TFT display & control for VK3CV 122GHz equipment

Mark Hughes GM4ISM

based on initial project by Barry Chambers, G8AGN

Barry G8AGN recently published a design for a status display of the VK3VC 122GHz 'transverters' offering a convenient indication of the operating mode and frequency to aid the operator.

I designed a PCB to work with the same hardware and his Arduino sketch, to make construction easier.

The concept is elegant and simple, logic levels from the 'transverter' switches which determine the operating mode are 'decoded' to allow an instant visual summary of the radio status on a 1.8 inch 160x128 TFT display

Serial data from the GPS engine, usually implemented for frequency disciplining, is also decoded to indicate the time and your precise location in 10 digit Maidenhead format.

This project involves wiring direct to the VK3CV board and removal of its on board LED is also catered for. These modifications and the connection of the display are done at your own risk.

Test the display before connection and beware that changes to the software could also cause pins to output voltages that could be detrimental or even cause damage. The voltages used are nominally compatible with the display and VK3CV boards but the Arduino sketch is designed to present only high impedance states or low impedance to ground (in lieu of physical switches)

The PCB

In its most simple form a PCB only has to marshal the data lines from the 'transverter' to an Arduino microprocessor and to the tft display module.

The design of a basic PCB is simple too. There is a potential issue in that the Arduino pro-mini used is available with a number of slightly different board layouts. Differences are usually associated with the Analogue input pins A4 to A7 not used in the original implementation.

Having already designed a versatile PCB layout that allows a number of different versions of the Arduino pro-mini to be used in a project, I placed this at the heart of my board for the 122GHz 'transverter' display PCB. The board became less simple ☺

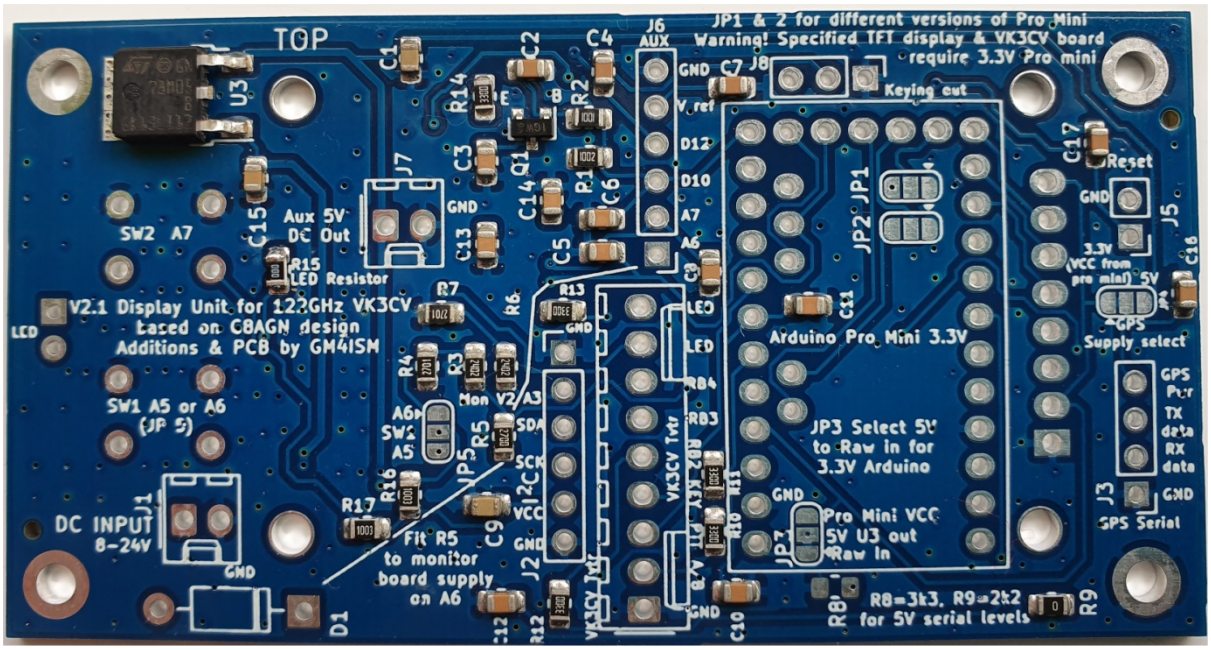
Please note that most pro-minis on the market are 5V, this project makes use of the **3.3V 8MHz ATMega328P .** This is to allow compatibility with logic levels on the TFT display, the 122GHz 'transverter' and several modern GPS engines such as the NEO-6M and 7M. **To use the extended sketch the Arduino pro-mini must present analogue pins A4,5,6 and 7. It important to check these are wired correctly *before* fitting the display.** The display should be fitted last! If you wire switches directly to the board without a header, it is best to fit these wires before the display as well!

