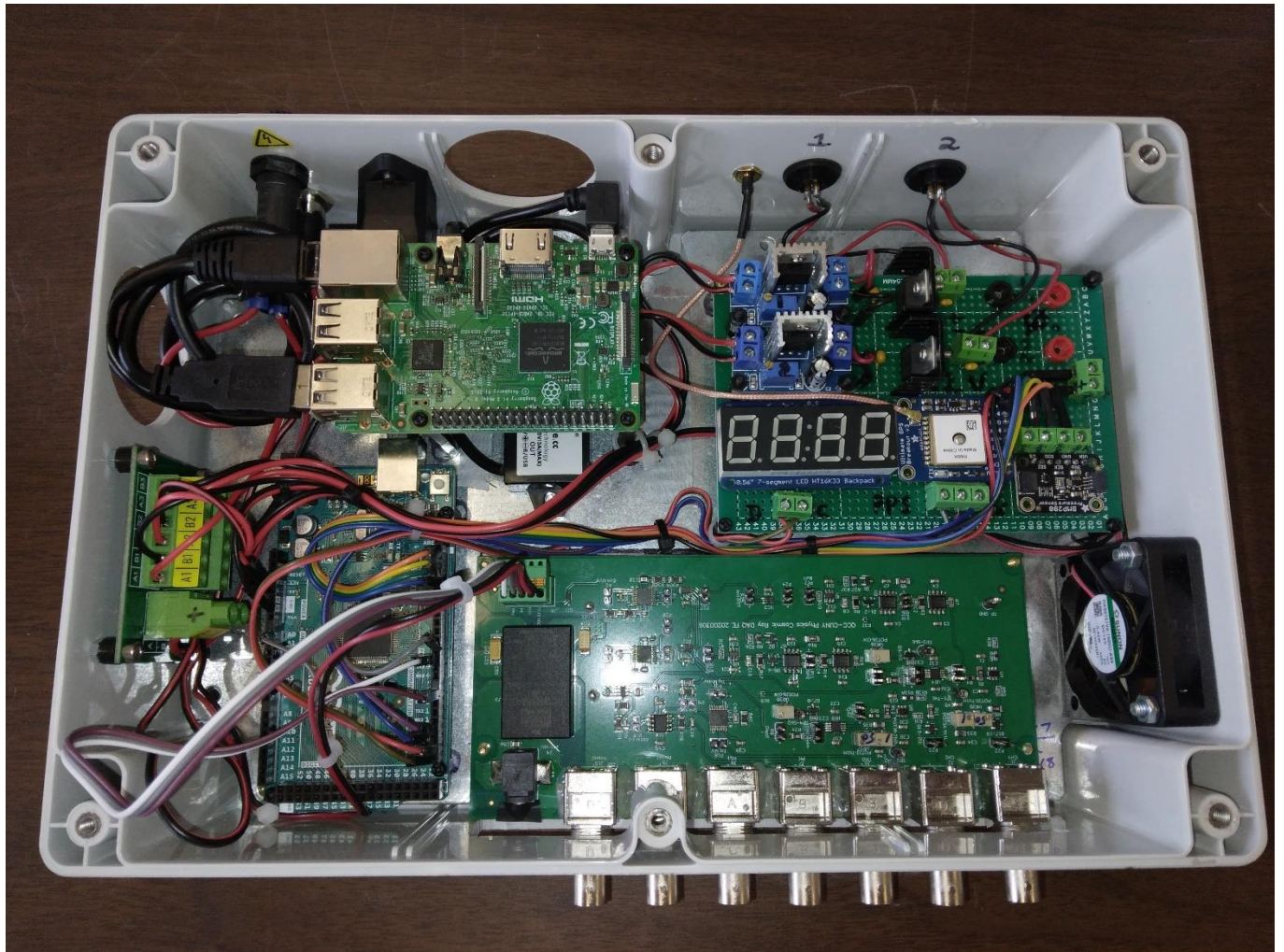


Cosmic ray muon detector DAQ assembly instructions

QCC-CUNY Physics dept. (Armendariz) – Draft 4-9-2024

The DAQ front-end PCB includes amplifiers, discriminators, event counters, and signal amplitude detector circuitry to make two channel coincidence measurements from 2 PMTs. The perforated electronics bread-board contains a GPS receiver, two LM317 variable voltage regulators, two voltage regulators, capacitors, ambient temperature and pressure sensors, LCD counter, voltage test points, and terminal blocks; the DAQ box also contains an Arduino Mega, Raspberry Pi, fan, terminal block, fuse, 20V to 5V DC-DC buck-converter, and various connectors.



You will need drill bits: 1/8", 9/64" (3.5 mm is okay), 3/16" (5 mm is ok), 1/4", 3/8", 1/2" (13 mm is okay)

Circular hole cutting tools: 3/4", 1 3/4"

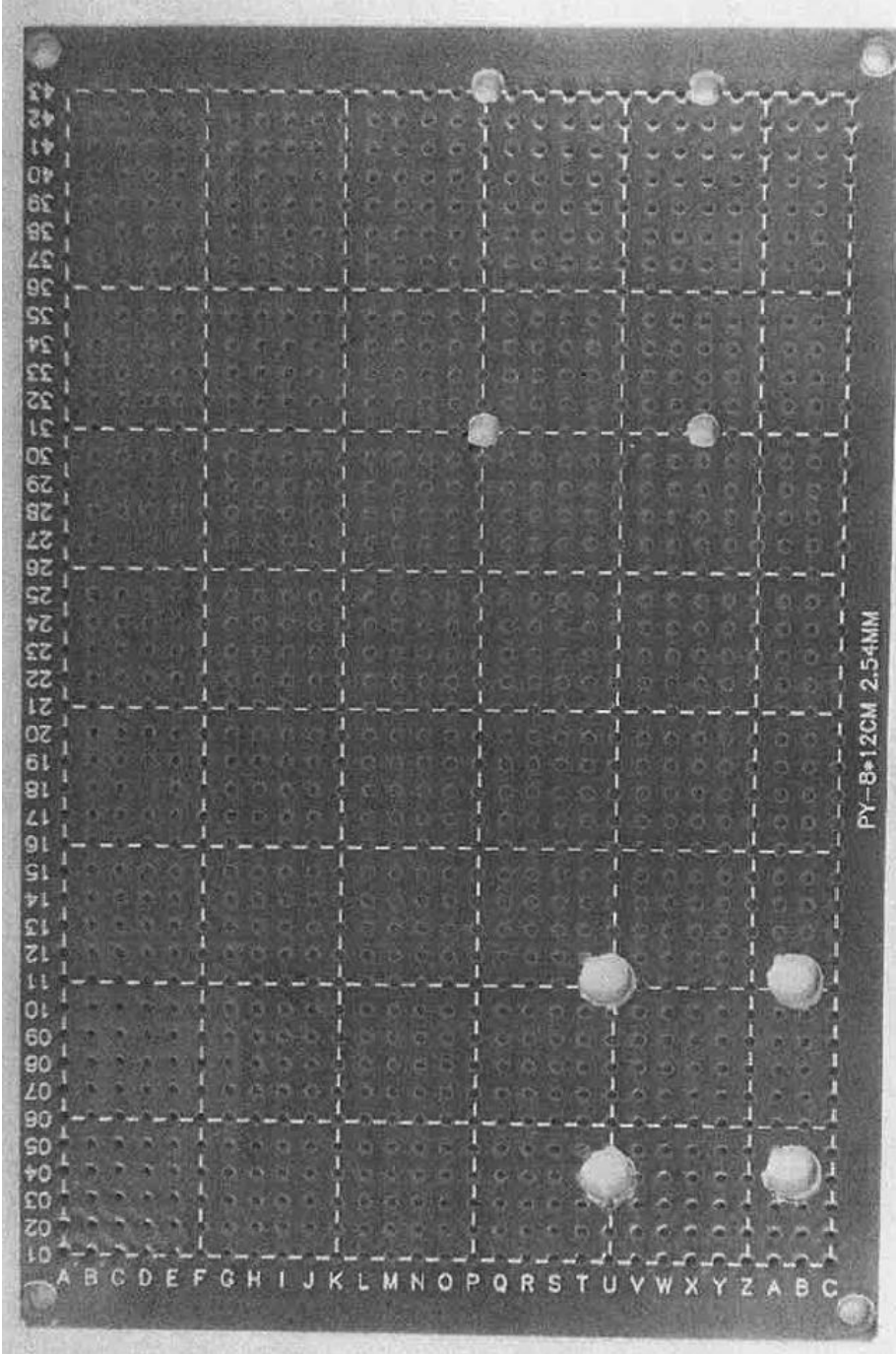
Drill, drill press, 2 clamps, screw drivers, wire cutters, wire strippers, solder iron, solder, wire, ruler

