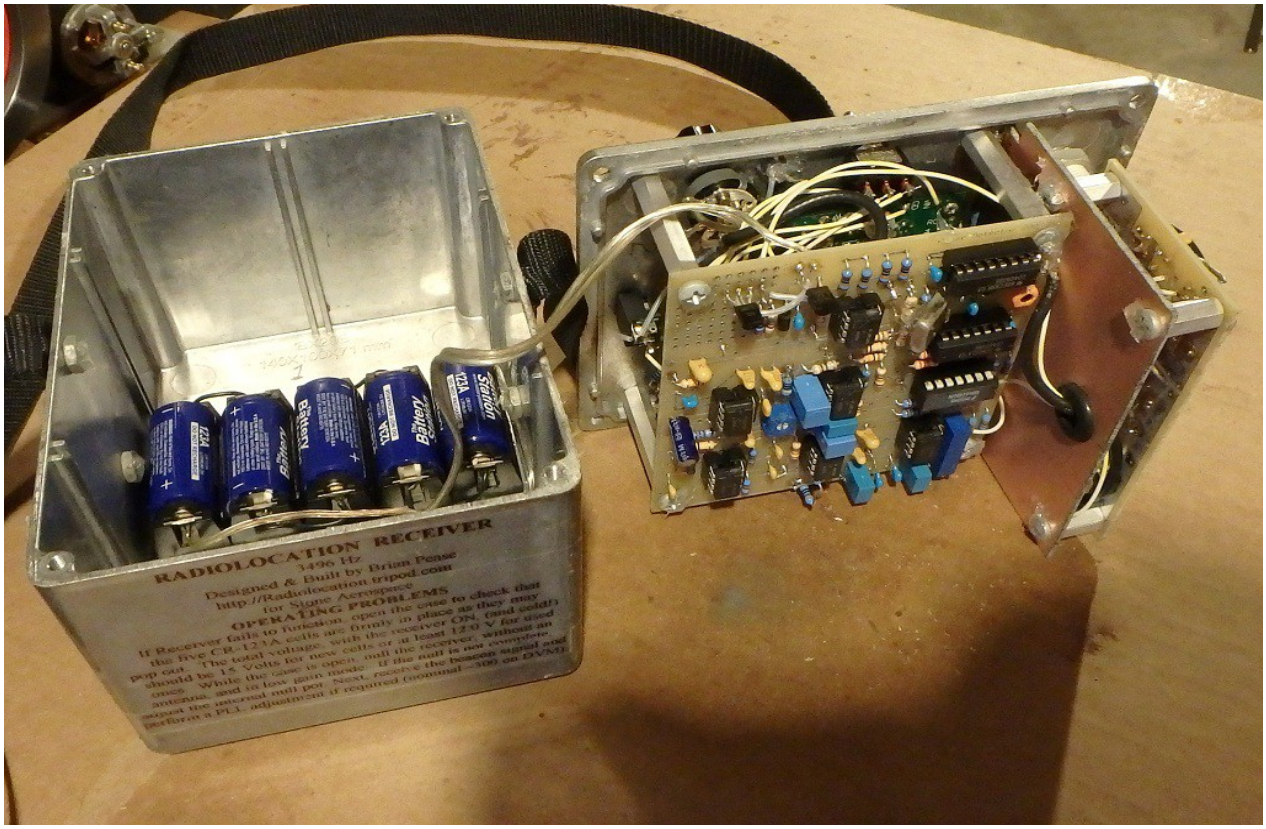
Constructing The Double-Quadrature (DQ) Receiver

I now (July 2020) recommend constructing the “Antarctic” version of the receiver, which has proven to be reliable in harsh field conditions on the sea ice of McMurdo Sound and the Ross Ice Shelf.

