STM32F411 Base Board

Datasheet

Base Board for a STM32F411 “BlackPill” USB Stick board.
Includes common user interface devices.
Includes ports for I2C, SPI, and UART external devices and bread boards.
Great platform to jump start MicroPython projects.

Version 1.3

Contents

Product Overview

Jump start your project with the STM32F411[1] Base Board (**Base Board)**. The board provides a patch-wire friendly (flexible) base for the low-cost **WeAct Studios' BlackPill** v3.1 USB Stick board. The **BlackPill** is not included, however this low-cost board is available from popular retailers[2]. The board includes common user interface devices and ports for external devices. The board is compatible with popular Integrated Development Environments (**IDE**).

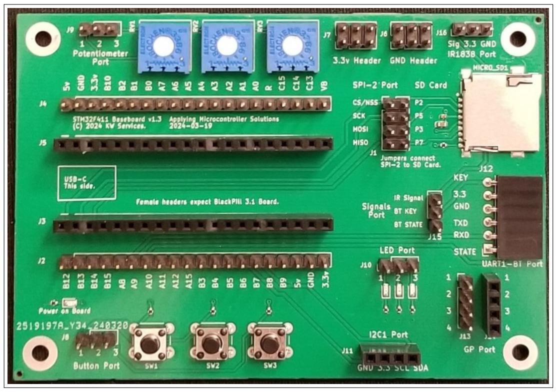


Figure 1: STM32F411 Base Board v1.3

FEATURES

- **Provides a dual socket for the BlackPill V3.1.**
- **Matching male pins for easy wire connections.**
- **Designed for easy patch wire connections.**
- **Supports Thonny's SD Card file system.**

APPLICATIONS

- **General purpose development board.**
- **Compatible with STM32Cube, Thonny and VS Code, etc.**
- **Great platform for MicroPython projects.**
- **Convenient to attach leads for a Logic Analyzer.**
- **Easily integrate with a bread board and external sensors.**

EXTERNAL DEVICE PORTS

- **MicroSD Port and SPI connection port.**
- **UART-1 Port (e.g. a Bluetooth dongle).**
- **I2C-1 Port (e.g. a small OLED I2C device).**
- **IR Port (e.g. an IR1838 device).**
- **Four-pin general purpose port**

USER INTERFACE DEVICES

- **Digital Output: Indicator LEDs (green, yellow and red).**
- **Digital Input: Buttons (wired with 10K ohm pull-ups)**
- **Analog Input: Potentiometers (10K ohms) wired to power.**

The **Base Board** is populated as shown in Figure 1. It includes several on-board user interface devices and port headers for external devices. Each device has an independent connection port and is wired to power (reducing wire clutter). To improve inter-connections and further reduce clutter, the devices and ports are distributed around the periphery of the board. The ports support external communication devices commonly required by projects (e.g. UART, I2C, and SPI devices).

1 ST and STM32 are Trademarks of STMicroelectronics. **BlackPill** is owned by **WeAct Studios'**. Thonny is owned by Aivar Annamaa and is distributed by https://thonny.org

2 Ali Express has WeAct's web store and Amazon has sellers of **BlackPill** boards and components with pre-soldered headers.

The STM32F411 Base Board holds the **BlackPill** board by way of a pair of 20-pin female headers. A separate pair of 20-pin male headers stand adjacent to the **BlackPill**. Commonly available DuPont female-to-female wires can attach to the male pins to form sturdy connections to on board devices and DuPont female-to-male wire to off board devices (e.g. bread boards). A schematic for the STM32F411 Base Board is provided in the Appendix.

Dimensions and Mounting:

The board weighs under two ounces and its dimensions are 100mm x 70mm with a mounting hole in each corner. The mounting holes are located within 5mm of the edges (90mm x 60mm). Note: The SMT32F411 Base Board has all of the ground points connected to the same ground plane on the PCB including the mounting holes.

Firmware and MicroPython Software

The KW Services github site provides a repository of MicroPython firmware and example code.

User Interface Devices

Indicator LEDs

There is a 3-pin male header connected to the indicator LEDs. The pins correspond to green, yellow and red LEDs respectively. Each pin is wired to a LED that is wired to a 10K ohm resistor to ground. Define a **BlackPill** pin as a digital output and set its value to one to illuminate a LED.

Buttons (Tactile switch)

There is a 3-pin male header connected to the buttons. The pins correspond to SW1-SW3 tactile switches respectively. Each pin is wired to a button that has a 10K ohm resistor “pulled-up” to 3.3 volts. Pressing the button connects the line to ground. Define a **BlackPill** pin as a digital input and read the value. It will read as a value of one. When the button is pressed the value read is zero.

