

The logo features a white diamond shape centered on a dark gray background. The background is filled with a complex, light gray circuit board pattern, including various lines, circles, and rectangular shapes that resemble electronic components and traces. Inside the white diamond, the text "Isik's Tech" is written in a bold, black, sans-serif font, with "Isik's" on the top line and "Tech" on the bottom line.

**Isik's  
Tech**

# **AFC-Pro**

## **Manual**

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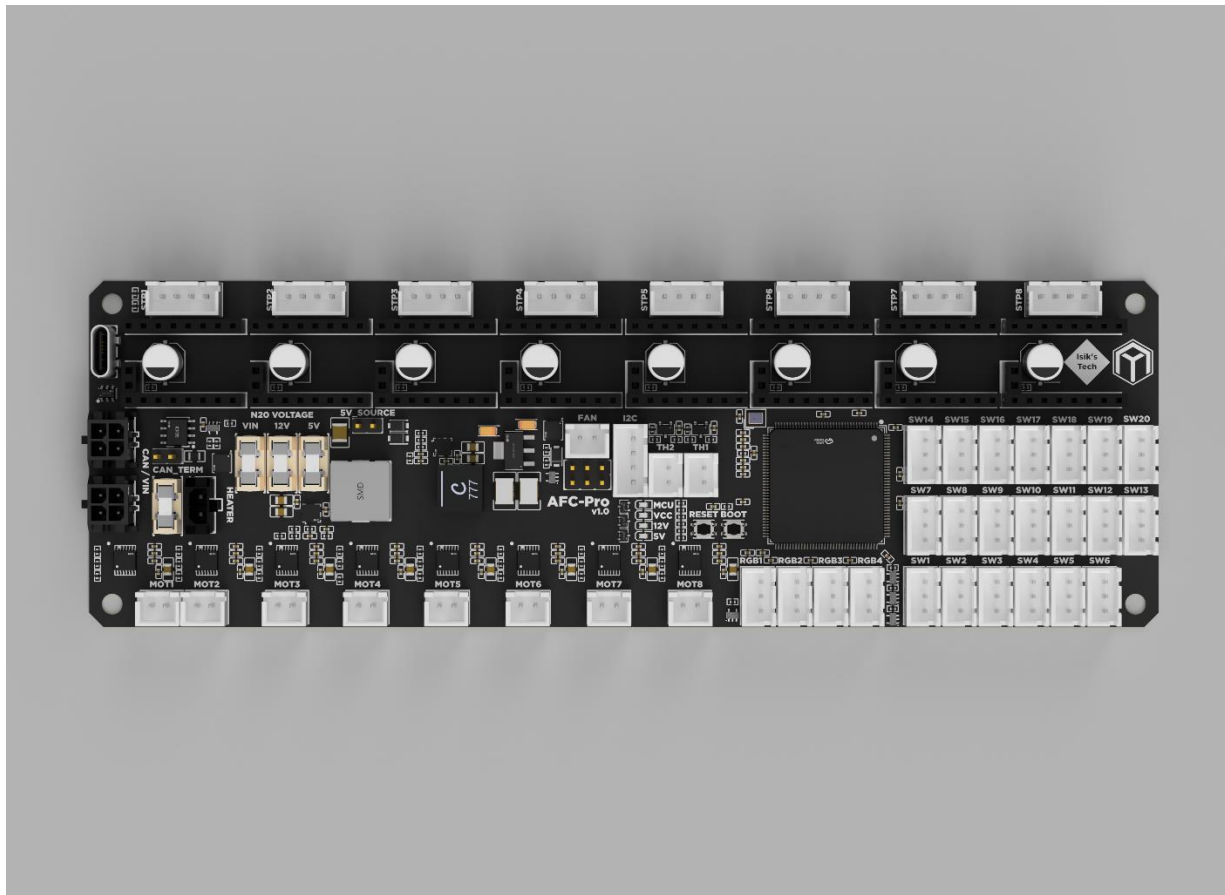
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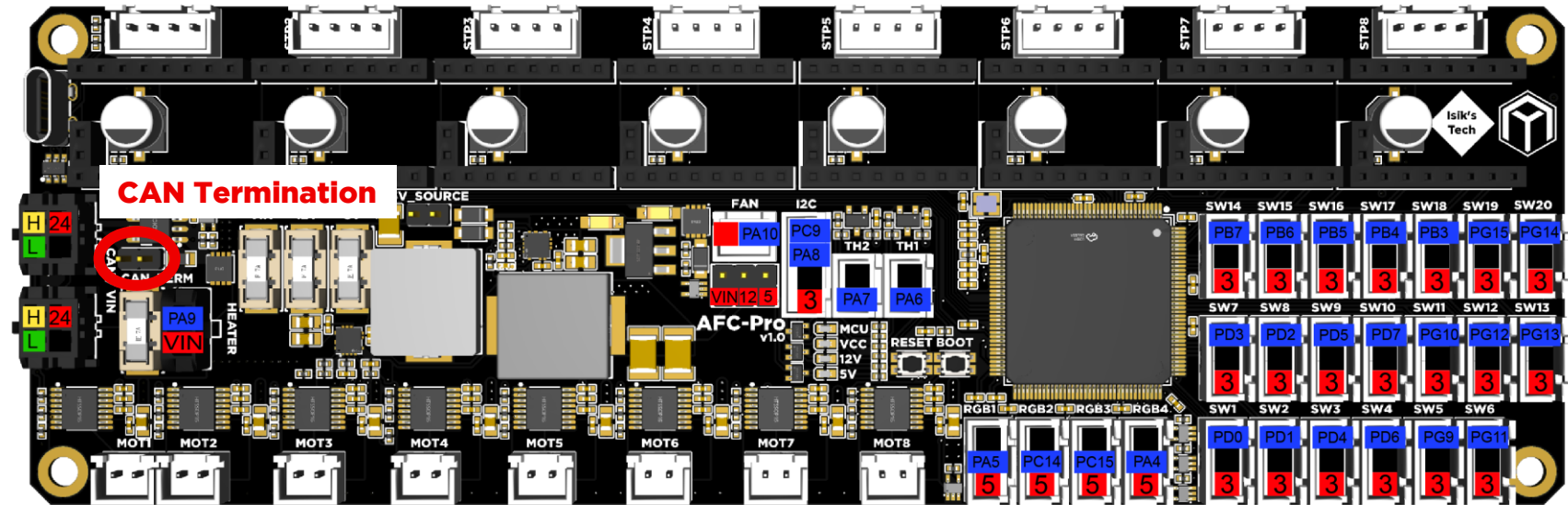