Nut drivers: 5mm, 5.5mm. Small Phillips screw driver, pliers

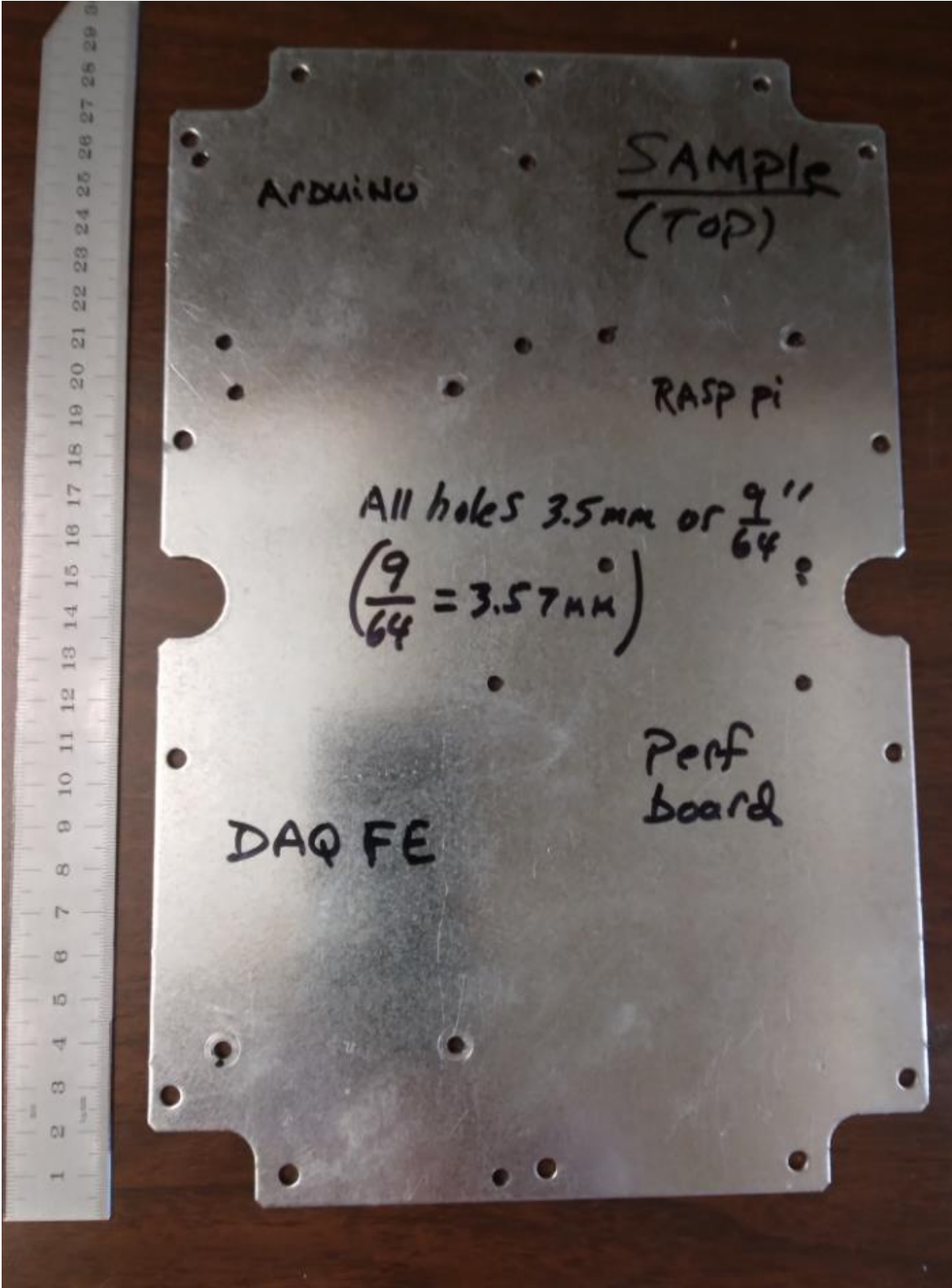
Drill 4 holes in the electronics perfboard with a 3/16" drill bit at holes 11B2, 4B2, 11U, and 4U

Drill 4 holes in the perfboard with a 1/8" drill bit at holes 43X, 31X, 43P, and 31P

See the example perfboard in the lab.



Drill holes in the mounting plate with a 9/64" drill bit (or 3.5 mm is also okay); use the example template to overlay over the plate you will drill holes into. After drilling, the holes have sharp burs, use the tool to clean them away



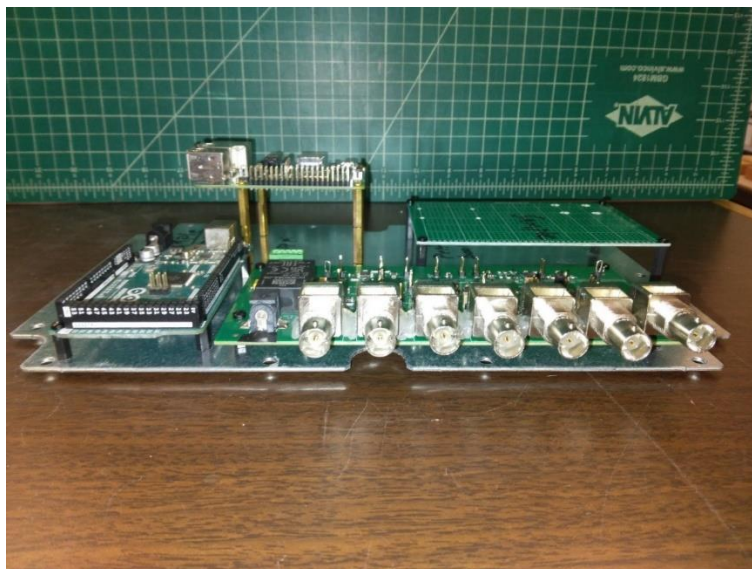
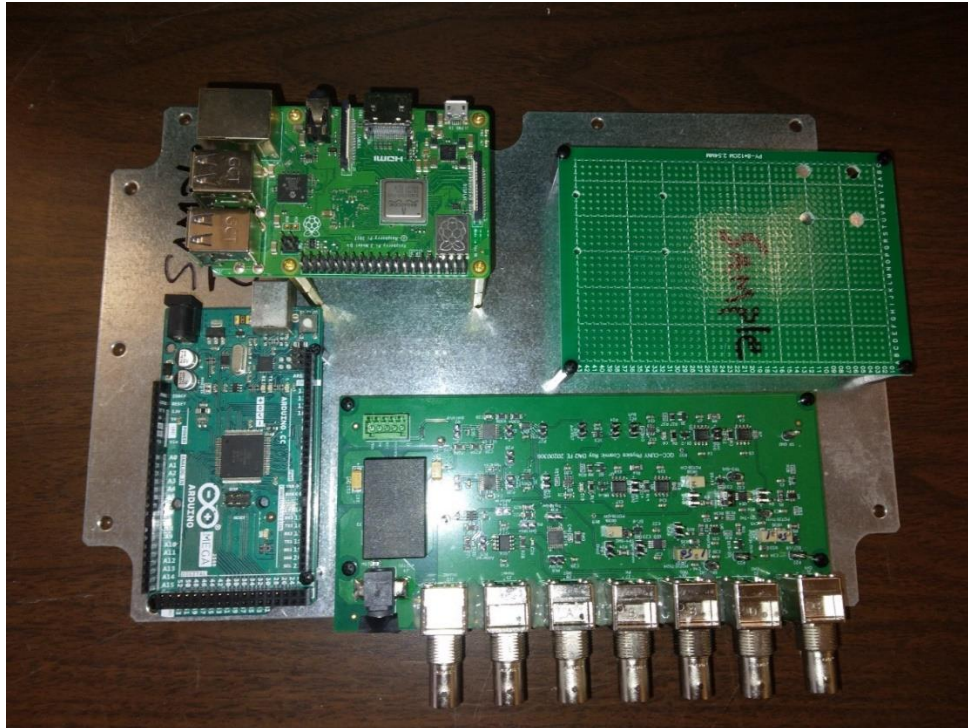
Tools needed to mount standoffs: nut drivers: 5mm, 5.5mm. Small Phillips screw driver, pliers

M2.5 Standoffs needed: 12 1cm, and 12 2cm (use 8 of them to make 4 4cm standoffs)

M2.5 hardware needed: 16 washers, 20 nuts, 20 bolts (bolts heads no larger than 4.7 mm)

Mount the Raspberry Pi with 4cm standoffs, the perfboard with 2cm standoffs, the Arduino Mega and DAQ FE board with 1 cm standoffs as shown in the picture; mount the LM317s with 1cm standoffs.

When screwing standoffs onto the metal mounting plate, insert the male ends of the standoffs through the holes from the top side of the plate; the nuts screw onto the standoffs underneath the plate.



Drilling out the enclosure

Use the various drawings and pictures below to mark on the enclosure the points where you will drill the holes, and cutouts. See the pictures for how they will look when finished.

