FreqEZ Hardware Construction

Rather than purchase a pre-assembled and tested Raspberry Pi HAT board from K8UT, you can build your own FreqEZ Controller using the information contained in this document. After completing the construction refer to the software installation and setup in the FreqEZ2Help.pdf file.

Assembled FreqEZ enclosure prior to cable installation

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Overview

Required Materials

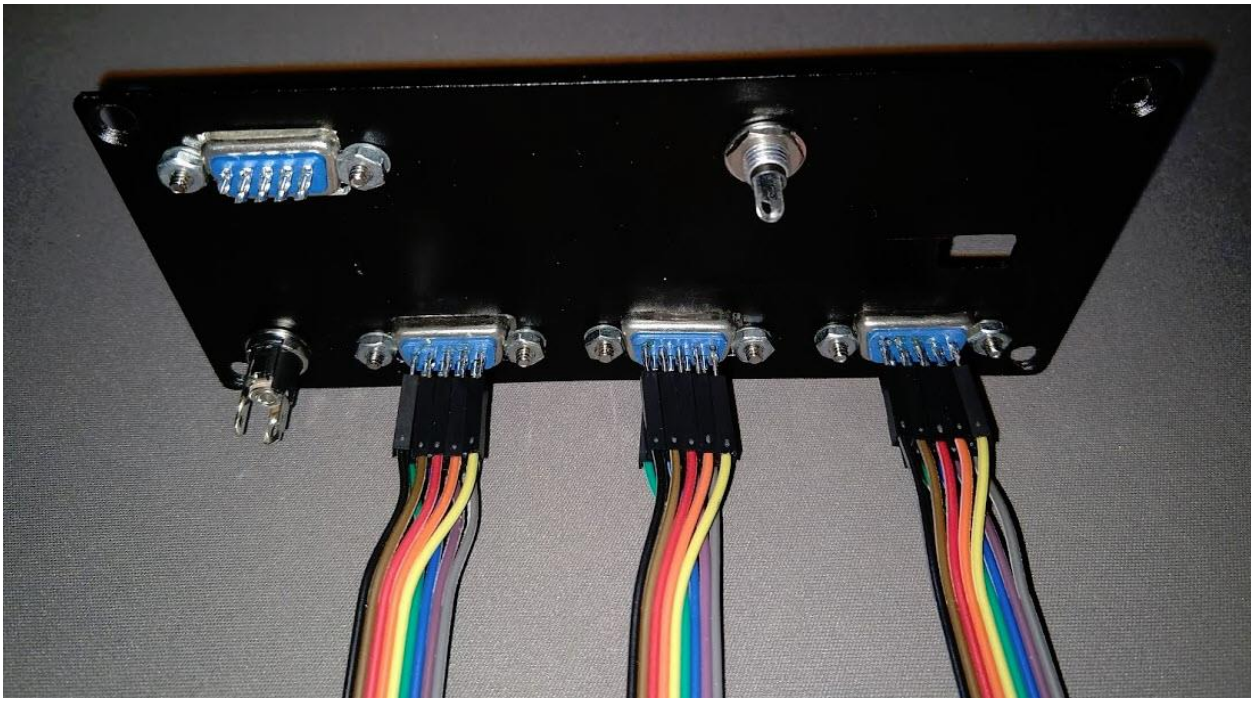
- Windows PC Console
    - Windows 7 or later
    - 8 GB of RAM minimum
    - 10 MB of disk space
    - Ethernet/WiFi connection
- Raspberry Pi Controller
    - Model 4 2GB recommended, but any model with 40 GPIO pins will work
    - Raspberry Pi micro-USB power cable with power supply or PC as a power source
    - 8GB (or larger) microSD card with latest Raspbian operating system. Fast card (class 10) recommended
- Band Decoder switches
    - Two SainSmart relay modules (or equivalent) with 8 relays each – 5 volt DC relay model
    - Dupont rainbow female-to-female jumper cables for connecting the 40 pin RPi GPIO connector to the SainSmart relay modules. (see text for details)
    - Dupont rainbow male-to-male jumper cables for connecting the SainSmart relay outputs to the DE-9 connectors. (see text for details)
- Electronic parts: five 1N4004 diodes (or equivalent), five .01 @ 100 volts ceramic caps
- Mechanical parts: twelve ¼" stand-offs for the Raspberry Pi and two SainSmart relays
- Optional
    - Enclosure – search Amazon or eBay for an aluminum enclosure with 203mm x 144mm x 68mm dimensions, a perfect fit for a Raspberry Pi and two SainSmart 8 relay boards
    - Mounting tray inside the enclosure – rather than connect the hardware devices directly to the case, cut a piece of aluminum or perf board to slide along the guides within the enclosure (see photos)
    - Connectors and wire – as appropriate for connecting the enclosure to external remote antenna switches. Suggest three D-sub 9 pin female for antennas, one D-sub 9 male for BCD inputs, RCA jack for PTT / Tx Inhibit), DC power jack for remote antenna switch 12 VDC

Parts List

The FreqEZ Parts List consists of components that were intentionally selected as being inexpensive and globally available. Using popular sources like Amazon, eBay, Mouser and DigiKey, hams should be able to purchase all of the FreqEZ components for approximately $100 (US).