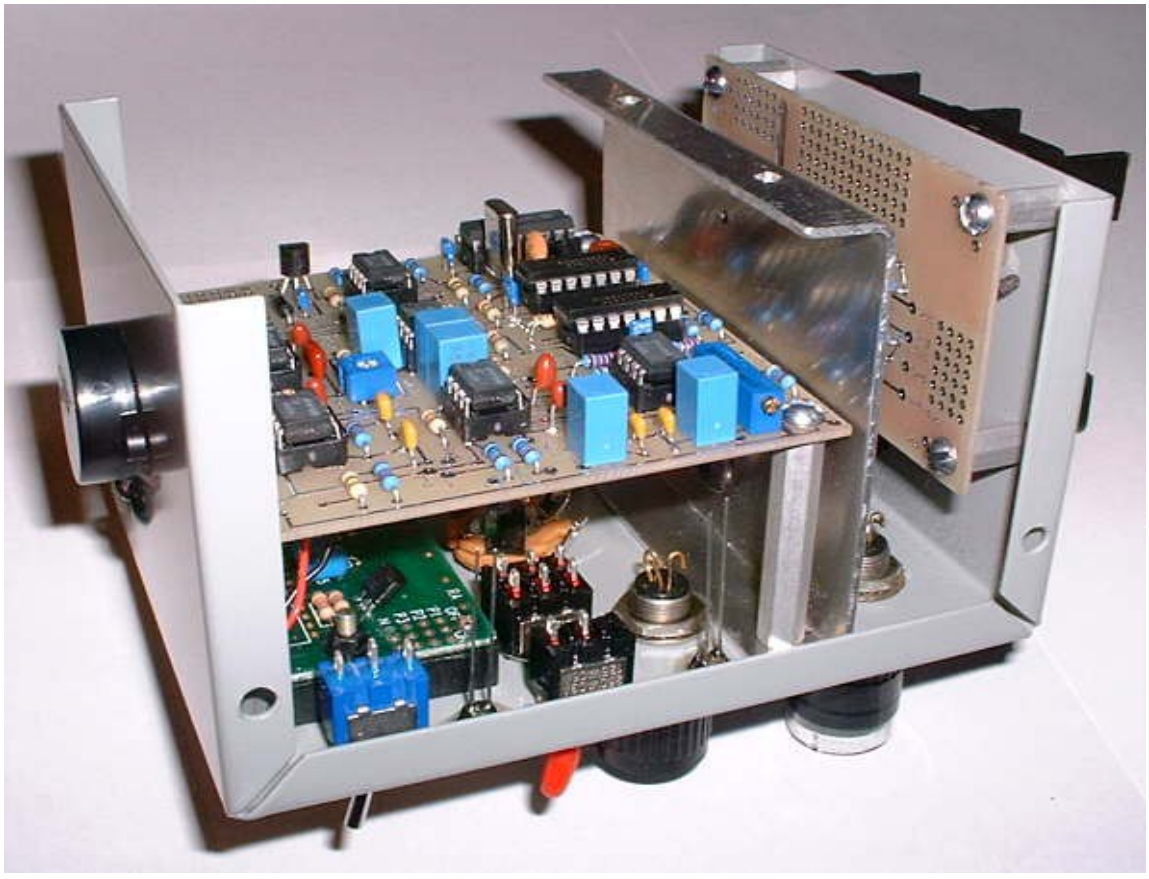
Those who don't need to measure depth (cave divers) can construct the simplified version of this receiver without the digital readout and the parts needed to make it work, and run it on a single 9V battery or external 12VDC. See the separate page for the Simplified DQ Receiver.

The Antarctic Receiver

This receiver has a gasket on the case and o-rings under the knobs primarily to make the controls “stiff” to prevent movement while walking. Liquid water ingress was not an issue in Antarctica! If common stereo headphones will be used, a stereo jack must be used. It may be wise to install both 1/8” and 1/4” jacks in case of headphone failure.



