Pico MP Display Base Board

Datasheet

Great platform to experiment with the Raspberry Pi Pico board.
Base for 24-bit color SSD1963 Integrated Display, Touch & SD Card.
Supports MicroPython 1.20 (or later) firmware.
Includes on-board components and ports for external devices.
MIT License.

Version 1.0.1

Applying Microcontroller Solutions

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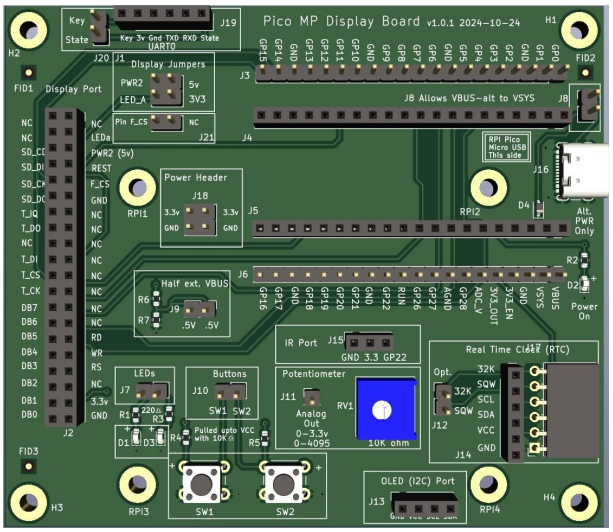
Contents

Product Overview

The Pico Display Base Board is a printed circuit board (PCB) designed for the RP2040 Raspberry Pi Pico board (“Pico”) and a 24-bit color SSD1963 TFT LCD display board. The PCB was designed for a project using the MicroPython firmware which supports all of the devices. MicroPython software available that supports graphic primitives.

The PCB includes various onboard components and ports for external devices. The male headers provide a flexible means to wire connections to the components. The ports have PCB connections to Pico pins and permit an easy way to simply insert the external device. There should be no need to solder any wires nor drill holes for any parts.

The product is only the PCB. The Pico, display board, wires and the external devices are not included. However these low-cost components are available from popular online retailers.



FEATURES

- **Carrier port for the Raspberry Pi Pico.**
- **Port wired for a 5/7-inch 24-bit color SSD1963 LCD display (Touchscreen/SD Card).**
- **Base board is wired for IR, RTC, OLED and UART devices.**
- **Connectable onboard devices.**

APPLICATIONS

- **Interactive GUI display using MicroPython.**
- **Power connector for autonomous operation.**
- **The board is well suited for general projects.**

The 40-pin Display Port is wired to specific GPIO pins to provide an eight (8) data line parallel interface for the LCD display including the control lines and additional (SPI-1) lines pins for the Thin Film Transistor (TFT) Touchscreen and SD Card. The PCB includes jumpers for LCD display power (3.3 volts and five volts as needed) and for an assigned Pico pin for the display board's optional flash chip. The Display Port has been tested with five and seven inch SSD1963 LCD display sizes.

The SSD1963 display boards all have a "standard" 40-pin male header, and so the desired board is just inserted into the matching 40-pin female port on the Pico Display MB Base Board PCB.

Beyond the Display, the Board was designed to ensure PICO pins are available for additional I2C, SPI and UART devices. The matching Pico male headers provide an easy means to wire to onboard devices or to test the with a Logic Analyzer. The male headers can also be used to add connections to sensors and devices on an external breadboard.

Connections for External Devices:

- Display Port — Eight data lines, four command lines, and control for integrated devices.
- OLED Port — I2C logic signals and 3.3-volt power for an OLED device.
- RTC Port — I2C logic signals and 3.3-volt power for a DS3231 RTC module.
- IR Port — A GPIO signal and 3.3-volt power for an Infrared Receiver device.
- BT UART Port — UART-1 logic signals and 3.3-volt power for a BT UART Module

Most of the general-purpose input/output (GPIO) pins are wired directly to the above mentioned display and external devices (see Pin Definitions below.)

The MicroPython Drivers

Available in GitHub are three separate Micropython class libraries (drivers) to support the Pico Display MB Base Board hardware:

- TFT Test program, TFT driver (with graphic primitives), and the TFT PIO driver.
- Touch test program and Touch ("XPT2046") driver.
- Test program and SPI-1 SD Card driver.

