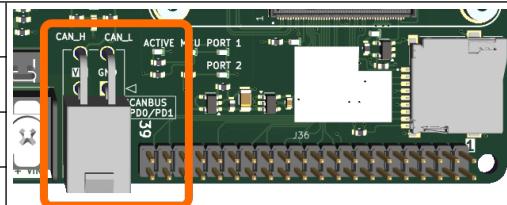
## I2C Header

|                                                                                                                       |              |
|-----------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J7                                                                                                     | Color: Black |
| MCU Pin(s): PB6-SCL, SDA-PB7                                                                                          |              |
| Power: +5V                                                                                                            |              |
| Logic Level(s): 3.3V                                                                                                  |              |
| Signal(s) Direction: Input/Output                                                                                     |              |
| ESD Protection: None                                                                                                  |              |
| LED Indicators: None                                                                                                  |              |
| PN: PH-00316                                                                                                          |              |
| Two IO Pins with 4.7k pull ups to +3.3V are available for use as an I2C interface or as general purpose input/output. |              |



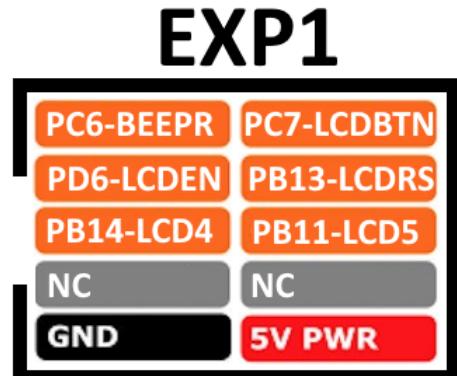
**Molex Mini-Fit CAN Connector**

|                                                                                                            |              |
|------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J6                                                                                          | Color: White |
| MCU Pin(s): PD0-CAN1RX, PD1-CAN1TX                                                                         |              |
| Power: VIN                                                                                                 |              |
| Logic Level(s): N/A                                                                                        |              |
| Signal(s) Direction: Input/Output                                                                          |              |
| ESD Protection: Moderate                                                                                   |              |
| LED Indicators: None                                                                                       |              |
| PN: 0039301040                                                                                             |              |
| CAN Bus Interface with VIN Power.<br><br>Power cabling must be able to carry required current to toolhead. |              |
| <b>WARNING: Removal of CAN Connector during operation will result in the Host crashing</b>                 |              |