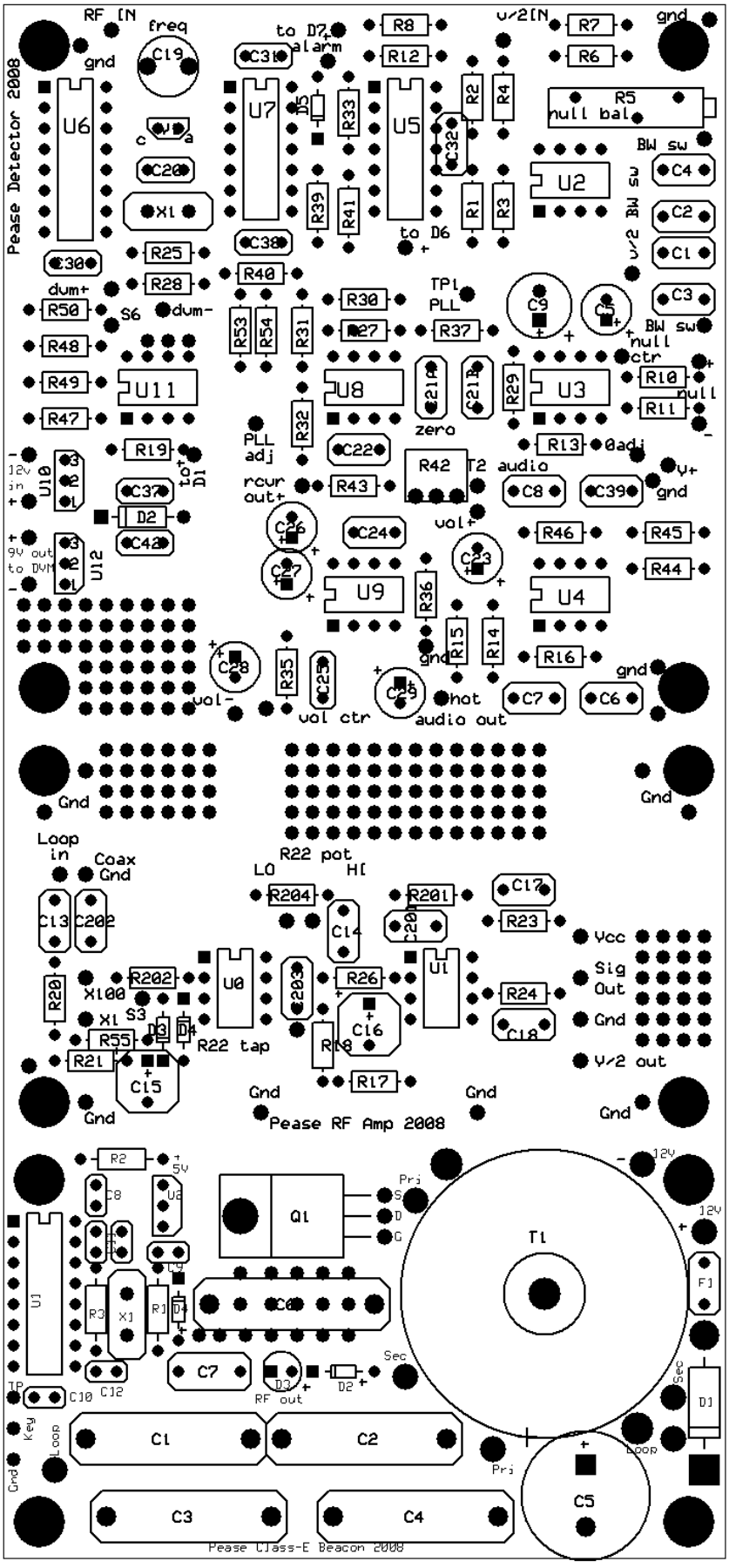
Interior view of the Antarctic Receiver

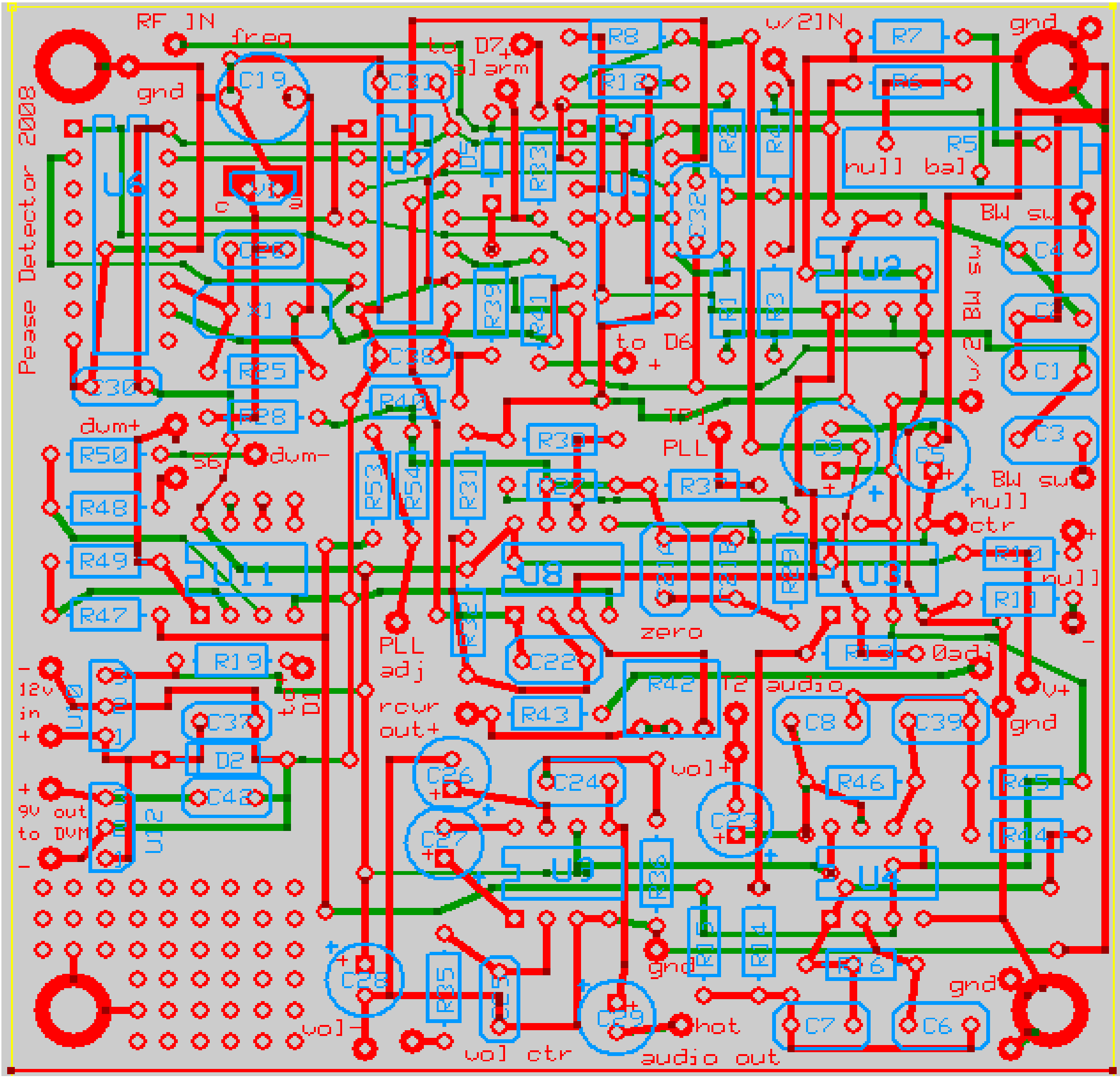

Interior view of DQ receiver in sheet metal box with external batteries

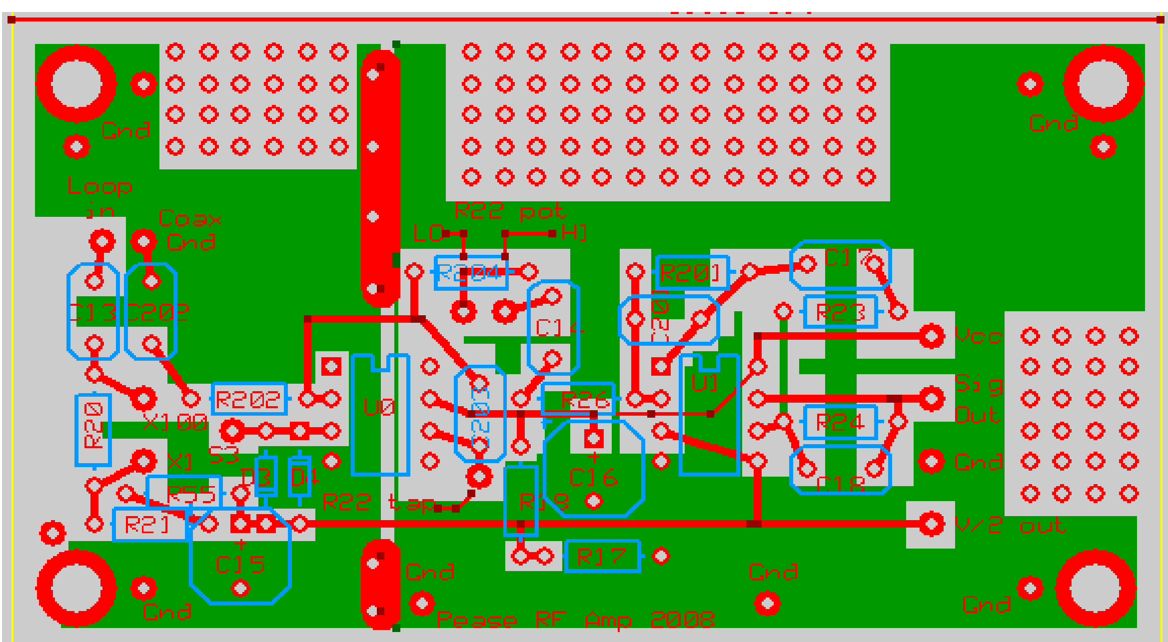
The CR123 cells seem to last forever. The copper clad PC board used as a shield and mount for the RF amp is aligned to fit into the slots in the case. The board is mounted with thin tin-plated steel, which is soldered to the copper and slipped under the mounting spacers for the Main Board. The battery holders are a bit tricky to install. The less common type with wire leads must be used. A layer of duct tape insulates them from the case. The screws must be small 4-40 with "pan" heads that don't stick up much. There must be a closed-cell packing foam spacer over the cells to help hold them in place. It might be better to use a generous amount of top quality double-sided foam tape to hold the holders in place.

See the *DQ Receiver-BeaconPartsLists* for parts advice and ordering, and *Notes on construction and use of the DQ Receiver and Beacon* on the DQ Receiver page of https://radiolocation.weebly.com . The latter document includes notes on initial receiver testing and alignment.