You will need:

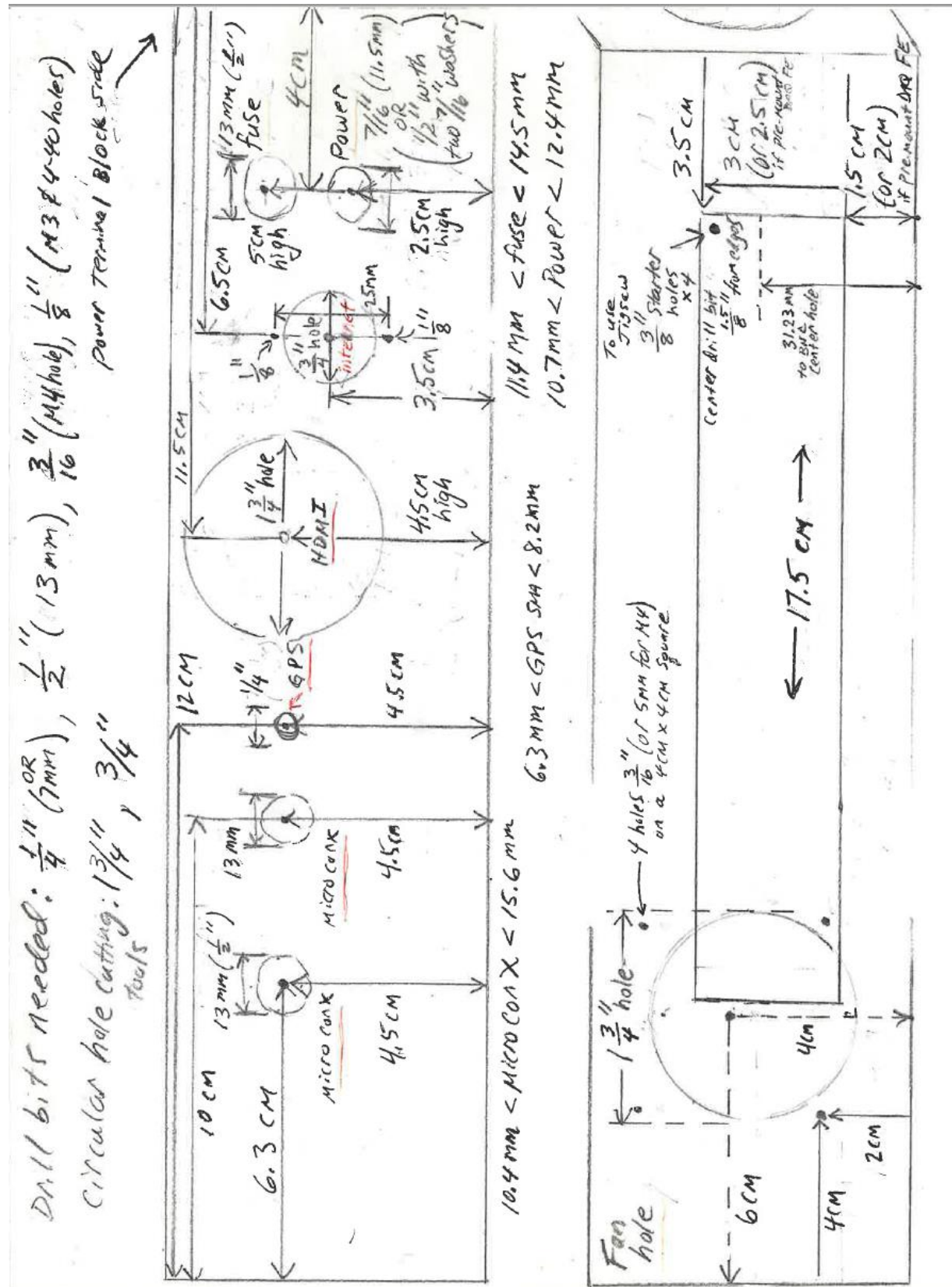
Drill press to drill all the holes

drill bits: 1/8", 3/16", 1/4", 3/8", 1/2"

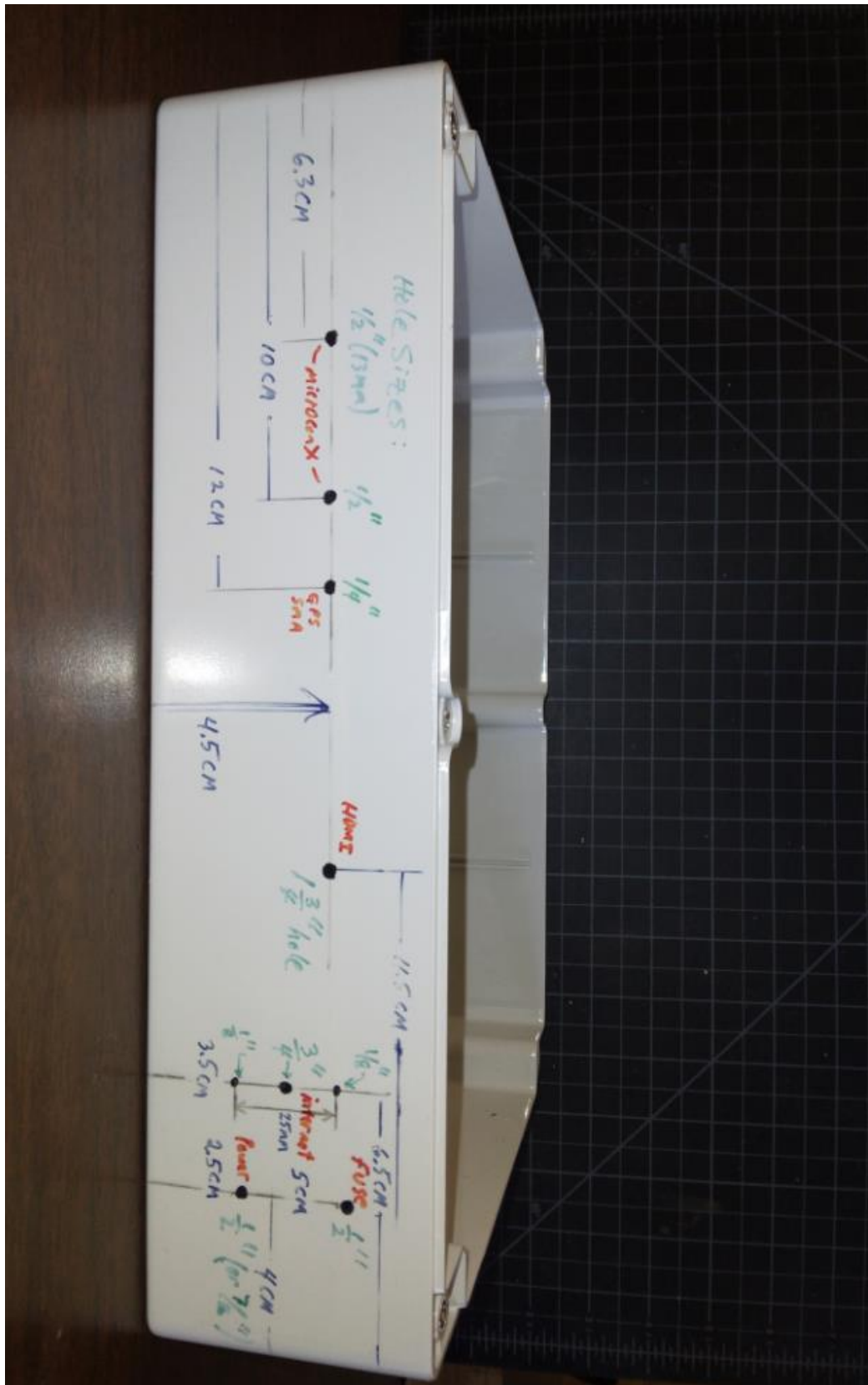
circular hole cutting tools: 3/4", 1 3/4"

Before using the circular cutting tool drill a smaller starter hole; be careful the box doesn't spin under the torque of the drill bit or circular cutting tool

This drawing has the holes and cutouts for 3 of the 4 sides of the enclosure:



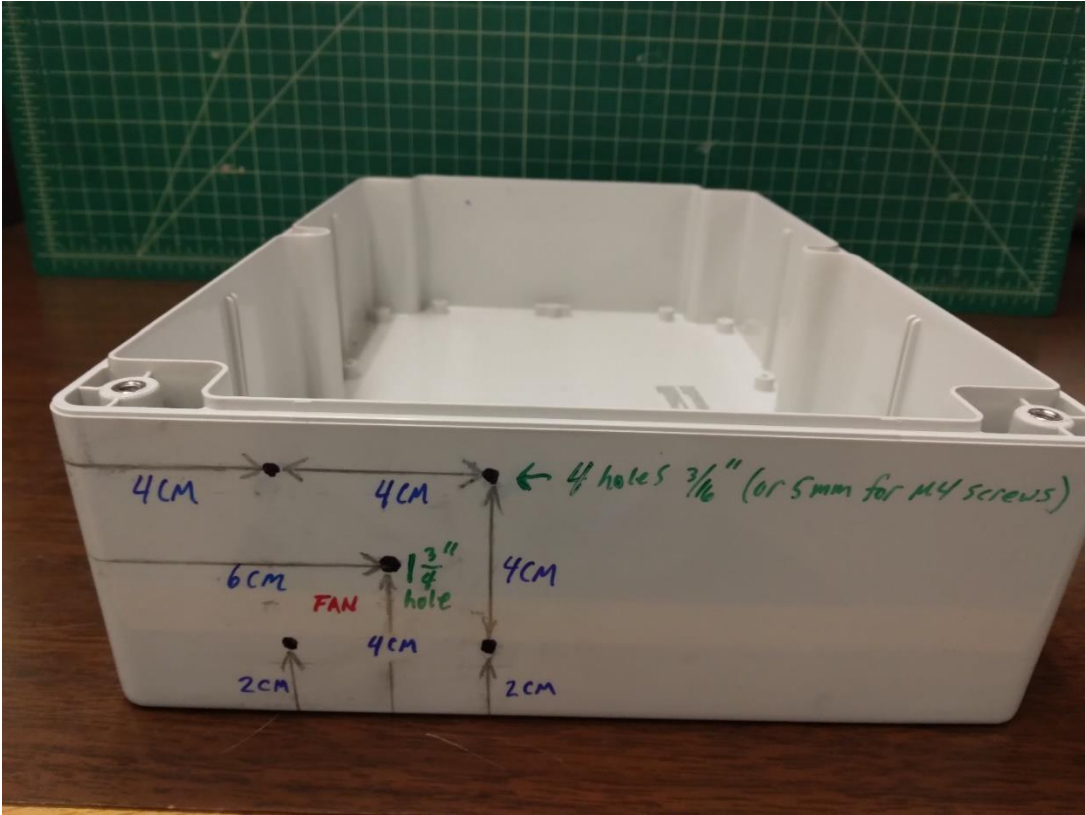
Rear side of the enclosure where all the connectors will go



