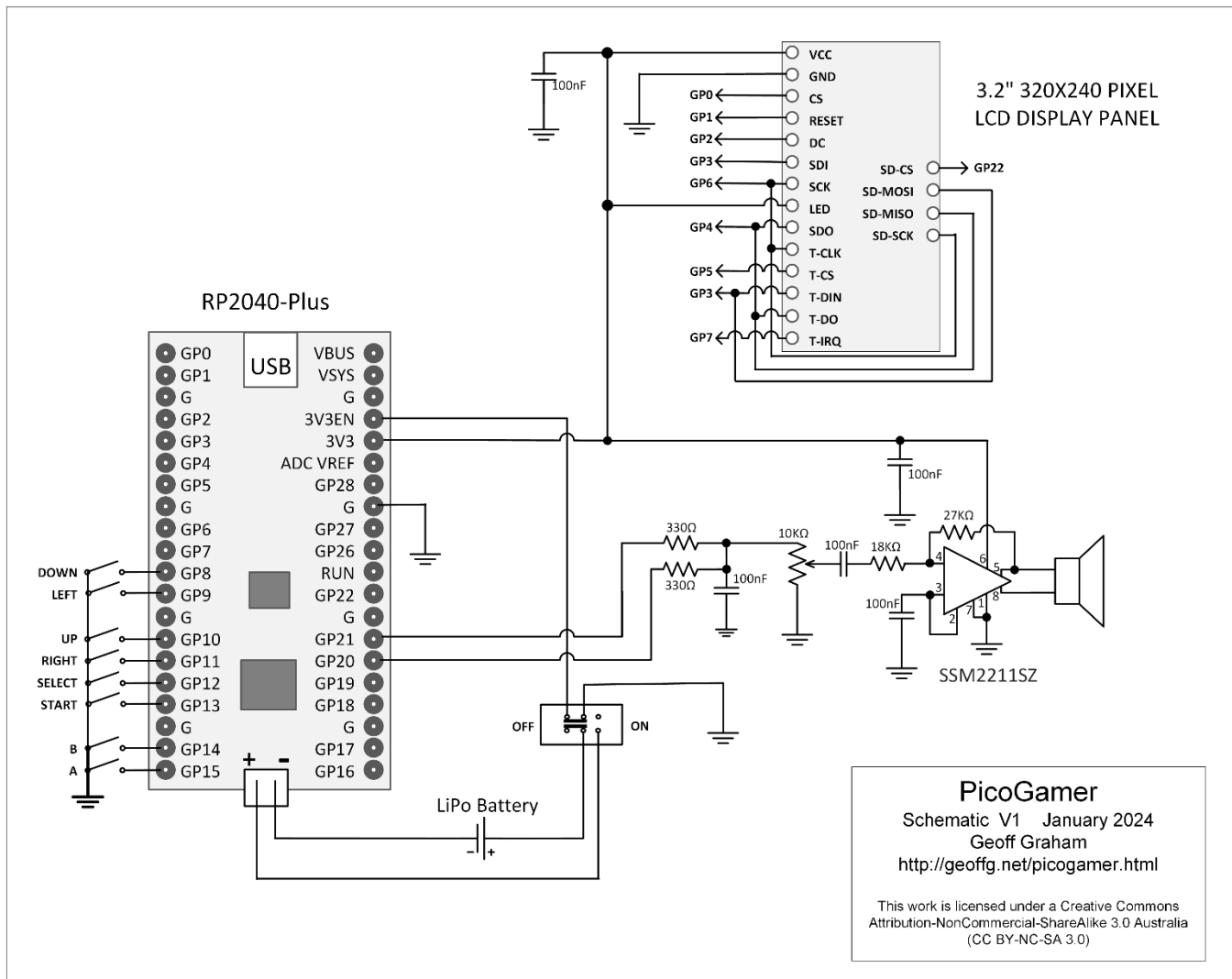# Pico Gamer
Construction Notes

The core of the device is the Waveshare RP2040-Plus processor board. This is a low cost, pin for pin compatible clone of the Raspberry Pi Pico with three important upgrades:

1. It includes a Lithium Ion battery charger.
2. It has a fast flash memory chip so that we can be confident in overclocking the RP2040 processor to 252MHz.
3. It has a minimum of 4MB of flash vs just 2MB on the standard Pico. This means that we can store 30+ games in the internal memory (the standard Pico struggles to store 8 games).

The RP2049-Plus comes in two versions with 4MB or 16MB of flash memory. You only need the 4MB version as that will store more games than you should ever need. However, the 16MB version will work just as well. The firmware at the bottom of http://geoffg.net/picogamer.html contains two versions of the firmware configured for 4MB or 16MB flash so you can use either.

The circuit is quite simple with the RP2040-Plus at the centre. The button switches directly connect to it (internal pullups are used) and it drives the LCD, SD card and touch controller via an SPI bus.

The audio is generated as a stereo PWM (pulse width modulated) signal which is summed and filtered by the two 330Ω resistors and the 100nF capacitor before being fed to the audio amplifier via the volume potentiometer.

The LCD and amplifier are powered by the 3.3V output from the RP2040-Plus which remains constant regardless of the battery voltage. Note that the battery is disconnected when the power switch is in the off position so this means that the device needs to be turned on and connected to power to charge the battery.