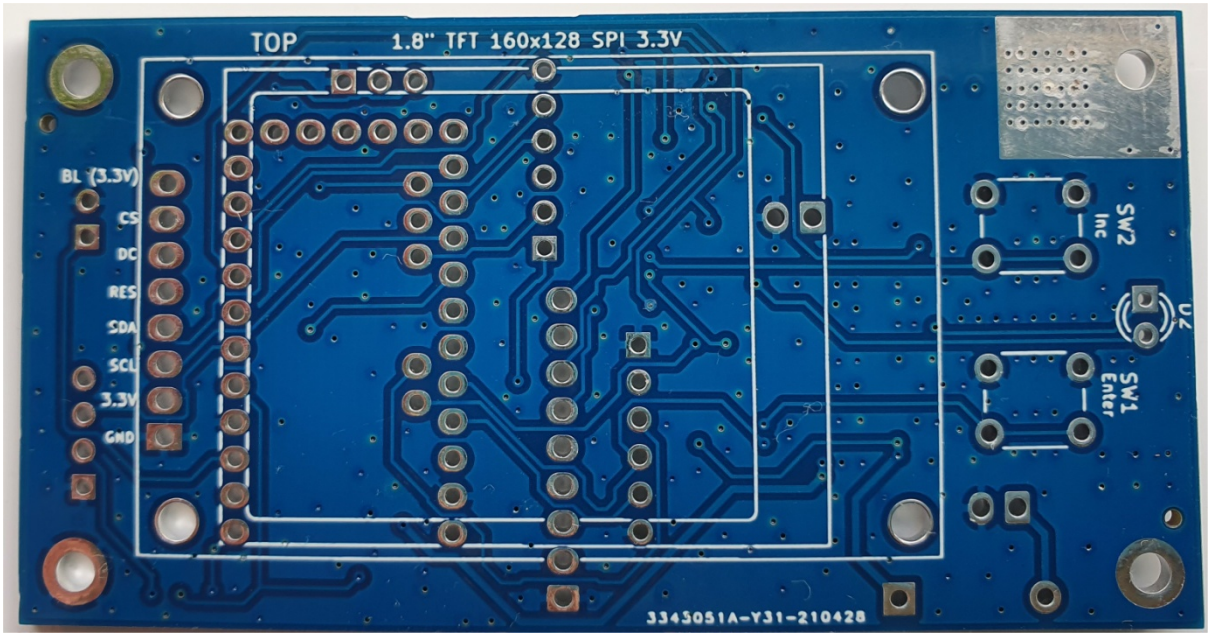
Appendix 1 shows the link settings and pins used for a number of Arduino pro-mini variants. The board can also accommodate 5V Arduino modules for other projects and different displays.

The PCB is tied to a specific TFT display pinout, restricting the types that can be fitted directly. The majority of 1.8” displays presently on the market do conform to the pinout implemented but you must check compatibility. One type has been observed to fit mechanically but the display is inverted. This can be fixed in line 232 of the sketch. change **tft.setRotation(1);** to **tft.setRotation(3);**

Having not yet built up my own 122GHz system, I decided that the display, suitably mounted remote from the RF head, would be a good place to mount the A/B PTT and Key switches. The Dual LED could be relocated here and I saw the potential for making the unit control the channel switching, not just read it.

The V2.1 board with standard SMD component load.



