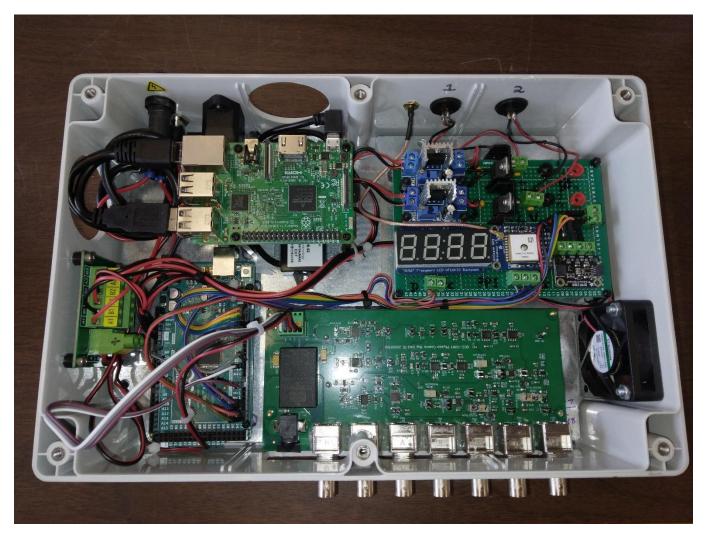
Cosmic ray muon detector DAQ assembly instructions

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.

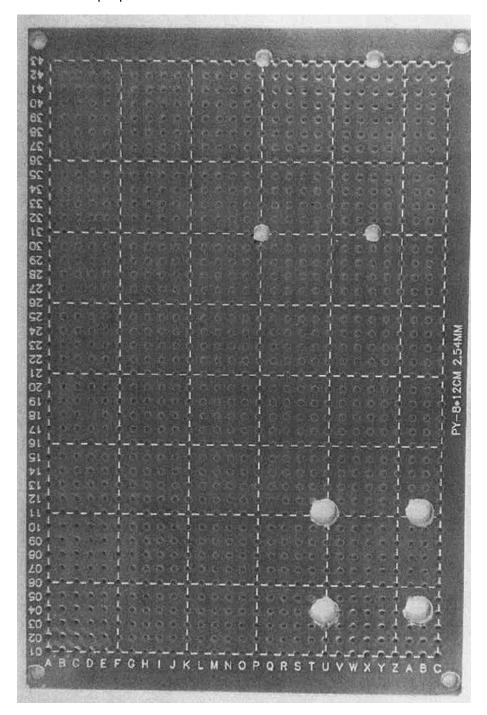


You will need drill bits: 1/8", 9/64"(3.5 mm is okay), 3/16" (5 mm is ok), ¼", 3/8", ½" (13 mm is okay) Circular hole cutting tools: ¾", 1¾"

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

2.6 (DUINO) RASP All holes 3.5 mm of Perf DAQ FE P e -1 O

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

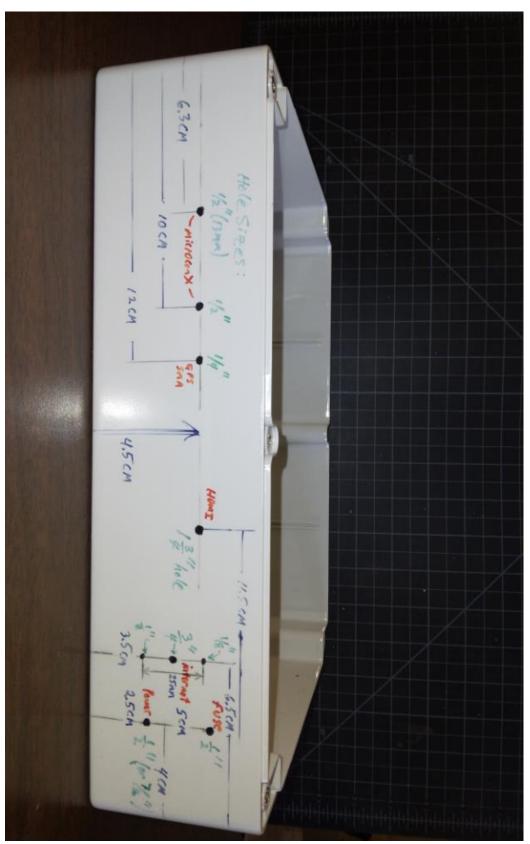
drill bits: 1/8", 3/16", 1/4", 3/8", 1/2"