The external devices and components can utilize standard MicroPython libraries.

Hardware Details

The PCB was designed to use “generic” external devices to reduce cost and for easier upgrading/replacement. The layout allows development with simultaneous access access to the display and component wiring. The PCB contains mounting holes (discussed in more detail below.)

All components (the PCB and optional external devices) are self-contained and accessed via male headers. There should be no need to solder any wire nor drill holes for any parts.

Desktop Power to the Raspberry PI Pico

Board Power via the Pico

Insert a standard USB “data” cable into a desktop computer and plug the smaller end into the micro USB port of the Pico. This provides a nominal five volts (low-current) to the Pico. The Pico board regulates this power to 3.3 volts. The Pico provides power to all of the GPIO and 3.3v logic devices. The PCB indicates the availability of power by illuminating a small red LED on the left edge of the PCB.

The Pico is providing 3.3 volt power to itself, all devices, and any five inch or small TFT LCD Display.

Board Power via the USB-C Port and connect the “J8” Jumper

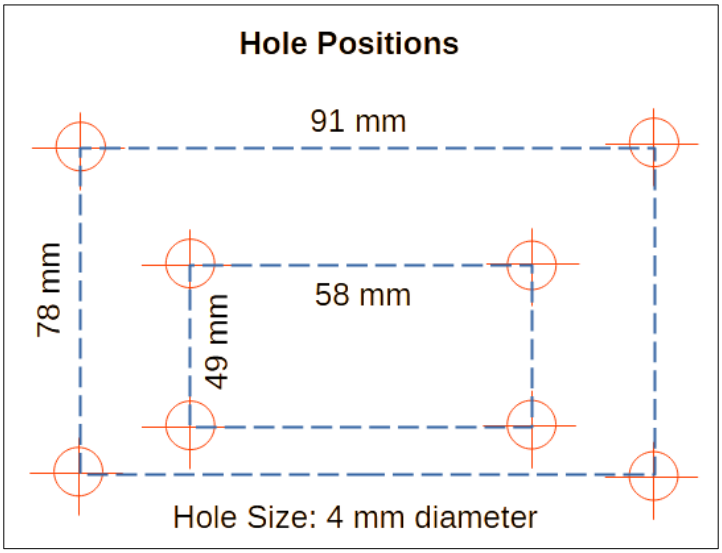
A project-provide five-volt power supply can plug into the USB-C port to power the Display and optionally the Pico’s through the diode-protected VSYS pin. Power options are user controlled via small jumpers. Then the Pico board uses five volts from its Micro USB connection to the desktop or regulates the external five power to 3.3 volts. The Pico can then provide power to all of the GPIO and 3.3v logic devices. Since the seven-inch display needs five volt power, the Base Board allows both power connections. The PCB indicates the availability of power by illuminating a small red LED on the left edge of the PCB.

Headers/Ports

The headers are standard 2.54 mm pitch male connectors that can be utilized by standard “DuPont” Female-to-Female wiring cables. The ports are standard 2.54 mm pitch female connectors that can be utilized by devices with standard pitch male headers (basically, you just plug the device into the port).

PCB Mounting Holes

The PCB board is 99 mm wide by 86 mm high. The PCB has two sets of mounting holes:



The outer mounting holes are 4 mm from the PCB board edge and could be utilized for mounting or a 3-D printed case. The RPI mounting holes provide a means to mount the PCB to other maker products. The inner "RPI" mounting holes are the same as a Raspberry Pi 4/5 model-B board. The left RPI holes are 22 mm from the PCB left edge. The bottom RPI holes are 7 mm from the bottom of the PCB. The holes fit M3 Nylon or brass hex spacers and screws.

Pin Definitions

The Pico has 28 GPIO pins and various power pins; twenty pins on each side of the board. The Pico pins are assigned and wired mostly to the Display Port. Below is a table listing the Pico pin assignments to the Display Port and the I2C (GP8/GP9) pins for the external device ports. GP22 is assigned to the IR Port. If one does not use the Display Port, one can re-use its pins elsewhere (via the male headers). For better understanding, please see the schematic in the appendix.