## AFC-Pro Features

AFC-Pro is a controller PCB designed for Armored Turtle's Box Turtle AFC system. It features:

- 8x Stepstick Slots for TMC2209-based Stepsticks
- 8x Brushed DC Motor Drivers Supporting 5V, 12V and 24V Motors
- 4x ARGB LED Connectors
- 20x Switch Connectors
- 2x Thermistor Connectors
- I2C Connector for Chamber Sensors
- 1x VIN/12V/5V Fan Connector with Speed Control
- STM32H723 MCU
- USB and CAN Support with CAN Daisy Chaining Connector
- 12V & 5V Buck Converters

## Pinout



Motor	Stepper Pins				Brushed Motor Pins				
	STEP	DIR	EN	UART	IN1	IN2	SLP	FAULT	FBK
1	PE7	PG1	PE10	PE8	PE9	PE11	PE15	PE12	PC4
2	PB2	PA3	PG0	PF15	PE13	PE14	PD9	PD8	PC5
3	PA0	PC1	PA2	PA1	PB10	PB11	PB13	PB12	PB0
4	PF9	PF8	PC0	PF10	PB14	PB15	PD11	PD10	PB1
5	PF5	PF4	PF7	PF6	PD12	PD13	PG3	PG2	PF11
6	PF1	PF0	PF3	PF2	PD14	PD15	PG5	PG4	PF12
7	PE5	PE4	PC13	PE6	PC6	PC7	PG7	PG6	PF13
8	PE1	PE0	PE3	PE2	PC8	PA15	PC11	PG8	PF14