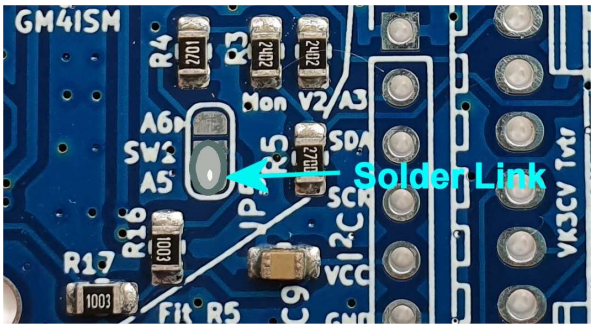


The PCB is designed to be flexible with a view to other possible uses. Unused pins are available on headers. Potential dividers have been added to a couple of analogue inputs. One of those (A6) is wired to monitor the supply voltage to the board incorporating a 10:1 potential divider and small series resistor (R3, 4 and 5) with the default surface mount component load. The other, (A3) is presenter on a header J2 (2) via its 10:1 potential divider R6 and R7. The values chosen allow an input voltage range of 0V to approx 30V

Lines from the Arduino to the frequency control pins, A/B and PTT are buffered with a 330 Ohm series resistor. This ***should*** provide a degree of protection through current limiting, should an error result in a low impedance HIGH state being put out by an Arduino Pin. It is not a guarantee that damage cannot occur. Please read the comments in the sketch.

An output pin (D10) is also wired to drive an open collector switch Q1. This is presented on a header (J8 Keying Out) and can be connected back to the Keying line (linking J8 pins 2 and 3) when used as a CW auto keyer.

2 pins are allocated to on-board pushbutton switches allowing a simple user interface to be implemented. A5 or A6 can be selected (JP5) for SW1 and A7 the SW2. The Sketch requires JP5 to be linked to select A5 for the ENTER switch, SW1.



Note, the use of A6 or A7 for reading a switch status requires an external pull-up resistor and ‘analogRead’ within the sketch. 100K Ohm resistors R16 and R17 to VCC (3.3V) are fitted for this purpose with the standard SMD load.

A4 and A5 are presented on a header as an I^2C port for other projects. This cannot be used for I^2C with the GM4ISM modified version of the 122GHz display sketch because A4 and A5 are used for other things.

A 5V regulator has been added on board to reduce the stress on the Arduino internal 3.3V regulator. The PCB is an adequate heatsink for this so long as the Aux 5V line is not too heavily loaded and / or the input voltage is kept below 25V. It is easy to improve the heatsinking of this device with a solder pad beneath the device and a good thermal path to one of the mounting holes

To use the PCB with the original sketch by Barry G8AGN, requires only a few links/ and resistors to be fitted. The PCB is offered without components or with a standard load of Surface Mount Devices, factory fitted.

A serial port (Software serial on D2 and D3) is provided for connection to the GPS engine. By default this is assumed to be a 3.3V device, however the PCB can be configured to supply 5V to the GPS with JP4 (you have to carefully cut the 3.3V link between the pads and put a solder bridge to 5V)

Also, if you wish to use a 5V GPS with a 3.3V Arduino, the RXdata line needs to be level shifted. R8 and R9 need to be implemented on the board. Suggested values are 3K3 and 2K2. With the standard SMD load, R9 is fitted as 0 Ohms for 3.3V logic levels. Operation with a 5V GPS has not been tested.

Using the board.

Confirm you are using the correct Arduino type and that the TFT display is compatible before fitting.

The Arduino (or sockets for it) and PCB headers should be fitted before the display is soldered in place on the back, as the display will prevent access to the rear of the board. The holes for the display connection are deliberately over-size. This allows for small variations in the display size and makes it a *little* easier to unsolder the display if you have to. The display mounting holes should line up with holes on the PCB to allow secure fixing. It is recommended that the display is secured in place before finally soldering the connections to reduce board stresses.

Solder jumpers JP1 an JP2 according to the Pinout of the Pro-Mini you are using. The most common version that presents A4-A7, does not need any jumper setting <u>but there may be a ground pin that should be left disconnected from the PCB</u>. (see Appendix A)

For the original 'Status read sketch' few of the surface mount components are needed, Resistors R10-R13 are required and it is recommended that the regulator U3, D1 and decoupling capacitors for the supply, data lines and Arduino are fitted.