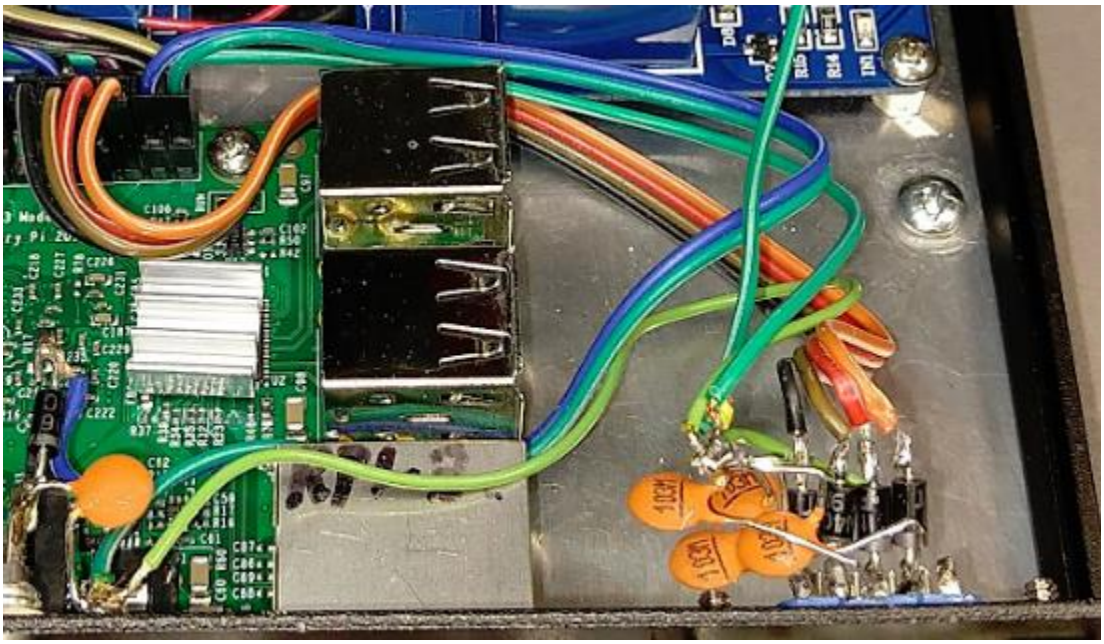
- 2 x SainSmart relay modules (or equivalent) with 8 relays each – 5 volt DC relay model
- Dupont rainbow female-to-female jumper cables for connecting the 40 pin RPi GPIO connector to the SainSmart relay modules. (see text for details)
- Dupont rainbow male-to-male jumper cables for connecting the SainSmart relay outputs to the DE-9 connectors. (see text for details)
- 5 x 1N4004 diodes (or equivalent)
- 5 x .01 @ 100 volts ceramic caps
- 12 x ¼" stand-offs for the Raspberry Pi and SainSmart relay modules
- 3 x D-sub 9 pin female connectors (to remote antenna switches)
- 1 x D-sub 9 pin male connector (to rig BCD connector)
- 1 x RCA jack (for PTT / Tx Inhibit)
    -
- 1 x DC power jack (for remote antenna power 12 VDC)
- Optional
    - Enclosure – search Amazon or eBay for an aluminum enclosure with 203mm x 144mm x 68mm dimensions, a perfect fit for a Raspberry Pi and two SainSmart 8 relay boards
    - Mounting tray inside the enclosure – rather than connect the hardware devices directly to the case, cut a piece of aluminum or perf board to slide along the guides within the enclosure (see photos)

FreqEZ Rear Panel Connectors and Cable



Female Antenna Relay Connectors

Separate three 9 conductor cables from the DuPont male-to-male rainbow cable. Look closely and strip-away the wire so that each 9 conductor bunch will follow the resistor color code (makes wiring easier): Black, Brown, Red, Orange – through- Grey. The male pins of the DuPont cable will fit nicely into the solder cups of the D-Sub connector. (makes soldering easier – no cutting or insulation stripping) Look CLOSELY at the pin diagram of the connectors and again follow the resistor color code: Pin1 = Black; pin2 = Brown; pin3 = Red – through pin9 = Grey. The opposite end of these wires will connect to the SainSmart relay terminals in Final Assembly.



Male BCD connector

– See photo, especially the 4 conductor Black Brown Red Orange ribbon cable.