Rear side of the enclosure with all the connectors mounted



Fan side of the enclosure

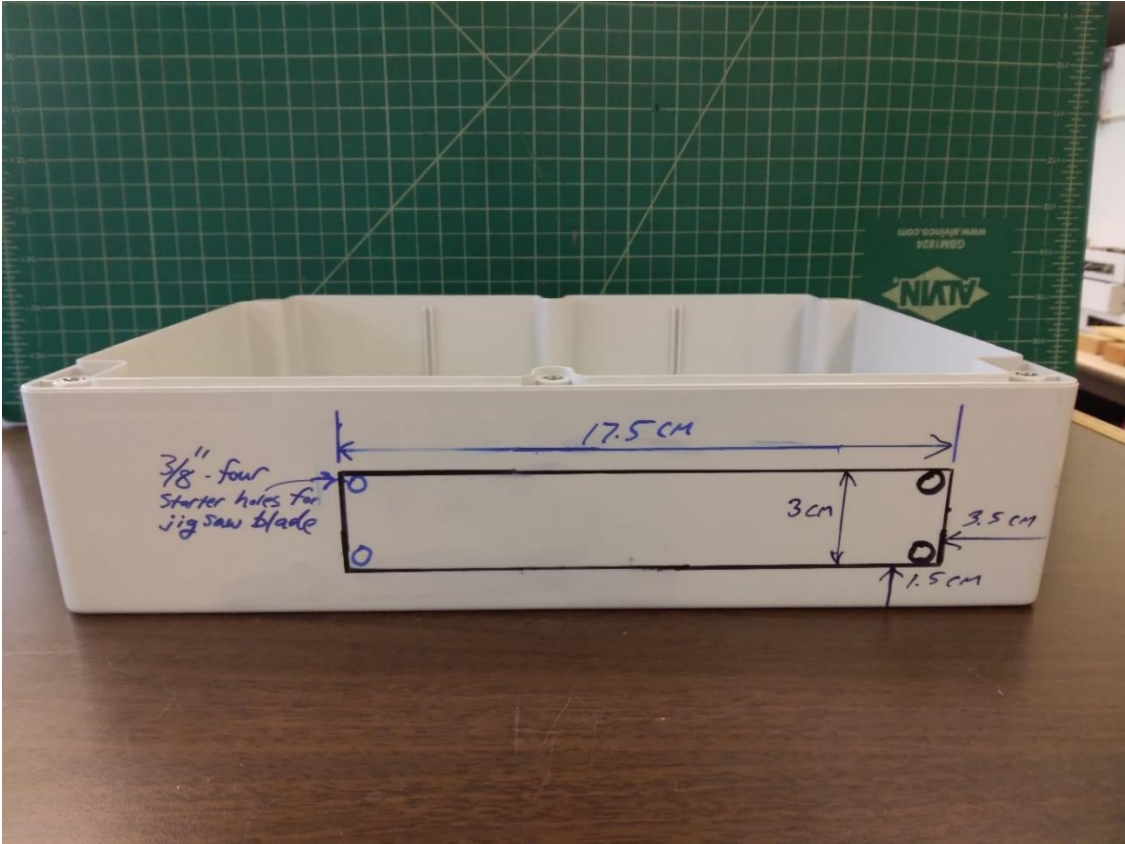


Fan side of the enclosure after cutout and holes drilled

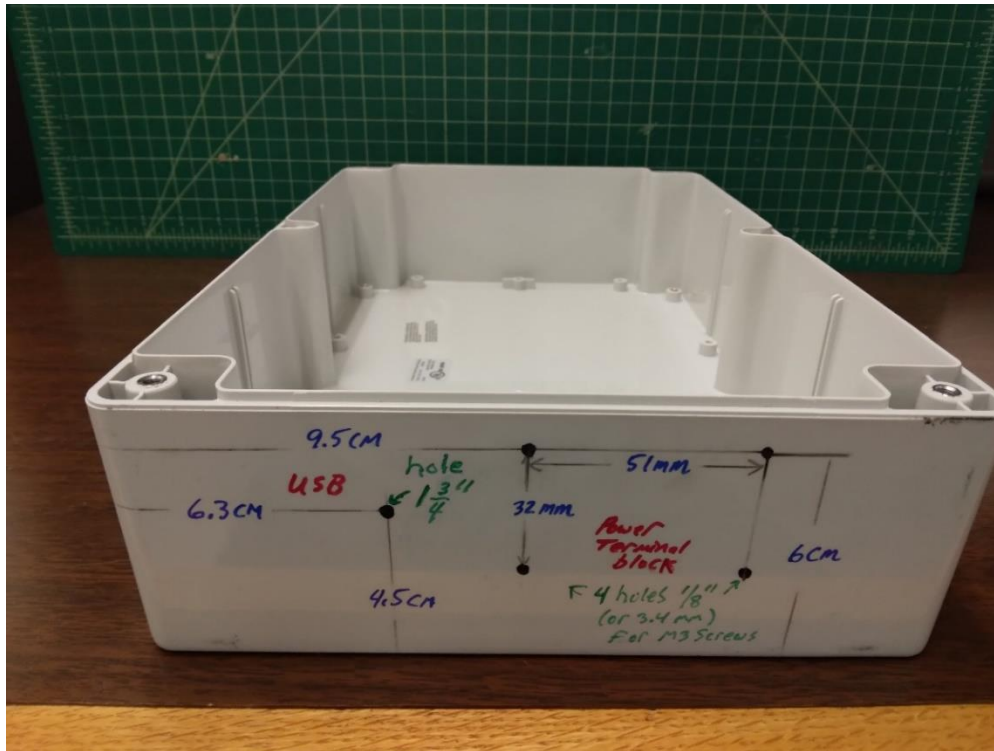
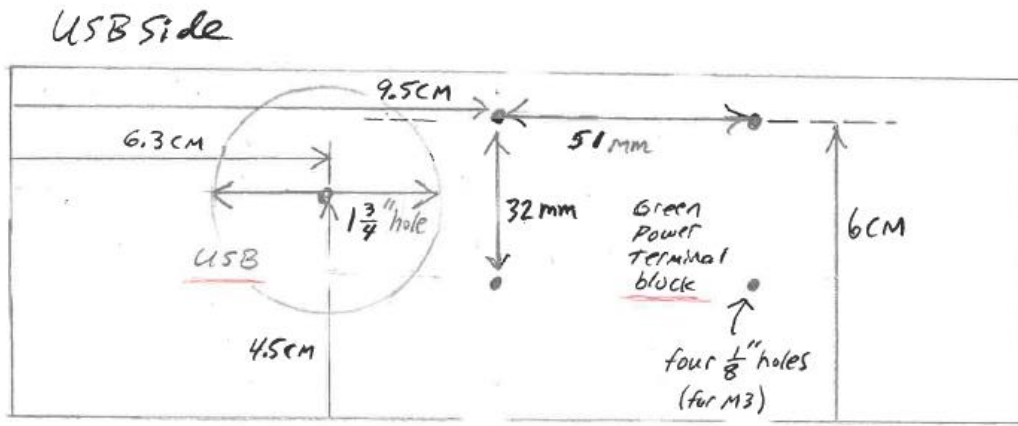


Front side of the enclosure where the slot gets cutout for the DAQ front-end circuit board.

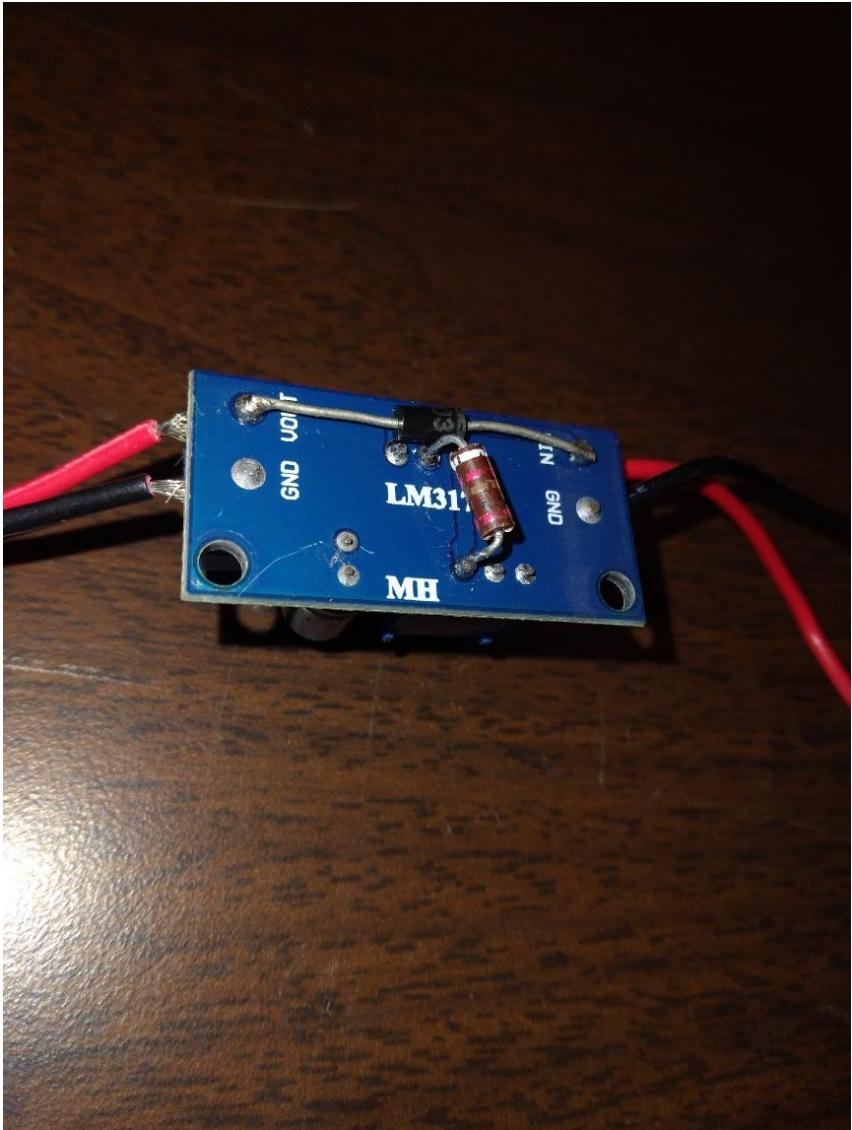
Put the lid on the box and secure it in the vice when drilling and cutting out the slot. Use a 3/8" drill bit to make 4 starter holes to fit the jigsaw blade into when cutting out the rectangular slot.