Below is a table listing the pin assignments to each header/port.

Display and External Device Port GPIO Pin Assignments
Sorted by Pin

Left Side		**Wired to:**	**Right Side**		**Wired to:**
GP0	LCD DB0	Display Port	GP28	ADC2**	x
GP1	LCD DB1	Display Port	GP27	ADC1**	x
GP2	LCD DB2	Display Port	GP26	ADC0**	x
GP3	LCD DB3	Display Port	GP25		Pico LED
GP4	LCD DB4	Display Port	GP22	IR	IR Port
GP5	LCD DB5	Display Port	GP21	I2C0 SCL*	RTC & OLED
GP6	LCD DB6	Display Port	GP20	I2C0 SDA*	RTC & OLED
GP7	LCD DB7	Display Port	GP19	T_IRQ***	Touch on DP
GP8	LCD RS	Display Port	GP18	T_CS***	Touch on DP
GP9	LCD WR	Display Port	GP17	UART-0 RXD***	UART Port
GP10	LCD RF	Display Port	GP16	UART-0 TXD***	UART Port
GP11	LCD REST	Display Port			
GP12	T_DO & SD_DO	T/SD on DP			
GP13	SD_CS	T/SD on DP			
GP14	T_CLK & SD_CLK	T/SD on DP			
GP15	T_DIN & SD_DIN	T/SD on DP			

Notes: Pins marked as X are unassigned.

* The GP20/GP21 pins are I2C pins and can be utilized simultaneously by several devices as each device has its own distinct address. Hardware pull-ups for the I2C were not included as the expected external devices do not need them.

** These GPIO are often reserved for Analog Input (ADC pins).

The RP2350 “Pico2” board will operate in the Pico Display MB Base Board using MicroPython’s “PICO2” firmware. However, the current Micopython TFT Library, which uses PIO written for the RP2040, and has not yet been migrated to the Pico2 PIO code.

*** Alternately, these four pins can be used for a SPI-0 connection

External Devices

The builder can use their favorite external devices and battery source. The board is wired for specific pins as described in the Pin Definitions above to facilitate the organized wiring of a project. If not being used by the wired device, they can be configured for other uses. Finally, the matching Pico male headers can also be utilized for off-board devices or to attach a Logic Analyzer.

Suggested external devices are described below:

Real Time Clock Module

MicroPython supports interfaces for user-supplied DS1307 and DS3231 real time devices. The PCB was tested with the DS3231 board (which contains a DS3231 “RTC” chip and an AT24Cxx EEPROM chip.) The module has an attached battery holder for a CR2032 “coin” battery.

The RTC port has two female header “ports” connected to its logic and power signals. The port is wired to the I2C-1 pins. This allows the user to choose to insert the module into the vertical port or into the horizontal port. Otherwise, one can connect dupont wires between one of the ports and an offboard block to interface additional I2C devices.

OLED Board

Besides the large TFT displays, MicroPython also supports small I2C OLED displays typically called SSD1307 devices. The PCB was tested with a small 0.96 inch OLED (Yellow/Blue 128x64 pixels) display board. The port is wired to the I2C-0 pins (GP20 and GP21). The OLED’s male header can be inserted easily into the port.

Infrared Receiver Board

There are custom MicroPython libraries that support an Infrared Receiver. The PCB was tested with the Infrared Receiver (IR1838) board which included a small handheld “remote”. The signal is wired to GP22. The male header of the IR receiver module can be inserted easily into the port.

Bluetooth UART Module

MicroPython supports devices with a UART interface. There are several inexpensive Bluetooth UART modules. The module male header pins align with the port. The port is wired to the UART-0 TX an RX ports (GP16 and GP17) and so the user simply inserts the module into the port.

24-bit Color SSD1963 Integrated Display Board

The Display Port supports various LCD display sizes. It has been tested with five and seven inch displays. The SSD1963 display boards all have a “standard” 40-pin male header, and so the desired display board is just inserted into the matching 40-pin female port on the PCB. Please ensure your TFT LCD Display has male header pins exactly as those shown in photos below.