circular hole cutting tools: $\frac{3}{4}$, 1 $\frac{3}{4}$

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

13mm (EI power Termina / Block Side Drill bits needed: 4" (Imm), 2" (13mm), 3" (M4 hole), 4" (M3 & 4 - 40 holes) 10.7mm < Power < 12.4mm and. MHY < FUSE < 14,5 mm Power tuse 3.5 CM In On (01 2.5 if picfor ZCM 304 5 if pre.m. S 4:9 6.5cm Center drill bit Jigsen Jigsen 3 Start to BUC Hole 2 3.5cm 2 11.504 13 "hale HISCA 6.3 mm < GPS SM < 8.2 mm HOMI -17.5 CM 4 holes to "OT SMH FOR HE 12 CM 4.5 CM 60 "H. K-> in all 4.500 10.4 mm < Hiero Con X < 15.6 mm Midd CONK lund Circular have cutting: 1 . Toc/S 4 hole-3 MIM 4,5 cm Micro Cank ⇒ Hem 10 cm 6.3 CM Vº Zem 604 HCM Fan V

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

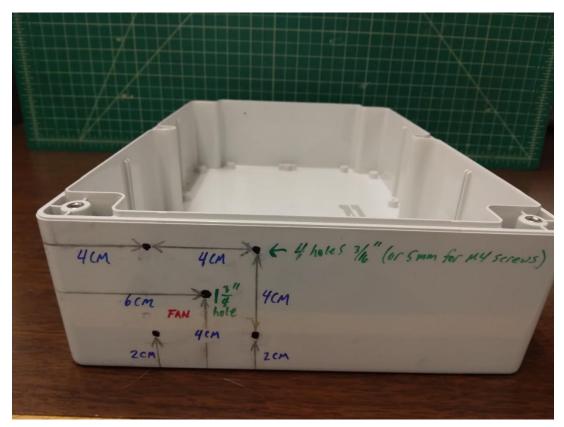


Rear side of the enclosure where all the connectors will go



Rear side of the enclosure with all the connectors mounted

Fan side of the enclosure

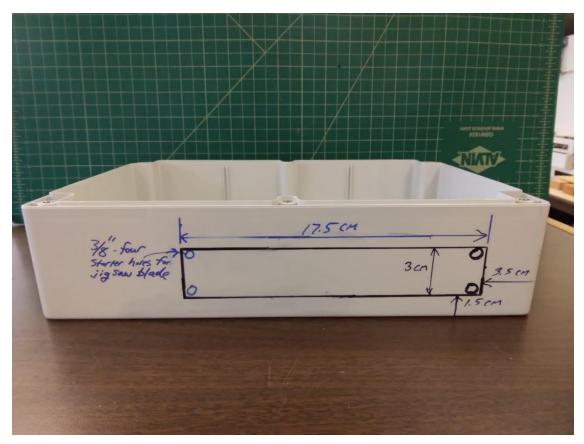


Fan side of the enclosure after cutout and holes drilled



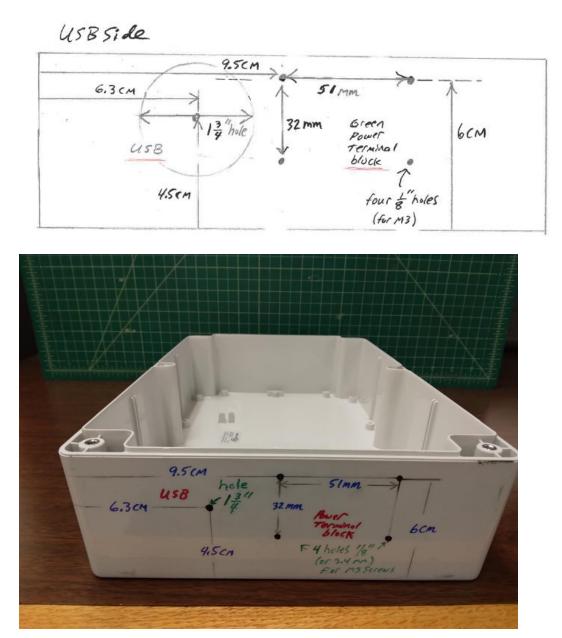
Front side of the enclosure where the slot gets cutout for the DAQ front-end circuit board.