USB side of the enclosure which also has 4 holes for the power terminal block



On two LM317 variable voltage regulators solder a 200 Ohm resistor and Diode IN4004 underneath



Need: wire 22 AWG single core, black 1.35m, red 1.75m. Cut the wires as described below.

Need: Fourteen 12" male-to-male jumper wires (including one black and one red). Strip and tin the ends of some of them as specified below.

TLE _____ DAQ wiring _____ Project No. _____
Book No. _____
Page No. _____

22 gauge wires needed:

Black & Red

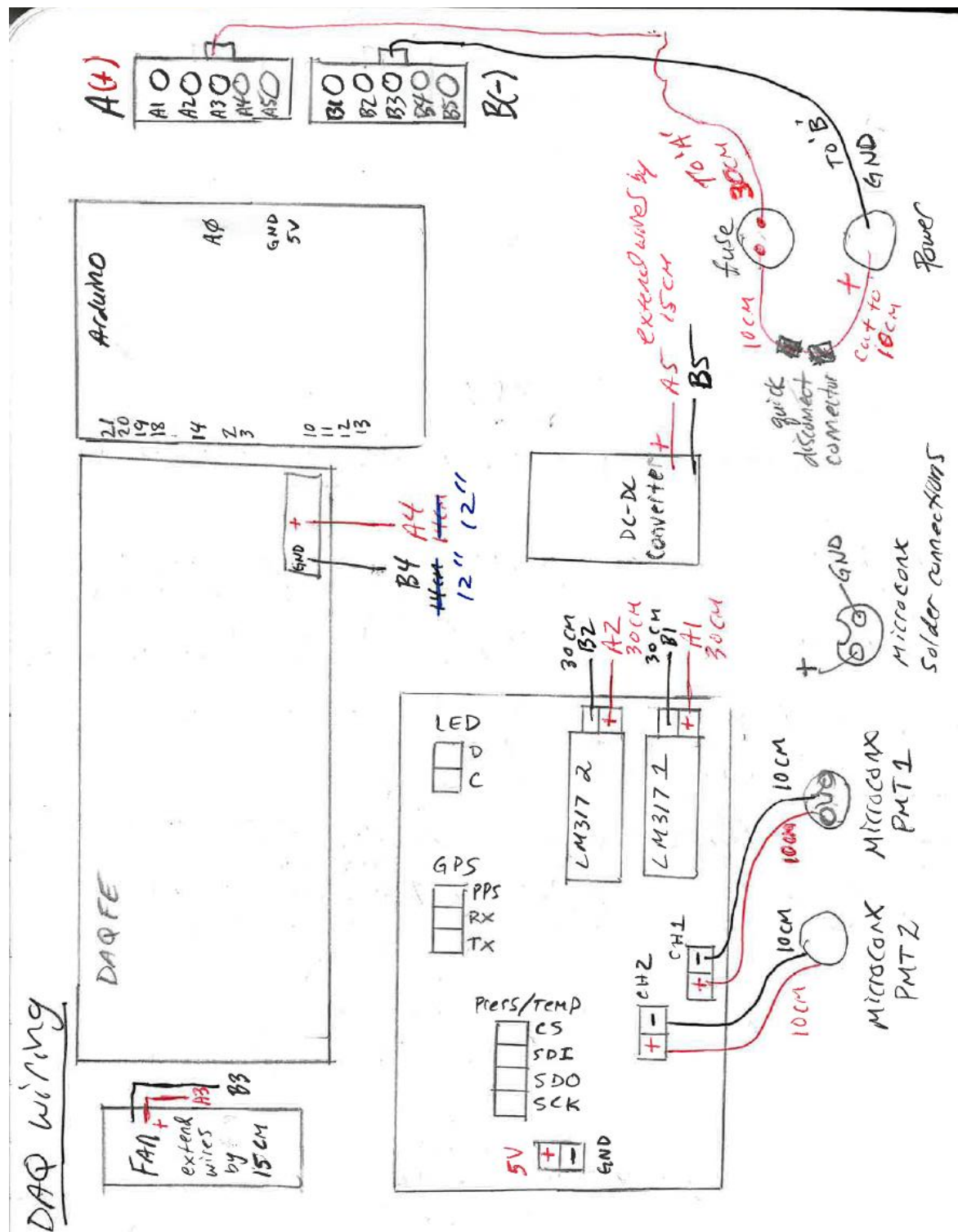
- ① 15 cm for Fan - 1 blk 1 red
- ② 15 cm for DC converter - 1 blk 1 red
- ③ 10 cm for LM317 signals - 2 blk 2 red
- ④ 12" DAQ FE POWER - 1 blk 1 red
- ⑤ 30 cm (2 red, 2 black) for LM317 Power
- ⑥ Red 30 cm (1) - fuse to terminal block
- ⑦ Red 10 cm (1) fuse to quick disconnect

12" Jumper wires (male to male)

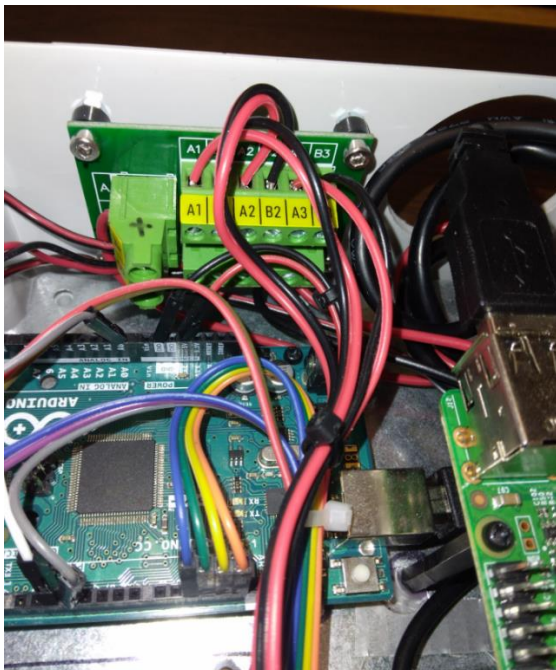
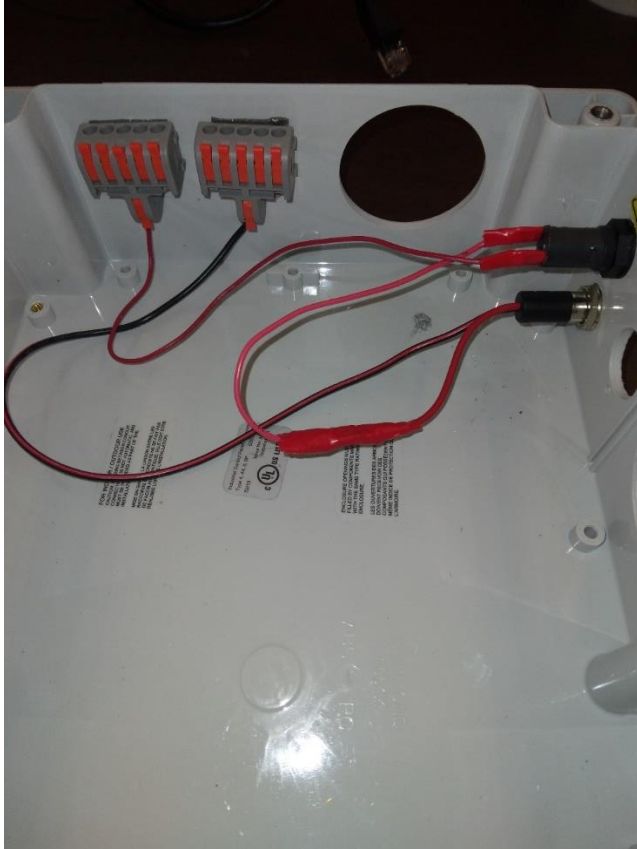
Arduino

