Instructions/parts Mark 3 PI Zero (2) w + DIANH PI Z form Factor Board
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The intent of this project is to build an APRS device which can be treated as an appliance: it requires minimal configuration and once configured can just be plugged in/powered up and used. The Mark 3 APRS Appliance consists of the following parts:

- PI Zero W (1200 baud only) or PI Zero 2 W (1200 baud and 9600 baud)
- A DINAH AllStar radio interface: in this case a DINAH with form factor of a PI Zero stack
- Optional: A second USB WIFI dongle to support connection to local WIFI network (on board WIFI is hot spot ATGP on 10.0.0.5)
- Optional: A GPS: either a USB GPS puck or an integrated GPS board

The Mark 3 (or PI Zero design) of the APRS Appliance comes in three variants:

- Variant 1: PI Zero (2) W and DINAH board in PI Zero form factor (not a typical configuration)
- Variant 2: PI Zero (2) W, Makerspace USB Hub, DINAH board in PI Zero form factor with typically an additional USB WIFI adapter and a USB GPS puck
- Variant 3: PI Zero (2) W, Makerspace USB Hub, DINAH board in PI Zero form factor, typically with an additional USB WIFI adapter and an integrated GPS

These configurations do not fit within any of the typical PI Zero cases.

For variants 2 and 3 (both use the same case), Chad Baldi kindly designed a plastic case for the assembly and Chad Baldi and Dave Kostin both kindly 3D printed cases for me. The STL files for the case are:

- 20220211-aprs-mark3-base.stl
- 20220211-aprs-mark3-cover.stl

To assemble the stack you will need standoffs, and M2.5X0.45 screws. Ordered individually, these can easily cost in excess of $50. One of the goals is to contain costs for the design and one can assemble the system using:

- $11 Amazon standoff kit:
  - https://www.amazon.com/gp/product/B0756CW6Y2/

- $7 Amazon selection of M2/2.5/3 screws:
  - https://www.amazon.com/dp/B07LC74BC3

You will need the following parts:

- $15 (in normal times) PI Zero 2 W for 1200 and 9600 baud/$10 (in normal times) PI Zero W for 1200 baud only
- $8 16 GB or larger microSD card:
- https://www.amazon.com/gp/product/B073K14CVB/

- $5 heat sink:
  - https://www.amazon.com/gp/product/B01EE4W730/

- $14 Makerspot 4 port USB Hub:
  - https://www.amazon.com/gp/product/B01IT1TLFQ/

- $45 (reportedly) DINAH PI Zero form factor:
  - https://kits4hams.com/dinah

- $7 PS2 cable: 6 pin minii-din cable for use between DINAH and transceiver
  - https://www.amazon.com/gp/product/B001TKQOTG/

- $18 USB ribbon cable: micro-USB up/normal USB down 10 cm:
  - https://www.amazon.com/dp/B07X2YVD7F

- $9 Ferrite beads (place on all external cables to reduce RFI): https://www.amazon.com/dp/B07SKK9PGD

- $11 Small form factor Raspberry PI compatible USB WIFI dongle:
  - https://www.amazon.com/gp/product/B06Y2HKT75/
  - optional but recommended

- $20 USB GPS puck:
  - https://www.amazon.com/dp/B073P3Y48Q
  - optional but recommended

A Raspberry PI OS image to support this stack may be found at:

- https://drive.google.com/file/d/1ZkZQmRpCHOKm-dbgMWxH5YxCqe-QIvHT/view?usp=sharing

We have not optimized the stack, but rather tried to cost contain the hardware and leverage a single case design for both variant 3 and variant 2 (which means there is extra space where the integrated GPS unit would fit.

The assembled unit looks like (including integrated GPS):