Without the Pushbuttons, the modified sketch just reads the status and cant initiate the CW auto keyer.

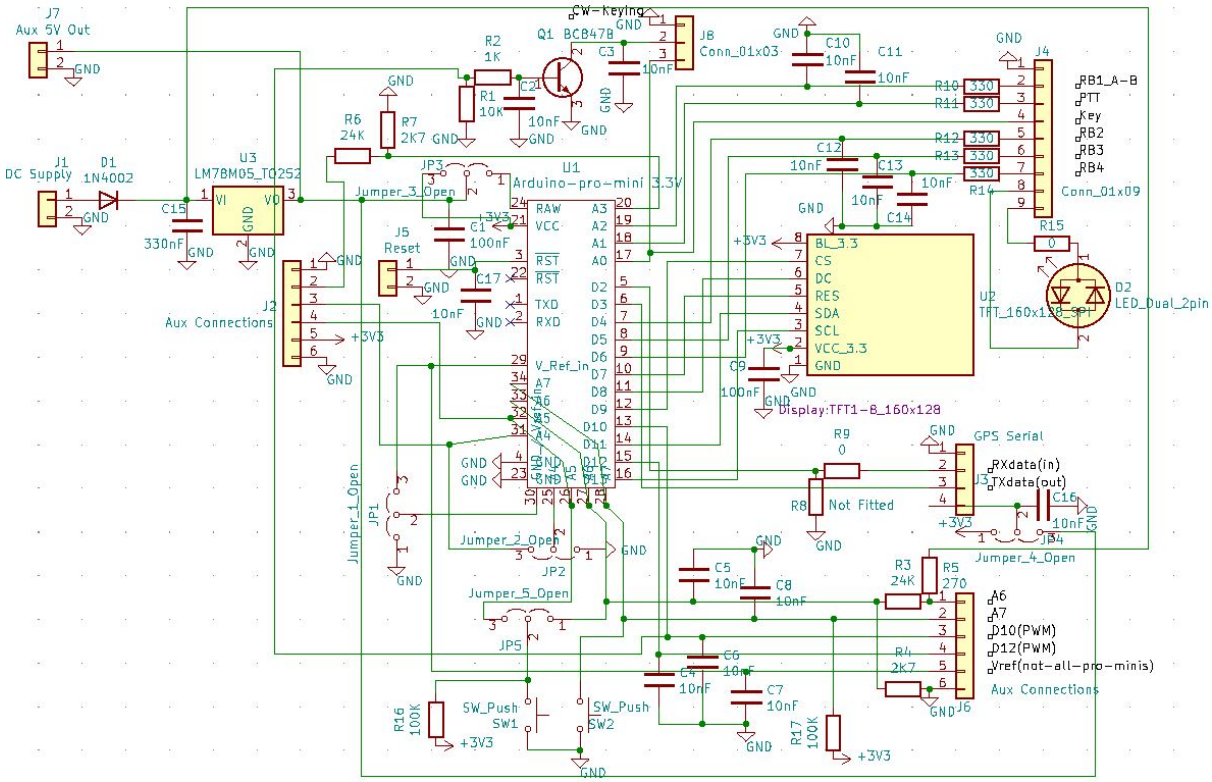
For the additional functionality offered by the GM4ISM modified sketch, almost all components will be needed.