Potentiometers

There is a 3-pin male header connected to the buttons. The pins correspond to the signal of the RV1-RV3 (10K ohm) potentiometers respectively. Each potentiometer is wired to ground and 3.3 volts. Define an appropriate **BlackPill** pin as an analog input and read the value. It will read as a 12-bit value between 0 and 4096. Use a small flat head screw driver to turn the dial which adjusts the resistance applied and changes the reading. Note: Avoid using pins A4, A5, A6 and A7 as they are configured for the **BlackPill**’s Flash device.

External Device Ports

The external device ports significantly reduce wire connections. You can just push a device into the port and start using it. Although, I specifically designed the port for a particular device, you can simply put into the port any suitable device with a similar pin out. Or, you can use the port as a convenient way to interface to an external bread board.

There are no external devices included.

<u>MicroSD Port and SPI Connection</u>

The MicroSD Port consists of a TF Card Socket (TF-01A) and an eight-pin male header for the SPI connection. The TF Card Socket holds a standard “MicroSD” (TF Card) formatted as FAT32. I typically use a 32 GB card. A schematic for the TF Card Socket is provided in the Appendix. By placing jumpers (as shown) the TF Card Socket is wired directly to the SPI-2 pins of the **BlackPill**.

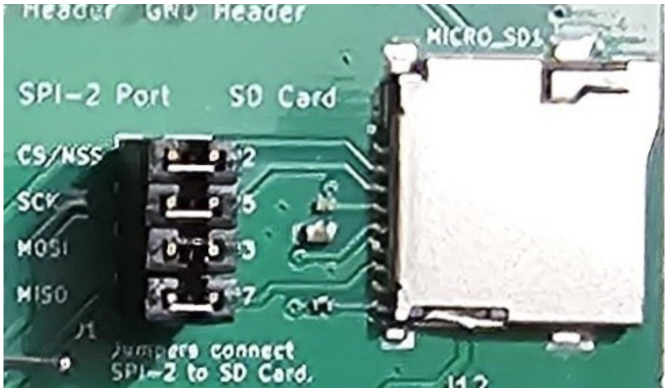


Figure 2: Jumper Setup for Micro SD via SPI-2

<u>Using Thonny</u>

Thonny supports the MicroSD Card. The Thonny Files pane normally shows desktop directories (“This computer”) and the files loaded into the internal Flash storage area (“MicroPython device /flash”). After mounting the SD Card, Thonny will show a list of the files on the SD Card. MicroPython Instructions for mounting are provided in the documents at the github site.

<u>UART1- BT Port</u>

The port has a 6-pin socket directly wired to the UART-1 pins (RX= Pin A9 and WX=Pin A10) and power lines in a manner suitable for a small “UART to Bluetooth” dongle device (see devices available from retailers in footnote 2 above.)   Most dongles also have optional signals called “State” and “Key”.   If your program needs either of these signals, you can connect wires to the appropriate pin of the Signals Port’s three-pin male header (just to the left of the six-pin socket.)

<u>I2C1 Port</u>

The port has a 4-pin socket directly wired to the I2C-1 pins (SCL=Pin B6 and SDA=Pin B7) and power lines in a manner suitable for a small OLED device (see devices available from retailers in footnote 2 above.) One can simply push the OLED into the port's socket [by matching the Port's pin labels with the OLED's pin labels.]

<u>IR Port</u>

The port is a 3-pin header with a signal and power lines. Any **BlackPill** pin will be connected to the IR Port "Sig" pin [by using the Signal pin on the Signals Port.] The layout assumed a connection to an external IR1838 breakout device.

Alternatively, any 3.3 volt device needing a single **BlackPill** line could be connected.

<u>Four-pin Port</u>

The GP Port provides up to four pins to attach an external device or connect to a bread board..

This GP Port consists of a male header and a female header labeled 1 to 4. Internally, there is a trace between Pin 1 of the male header and Pin 1 of the female header; and so forth. For example, one can plug a sensor (see Figure 2) into the female port. Then connect wires between various pins of the **BlackPill** to the appropriate GP Port's male pins.

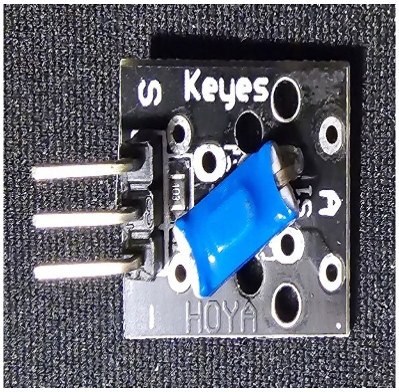


Figure 3: Example of a sensor that fits into the GP Port.

Details

Power Considerations

Normal development usage is to plug the BlackPill into the **Base Board** and attach a USB-C cable between a desktop computer and the USB-C port on the **BlackPill**. Since the board is powered by your desktop's USB port, the project's total current draw is limited by the desktop's USB port.