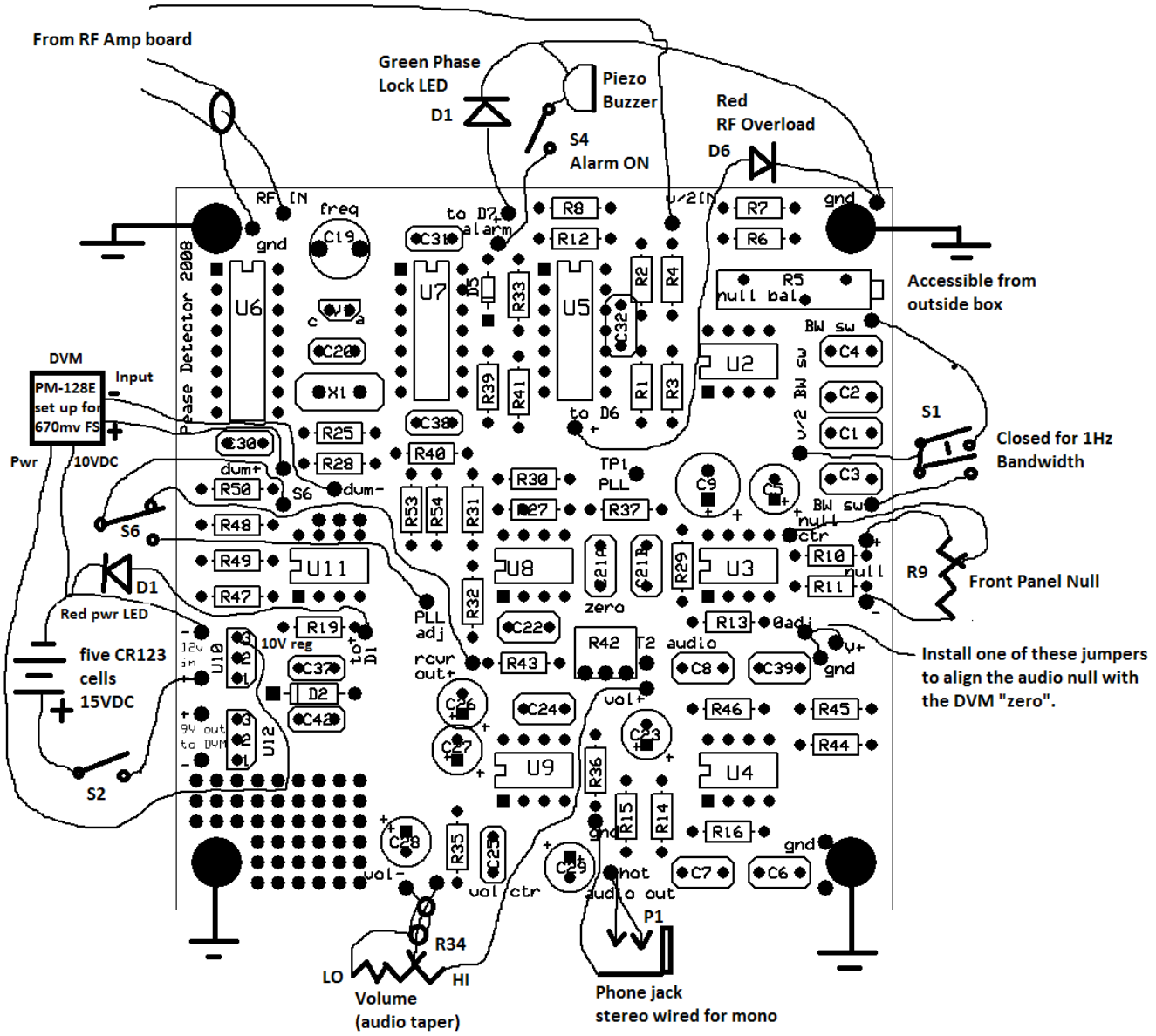
A B&W image of the 3 PC boards showing the parts placement is shown below. This includes parts on the detector board that likely will not be installed such as parts for the alarm and the regulator for certain DVM models, U12. Use this guide when mounting parts as there is no silkscreen printing on the board, just some part numbers in copper. Be very careful to place the parts in the correct holes as there are many "vias" (holes) that connect traces from top to bottom that are large enough for component wires! Color images showing both top and bottom traces are included for reference. Here you will just be working with the detector and RF amp boards. There is extra "prototype" space on both boards to add extra features.


Pease Detector 2008
RF IN
freq
gnd
C19
U6
U7
U5
U2
U11
U8
U3
U9
U4
U10
U12
D5
D6
D7
alarm
to D7
to D6
to D1
X1
C20
C30
C31
C38
C32
C22
C21a
C21b
C26
C27
C24
C23
C25
C28
C37
C42
C8
C39
C7
C6
R8
R12
R7
R6
R5
null bal
R2
R4
R1
R3
R33
R39
R41
R25
R28
R40
R50
R48
R49
R47
R53
R54
R31
R30
R27
R37
R32
R43
R42
R29
R10
R11
R13
R46
R45
R44
R36
R15
R14
R16
R35
R19
D2
C4
C2
C1
C3
C5
BW sw
v/2 BW sw
null ctr
null
0adj
v/2IN
gnd
dvm+
dvm-
S6
TP1
PLL
PLL adj
zero
T2 audio
rcvr out+
vol+
vol-
vol ctr
audio out
hot
12v in
9V out to DVM
Gnd
Loop in
Coax Gnd
R22 pot
LO
HI
C13
C202
R204
R201
C17
C14
C20
R23
R20
R202
X100
S3
D3
D4
R22 tap
R55
R21
C15
U0
C203
R26
C16
R18
U1
R24
C18
R17
Vcc
Sig Out
Gnd
V/2 out
Pease RF Amp 2008
R2
5V
C8
U2
Q1
Prj
S
D
G
T1
12V
F1
U1
R3
X1
R1
D4
C9
C7
D3
D2
RF out
Sec
TP
C10
C12
Key
Loop
Gnd
C1
C2
C3
C4
C5
D1
Pease Class-E Beacon 2008