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.





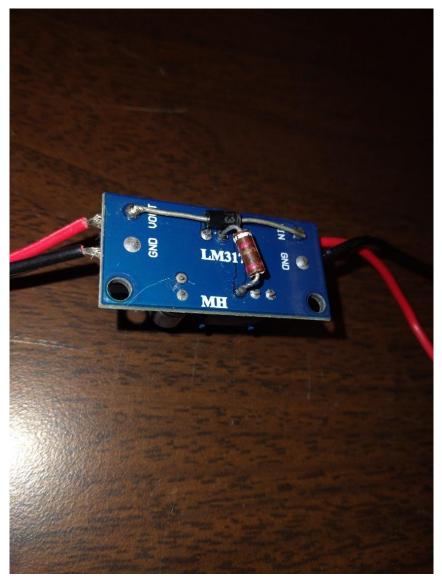
USB side of the enclosure which also has 4 holes for the power terminal block





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

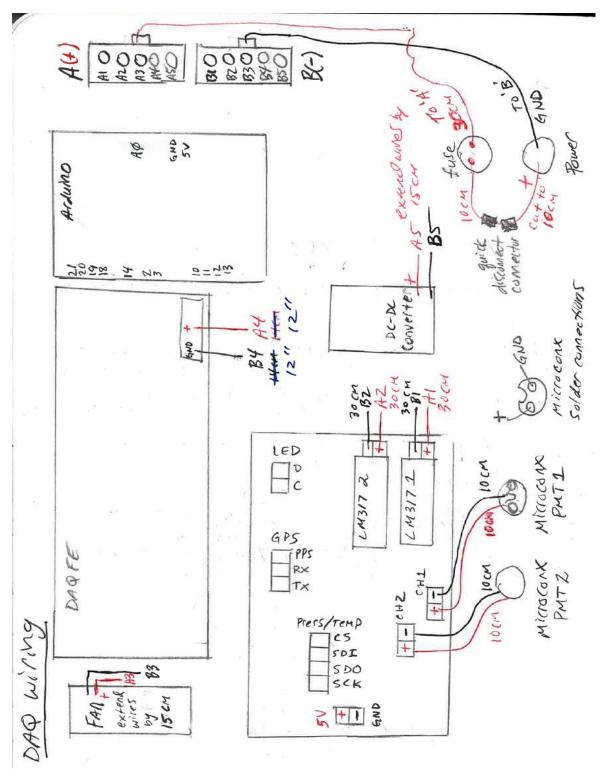




Need: wire 22 AWG single core, black 1.35m, red 1.75m. Cut the wires as described below.

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.

Project No. DAQ wiring Book No. TLE -Black & Red !! m Page No. gange wires needed: @15 cm for De converter-1 blk 1 red 3 10 cm for LM317 signals-2 blk 3 10 cm for LM317 signals-2 blk 2012" DAQFEPOWER - 1 BIK (5) 30 CM (2 red, 2 black) for LM317 Power (6) Red 30 cm (1) - fuse to terminal block (1) Red 10 cm (1) fuse to quick disconnect 12" Jumper Wires (Mak to male) Black (1), Red (1) for 5V & GND to perform 4 conductor shand from pressure Henp sensor 4 performant Pin 13 to SCIC, pin 12 to SDO, Pin 11 to SDI, Pin 10 tics conductor strand from GPS-Supard in ends of one sile Pin 3 to pps, Pin 18 (Tx 2) to Rx, Pin 19 (Rx 1) to TX - 3 conductor Strand from DAQ FE stop and the ends of one side pin Ap to PK, Pin 14 (TX3) to RST, Pinz to TRG 2 Conductor Strand from LED Backpack Counter strip and the ends of one side Pin 20 (SDA) to 'D' Pin 21 (SCL) to 'C'

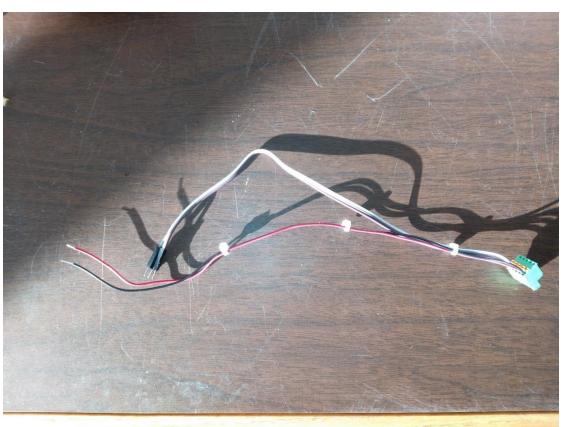


The wires will be used to make various connection in the DAQ enclosure; see the drawing:

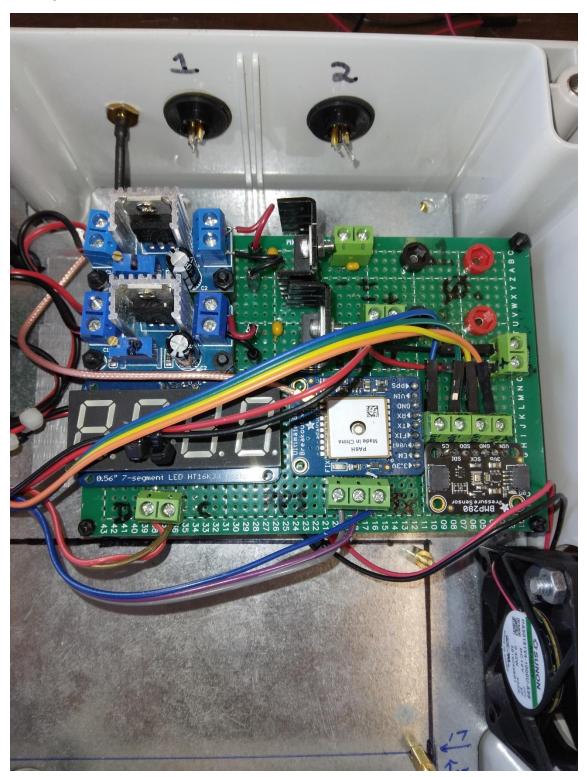
Wire the power input connector to the fuse using a quick disconnect connector on the positive red wire. The power connector requires a washer with an ID of 7/16", and an OD between: $\frac{1}{2}$ " < OD =< 7/8". The two gray terminal blocks with orange tabs are an older design; now we are using the green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







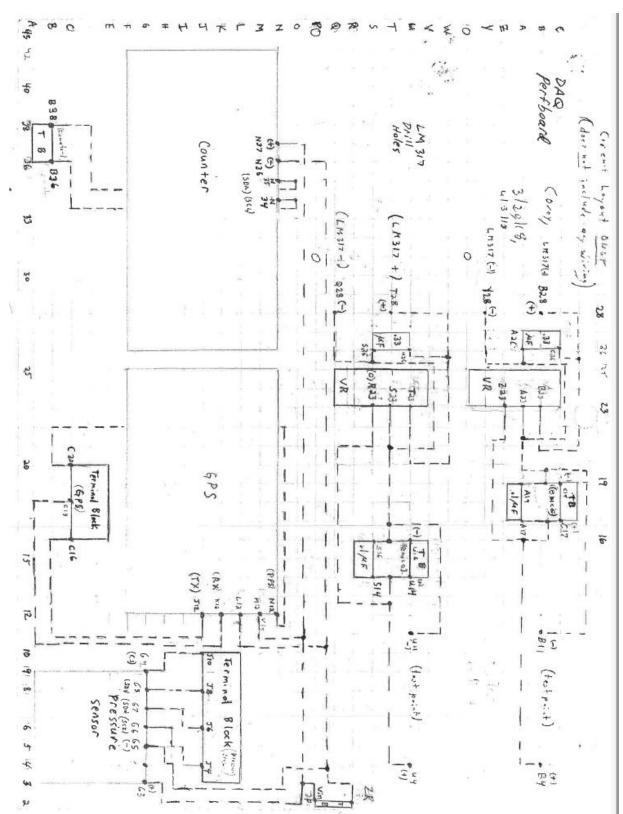
Assemble the wires to this connector that plugs into the DAQ front-end PCB. The wires bring 15V power, and signals to and from the Arduino Mega board



