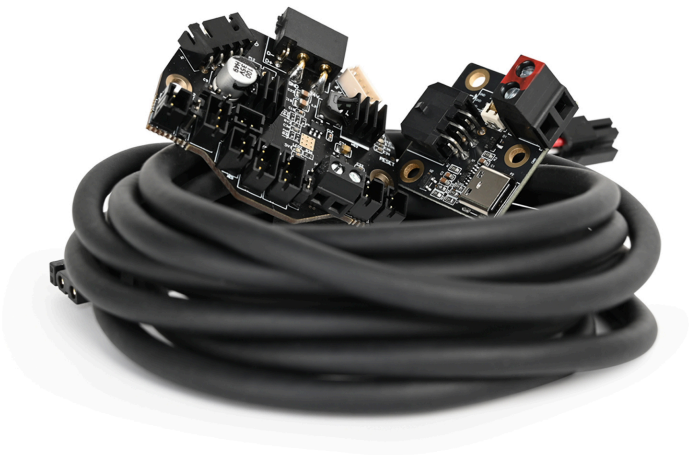
Nitehawk-36 Toolboard



Introduction

Nitehawk-36 by LDO is a toolboard featuring RP2040 MCU, TMC2209 stepper drive, ADXL345 accelerometer, and USB port. Nitehawk-36's USB based connection method allows for a simple and easy setup compared to other CAN toolboards. The USB connnection also allows for a secondary USB port to connect your nozzle webcam or eddy current probe.

Features

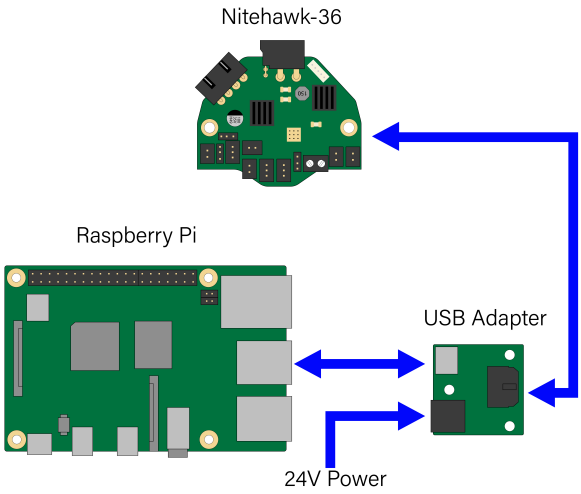
- **Convenient wiring**, no more complicated and error prone breakout cables - nitehawk only requires 24V power and a USB connector to the RPI host.
- **USB Klipper connection**, no additional software or hardware setup compared to CAN.
- **Secondary USB port**, an onboard USB port allows you to connect a second USB device to your toolhead without running an additional umbilical cable.
- **Custom toolhead cable**, a single combined USB data and power cable rated for drag chain use, but can also be used in umbilical configuration.
- **Convenient Input Shaping**, run input shaper calibration at anytime with an onboard accelerometer.
- **Tacho enabled HEF**, the hotend fan port is three pin tachometer compatible, allowing for additional diagnostics and safety.

System Overview

The Nitehawk system consists of two PCBs and the Umbilical Cable. A simplified wiring diagram is shown below:

- **Nitehawk-36**, this is the main PCB, which houses the MCU, stepper driver, fan drivers, and other circuits.

- **Umbilical Cable**, this is a custom flex cable that is rated for drag chain use. It delivers 24V power to the main Nitehawk PCB while also carrying USB data.
- **USB Adapter**, this simple PCB combines 24V power from the power supply and USB data from the Raspberry Pi into a unified connection to the main Nitehawk PCB via the Umbilical cable.



Printed Parts

USB Adapter Mount

USB Adapter Mount , this is the mount for the USB adapter PCB. It is designed to be used with a standard Voron DIN clip and can be mounted in two different orientations. It also features a cover to reduce the chance of static discharge onto the PCB.