- Black (1), Red (1) for 5V & GND to perf board
- 4 conductor strand from pressure/temp sensor ~~to perf board~~
Pin 13 to SCK, Pin 12 to SDO, Pin 11 to SDI, Pin 10 to CS
- 3 conductor strand from GPS - Strip and tin ends of one side
Pin 3 to PPS, Pin 18 (Tx 1) to RX, Pin 19 (Rx 1) to TX
- 3 conductor strand from DAQ FE
Strip and tin ends of one side
Pin A to PK, Pin 14 (Tx 3) to RST, Pin 2 to TRG
- 2 conductor strand from LED Backpack counter
Strip and tin ends of one side
Pin 20 (SDA) to 'D'
Pin 21 (SCL) to 'C'

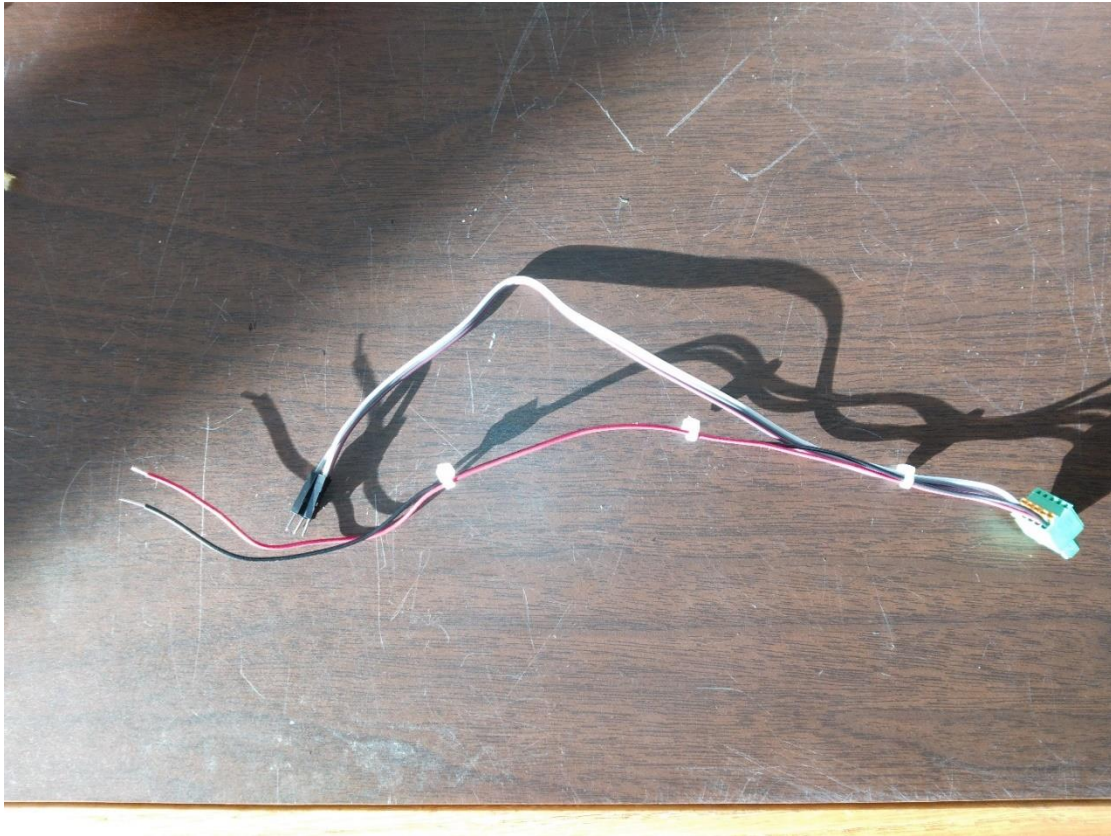
The wires will be used to make various connection in the DAQ enclosure; see the drawing:



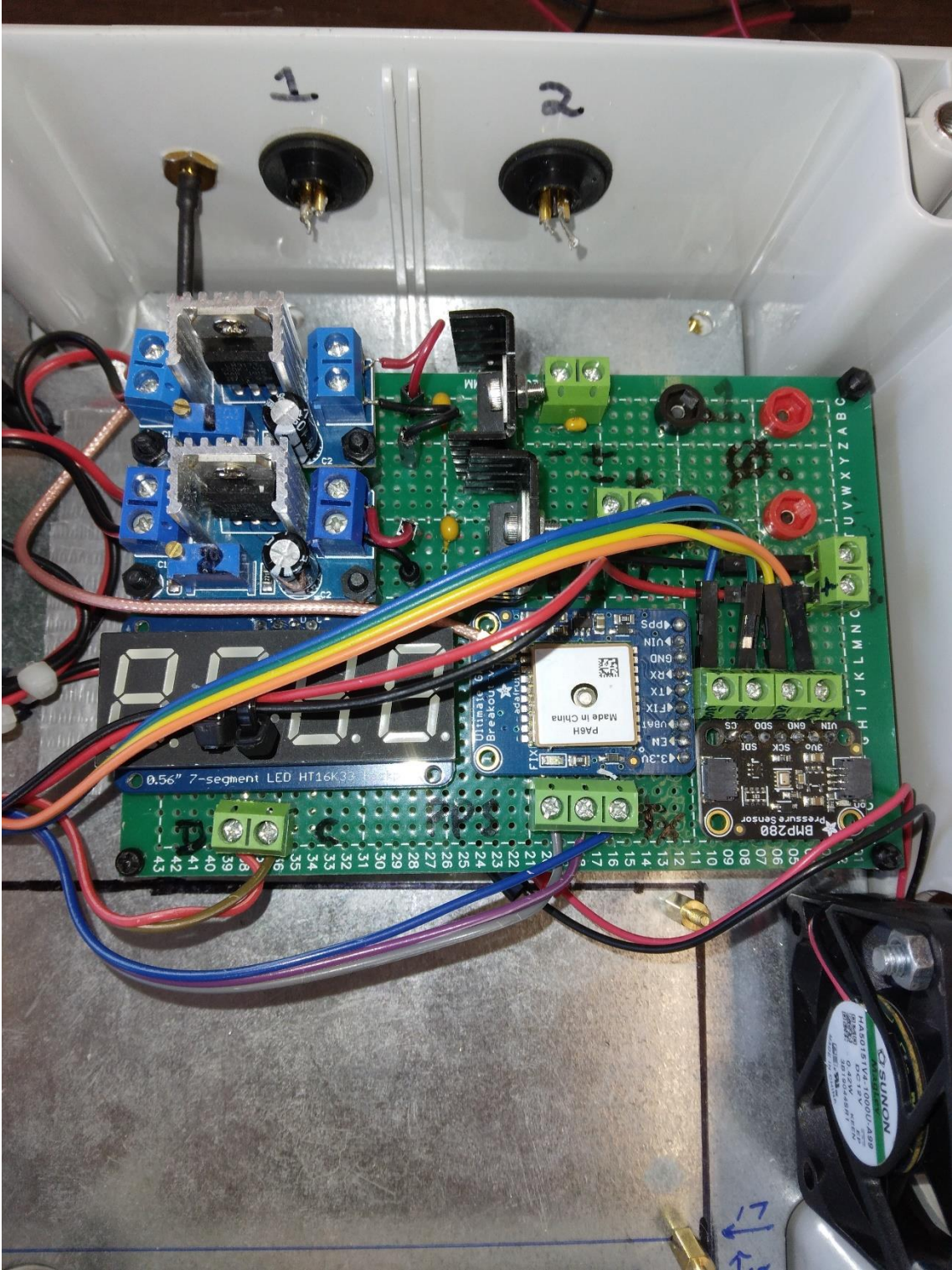
Wire the power input connector to the fuse using a quick disconnect connector on the positive red wire. The power connector requires a washer with an ID of 7/16", and an OD between: $\frac{1}{2}'' < OD \leq \frac{7}{8}''$. The two gray terminal blocks with orange tabs are an older design; now we are using the green terminal block shown in the bottom picture.



Assemble the wires to this connector that plugs into the DAQ front-end PCB. The wires bring 15V power, and signals to and from the Arduino Mega board

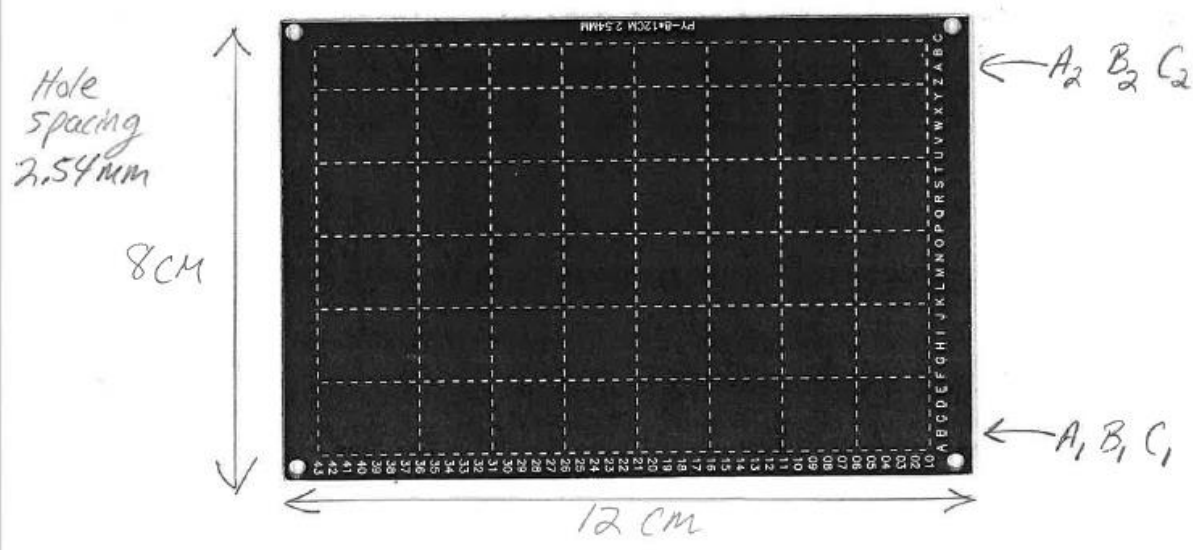


Assemble the electronics components on the perfboard and solder all the connections. there are several drawings and tables below that describe how this is done. This is what it will look like when finished:

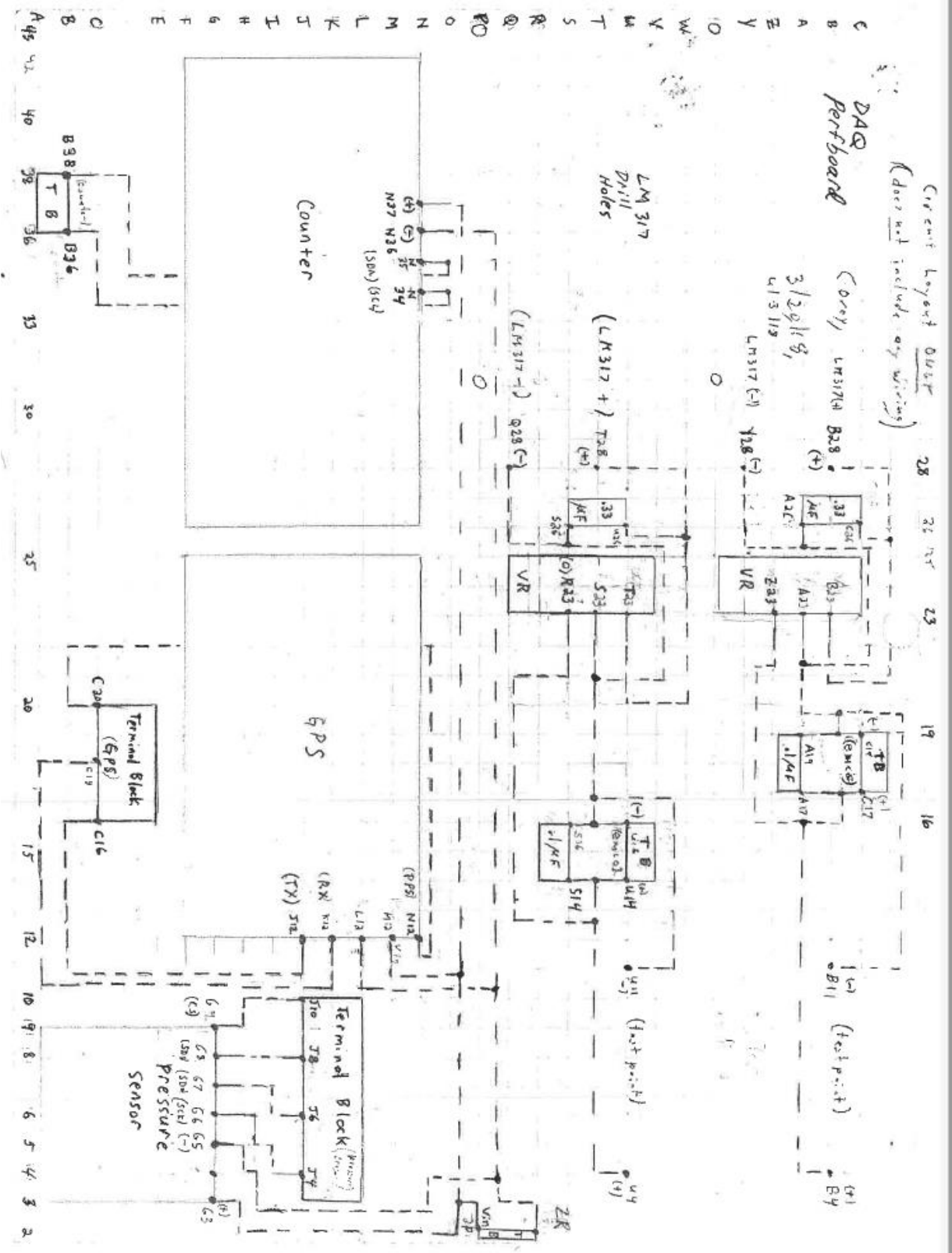


This tells where the electrical components get mounted on the perfboard

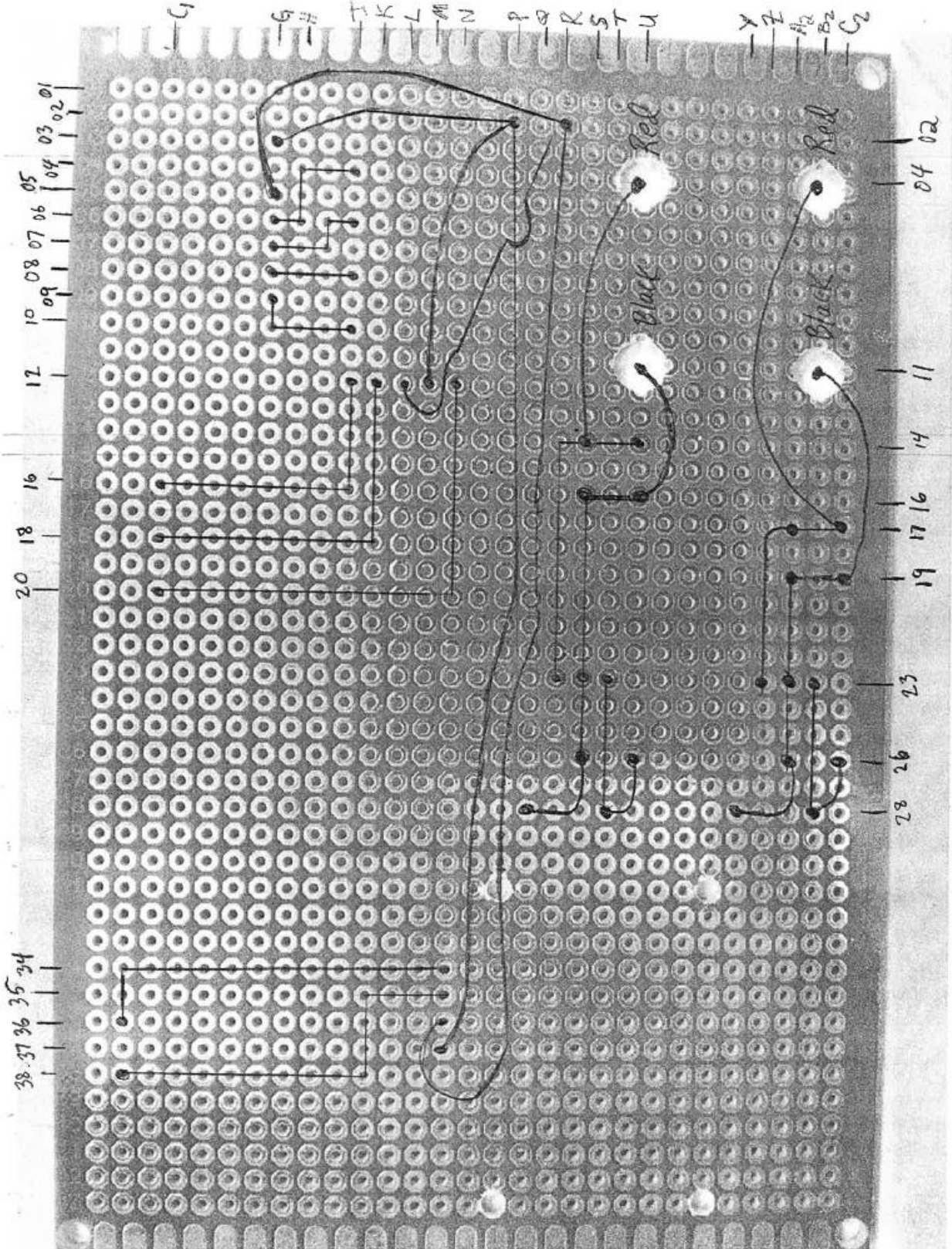
- 1 Drill four $3/16"$ holes for test points at $11B_2$ $4B_2$ $11U$ $4U$
Black Red Black Red
- 2 Drill four $1/8"$ holes for LM3175:
 $43X$ $31X$ $43P$ $31P$
- 3 Solder four 4cm wires to board: Red: $28B_2$ & $28T$ Black $28Y$ & $28Q$
- 4 Capacitors #334 $.33\mu F$ $26C_2$ $26A_2$ #104 $0.1\mu F$ $19A_2$ $17A_2$
- 5 Capacitors $.33\mu F$ $26U$ $26S$ $.1\mu F$ $16S$ $14S$
- 6 Voltage Regulator $23B_2$ $23A_2$ $23Z$
input pins GND output pins
- 7 Voltage Regulator $23T$ $23S$ $23R$
input pin output pin
- 8 Terminal blocks for voltage regulators $17C_2$ $19C_2$
- 9 terminal block for voltage regulator $14U$ $16U$
- 10 LCD counter $34N$ $35N$ $36N$ $37N$ Terminal block $36B_1$ $38B_1$
- 11 GPS $12F$ to $12N$ Terminal block $16C$ $18C$ $20C$
- 12 Temp-pressure sensor $3G$ to $9G$ Terminal block $4J$ $6J$ $8J$ $10J$
- 13 Terminal block for 5V power $2P$ $2R$