Preparing the cable: Separate a 4 conductor cable from the DuPont female-to-female rainbow cable. Look closely and strip-away the wire so that the four conductor bunch will follow the resistor color code (makes wiring easier): Black, Brown, Red, Orange. Cut the connector body off one end of the 4 conductor, so that the cable has a female connector on one end and bare wires on the opposite end. Strip the insulation on the bare wire end for about ¼ from the end of those four conductors.

Soldering the diodes: See photo – especially the four diodes soldered to the 9 pin male DB-9 connector. Trim the leads of 4 x 1N4004 diodes to about ½ inch in length. Bend the Anode end (un-banded end) of the diodes into a J-hook shape to facilitate soldering of the wire and the bypass caps. Solder the Cathode end (banded end) of the diodes to pins 1 through 4 of the 9 pin BCD male connector. ON the Anode end, solder the stripped section of the four conductor wire (in order: pin1 = Black; pin2 = Brown; pin3 = Red; pin 4 = Orange). The opposite end of these wires will connect to the Raspberry Pi in Final Assembly.

Soldering the .01 bypass capacitors: See {ugly} photo – install a ground lug under the nut holding the DB-9 9 pin male connector to the end-plate. Shorten the leads of the four bypass capacitors as necessary to allow each to be soldered to the banded end (with the J-hook shape) of the diodes, with the opposite ends tied together to the end-plate ground lug.

Attach a ground connection: Solder a short piece of wire between pin 9 of the BCD connector and the ground lug that was installed in the previous step.

PTT / Tx Inhibit Line

Preparing the cable: Separate a 2 conductor cable from the DuPont female-to-female rainbow cable. Look closely and strip-away the wire so that the 2 conductors will be Blue and Green (blue will be the signal line, green will be ground). Cut the connector body off one end of the 2 conductor cable, so that the cable has a female connector on one end and bare wires on the opposite end. Strip the insulation on the bare wire end for about ¼ from the end of two conductors.

Soldering a diode: See photo – especially the diode soldered to the RCA jack. Trim the leads of 1N4004 diode to about ½ inch in length. Bend the Anode end (un-banded end) of the diodes into a J-hook shape to facilitate soldering of the wire and the bypass caps. Solder the Cathode end (banded end) of the diodes to the center pins of the RCA jack. On the Anode end, solder the stripped section of the blue wire. Solder the green wire to the ground lug of the RCA jack. The opposite end of these wires will connect to the Raspberry Pi in Final Assembly.

Soldering a .01 bypass capacitor: See photo. Shorten one leads of the bypass capacitor as necessary to allow one end to be soldered to the banded end (with the J-hook shape) of the diode, with the opposite end solderd toe the RCA jack ground lug.

Connecting the Raspberry Pi to the SainSmart Relay Modules

Refer to the manufacturer's instructions for your remote antenna switches. From those instructions decide how to wire your SainSmart relays. In most cases, you will want to wire a common ground or a common + 12 volts DC supply to the Normally Open (N/O) contacts of the 8 relays.

The switched contacts of the SainSmart relays will connect to external devices such as remote antenna switches and band filters. The following diagram illustrates the RPi GPIO connector and the pins of the SainSmart modules to which it connects.