Toolboard Mount

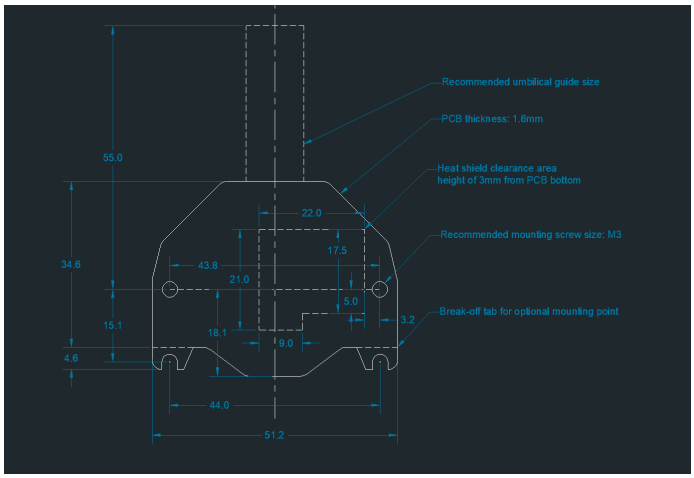
The mount for your toolboard will depend on the toolhead and specifically the extruder which the PCB is typically mounted behind. The following lists some of the toolboard mounts that are designed specifically for, or are compatible with Nitehawk-36:

- Universal Mount , a universal mount that allows the Nitehawk-36 to be mounted behind 36mm pancake motors at any orientation. Designed by camerony .
- Generic Orbiter 2 Mount , mounts the Nitehawk-36 to Orbiter 2. Should work on most toolheads.
- Xol + O2 Mount , a mount for the Xol toolhead with the Orbiter 2 extruder. Designed by jontek2 .
- G2SA and WWG2 Mounts , mounts designed for Galileo Standalone (G2SA) and WristWatch G2 (WWG2) extruders. Design by Blamm based on works from Tetsu.
- Stealthchanger PCB36 Mount , is a mounting system specifically designed for StealthChanger toolheads. Designed by ThessienDSD .
- LGX Lite Rigid Mount , a minified mount for the LGX Lite and LGX Lite V2. Designed by EllaFoxo .

If you designed a mount for Nitehawk-36 and wish for it to be highlighted here, please contact a member of the LDO team on Discord!

Designing Your Own Mount

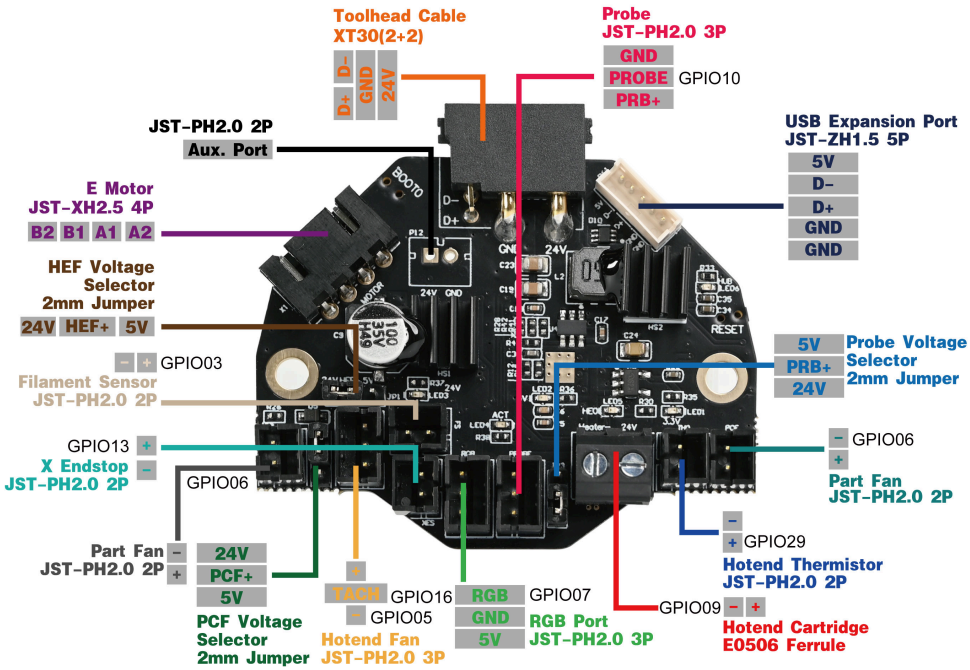
If you wish to design your own mount, we provide here some dimensions to reference:



Klipper Config Files

A Klipper Configuation can be found in the Nitehawk-36 github repo here .

Port and Pin Definitions



Device/Port	PCB Label	Connector Type	RP2040 Pin	Description
E Motor	MOTOR	JST-XH2.5 4P	gpio23/24/25/0/1 (step/dir/ena/uart/tx)	A stepper motor port for the extruder. Driven by a TMC2209 chip. The current sense resistor is 100 mΩ. Enable is active low
Filament Sensor		JST-PH2.0 2P	gpio3	Connects to the filament sensor. Supports switch based sensors only.

Probe	PRB	JST-PH2.0 3P	gpio10	Probe for bed leveling and/or Z sensing.
X Endstop	X-STOP	JST-PH2.0 2P	gpio13	Connects to the X endstop. Supports switch based endstops only.
Part Fan	PCF	JST-PH2.0 2P	gpio6	Connects to part cooling fan.
Hotend Fan	HEF	JST-PH2.0 3P	gpio5/16 (fan/tacho)	Connects to hotend fan. The fan control pin is gpio5 and the tachometer sensor pin is gpio16.
Aux. Port	(P12)	JST-PH2.0 2P (unpopulated)		This is an unpopulated port that can be optionally soldered with a PH2.0 connector. It can be used as an always-on 24V fan port.
PCF Voltage Selector		2.0mm Jumper		Selects the supply voltage of the part fan. Selection of 24V or 5V.
HEF Voltage Selector		2.0mm Jumper		Selects the supply voltage of the hotend fan. Selection of 24V or 5V.
Probe Votage Selector		2.0mm Jumper		Selects the supply voltage of the probe port. Selection of 24V or 5V.
USB Expansion Port		JST-ZH1.5 5P		Connects to USB expansion board.
Neopixel		JST-PH2.0 3P	gpio7	Connects to neopixel LEDs.
Hotend Heater	HE0	E0506 Ferrule	gpio9	Connects to the hotend heater.
Hotend Thermistor	TH0	JST-PH2.0 2P	gpio29	Connects to the hotend thermistor. Uses a 2.2kΩ pull up resistor.
Activity LED	ACT		gpio8	A small software controlled onboard LED. Active low.

Accelerometer			gpio27/18/20/19 (cs/clk/mosi/miso)	ADXL345 accelerometer for input shaping. Controlled via software SPI.
Toolhead Cable		XT30(2+2)		A USB port for toolhead.

Electrical Specifications

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Comments
Power Supply Input	V_{in}	20	24	28	V	power input for the toolboard.
Temperature	T_{env}			65*	°C	operating ambient temperature
5V Current	I_{rpi}			5	A	current output for the 5V buck converter.
Fan Current	I_{fan}			TBD	A	current rating for each fan port (HEF and PCF).

*This was previously incorrectly marked 85°C. Note that board temperature is also influenced by heat from the extruder motor and the onboard stepper drive.

Note: The max wattage is 120W.

Note: If the rated current of your stepper motor is 1A, we recommend setting it below 0.7A. If you need more than 0.7A, please add extra heat dissipation for your board.