Link JP5 should be soldered to select A5

A link should be made on J8 (pins 2-3) to connect the CW keyer to the Key input

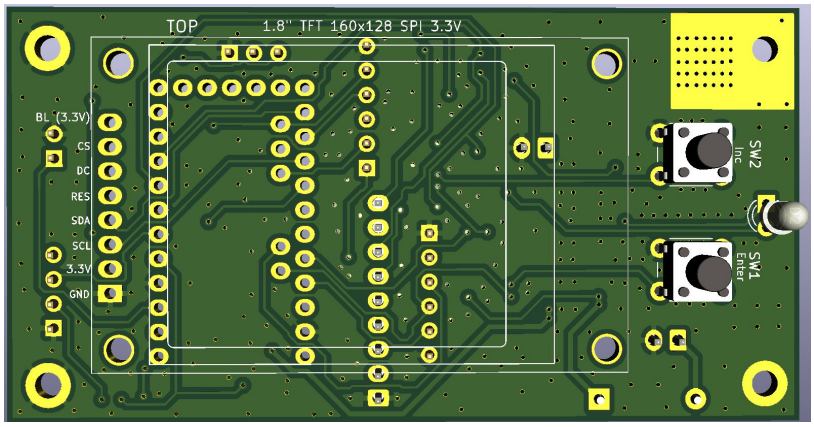
Pushbuttons for Enter and Inc. are needed.

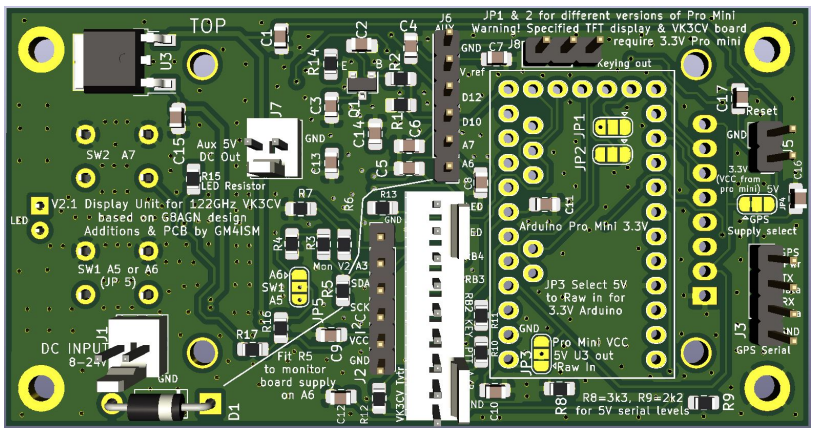
The Dual Led D2 is connected only to a header (via a 0 ohm resistor R15). This is intended to be used by removing the LED on the VK3CV board and wiring its connections to the Display board LED. It is probably a bad idea to have both LEDs in the circuit at the same time. Using the original VK3CV specified type LED, LED Pin 2 should be the short leg (without the series zero ohm resistor, Header Pin 8)



Schematic of the Display PCB V2.1

3D models of the PCB populated (except display and Arduino)





The Arduino Sketches

The Arduino sketch which adds the extra functions I was after is a modified version of Barry G8AGNs sketch V1.8b. The board is compatible with Barry's original sketch.

Barry has kindly given his permission for the modified sketch to be published for the 122GHz community.

The modifications I have done to the sketch keep the interface pretty much as designed by Barry.

Slight modifications to what is displayed in some switch conditions, (eg Indicating Full Duplex and renaming LO as TX in that condition)

The extra functions the modified sketch provides are:-

Display of supply voltage(s)

Indication of whether the Receive frequency is above or below the LO and an output status line to control a switchable Quadrature IF combiner, (Also available.)

Control the channel selection from the display interface. The software can detect if the channel switches are already set and won't assert control unless the switches are selecting CH0 (all open.) It also relinquishes control if any of the channel switches are set differently from the software commanded channel.

A CW auto keyer, able to send looped CW messages in standard QSO format, with user defined callsigns up to 11 characters long. CW messages etc. can be set without a PC.

The Maidenhead Locator for the CW keyer is set by the GPS. If GPS is not present it can be manually set. It will be overwritten when GPS lock is achieved (but not mid-message)