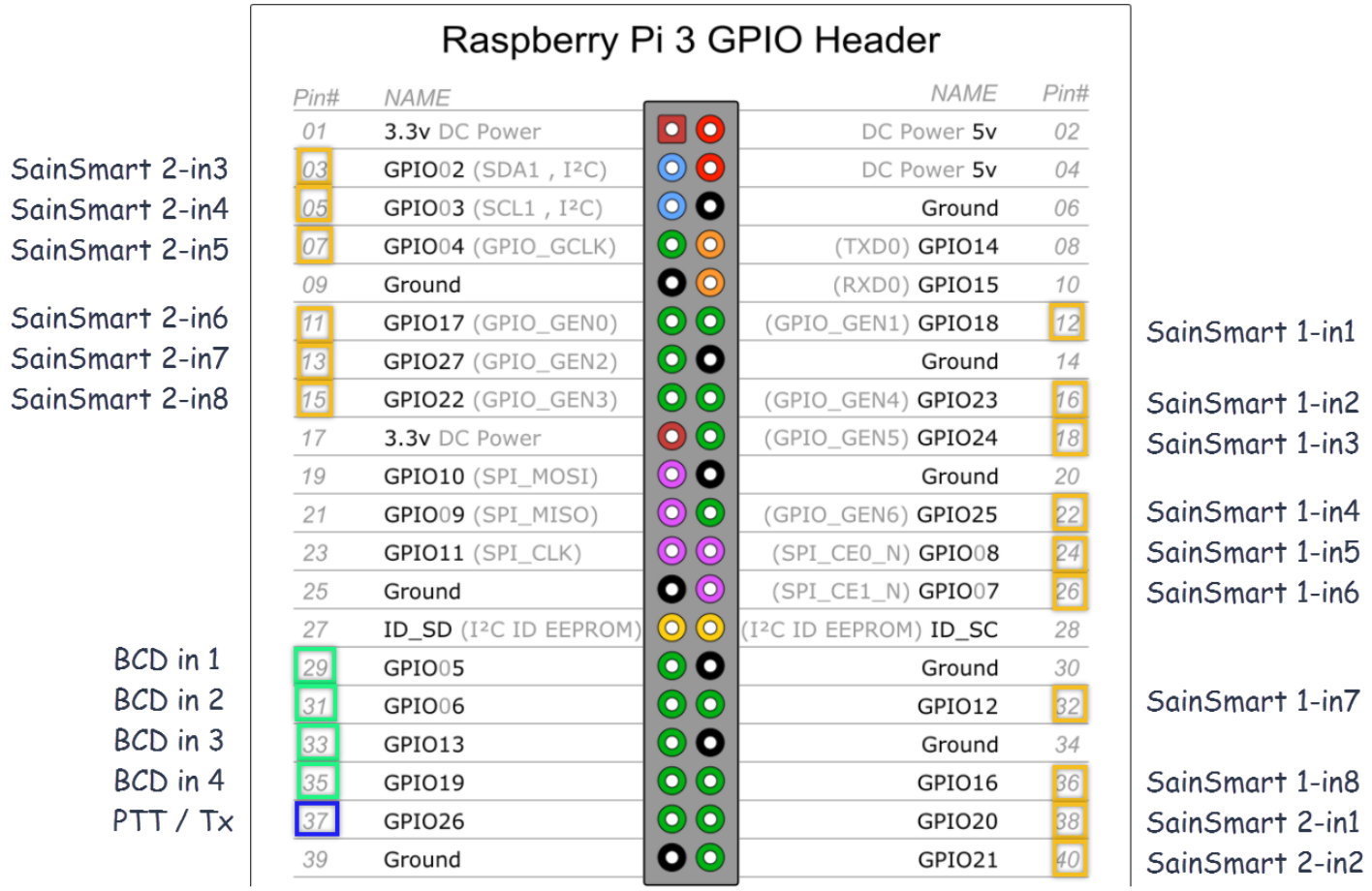
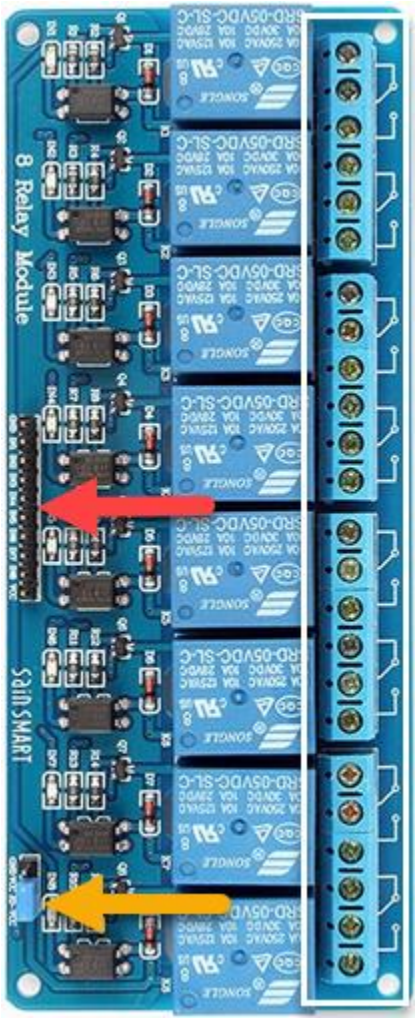


Figure 1: The Raspberry Pi 40 Pin GPIO Connector (courtesy: www.ele4ment14.com)

Figure 1 shows the allocation of FreqEZ pins for Band Decoder switching (16 orange rectangles), optional BCD control (4 green rectangles), and optional PTT sense/Tx inhibit (1 blue rectangle).

Connecting to the Raspberry Pi for Band Decoder Operation

Refer to the red arrow in adjacent photo. This table lists the connection scheme between the 8 relay board and the Raspberry Pi GPIO pins for Band Decoder operation.



10 pin connector on 8 relay board. For relays 1-8

```
GND (ground) to GPIO pin 6
In1 (relay 1) to GPIO pin 12
In2 (relay 2) to GPIO pin 16
In3 (relay 3) to GPIO pin 18
In4 (relay 4) to GPIO pin 22
In5 (relay 5) to GPIO pin 24
In6 (relay 6) to GPIO pin 26
In7 (relay 7) to GPIO pin 32
In8 (relay 8) to GPIO pin 36
VCC (+5 vdc) to GPIO pin 4
```

10 pin connector on a second 8 relay board. For relays 9-16

```
GND (ground) to GPIO pin 34
In1 (relay 9) to GPIO pin 38
In2 (relay 10) to GPIO pin 40
In3 (relay 11) to GPIO pin 3
In4 (relay 12) to GPIO pin 5
In5 (relay 13) to GPIO pin 7
In6 (relay 14) to GPIO pin 11
In7 (relay 15) to GPIO pin 13
In8 (relay 16) to GPIO pin 15
VCC (+5 vdc) to GPIO pin 2
```

Connecting SainSmart Relay Modules to Remote Devices

Refer to the manufacturer's instructions for your remote antenna switches. From those instructions decide how to wire the output contacts (white rectangle below) of your SainSmart relays. In most cases, you will want to wire a common ground or a common + 12 volts DC supply to the Normally Open (N/O) contacts of each of the 8 relay modules.