Operating Environment

Nitehawk-36 has been tested to operate in enclosed printer environments with temperatures of up to 65°C. However, this is a nominal temperature rating of which many factors will influence the actual temperature on your toolboard:

1. **Stepper Motor Current**. Setting the current of the onboard TMC2209 to above 0.6A can raise the temperature of your toolboard. Additionally, heat from stepper motors running high current can be transferred to your toolboard if they are mounted close together.
2. **High hotend Power**. Using a high powered hotend and/or setting very high hotend temperatures in your prints can raise the temperature of your toolboard.
3. **Enclosures**. Enclosing your toolboard can worsen air convection and cause your toolboard to heat up over the span of a print.
4. **Active Cooling**. Using active cooling (i.e. fans) can help keep the temperature of your toolboard low. This can help conteract the other factors that heat up the toolboard.

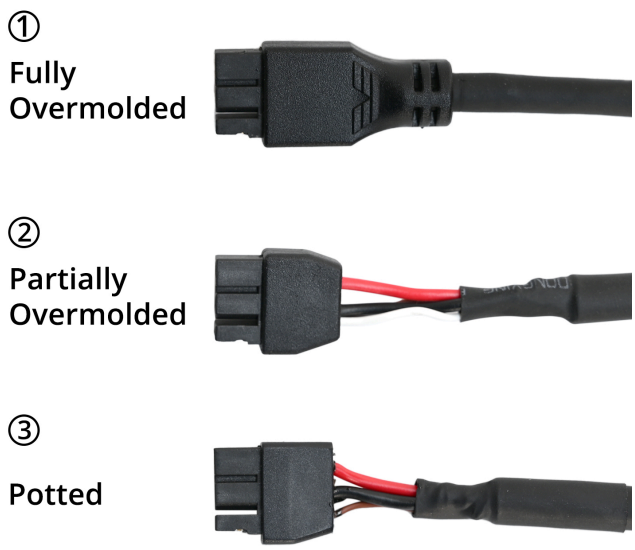
Note that elevated operating temperatures can reduce the lifespan of components (mosfets, power supplies, microcontrollers) on your toolboard.

Umbilical Cable

Connector Variants (Toolboard side)

The connector used at the toolboard side is Amass XT30(2+2)-F. You may encounter three variants. all variants are compatible with Nitehawk-36, Nitehawk-SB, and Orbitool Toolboards but have different form factors,

1. **Fully Overmolded**, this is the default version that is shipped with Nitehawk-36 V1.3 and above. This version provides good strain relief but cannot bend at the connector end like variant #2 or #3.
2. **Partially Overmolded**, this is the default version that is shipped with Nitehawk-SB and Voron kits. This version has a length of exposed wiring which allows the cable to bend easily at the toolboard side (needed when using Stealthburner + cable chains)
3. **Potted**, this variant shipped with the old Nitehawk-36 V1.2 and Nitehawk-SB kits. This variant has now been replaced by variant #1 and #2.



Cable Pinout (Toolboard Side)

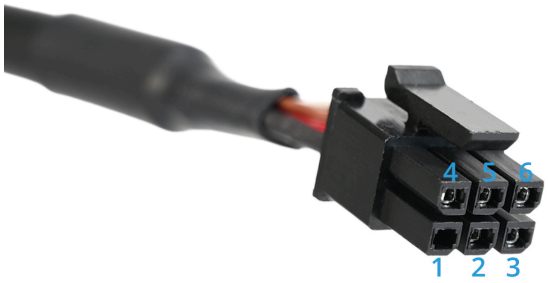
The following shows the detailed pinout of the XT30 connector:

Pin #	Name	Colour	Description
1	GND/Shielding	Black	Cable shielding and GND on the PCB share this pin.

2	24V	Red	Provides 24V power to the toolboard.
3	D+	Brown/Green	USB Data +. This conductor may be brown or green depending on batch.
4	D-	White	USB Data -

Cable Pinout (Adapter Side)

Micro-Fit 3.0 is the connector used at the USB adapter side of the umbilical cable. This connector is fairly easy to crimp and allows for the cable to be easily shortened if needed. **Never** plug or unplug this connector when the machine is powered! Doing so may risk damage to the Nitehawk or your Host (Raspberry Pi). The following shows the detailed pinout of the connector:



Pin #	Name	Colour	Description
1	NC/GND		This pin is not connected at the cable, but is connected to GND on the PCB.
2	NC/Shielding/GND		Cable shielding is connected to GND on the PCB. In newer versions this pin is not used.
3	GND	Black	In newer versions, GND and shielding share the same conductor.
4	D+	Brown/Green	USB Data +. This conductor may be brown or green depending on batch.
5	D-	White	USB Data -
6	24V	Red	Provides 24V power to the toolboard.