## **5V\_SOURCE Jumper**

This jumper should not be populated during regular operation. Populating this jumper makes MCU draw its power from the USB C cable, which can be useful for firmware flashing in certain scenarios (when there isn't a convenient 24V source). In this mode, the PCB won't be fully functional. Brushed motors and ARGB LEDs are wired to only draw power from the 5V buck converter on the PCB to not draw too much power from the USB C cable.

## **Advanced Brushed Motor Driver Features**

AFC-Pro features DRV8876 brushed motor drivers with some extra features over the drivers used on AFC-Lite, currently not used by Box Turtles:

- Selectable 5V, 12V and 24V motor voltages
- Fault signal, letting the MCU know if something is not working as expected, like the motor stalling
- Analog motor current feedback pin to monitor motor power draw in software
- Increased 3A current capacity

## **Setting Brushed Motor Voltage**

AFC-Pro uses fuse holders to set the brushed motor voltage. By default, your AFC-Pro will come with a fuse populated in the 5V fuse holder, and no fuses in 12V and VIN fuse holders.

**IMPORTANT:**

**DO NOT POPULATE MORE THAN 1 N20 FUSE HOLDER WITH A FUSE.**

**DO NOT CHANGE THE FUSE POSITION WHEN THE BOARD IS POWERED.**

Stock Box Turtle builds use 6V N20 motors, typically powered with 5V. Unless you know you need to use a different voltage, do not change the fuse location. Powering a motor with a higher voltage than it's rated for can damage the motor.

## Firmware Flashing (CAN with Katapult)

First of all, make sure CAN is already set up on your printer. You can follow Esoterical's guide here: <https://canbus.esoterical.online/>

1. Connect the AFC-Pro to CAN, power and USB, turn it on.
2. SSH into Pi.
3. Install Katapult using `git clone https://github.com/Arksine/katapult.`
4. Go to `~/klipper`, do a `make clean`, then `make menuconfig`, use the Klipper settings in the beginning of the next page, then `make`.
5. Go to the Katapult directory `cd ~/katapult/`, do a `make clean`, then `make menuconfig`, use the Katapult settings below, then `make`.
6. On the AFC-Pro, hold the BOOT button. While holding it press and release the RESET button, then release the BOOT button.
7. Use `lsusb` to verify that your AFC-Pro is in DFU mode.
8. Flash Katapult using `sudo dfu-util -a 0 -d 0483:df11 --dfuse-address 0x08000000:leave -D out/canboot.bin.`
9. Use `~/klippy-env/bin/python ~/klipper/scripts/canbus_query.py can0` to find AFC-Pro's UUID. It'll say Canboot next to it.
10. Flash Klipper using `cd ~/katapult/scripts && python3 flashtool.py -i can0 -f ~/klipper/out/klipper.bin -u <uuid>`, replace `<uuid>` with your AFC-Pro's UUID.

Katapult settings:

```
Micro-controller Architecture (STMicroelectronics STM32) --->
Processor model (STM32H723) --->
Build Katapult deployment application (Do not build) --->
Clock Reference (25 MHz crystal) --->
Communication interface (CAN bus (on PB8/PB9)) --->
Application start offset (128KiB offset) --->
(1000000) CAN bus speed
() GPIO pins to set on bootloader entry
[*] Support bootloader entry on rapid double click of reset button
[ ] Enable bootloader entry on button (or gpio) state
[*] Enable Status LED
(PC10) Status LED GPIO Pin
```