The **BlackPill** regulated power lines are utilized on the **Base Board**. When the attached BlackPill is connected to a desktop, the "Power on Board" indicator will illuminate (in the lower left corner of the board). Note: The five volt ("5v") pin is not regulated and may not be five volts.

You use your desktop's development IDE to interact with the **Base Board.** In MicroPython, files can be uploaded to the MicroPython's flash filesystem. The flash will continue to hold the files after software reset or power is removed.

Discussion on BlackPill board

The **BlackPill** v3.1 is manufactured by **WeAct Studios'** and uses a STM32F411CEU6 48-pin chip from ST Microelectronics.

The **BlackPill** board includes a USB-C connector, a 4-pin SWD header, onboard buttons, a blue LED and an 8 MB flash drive. The GPIO and Power are distributed out to 40 pins separated into two 20 pin headers. The user button called KEY is attached to Pin PA0. The blue LED is attached to Pin PC13. The board includes a primary 25 Mhz crystal and a secondary low-speed 32.768 Khz crystal. The **WeAct Studios' GitHub** web site says there is a protection diode on the **BlackPill** v3.1 board. The **BlackPill** board uses a SOT-23 LDO regulator marked 3AVL which is mentioned on the STM32-Base web site as a ME6206 LDO that provides 3.3 Volts at 300 mA (BlackPill v2.0).

The **BlackPill** can be flashed via the SWD port or the USB port. The 4-port SWD header can be connected to an inexpensive external ST-LINK v2 device that is compatible with the STMicroelectronics' (ST) STM32Cube Programmer ("**PRG**"). The **PRG** software is free to registered users.

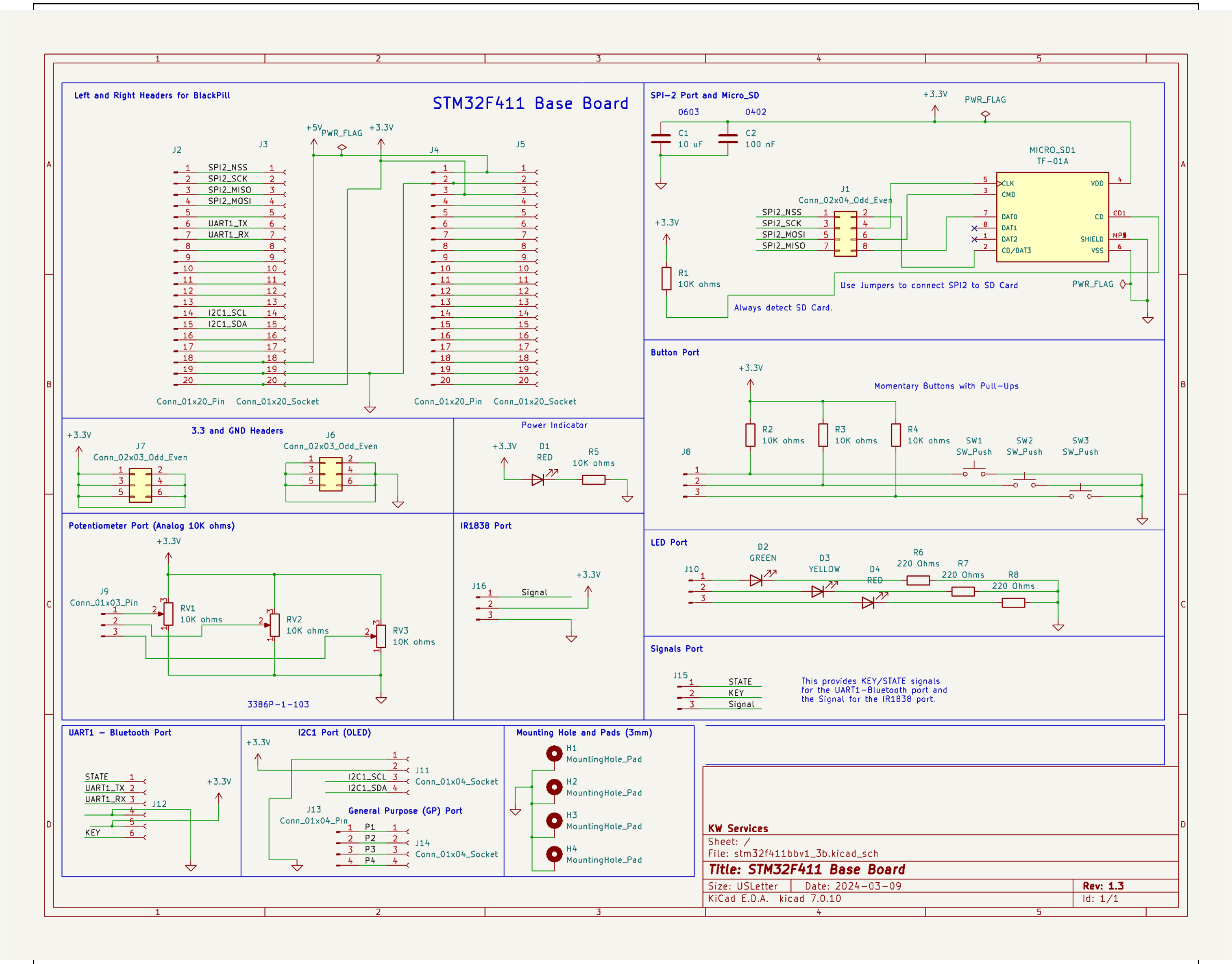
PRG can flash the **BlackPill** using the USB-C port, but getting the port to be recognized by PRG can be tricky (and works best with a completely new **BlackPill**). The easiest approach is to use the SWD port and the ST-LINK device.