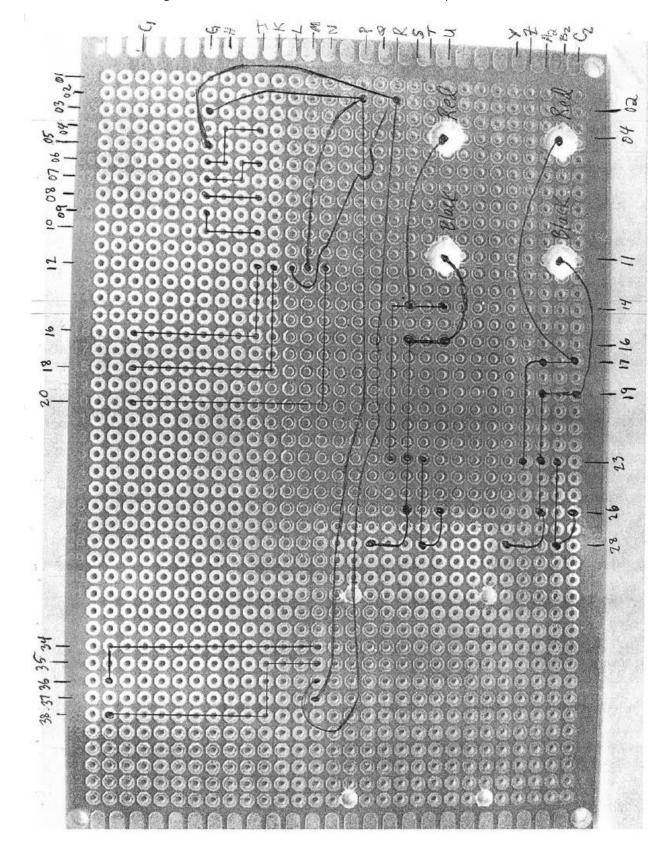
Assemble the electronics components on the perfboard and solder all the connections. there are several drawings and tables below that describe how this is done. This is what it will look like when finished:

1 Drill four 3/16" holes for test points at 1132 4B2 114 44 2 Drill four 1/8" holes for 12 M3175: 43× 31× 43P 31P 3 Solder four 4cm wiles to board: Red: 28B2 \$ 28T Black 284\$280 9 Solder Tour 4CM when to sound. Acan Love 4 4 Capacitors #334 F 26C2 26A2 Dolph F 19A2 17A2 5 Capacitors .33 µF 26U 26S .1µF 16S 14S 6 Voltage Regulator 23B2 2342 232 10 Voltage Regulator 23T 23S. 23R input - The output pin 8 Terminal blocks for voltage Regulators 1762 1962 10 LCD counter 34N 35N 36N 37N Terminal Block 36B, 38B, Il GPS 12 F to IZN Terminal block 16C, 18C, 20C, 12 TEMP-pressure sensor 3G to 9G Terminal block 4J 6J 85 105 13 Terminal block for 5V power 2P 2R HWEST WOTLER-M C-A2 B3 G Hole Spacing 2,54 mm 8CM -A, B, C, 12 CM

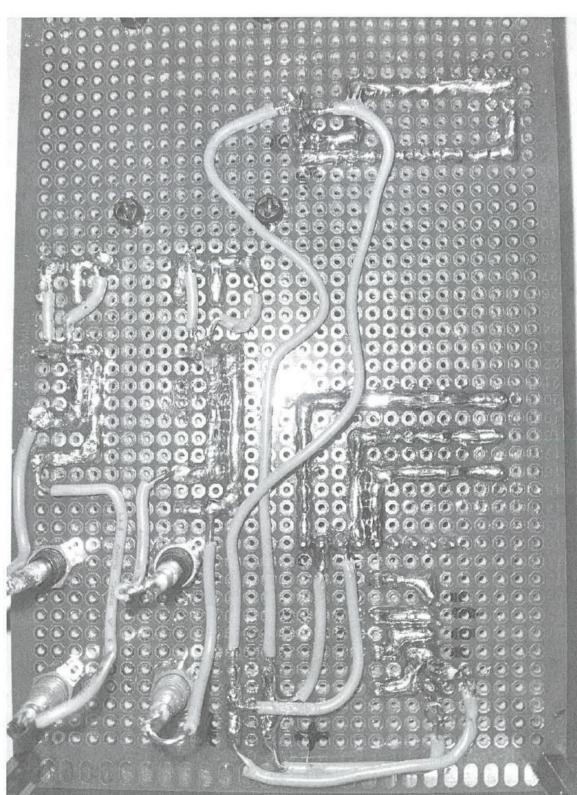
This tells where the electrical components get mounted on the perfboard