Firmware Setup and Update

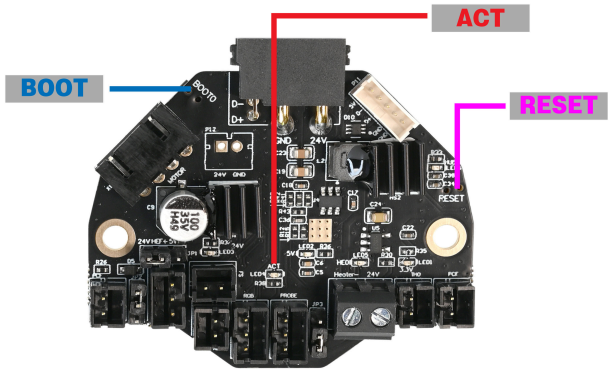
The firmware for Nitehawk consists of two components: Katapult and Klipper. Katapult is a bootloader designed specifically for Klipper, it ensures that the software on the RP2040 MCU boots up smoothly and allows for easy updating of the Klipper firmware. You can learn more about Katapult here . Klipper is the main firmware that runs on the RP2040 MCU, you can learn more here .

Your Nitehawk will come shipped with both Katapult and Klipper installed. Ideally, you will only ever need to occasionally update the Klipper firmware and never have to touch Katapult. If the Katapult bootloader was

erased or is not present for any reason, you can check this below Installing the Katapult Bootloader section for instructions on how to reupload Katapult.

Hardware Setup

No special setup is required for installing either Klipper or Katapult. Nitehawk simply needs to be hooked up as it operates normally in your 3D printer, with the toolboard connected to your Klipper host device (e.g. Raspberry Pi) via the USB adapter board. You also need access to the two buttons (RESET and BOOT0) on the toolboard. Also ACT light are important later. Reference the photo below to find the buttons and the ACT light.



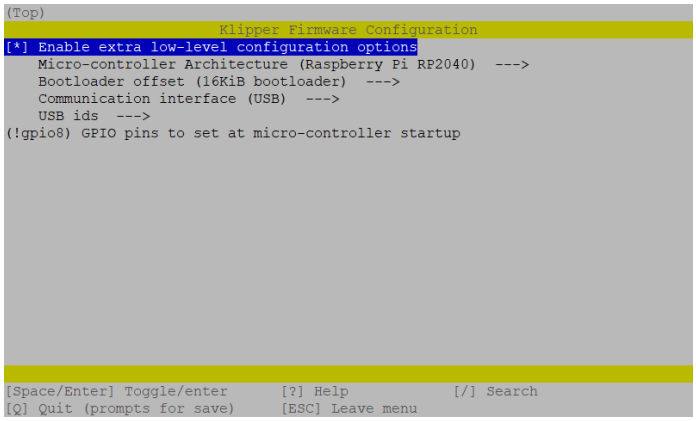
Compiling Klipper Firmware

The following instructions are for compiling and upload new Klipper firmware to your Nitehawk toolboard. You need to perform these steps if you want to update your klipper firmware to the newest version or if you are doing a fresh install and just uploaded Katapult (see the previous sections). Before compiling the firmware, you will need to have Klipper already installed on your host device (e.g. Raspberry Pi).