Parts List

1	PC board 188 by 80 mm.
1	Custom 3D printed case 199x90x26mm (see notes below).
6	Tactile Switch, Coloured 8mm diameter Button, SPST Momentary, PCB Mount, 4 pins with 5x5mm pitch (Altronics Cat S1095, S1094, S1096, S1098, S1099. Jaycar: Cat SP0720, SP0721, SP0722, SP0723, SP0724)
2	Tactile Switch, SPST Momentary, Miniature PCB Mount, 4 pins with 4x6mm pitch, shaft height above PCB: 13mm
1	Slide Switch, DPDT PCB Mount Miniature (Altronics Cat S2060, Jaycar Cat SS0823)
1	Loudspeaker, DB Unlimited SW280408-1 (available from Mouser or Digikey)
1	Potentiometer, Alpha 10KΩ Log 18T, 8mm spline shaft, 16mm diameter, single gang, horizontal PCB mounting (eg Altronics Cat R2233)
1	LCD display, 3.2" diameter, 320x240 pixel, ILI9341 controller, with full size SD card socket.
1	Battery, Lithium Ion Polymer (LiPo) 3.7V, 900 to 1100mAh, (eg Altronics Cat S4724)
1	Pin Header, 4 pin Single Row.
1	2-pin Molex PicoBlade plug, 1.25mm pitch, with attached leads.
4	M2 x 6mm machine screw (eg, Altronics Cat H3101)
1	Double Sided Foam Adhesive Tape

Semiconductors

1	Waveshare RP2040-Plus, 4MB flash memory, without header pins (Waveshare SKU: 20290)
1	SSM2211SZ push-pull audio amplifier, SOIC-8 (available from Digi-Key, Mouser, RS)

Capacitors (Thru Hole)

5	100nF, 50V, 5mm pitch, Ceramic Monolithic Capacitor.

Resistors (Thru Hole 0.25W 5%)

2	330Ω
1	18KΩ
1	27KΩ

Sourcing the Parts

The Waveshare RP2040-Plus is available from Waveshare (https://www.waveshare.com/rp2040-plus.htm) as well as Amazon, Little Bird Electronics and Core Electronics. Make sure that you purchase it without header pins.

The battery charger socket on the RP2040-Plus is a 2-pin Molex PicoBlade. Matching plugs with wires can be purchased from drone suppliers such as https://www.dronepartsgarage.com.au, Note that the JST style connectors such as JST-SH or JST-XH are not compatible.

The LCD is a 3.2" panel with a 320x240 pixel resolution using the ILI9341 controller from eBay or ALIExpress. Check that the vendor's photo matches this image as there are some incompatible designs.

The coloured tactile switches are 8mm diameter from Altronics, Jaycar or RMS Components in Australia and New Zealand as well as international suppliers. Note that the Altronics version has a better "clicky" feel.

The START and SELECT switches need a long shaft (overall height 13 mm) available on eBay and ALIExpress. Or you can use the Altronics Cat S1119 and trim it to the right length.

The volume potentiometer is made by Alpha and is sold by Altronics (Cat R2233), eBay and ALIExpress. Its depth must be less than 10mm and it should have a 8mm long knurled shaft.

The PCB can be made by any fabricator. I used https://jlcpcb.com/ and they made five boards (their minimum) for about US$10 + freight.

Sourcing the Case

Go to JLC3DP (http://jlc3dp.com/) and upload the two STL files (one for the top and the other for the base of the case) and select their Stereolithography (SLA) technology using the LEDO 6060 resin. JLC3DP will assign an engineer to check the design but it should be OK as they have previously made the case many times. Cost should be about US$17.50 (+freight).

The resin can go slightly yellow with age so you may wish to spray paint it. Rust-Oleum 340g Satin 2X Ultra Cover (available in Australia from Bunnings) is prefect for this job. If you are new to spray painting remember to spray very lightly and build up the coverage with several light coats letting it partially dry between each coat.

Build Notes

The components are soldered to both sides of the PCB which drops neatly into the 3D printed case. Refer to the high resolution photographs for component placement.

It is best if assembly is done in this order:

1. Start with the SSM2211SZ audio amplifier which is an 8-pin SMD package. This mounts on the front side of the PCB. See this for soldering hints: https://geoffg.net/SurfaceMount.html

2. Next install the RP2040-Plus on the rear side of the PCB. This sits flush on the PCB. Make sure that it is aligned with the USB socket at the top edge of the PCB.

3. The battery charger plug and cable should be next. Make sure that the lead from the + side of the RP2040-Plus connector goes to the pad marked + on the PCB regardless of the wire's colour.

4. Install the resistors and capacitors.

5. The LCD panel needs careful handling as they are notoriously sensitive to static discharge so make sure that you ground yourself before unwrapping it. Install a four pin header for the SD card in the locations marked SD-CS, etc. Then insert the LCD panel in position on the <u>front side</u> of the PCB and push the pins into the drill holes in the PCB then push it down until it is flush with the PCB. Turn the PCB over and temporarily place it into position in the top section of the 3D printed case. Then push down on the LCD display's header pins until the LCD glass sits flush with the case's front bezel, don't push too hard, just flush is enough. Then solder and trim the pins.

6. The volume potentiometer and the speaker are mounted on the rear of the PCB. The speaker is held in place by four M2 machine screws inserted from the front side of the PCB which self-tap into the speaker's mounting holes (nuts and washers are not required).

7. Install the coloured button switches, the long shaft tactile switches and the power switch, all on the front of the PCB.

8. The battery should be secured in its position on the rear of the PCB using double sided adhesive foam tape. Cut it's connector off and solder the leads directly to the PCB. It will be partially charged so do not short it's leads and ensure that the power switch is off before soldering.

9. The two halves of the case are held together by 16mm long M3 bolts inserted in the bottom half of the case and self-tap into the plastic of the top case. This is secure but note that it will not survive repeated disassembly and reassembly.

Loading the Firmware

Go to http://geoffg.net/picogamer.html for the latest firmware release and instructions for loading it (it is easy).