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

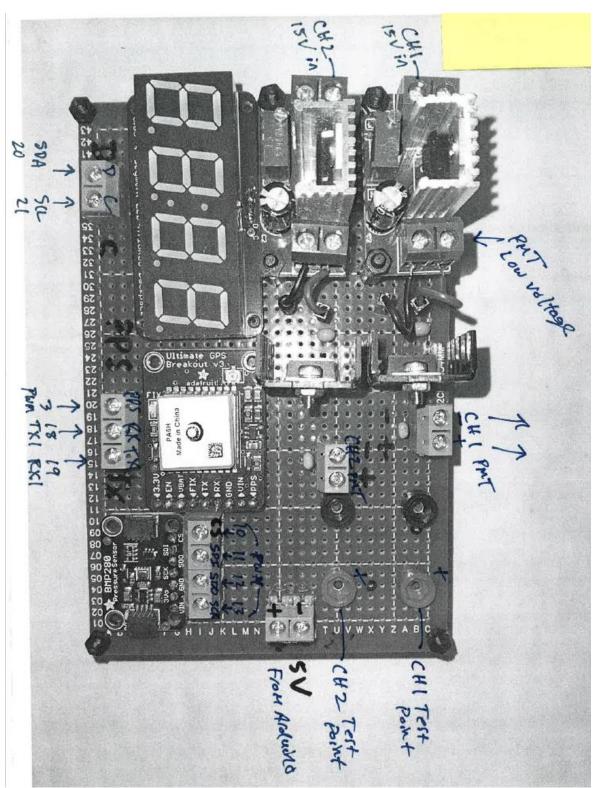


This shows you an example of the soldering connections on the underside of the perfboard

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 289-265-235-165-164-11u 368, - 34N 23R-14S-144-44 36N - 02R 28T-23T-26U 37N - 2P 284-26A2-23A2-19A2-1962-11B 20G - 12N 23Z-17A2-17C2-4B2 1801 - 12K 28B2-23B2-26G2 16 C1 - 12 J 121 - URR 12M-QP 9G-10J 8G - 8J 76-65 Standoff Sizes 6G-4J Raspberry Pi YCM 56 - 2R 39-2P DAQ Perfboard 2CM Arduno Icm LM317 5 ICM