- Log on to your Klipper host via SSH, windows users can use putty or any other SSH client. Mac and Linux users can simply connect with the `ssh` command in their command line terminal. Run the following commands to open the firmware configuration interface:

```
cd ~/klipper
make menuconfig
```

In the configurator, Enable extra low-level configuration options, choose Raspberry Pi RP2040, match the rest of the settings with the screenshot below:



- Most importantly, make sure you set the `16KiB bootloader` offset. Otherwise you will erase the Katapult bootloader!
- Enter `Q` to quit and confirm with `Y`es when prompted to save. And run the following to generate the firmware file:

```
make clean
make
```

A firmware file called will now be generated and can be located in the directory `~/klipper/out`. You are now ready to upload this firmware to the Nitehawk toolboard. The recommended method is uploading via the `make flash` command.

Uploading Klipper (via make flash)

- Run `ls /dev/serial/by-id` to find the USB ID of your Nitehawk toolboard. The USB ID should have a format similar to this: `usb-Klipper_rp2040_1234567890000000-if00`.
- Run the following commands. This will install the `python`, `pip`, and the `pyserial` python module if it is not present. You may receive an `error: externally managed environment` when running the last command. This simply means `pyserial` has already been installed and you may move on to the next step.

```
sudo apt install python3 python3-pip
pip install pyserial
```

Run the following commands to upload the firmware to the MCU directly:

```
cd ~/klipper
sudo service klipper stop
make flash FLASH_DEVICE=/dev/serial/by-id/<your USB ID>
sudo service klipper start
```

If you encounter any connection issues after flashing the new firmware, reboot your printer. Your toolboard should now have the newest firmware. If the flashing process failed, you may want to try using the the second method and upload Klipper via Katapult

Uploading Klipper (via Katapult)

In this section we will use an alternative method to upload klipper firmware using the Katapult bootloader. If your toolboad is missing the Katapult bootloader for any reason, you should follow the next section to install it first.

- First we will check and install the Katapult package (if necessary):

```
test -e ~/katapult && (cd ~/katapult && git pull) || (cd ~ && git clone https:/
```

To upload Klipper, we will use a Python script to communicate with the Katapult bootloader inside of the Nitehawk Toolboard. First, we will first need to setup a Python3 environment. Run the following:

```
virtualenv -p python3 ~/katapult-env
~/katapult-env/bin/pip3 install pyserial
```

This creates a Python 3 environment in the location `~/katapult-env/` and installs the module `pyserial` which is required to run the upload script.

- Now we must force Nitehawk to enter the Katapult bootloader and obtain the USB serial address. Start by quickly double clicking the **RESET** button, you should see the **ACT** light blinking slowly.
- Next run `ls /dev/serial/by-id/` . You should see something like `usb-katapult_rp2040_A1234567898D1234-if00` - note that the address contains the word `katapult` . If not, this means either your Nitehawk did not have Katapult installed or you did not enter the Katapult bootloader properly. Copy the address down for the next step, do not exit the bootloader yet.
- Finally run the following but substituting the address with the one you obtained in the previous step. If everything was correct, you should see some write and verification progress followed by `Flash Success` at the end.

```
~/katapult-env/bin/python3 ~/katapult/scripts/flashtool.py -d /dev/serial/by-i
```

As a finally verification, run `ls /dev/serial/by-id/` . you should see a Klipper USB serial address in the form of `usb-Klipper_rp2040_E1234567A12D9835-if00` .

Installing the Katapult Bootloader

In this section we will compile and upload the Katapult Bootloader. Note that your Nitehawk toolboard normally ships with Katapult pre-installed and you only need to perform the following operations if Katapult was inadvertently overwritten or lost.