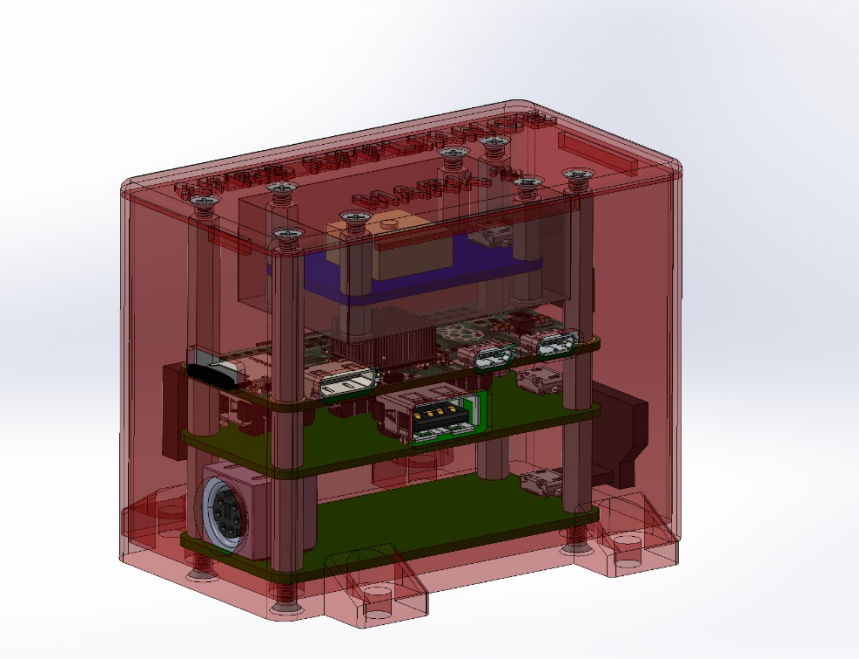

Figure 1: solid model of assembly in case (including integrated GPS)

The stack looks like:

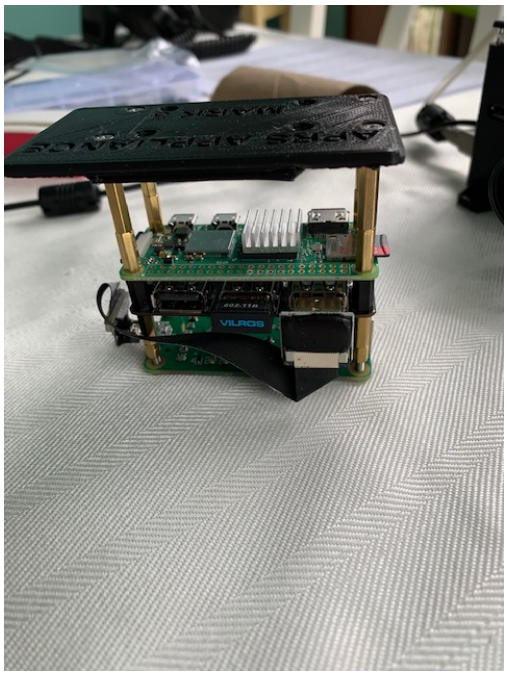

Figure 1: stack for variant 2 no integrated GPS

The stack consists of:

1. Install 14 mmX14 mm heat sink on PI Zero 2 W (not technically required, but a good practice)
2. Screw male M2.5X5 from spacer kit (for testing) or M2.5X10 flat head from screw set to assemble in case bottom
3. DINAH PI zero form factor board (remember to open jumper JP3)
4. Spacer M2.5X5+5 (male and female)
5. Spacer M2.5X11 (female on both ends)
6. Makerspot 4 port USB hub: align the end micro USB port on Makerspot USB Hub on same end as micro USB port on DINAH
7. 10 mm spacers from Makerspot USB hub (male end down)
8. PI Zero 2 W (or PI Zero W for low power 1200 baud only): SD card slot aligned over 6 pin mini-din on DINAH: this should align the POGO pins from the USB hub
9. M2.5X11+6 spacer (male and female)
10. M2.5X20+6 spacer (male and female: female should be on top)
11. Screw M2.5X6 flat head from screw set to assemble in case top
12. Run USB ribbon cable with micro USB up plugged into DINAH micro USB port to the right hand most USB port (of the set of 3) on the USB hub using USB male down plug
13. Plug the WIFI dongle into the center USB port of the set of three USB ports on the WIFI hub (this set of three plugs will be hidden by the case)
14. Plug the USB GPS puck into the single USB port on the USB Hub: this port will be exposed when in the case
15. Run a 6 pin mini-din cable from the DINAH 6 pin mini-din port to the transceiver 6 pin Minji-din port

Test freestanding unit without case first. Once you have confirmed it is working, assemble in case:

- Aligning 6 pin mini-din port on DINAH board and single USB port USB hub with side of case should allow you to align the parts at the bottom of the case and assemble with the M2.5X10 screws.

There is about a 5 mm gap between the case top and the main case but this does not seem to be a functional issue.

With integrated GPS:

One can also assemble this with an integrated GPS. In case, omit the GPS puck and add:

- $30: AdaFruit Ultimate USB GPS: https://www.adafruit.com/product/4279 (order form Ada Fruit for bets price)
- $14 USB ribbon cable Micro USB down, normal USB down: https://www.amazon.com/dp/B07X9KHL8J

The system with integrated GPS is an engineering trade off: we get an integrated system with only a power connector and a cable to the transceiver, but the GPS performance is reduced. The Raspberry PI and USB hub interfere with GPS lock. We create a low cost shielding with aluminum foil to reduce this effect BUT this shielding also impairs speed of fix.

It is recommended that one use a GPS puck unless an integrated GPS unit is required (perhaps for a battery powered man portable station).

[instructions for producing a shield: to be developed]

[instructions for assembly: to be developed]