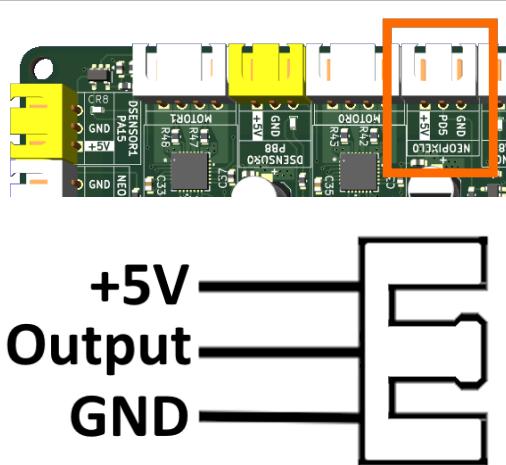


**EXP1/EXP2 Headers**

|                                                                                                                                                                                                                                                                                                                                  |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J3, J4                                                                                                                                                                                                                                                                                                            | Color: Black |
| MCU Pin(s): BEEPER-PC6, LCDBTN-PC7, LCDEN-PD6, LCDRS-PB13, LCD4-PB14, LCD5-PB11, SPI1MISO-PA5, SPI1SCK-PA6, LCDENCA-PC8, LCDCS-PA4, LCDENCB-PD9, SPI1MOSI-PA7                                                                                                                                                                    |              |
| Power: +3.3V, +5V                                                                                                                                                                                                                                                                                                                |              |
| Logic Level(s): 3.3V                                                                                                                                                                                                                                                                                                             |              |
| Signal(s) Direction: Input/Output                                                                                                                                                                                                                                                                                                |              |
| ESD Protection: None                                                                                                                                                                                                                                                                                                             |              |
| LED Indicators: None                                                                                                                                                                                                                                                                                                             |              |
| PN: 302-S101                                                                                                                                                                                                                                                                                                                     |              |
| EXP1/EXP2 follows the requirements for the standard interface for Klipper MCU based user interface, the BTT MINI 12864. This interface provides a graphical LCD Display with NeoPixel backlighting and a rotary push button switch for navigation.                                                                               |              |
| More complex user interfaces are available for commercial Marlin based 3D Printers but the BTT MINI 12864 uses all of the capabilities of a Klipper based MCU user interface.<br>Superior user interface functionality on the 3D printer using the KGP 4x2209 can be had using the DSI interface and a full color/touch display. |              |
| All the IO pins (including the SPI1 bus pins) in the EXP1 and EXP2 come directly from the MCU and can be used for other purposes and functions.                                                                                                                                                                                  |              |
| <b>CRITICAL: Under NO Circumstances is a device connected to either EXP1 or EXP2 headers is to be Added or Removed while Power is Applied.</b>                                                                                                                                                                                   |              |

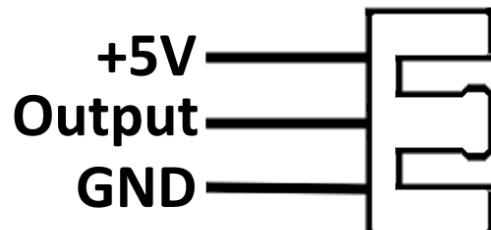
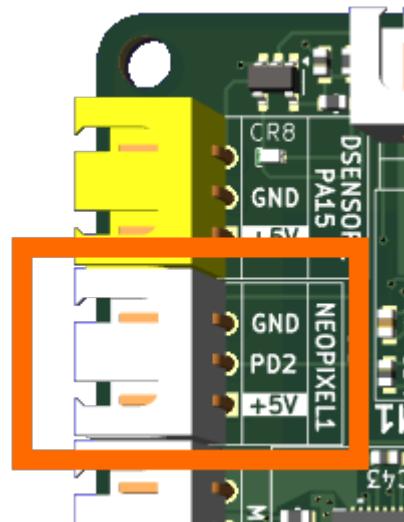


**JST XH 3 Pin NEOPIXEL0 Connector**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J24                                                                                                                                                                                                                                                                                                                                                                                                                             | Color: White |
| MCU Pin(s): PD5                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| Power: +5V                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| Logic Level(s): 5V                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| Signal(s) Direction: Output                                                                                                                                                                                                                                                                                                                                                                                                                    |              |
| ESD Protection: Good                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
| LED Indicators: None                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
| PN: XH-W-3A                                                                                                                                                                                                                                                                                                                                                                                                                                    |              |
| Interface is designed for WS2812 NewPixel LEDs and can support a string of them.                                                                                                                                                                                                                                                                                                                                                               |              |
| <p><b>NOTE:</b> NeoPixel Displays can draw up to 60mA of current during operation. If large numbers of LEDs are required for lighting the interior of the 3D printer, it is recommended that LED strip lighting, that is powered by VIN be considered.</p> <p><b>WARNING:</b> NeoPixel animations (such as “breathing”) add to the communications load between the MCU and SBC possibly resulting in unstable operation of the 3D printer.</p> |              |
|  <pre> +5V --- Pin 2 Output --- Pin 3 GND --- Pin 1 </pre>                                                                                                                                                                                                                                                                                                   |              |