All outputs from the two relay modules are identical: one single-pole double-throw (SPDT) "dry" set of contacts for each of 8 external connections. The switched contacts of the SainSmart relays connect to external devices such as remote antenna switches and band filters. In the following photo, the relay contacts begin on the left side with relay 1, through to relay 8 on the right side.

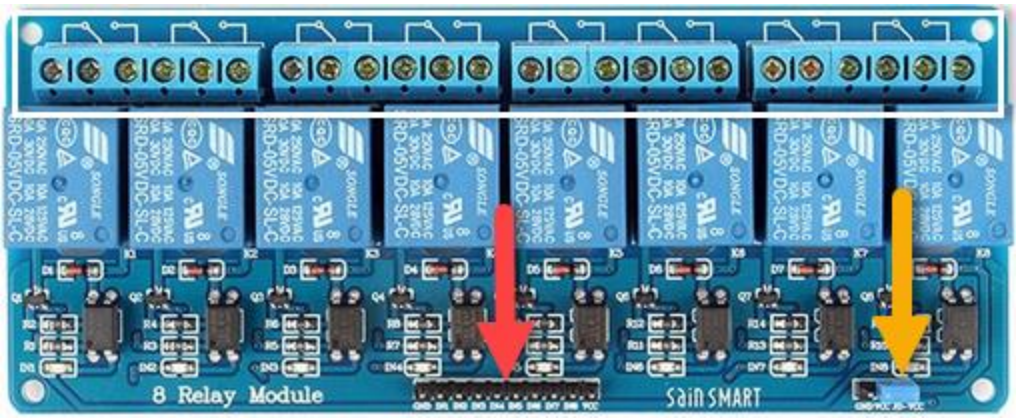


Photo 1: 8 Relay model showing connection for GPIO (red) rainbow cable and the jumper for 5 VDC operation (orange)