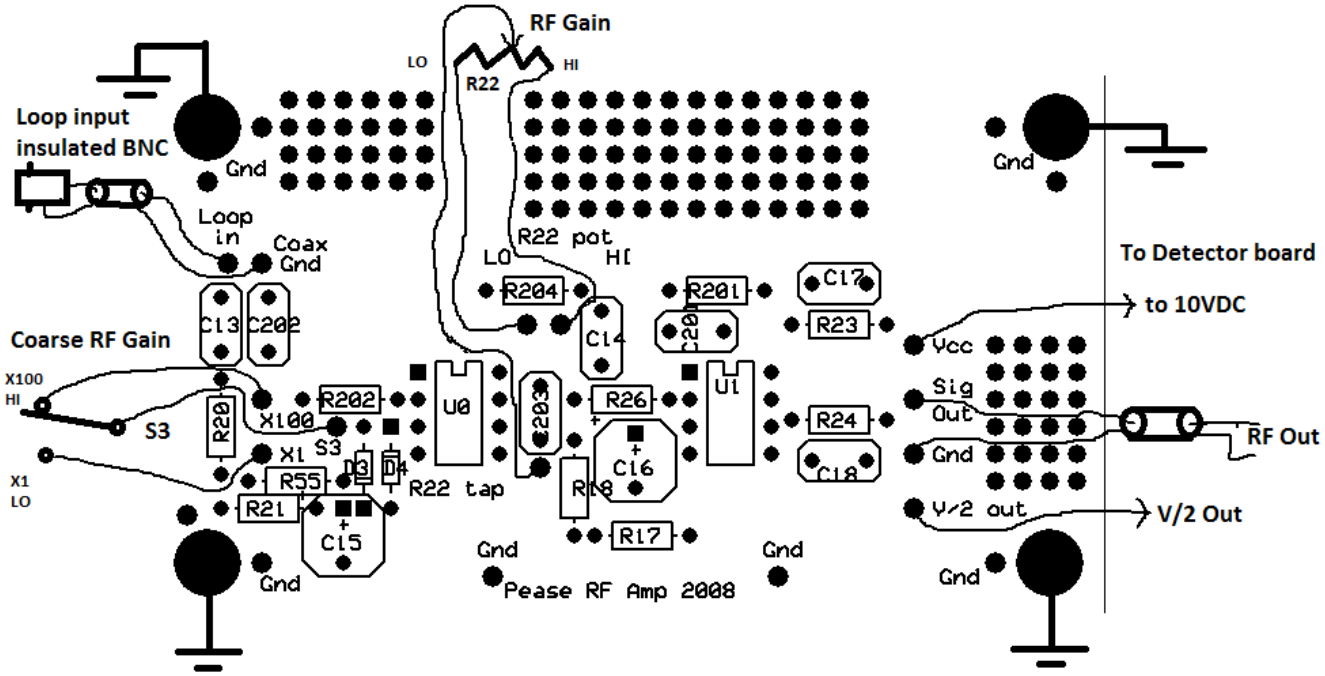

Pease Detector 2008
RF IN
freq
gnd
to D7
alarm
w/2IN
null bal
BW sw
w/2
dvm+
dvm-
S6
PLL
ctr
null
zero
0adj
PLL adj
rcvr out+
audio
gnd
V+
-12v in +
+ 9V out to DVM -
vol+
vol-
vol ctr
hot
audio out
to D6
TP1
T2


Gnd
Loop in
Coax Gnd
R22 pot
LO
HI
X100
X1
S3
R22 tap
Vcc
Sig Out
V/2 out
Pease RF Amp 2008