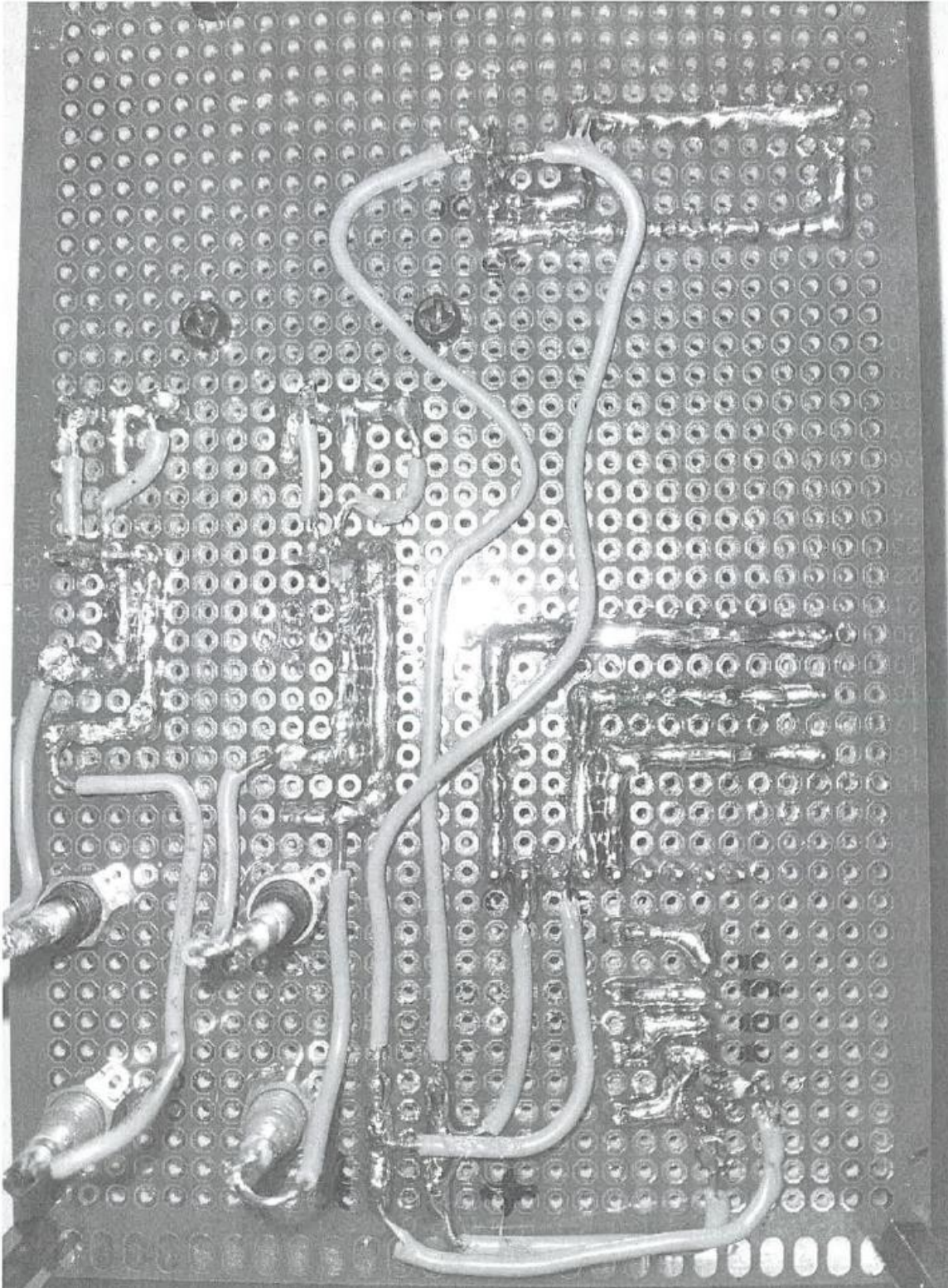
This shows the perfboard from its top side, and its solder connections as dashed lines are on the underside of the board



This shows the soldering connections to make on the underside of the perfboard



This shows you an example of the soldering connections on the underside of the perfboard



These are the solder connections on the underside of the perfboard. The sizes of the standoffs needed for the LM317s, and other boards, are below.

DAQ perfboard solder connections

38B₁ - 35N

36B₁ - 34N

36N - 02R

37N - 02P

20C₁ - 12N

18C₁ - 12K

16C₁ - 12J

12L - 02R

12M - 02P

9G - 10J

8G - 8J

7G - 6J

6G - 4J

5G - 2R

3G - 2P

28Q - 26S - 23S - 16S - 16U - 11U

23R - 14S - 14U - 4U

28T - 23T - 26U

28Y - 26A₂ - 23A₂ - 19A₂ - 19C₂ - 11B₂

23Z - 17A₂ - 17C₂ - 4B₂

28B₂ - 23B₂ - 26C₂

Standoff sizes

Raspberry Pi 4CM

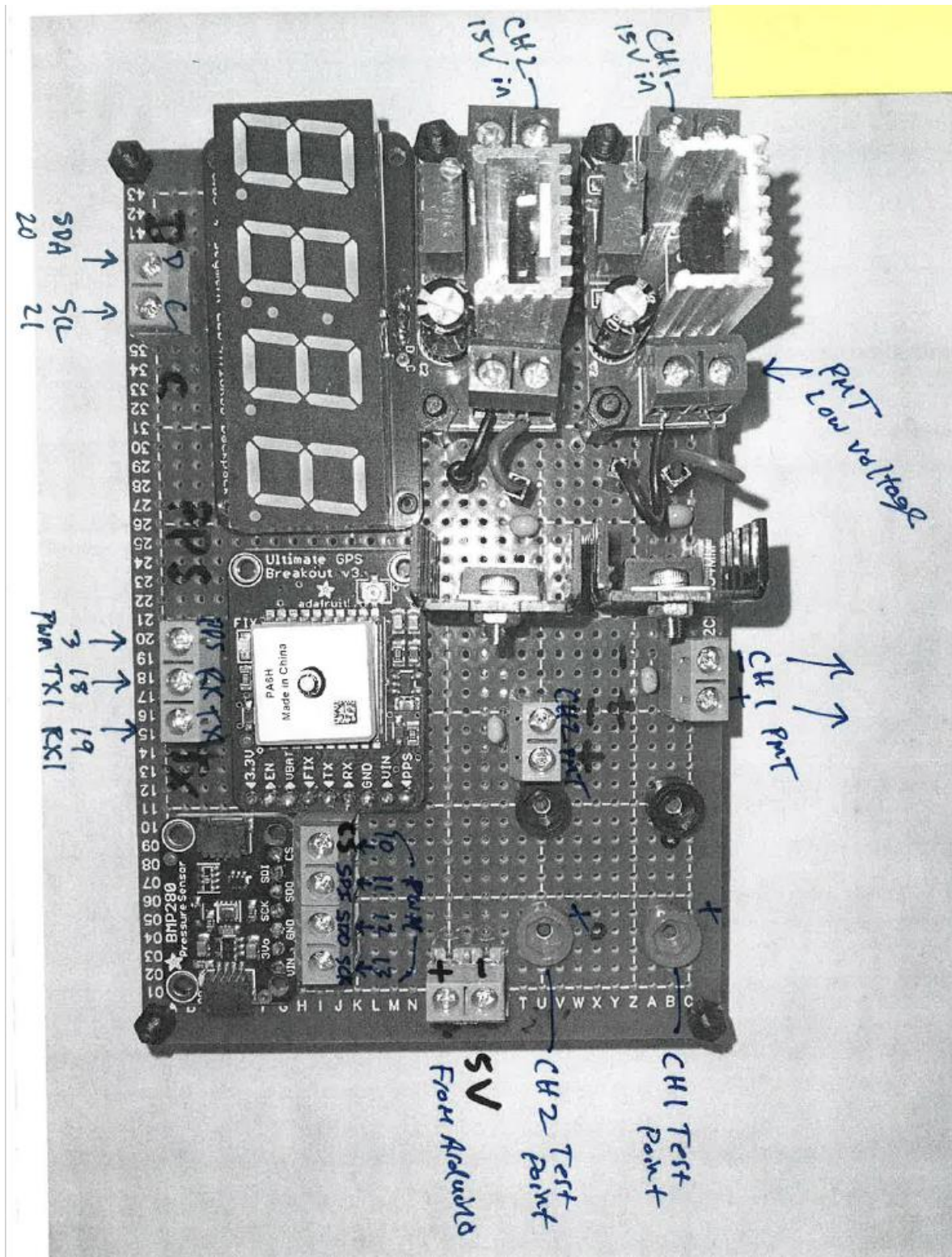
DAQ Perfboard 2CM

Arduino 1CM

LM317s 1CM

DAQ FE 1CM

This shows which wire connections are made from the perfboard to the Arduino Mega, power terminal block, and enclosure connectors



3D print the fan cover

DAQ FAN COVER - 3D print for Sunon Fan