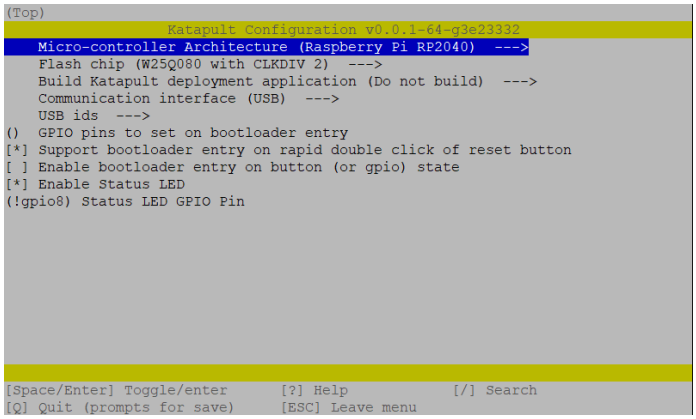
- Login to the Raspberry Pi. We will check and download the Katapult package (if necessary):

```
test -e ~/katapult && (cd ~/katapult && git pull) || (cd ~ && git clone https:/
```

Now we will configure need to configure some options:

```
cd ~/katapult
make menuconfig
```

This will bring us to the configuration menu. Make sure to set the options as below:



- Enter `Q` to quit and confirm with `Y`es when prompted to save. next run the following command to compile and generate the Katapult binary files:

```
make clean
make
```

A binary file called `katapult.uf2` will now be created in the location `~/katapult/out/`. Our next job is to upload this file into the RP2040 MCU on the Nitehawk toolboard.

- We now need to reboot the Nitehawk toolboard into system boot mode. This is done in three steps:

1. Press and hold both the **RESET** and **BOOT0** button.
2. Release the **RESET** button
3. Release the **BOOT0** button

- If done correctly, your Nitehawk should now have entered boot mode and become a sort of semi "thumbdrive". Run the command `ls /dev/sda*` to confirm. You should see something like `/dev/sda/ dev/sda1`. If you get something like `ls: cannot access '/dev/sda*': No such file or directory` this means either Nitehawk didn't enter boot mode or there is a problem with the physical connection between the Raspberry Pi and Nitehawk.
- We are now finally ready to upload Katapult. Run following commands:

```
sudo mkdir -p /mnt/pico
sudo mount /dev/sda1 /mnt/pico
sudo cp ~/katapult/out/katapult.uf2 /mnt/pico
sudo sync
sudo umount /mnt/pico
```

The above commands basically mount the Nitehawk as a storage drive and copies the katapult binary files into that drive. It then unmounts the drive. If everything went smoothly, you should now be able to see the **ACT** light located below the **BOOT0** button blink slowly. To double check that Katapult is installed, run `ls /dev/serial/by-id` . You should see something like: `usb-katapult_rp2040_A1234567898D1234-if00` which is USB serial address of Nitehawk running Katapult. A few small details to note here:

1. You will only see this address when Nitehawk is in Katapult bootloader mode and ***not*** in system boot mode or when Nitehawk is normally running Klipper.
2. You can force Nitehawk to enter the Katapult bootloader by quickly double clicking the **RESET** button on the toolboard. The **ACT** light blinks slowly in this mode as previously mentioned.
3. You will need enter the Katapult bootloader and the Katapult USB serial address to upload Klipper.
4. By following the above instructions, you will have uploaded Katapult but erased all other firmware, including any previously installed Klipper firmware.
5. Exit the Katapult bootloader by single pressing the **RESET** button, normally you would enter Klipper firmware. Since you just erased Klipper, you will just re-enter the Katapult bootloader.

- you are now ready to compile and upload Klipper - see the previous section here.

What's included in the kit?

Items	QTY
Toolhead PCB	1
USB Adapter PCB	1
USB Umbilical Cable 2.15m	1
USB-A to USB-C Data Cable, 0.4m	1
24V Power Cable	1
USB Hookup Cable	1
Self-Tapping Screw, M2x10	3
Machine Screw, SHCS, M3x8	2
Machine Screw, SHCS, M3x12	4
MicroFit3 style Male Connector, 3x2pin	1
MicroFit3 style Female Crimp Terminal	8
XH2.5 Female Connector, 4pin	1
XH2.5 Female Crimp Terminal	8
PH2.0 Female Connector, 2pin	5

PH2.0 Female Connector, 3pin	3
PH2.0 Female Crimp Terminal	30
Ferrule, 1008	4
Ferrule, 0508	4