Additionally, one can study the ST STM32F411 datasheet to better understand the STM32F411CEU6 chip.

Appendices

Appendix A: STM32F411 Base Board v1.3 Schematic

The schematic was created on Kicad.



Appendix B: Schematic of the MicroSD Port

An image from the JLCPCB web site[3] provides a schematic and footprint for the TF-01A device.

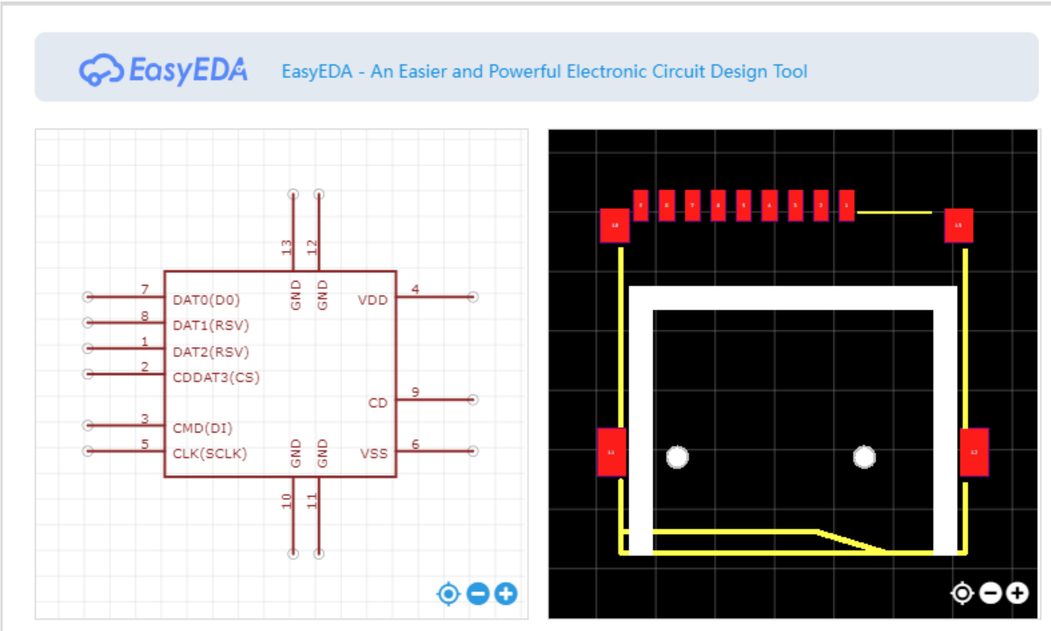


Figure 4: SD Card Socket (TF-01A) Schematic and Footprint.

SD Card Socket

The schematic shows that there are nine pins for signals and power. For a SPI connection, the signals only need to wire up to SD Card Socket Pins 2, 3, 5, and 7. Note: Pin 9 on the socket is pulled up with a 10K resistor to set the CD state to be "always on". The VDD and VSS pins are wired to the appropriate 3.3 volt and GND power pins.

Choose the SPI-2 Signals

The eight pin "SPI" male header is labeled with the corresponding SPI signal names on the left side and the four required TF-01A pins are listed on the right side of the header. The left side pins are internally wired to the pins B12, B13, B14 and B15 (the SPI-2 pins.) Therefore, inserting jumpers (see Figure 2) across the header pins causes the SPI-2 hardware port to be connected to the SD Card Socket [without using DuPont wires].

Alternatively, Use Different SPI Signals

Should you desire to use different BlackPill pins, remove the jumpers and connect DuPont wires directly to the right hand "SD card socket" pins.

3 Image taken March 21, 2024 from https://jlcpcb.com/partdetail/Korean_HropartsElec-TF01A/C91145