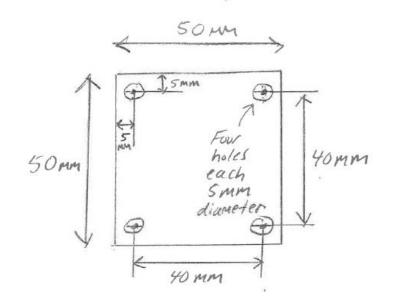
DAQ FE ICM



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



102 15V AC/DC Adapter	15V DC Power supply	olv.	Cui-Inc	SDISO-15-U-P5	Digikey 102-3797-ND		\$23.40	-	https://www.digikey.com/product-del
		comes with screws for lid			Digikey		Digikey		
103 Enclosure for DAQ, clear lid, gasket, plate		and plate	Hammond	1554X2GYCL	Mouser	11.81x7.87x3.54 inches	Mouser: \$47.81	۲	https://www.hammfg.com/electronic
104 metal plate for DAQ enclosure		for enclosure 15 Hammond	Hammond	1554XPL	Digikey Mouser	11.2" x 7.28 x 0.06"	Mouser: \$9.16	1	https://www.hammfg.com/files/parts
105 Barrel Plug (Power) Jack to Wire Leads 2.1 ID 5.5 OD	5.5 00	Tensility Internal 10-02878	10-02878		Digikey 839-1448-ND		\$5.17	-	https://www.digikey.com/product-del
106 Washer 7/16" for barrel plug power jack					Home-Depot	7/16" washer hole		-	
107 Electrical safety sticker 0.98"		Weidmüller 0.98 1700530001	1700530001		Amazon B09BZ7G63V Digikey 1700530001-ND	-860	\$6.95 (qty 10)		https://www.amazon.com/Weidm%C
108 FUSE, GLASS 3 5A 125VAC 5X20MM	fast blow		Bel Fuse Inc.	5MF 3.5-R	Digikey 507-1267-ND	5mm x 20mm		÷	https://www.digikey.com/en/product
Fuse S 109 Fuse Holder 16 A 400V 1 Circuit Cartridge Pan 20mm	Fuse Size 5mm x 1 20mm		SCHURTER Inc.	3101.0019	3101.0015 Digikey 486-1154-ND		\$4.02	-	https://www.dizikey.com/en/product
Cheaper option: Power Terminal Block (GKEEMARS) Wire					Amazon 809VSYG3H5(5			,	
Screws and nuts for GKEEWARS power 1111 distribution terminal blocks	M2.5 x 12 mm 3mm < head < 4.2mm							4	
Best option: Power Terminal Block Distribution Module 112 2x6 position	30Amp 48V	·	CZH-LABS, OONO D-1459	D-1459	Amazon B09D3BV22M	57 x 38 x 26.5 mm	\$12.99	-	https://www.amazon.com/OQNO-Pos
Screws and nuts for CZH-LABS power 113 distribution terminal block	M3 x 16 mm screws (4) with 8: nuts							4	
Female socket terminal block wire connector 114 to connect to DAQ FE PCB terminal block	TERM BLOCK PLUG SPOS STR 2.5MM	"Female socket	"Female socket" Phoenix Contact		1881354 Digikey 277-1433-ND		\$7.87	-	https://www.digikey.com/en/product
115 Mounting Bases, to tiewrap down wires	0.78" square	Black	HUASU		Amazon BO9PDQNKCZ		\$9.99 (qty 100)		https://www.amazon.com/HS-Mounts
116 Jumper wires, Male/Male - pack of 20 x 12"			\$3.95	Adafruit	Mouser 485-1955		\$3.95 qty 20 14 wires https://www.mouser.com/ProductDe	14 wire	https:
2 Conductor 1m, Black, Red, for DAQpower 117 wiring (cut into pieces)	22 AWG		Tensility Internat 30-00417	at 30-00417	Digikey T1307-1-ND		\$2.02	2	https://www.digikey.com/en/product
Standoff 1.563" (4 cm) 2-56, hex, Aluminum 118 to elevate Rasp Pi	threaded	female-female	RAF Electronic Hardware	2074-256-AL	Digikey 1772-2074-256- AL-ND		\$2.58 (qty 1)	4	https://www.digikey.com/en/product AL/11486722?s=N4.jgTCBcDailwHYFgi
Stand-offs 1cm, 2-56, hex, metal, for 1'9 Arduino LM317s. DAO FE		female-male						12	
120 Stand-offs 2cm, 2-56, hex, metal, for perfooard	đ	female to male						4	
121 screw for stand-offs, 2-56, metal							\$0.10		
122 Nuts for stand-offs. 2-56. metal									