The Display Port is wired to the Pico pins, and includes:

Component	**Pinout**
LCD Display	Eight data lines (DB0-DB7) Four control lines (DC, Write, Read, and Reset) LEDA (Backlight for five inch or smaller displays) PWR2 (Backlight for seven inch or larger displays)
Touch Controller (integrated)	Three SPI-1 pins and T-CS, IRQ
SDCard Adapter (integrated)	Three SPI-1 pins and SD-CS
ER3301 font ROM (usually unpopulated)	CS

The Solomon Systech website states these LCD Display features:

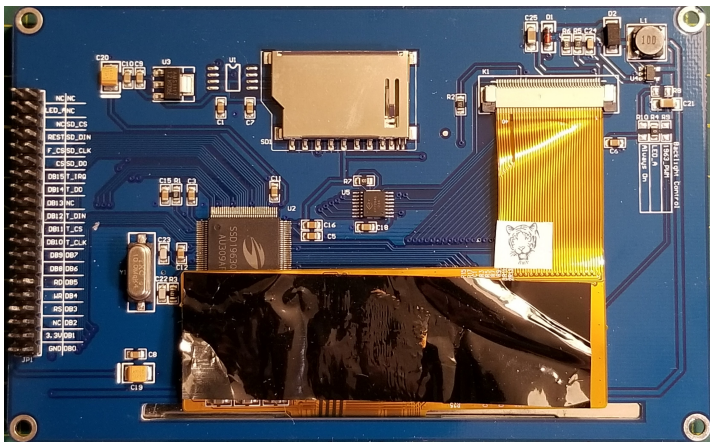
– Built-in 1215K bytes frame buffer. Support up to 864 x 480 at 24bpp display
– Support TFT 18/24-bit generic RGB interface panel
– Support 8-bit serial RGB interface
– Hardware rotation of 0, 90, 180, 270 degree
– Hardware display mirroring
– Hardware windowing
– Programmable brightness, contrast and saturation control
– 8/9/16/18/24-bit MCU interface
– Tearing effect signal

Note: the MicroPython driver is configuring the display as 800*480.

Five-inch Display Board

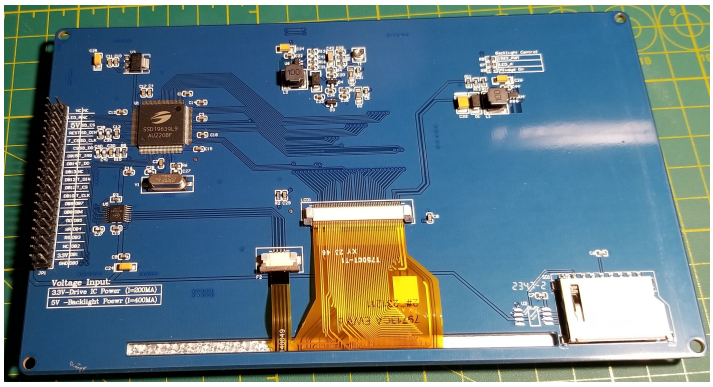
The above device is a 5-inch LCD (800x480 pixels) with a touchscreen. The 40-pin male header is already soldered to the board. Although rather large, it will operate nicely with the power from the Pico. Notice it also has an integrated SD Card. It has a spot for an extra flash chip, but typical these must be added by the user. Also, there is a jumper on Pico Display PCB for the LCD display board's optional font chip to connect to pin GP17 (the chip is usually unpopulated.)

Below is a picture of a typical 5-inch SSD1963 board.

TFT LCD Display (Front)	TFT LCD Display (Back)
	

Seven-inch Display Board

The 7 inch LCD (800x480 pixels) requires 5 volts on the PWR2 pin (which is just below the LED_A pin). There is a jumper on the Pico Display PCB that connects 3.3 volts to LED_A pin on the LCD Display board. For five volts, the PWR2 jumper is added and a five (5) volt power supply is connected to the USB-C port (just below the Pico Micro USB connector).

Display Male Header

Below is an enlarged view of the Display pinouts. Check the pinout of your prospective display to ensure it has the same configuration.

Enlarged View (showing the pin definitions)	Notes
	SD_xx pins are used for the SD Card. T_xx pins are used for the touchscreen. DB_xx pins (and others) are used by the display LCD. LED_A is usually connected to 3.3 volts.

Schematic

The schematic was created on Kicad 7.