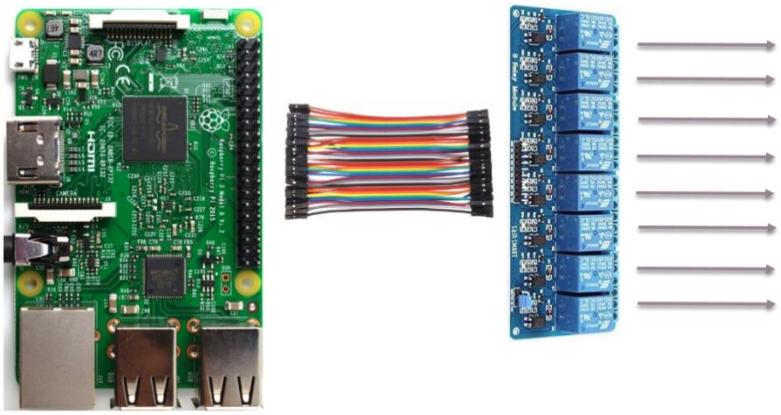
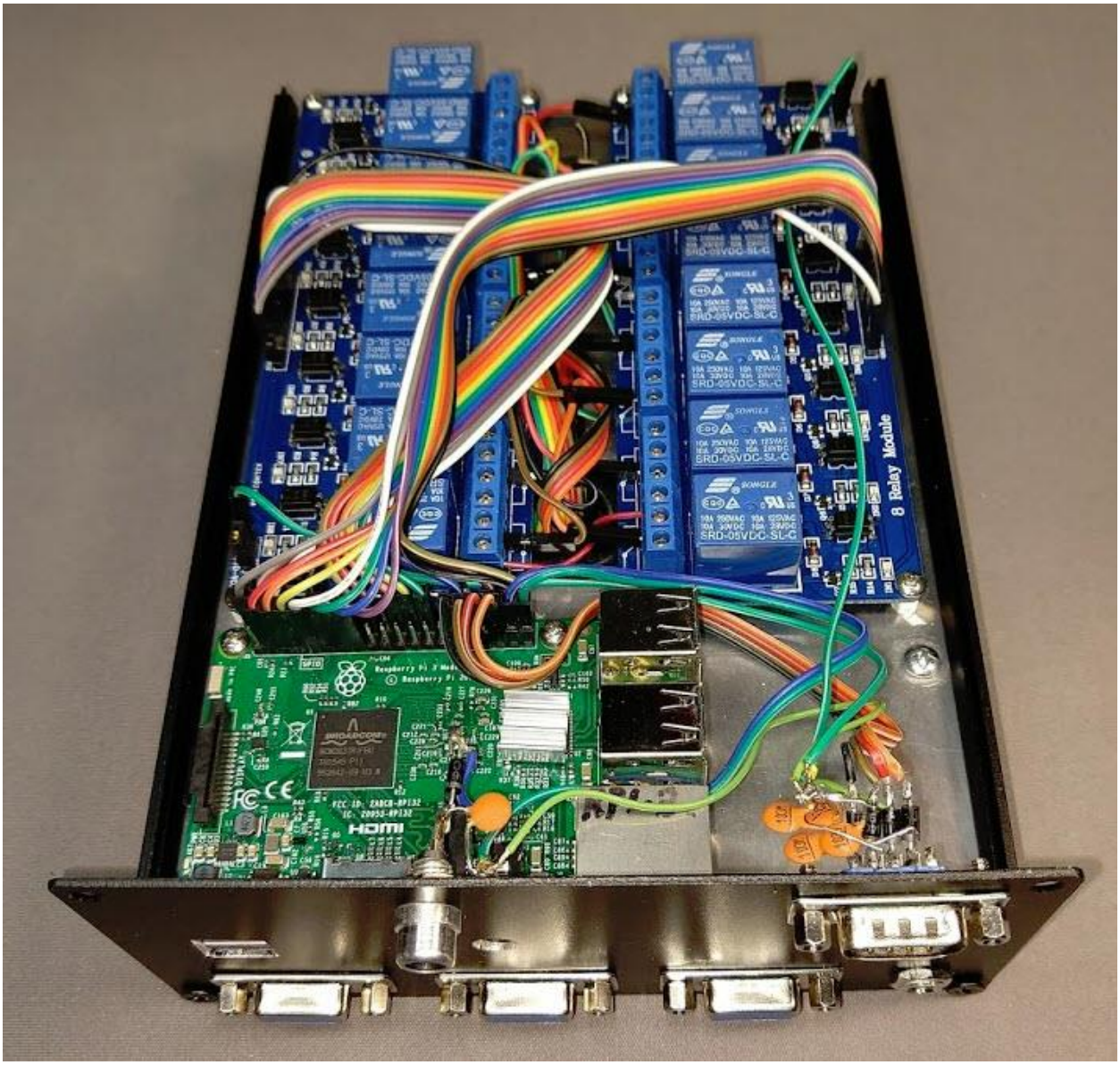


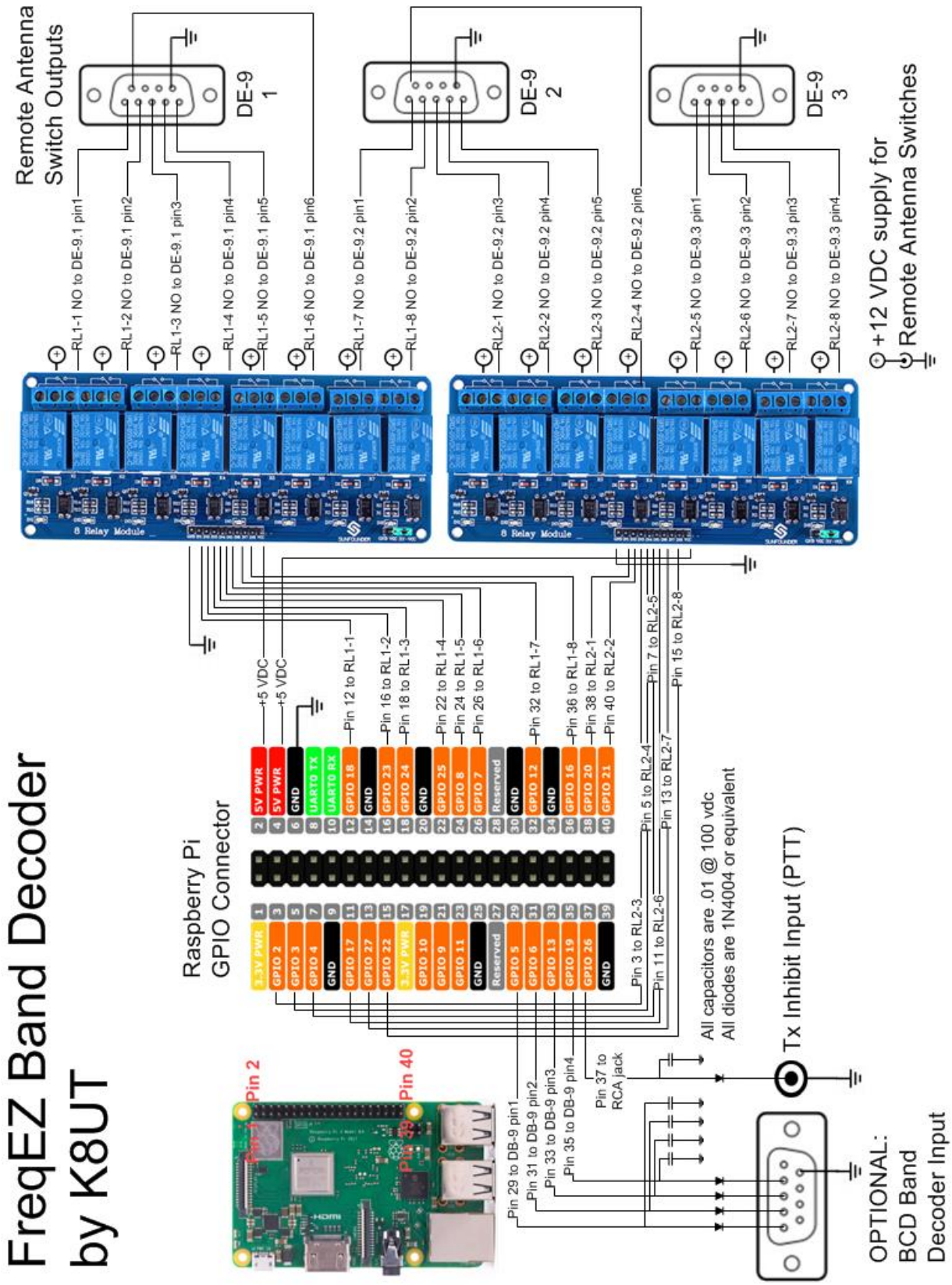
Figure 2: Raspberry Pi, Dupont rainbow jumpers, SainSmart relay module, outputs to external devices