**JST XH 3 Pin NEOPIXEL1 Connector**

|                                                                                                                                                                                                                                                     |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Designator(s): J28                                                                                                                                                                                                                                  | Color: White |
| MCU Pin(s): PD2                                                                                                                                                                                                                                     |              |
| Power: +5V                                                                                                                                                                                                                                          |              |
| Logic Level(s): 5V                                                                                                                                                                                                                                  |              |
| Signal(s) Direction: Output                                                                                                                                                                                                                         |              |
| ESD Protection: Good                                                                                                                                                                                                                                |              |
| LED Indicators: None                                                                                                                                                                                                                                |              |
| PN: XH-W-3A                                                                                                                                                                                                                                         |              |
| Interface is designed for WS2812 NewPixel LEDs and can support a string of them.                                                                                                                                                                    |              |
| <b>NOTE:</b> NeoPixel Displays can draw up to 60mA of current during operation. If large numbers of LEDs are required for lighting the interior of the 3D printer, it is recommended that LED strip lighting, that is powered by VIN be considered. |              |
| <b>WARNING:</b> NeoPixel animations (such as "breathing") add to the communications load between the MCU and SBC possibly resulting in unstable operation of the 3D printer.                                                                        |              |



## FAQs

Q: None of the stepper motors or endstop connectors are labelled for where they are used (for example the X, Y or Z axes), how do I know how to connect the KGP 4x2209 into my printer?

A: As discussed in “Orthogonality” in this document , the KGP 4x2209 takes advantage of Klipper’s ability to work features and functions that are not predefined

Q: How is sensorless homing invoked?

A: In the Klipper printer.cfg, using the DIAG pin specific to each TMC2209 stepper motor driver

Q: What version of OS should be loaded onto the SBC?

A: Unless there is a need for a Linux user interface, the “minimum” version of the selected OS will work without issue

Q: What is the minimum amount of SBC DDR memory is required?

A: Klipper will run comfortably with 1GB of DDR

Q: What is the minimum SD Card required?

A: 32GB is the minimum size. 64GB or 128GB will provide a comfortable amount of storage for the OS, Klipper, G-Code files and additional applications and utilities

Q: How much eMMC should be on the SBC?

A: As discussed in this document, the KGP 4x2209 was designed for SBCs with no eMMC. If an SBC with eMMC is to be used with the KGP 4x2209, the eMMC will have to be loaded on a separate board.

## Useful Links

KGP 4x2209 GitHub containing schematics and other technical information:

[http://github.com/3dApothecary-xyz/KGP\\_4x2209](http://github.com/3dApothecary-xyz/KGP_4x2209)

Sample Klipper `printer.cfg` for the KGP 4x2209:

[https://raw.githubusercontent.com/3dApothecary-xyz/KGP\\_4x2209/main/config/kgp\\_4x2209-sample-printer.cfg](https://raw.githubusercontent.com/3dApothecary-xyz/KGP_4x2209/main/config/kgp_4x2209-sample-printer.cfg)

KGP 4x2209 functional test information:

<https://github.com/3dApothecary-xyz/FunctionalTest/tree/main>

Klipper Introduction:

<https://www.klipper3d.org/>

Esoterical CAN Bus Guide:

<https://canbus.esoterical.online/>

Raspberry Pi Imager:

<https://www.raspberrypi.com/software/>

KIAUH GitHub:

<https://github.com/dw-0/kiauh>

CAN Bus Introduction:

The sample Klipper `printer.cfg` for the KGP 4x2209:

<https://www.ti.com/lit/an/sloa101b/sloa101b.pdf>

## SBC Information

Raspberry Pi CM4:

<https://www.raspberrypi.com/products/compute-module-4/>

Raspberry Pi CM5:

<https://www.raspberrypi.com/products/compute-module-5/>

BigTreeTech (BTT) CB1:

<https://bttwiki.com/CB1.html>

BigTreeTech (BTT) CB2:

<https://bttwiki.com/CB2.html>

Banana Pi BPI CM4:

[https://docs.banana-pi.org/en/BPI-CM4/BananaPi\\_BPI-CM4](https://docs.banana-pi.org/en/BPI-CM4/BananaPi_BPI-CM4)

Orange Pi CM4:

<http://www.orangepi.org/html/hardWare/computerAndMicrocontrollers/details/Orange-Pi-CM4-1.html>

Radxa CM3:

<https://radxa.com/products/cm/cm3/>

Pine64 SOQuartz:

[https://pine64.org/documentation/SOQuartz/\\_full/](https://pine64.org/documentation/SOQuartz/_full/)

## Update History

2025.08.20 – Initial release.