Klipper settings:

```
[*] Enable extra low-level configuration options
    Micro-controller Architecture (STMicroelectronics STM32) --->
    Processor model (STM32H723) --->
    Bootloader offset (128KiB bootloader) --->
    Clock Reference (25 MHz crystal) --->
    Communication interface (CAN bus (on PB8/PB9)) --->
(1000000) CAN bus speed
() GPIO pins to set at micro-controller startup
```

## Firmware Flashing (USB)

1. Connect the AFC-Pro to power and USB, turn it on.
2. SSH into Pi.
3. Go to `~/klipper`, do a `make clean`, then `make menuconfig`, use the settings below, then `make`.
4. On the AFC-Pro, hold the BOOT button. While holding it press and release the RESET button, then release the BOOT button.
5. Use `lsusb` to verify that your AFC-Pro is in DFU mode.
6. Flash Klipper using `make flash FLASH_DEVICE=0483:df11`.
7. Use `ls /dev/serial/by-id/*` to find your AFC-Pro's serial address.

```
[*] Enable extra low-level configuration options
    Micro-controller Architecture (STMicroelectronics STM32) --->
    Processor model (STM32H723) --->
    Bootloader offset (No bootloader) --->
    Clock Reference (25 MHz crystal) --->
    Communication interface (USB (on PA11/PA12)) --->
    USB ids --->
() GPIO pins to set at micro-controller startup
```

## Klipper Config

Klipper config and other software needed can be found on Armored Turtle's AFC Klipper Add-on GitHub repository:

<https://github.com/ArmoredTurtle/AFC-Klipper-Add-On/>

## Troubleshooting

For Box Turtle related help, you can find Armored Turtle's documentation here: <https://www.armoredturtle.xyz/docs/>

1. Do I need to connect 24V and GND to the MX3.0 connector if I'm using USB?

Yes. The USB C connector is only used for data. You need to connect 24V power and GND to the MX3.0 connector even if you're not using CAN. Also, make sure the 5V\_SOURCE jumper isn't populated.

2. I'm able to connect to the PCB with USB but brushed motors and RGB LEDs aren't working.

Make sure the 5V\_SOURCE jumper isn't populated.

3. Klipper can't communicate with my SPI-based stepsticks.

AFC-Pro only fully supports UART stepsticks, like TMC2209s. You can use other stepsticks too, but only in STEP/DIR mode.

4. [Insert CAN-related issue here]

Esoterical has a great CAN bus guide, I recommend checking it out for more information: <https://canbus.esoterical.online/>

5. Do I need to use Katapult if I use CAN?

No. However, it makes firmware flashing much easier. To avoid confusion, this manual only covers CAN with Katapult.



## Specs

VIN	24V 10A Fused
5V Buck Converter	Texas Instruments TPS56A37 5V@10A
12V Buck Converter	Texas Instruments TPS56A37 12V@10A
Brushed Motor Drivers	Texas Instruments DRV8876 Max 3A Peak (Per Driver) 8A Fused (All Drivers)
MCU	STM32H723 550 MHz 1M Flash
Communication	CAN w/ Daisy Chaining USB C
Stepstick Slots	8
Brushed Motor Drivers	8
ARGB LED Ports	4
I2C Ports	1
Thermistor Ports	2
Heater Ports	1
Switch Ports	20
Fan Ports	1 Speed Control 5V/12V/24V
Connector Types Used	MX3.0 XH USB C

## Debugging

The SWDIO and SWCLK pads on the back side of the PCB can be used for debugging purposes, with an ST-Link. You will likely also need to use the 3.3V, GND and NRST pads, located next to each other.

## Schematic

Schematic can be found on the GitHub repo:

[https://github.com/xbst/AFC-Pro/blob/master/Docs/AFC-Pro\\_Schematic.pdf](https://github.com/xbst/AFC-Pro/blob/master/Docs/AFC-Pro_Schematic.pdf)

## Thanks

- Robert Klotz
- jimmyjon
- EricVA
- Trev1Ak
- Wondro
- Hdale
- Belial
- Moosaka



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