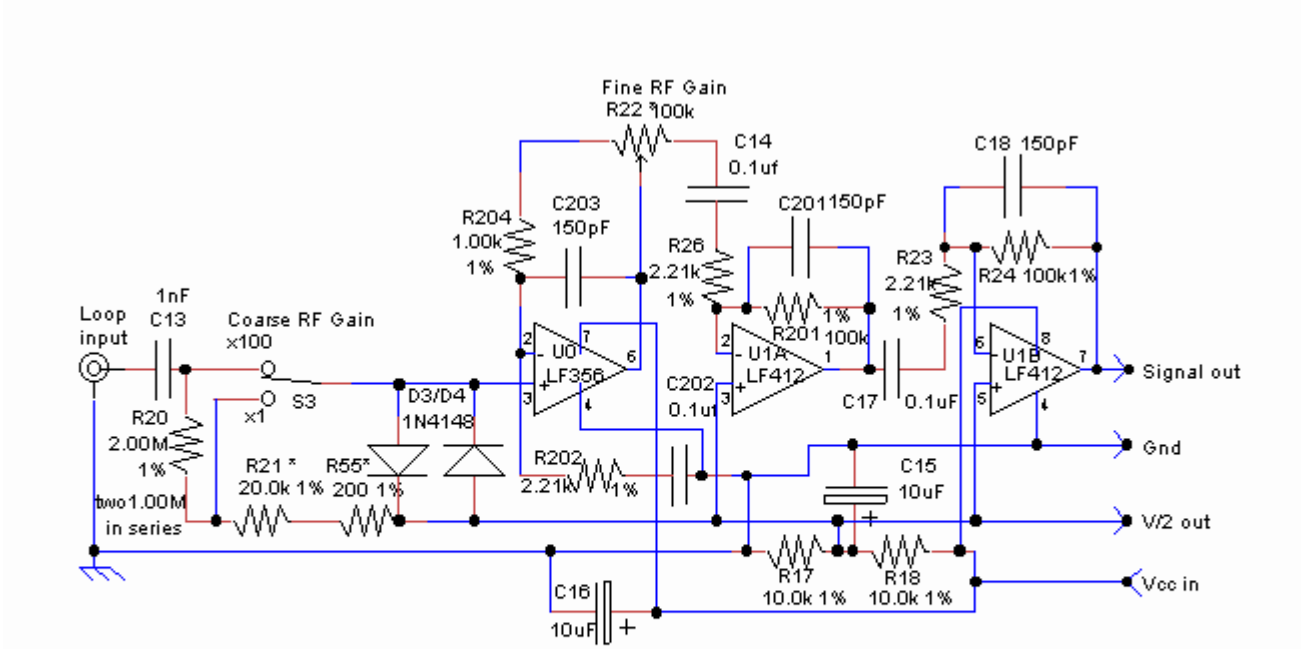
The front panel wiring diagrams are shown below. Small coax cable is used to route the RF signal from the RF Amp board. S4, and the piezo buzzer form the alarm, but are optional. The DVM shown is the general purpose PM-128E that I can supply. I will configure it and test it. It will just need the addition of C40, R51A, and R51B. Any headphones can be used, but I recommend the kind that block outside sound. Higher impedance phones like the mono Telex 600 “language lab) phones I can supply have less feedback to the loop antenna than common 32 Ohm stereo phones. The stereo phones are more comfortable and block more outside noise. Note that the Telex phones will not function in a stereo 1/4” jack unless just the tip contact is wired, otherwise the audio amp will be shorted out. Once the receiver is complete, and you have a working beacon as a signal source, consult the *Notes on Construction and use of the DQ Receiver and Beacon* for initial receiver tests and adjustments.