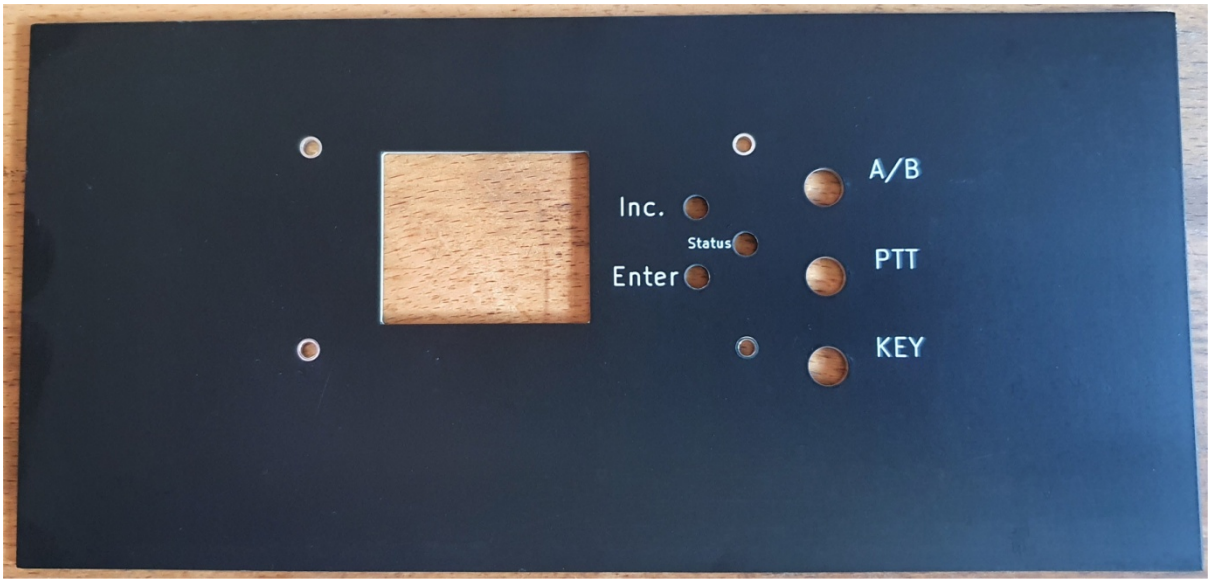
CW keyer parameters, callsigns etc. are all stored in EEPROM. On first use, the EEPROM is loaded with the defaults and the CW Keying data arrays.

Front Panel Mounting

To complete this project, I decided to also produce a front panel for a small enclosuer behind which the display and button could fit. The front panel can also be used to mount the A/B, PTT and Key switches.

Photo of Mk1 Protoype display mounted on Mk 1 PCB Bezel

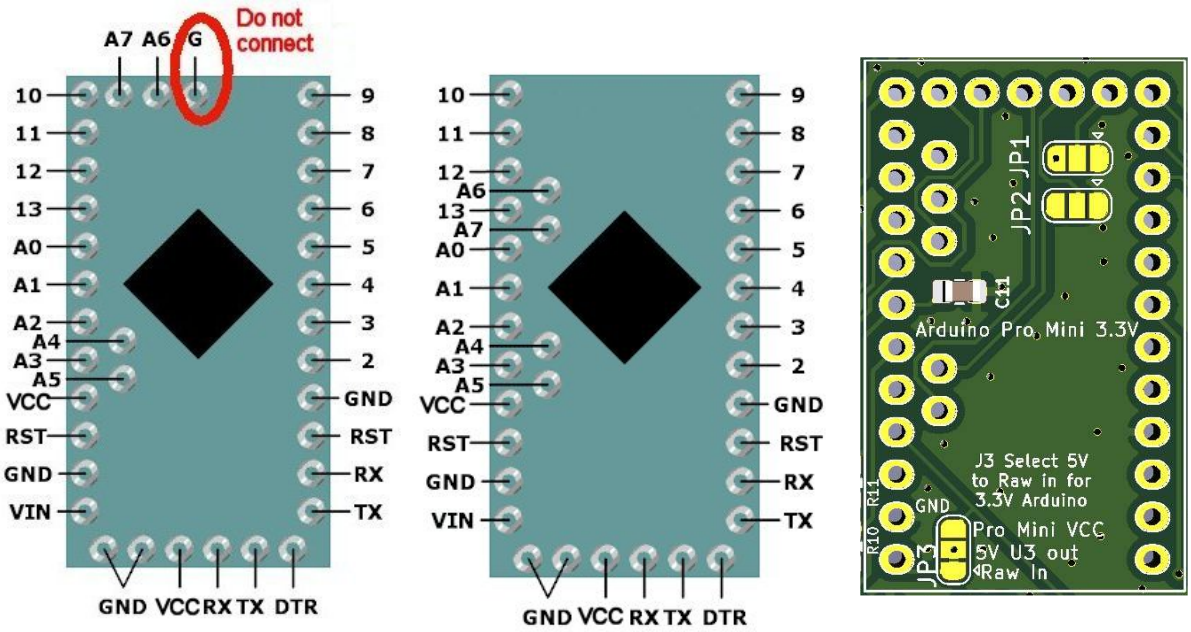
The Mk 2 front panel is bigger and silk screen marked on the back for a number of different standard enclosures (it has to be hand cut by the user to fit the chosen enclosure)