FreqEZ After Cable Installation

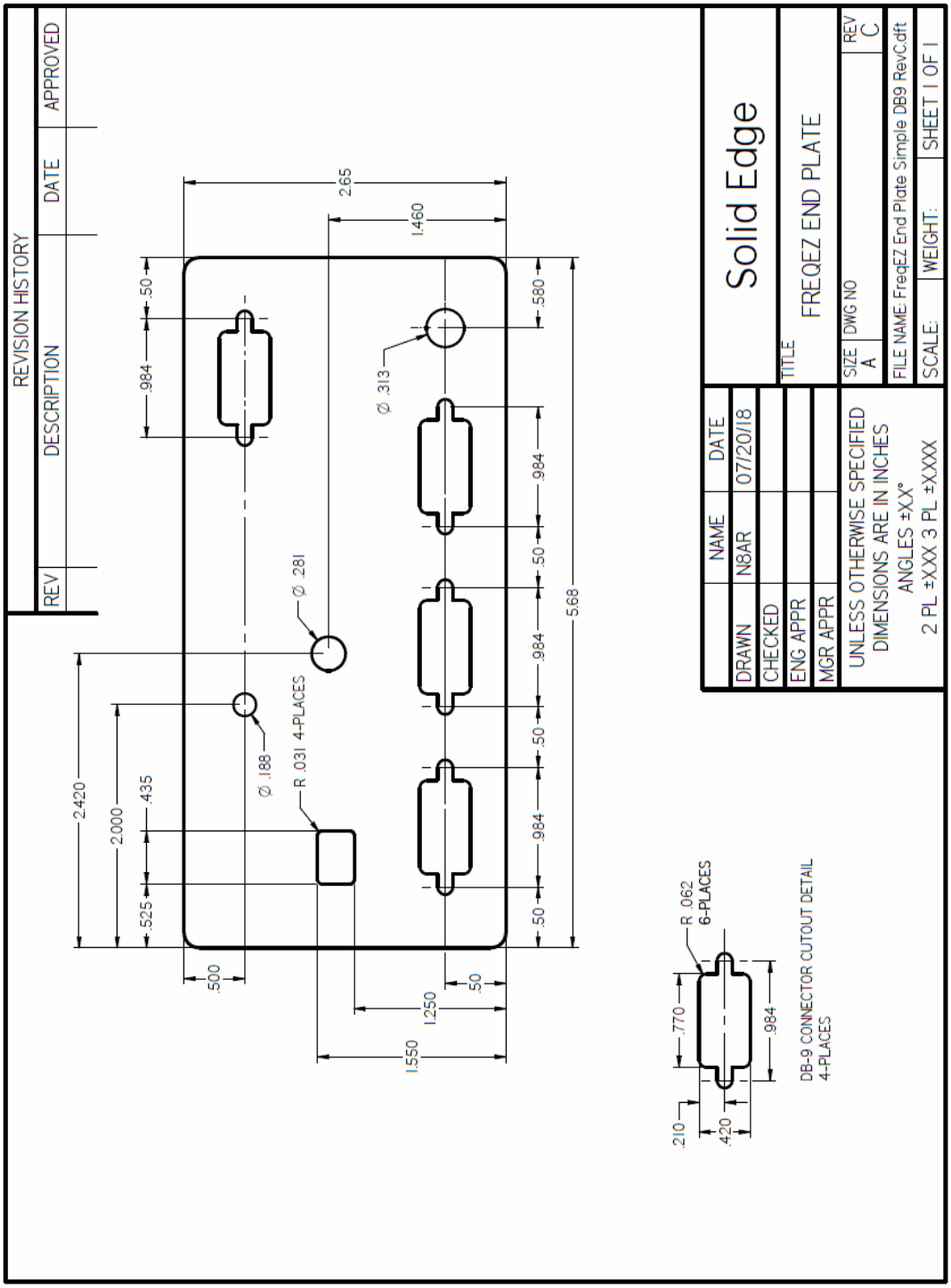
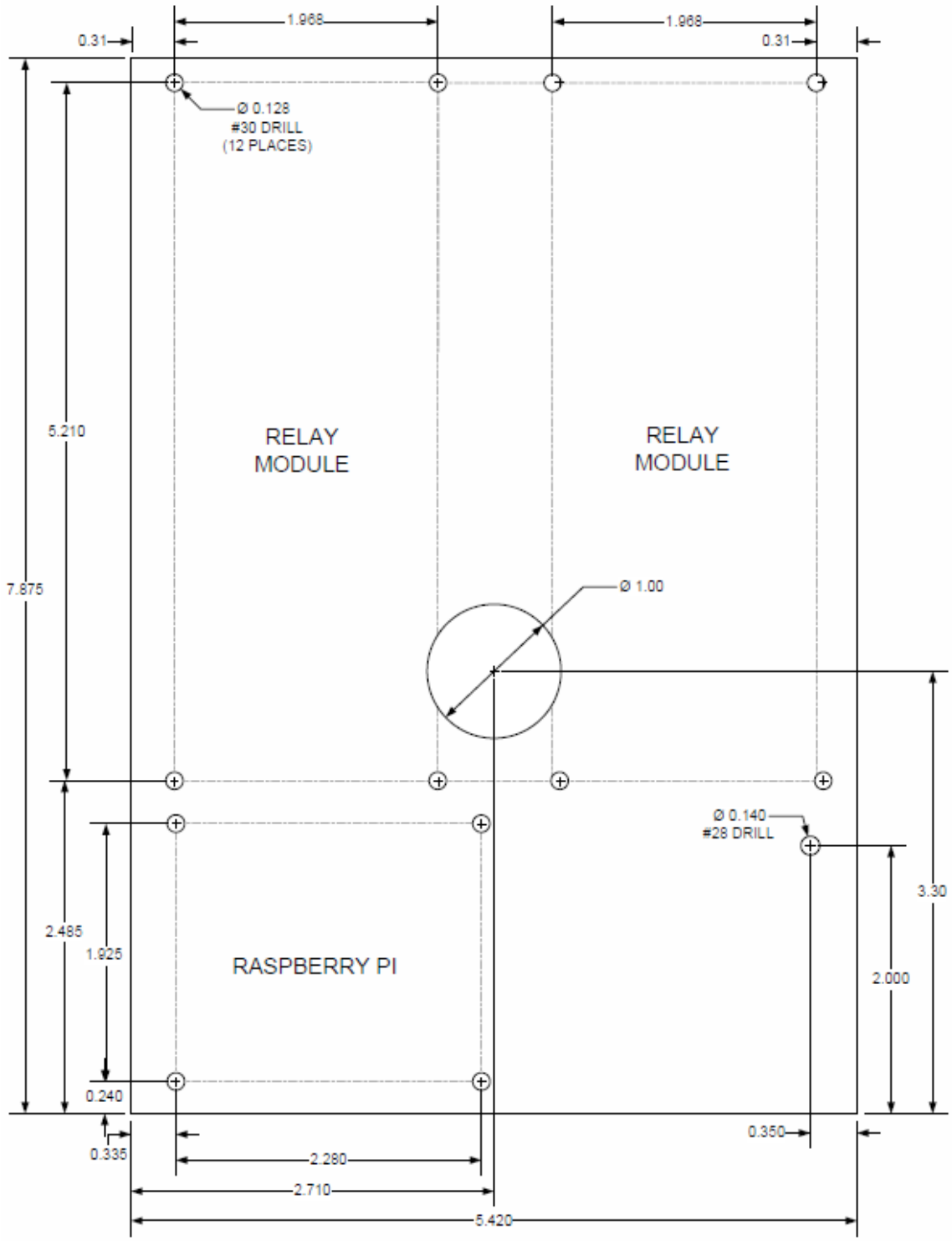


Appendix

FreqEZ Schematic



FreqEZ End Plate dimensions



FreqEZ Mounting Plate (tray) Dimensions