Not all parts are updated on this list for the DAQ enclosure

OPTIONAL: screw for stand-offs, Nylon, 2-56 round head, 124 slotted									
	BINDER SLOTTED S	Head diameter 0. Essentra Compon 0102568018	Essentra Compon	0102568018	Digi-key RPC7500-ND	L= 0.188" (below head)	\$0.10	4	https://www.digikey.com
OPTIONAL in bulk: NOT GOOD QUALITY 125 Standoffs kit 450PCS M2.5 Nvlon. Hex	male-female, femal	e-female	MCMAS KE- Yontaifeng	HTM 25P450B	Amazon BOB5LTOXX8		\$13.99		https://www.amazon.con
126 USB2.0 A Male to Right Angle USB B Male Cable 12", black			Inovat		Amazon	BOTHB91CRM	\$7.99	1	https://www.amazon.con
127 Ethernet cable, jack to plug panel mount, 1 ft	CABLE MOD 8P8C JACK-PLUG 0.98'	unshielded CAT5 Adafruit	Adafruit	606	909 Digi-key 1528-1572-ND	total L = 0.98 ft (303 mn	\$4.95	Ļ	https://www.digikey.com
128 Test point, panel mount, red 20 AWG	BAN2 F DLPI INSUL	Tip Jack	Radiall USA, Inc.	R921921000	Digi-key 2201-R9219210	Digi-key 2201-R9219210CRed, Tip Jack L = 0.744"	\$1.81	2	https://www.digikev.com
129 Test point, panel mount, black 20 AWG		Tip Jack	Radiall USA, Inc. R921920000	R921920000	Digi-key 2201-R9219200	Digi-key 2201-R9219200C Black, Tip Jack, L=0.74	\$1.81	2	https://www.digikey.com
Can get bulk: 130 Terminal Block Connector 60pcs 2 & 3 Pin	need 8 two-termin	14-22 AWG, gree Thisesm	Tnisesm	CATN-T03G	Amazon B088LSS14J		\$8.99 (60 pieces)	1 three	
131 Fan for enclosure	FAN AXIAL SOX15MM VAPO 12VDC0 Sunan	M VAPO 12VDC0.	Sunan	HA50151V4-1000U	HA50151V4-1000U Digi-Key 259-1816-ND	24	\$6.10	-	https://www.digikey.com https://www.onlinecomp
132 Screws (needs nuts) for Sunan Fan	M4 x 25mm (or use 8-32 x 1")		yusheng/Esreake ES-M4PWMFT	ES-M4PWMFT	Amazon B098QZQ8FT	M4 x 25 mm	\$7.99 (qty 50) 4 (2 is ok)	(2 is ok	
133 DC Buck Converter 12v to 5v 3A 15W Micro US 2 PCS DC Converter	s 2 PCS DC Converter	For Rasp Pi	Aideepen (Amazon)	F	Amazon 809TFLZMC2	46x14x27mm (1.81x0.5	\$11.99 for 2	2	https://www.amazon.con
134 Double Sided Tape, 3M, Waterproof, High Tem 0.5" x 15.6'	n 0.5" × 15.6'		Rusenweelite	RS-5952-Z	Amazon B08JTSVLZM	0.5" x 15.6'	\$8.95 roll		https://www.amazon.cor
135 Screws and nuts for Aideepan DC Buck converter									
136 Arduino Mega 2560		Mega 2560	Arduino	4000067	digikey 1050-1018-ND Mouser: 358-RPI3-		\$38.50		https://www.cipikey.com
137 Raspberry Pi 3 B+		Pi 3 8+			MODBP-BULK		04'T40	-	https://www.adafruit.com
138 Digital counter		4 digit LED Displi Adafruit	Adafruit	878	Digikey 1528-1473-ND		1720	H	https://www.digikey.com
139 Barometric Press, Temp, Alt. sensor			Adafruit 2651				\$9.95	-	https://www.digikey.com
140 6" Cable for GPS antenna-to-receiver			Adafruit	851	Digikey 1528-2053-ND		\$3.95	-	https://www.digikey.com
141 GPS reciever breakout board			Adafruit	746	Digikey 1528-1153-ND			-	https://www.digikey.com
142									https://www.adafruit.co
143 GPS external Antenna 28dB gain 144		Active antenna 3. Adafruit	Adafruit	096	Digikey		\$14.95	-	https://www.digikey.com https://www.adafruit.co
can purchase in bulk:	includes 5 7x9cm,								
145 Perfboard 8x12 cm, copper clad, prototype	5 8x12cm		NUNGUI	ALL	Amazon B07YFYDW5C		\$11.99 (qty 10)	-	https://www.amazon.cor
146 2 position connecter receptacle (female)	Micro ConX panel	micro - panel mo	Conxall/Switchci	17282-256-300	micro - panel mg Conxall/Switchcr 17282-25G-300 Digi-Key: 17282-25G-300		\$4.44	7	https://www.digikey.com
147 DAQ - LM317:									
148 LM317 voltage regulator with pot	LM317 adjustable		Proto Supplies	PWR-1			\$2.79	2	https://protosupplies.co
149 200 Ohm (180-240 Ohm is ok) resistor for LM317	1317							2	
150 Diode IN4001 for LM317								2	
151 12V Linear Voltage Regulator IC Positive Fixed 1 Output 1A TO-22		Input (Max) 35V Current Out 1A max	onsemi	MC7812ACTG	Digikey MC7812ACTGOS- ND		\$0.89	2	https://www.digikev.con
15. 7.5V Linear Voltage Regulator IC - 2 Amp		Input (Max) 35V Current Out 2A max	STMicroelectron ics	L78575CV	Digikey 497-14164-ND		\$126	2	https://www.digikey.con
153 HEATSINK TO-220 2.5W LOW PROFILE		For voltage regs	Aavid, Thermal D	507302800006	For voltage regs (Aavid, Thermal D 507302B00000G digikey: HS115-ND		\$0.28	2	https://www.digikey.com
154 Canaritor 0.33 microf (for Volt Reg input)								2	