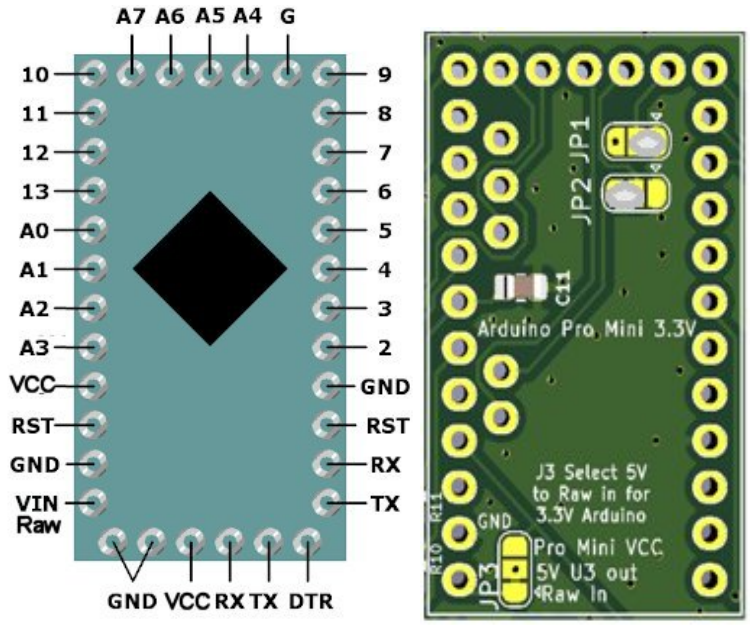
Appendix A

J1 and J2 are for different footprint Arduino Pro Mini boards

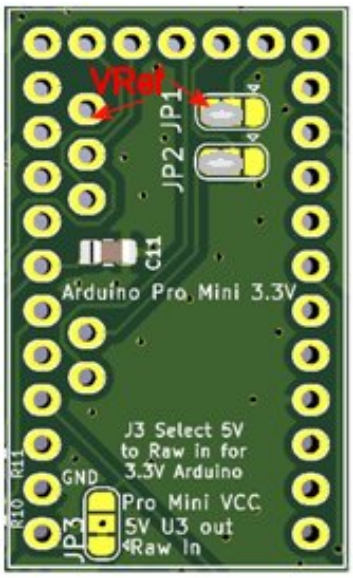
No jumper connections JP1 and JP2 required for these format Pro-Mini boards

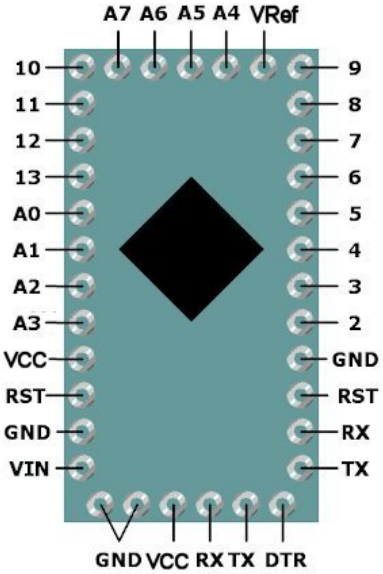


JP1 centre to Right (Gnd), JP2 Centre to left for this varaiety.



JP1 centre to Left (VRef), JP2 Centre to left for rare Pro Mini boards with VRef presented





Using a 5V Pro-Mini for other projects. BEWARE the TFT display used in the 122GHz project is not compatible with 5V operation! All lines marked VCC will become 5V, not 3.3V