Detector Board Front Panel Wiring

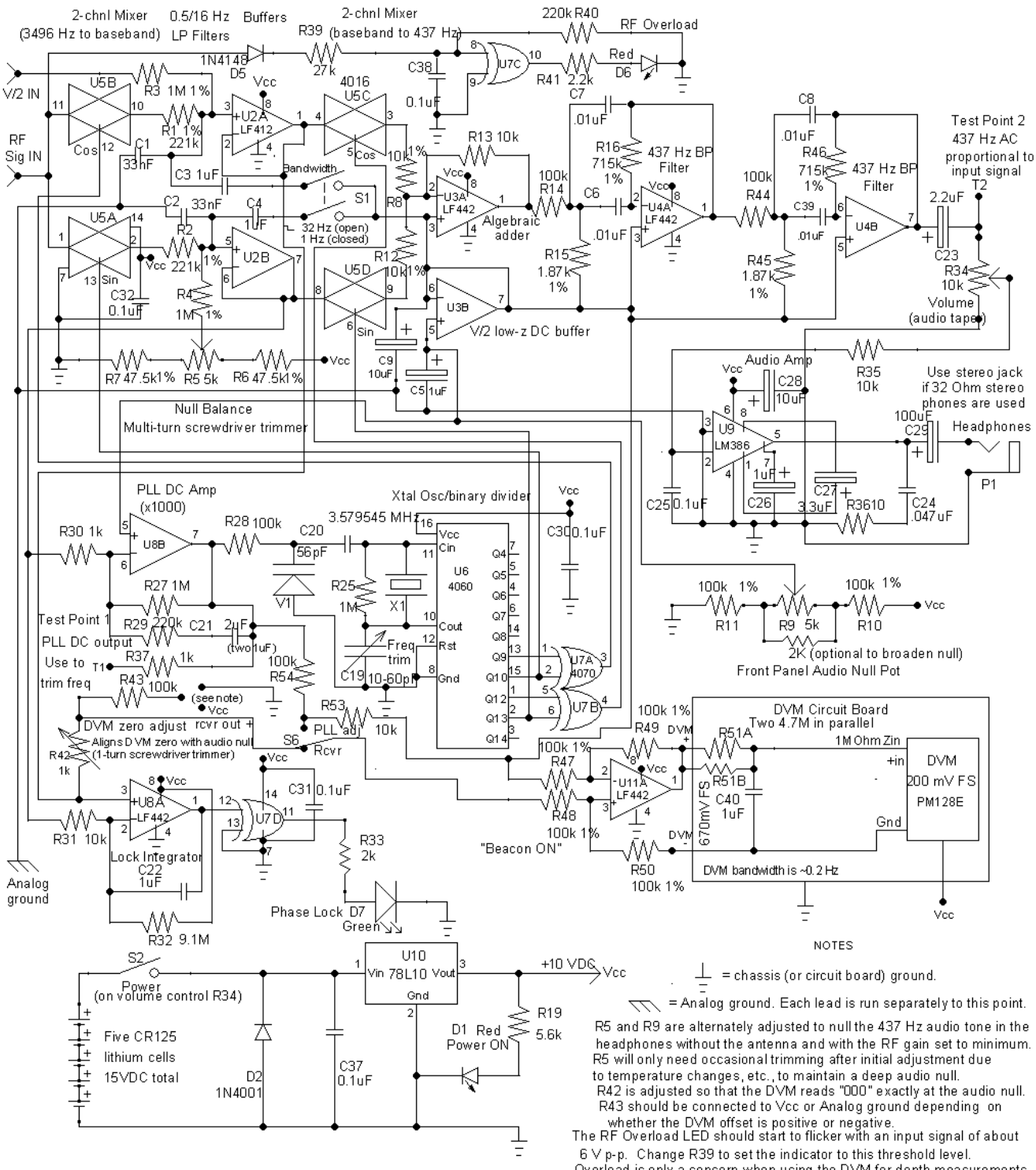


RF Amp Front Panel Wiring



* If "absolute" calibration is desired, R21/R55 should be trimmed to make the attenuation precisely 100:1 and R22 must be a precision 10-turn linear pot with calibrated dial.

RF Amplifier for 3496 Hz DQ Beacon Receiver



NOTES

= chassis (or circuit board) ground.

= Analog ground. Each lead is run separately to this point.

R5 and R9 are alternately adjusted to null the 437 Hz audio tone in the headphones without the antenna and with the RF gain set to minimum. R5 will only need occasional trimming after initial adjustment due to temperature changes, etc., to maintain a deep audio null.

R42 is adjusted so that the DVM reads "000" exactly at the audio null.

R43 should be connected to Vcc or Analog ground depending on whether the DVM offset is positive or negative.

The RF Overload LED should start to flicker with an input signal of about 6 V p-p. Change R39 to set the indicator to this threshold level. Overload is only a concern when using the DVM for depth measurements.

Adjust C19 (slowly) until the receiver phase-locks on a moderately strong beacon signal. Next, monitor the DC voltage at Test Point T1. Center the PLL by Adjusting C19 VERY slowly until T1 is roughly Vcc/2. If the beacon is fixed-tuned (no trimcap), C19 will seldom if ever require readjustment. Change S6 to PLL adjust and note the value (including polarity) for use in field adjuatment.

DQ Receiver Main Board (Detector)

Title: DQ Antarctic Receiver Main Ckt Board		
Author: Brian Pease Thru-the-Earth Radiolocation		
File: \TinyCadDesigns\DQmainboardNewRcvr2020.dsn		Document
Revision: 2.0	Date: 18 July 2020	Sheets: 1 of 1

Loop Antennas for the DQ Receiver

All DQ receivers can use the same loop antennas for receiving. All are simple parallel tuned L-C circuits fed with RG58 or RG174 (my favorite) coax. Larger loops with more weight of copper wire work best, although small ferrite rod loops are very useful also. Aim for 100k Ohms or greater at resonance so that the thermal noise of the loop overcomes the receiver noise. See the *Receiver Loop Notes* in the *Notes on Construction and use of the DQ Receiver and Beacon* for 3 receive loops I have used. The aluminum bicycle rim loop is shown in the Antarctic photos. My 22 inch loop is shown below. The white cord on the front of the loop is the 6 ft cord (with a bar to step on) used for ratiometric depth measurement.

See *Building the Simplified DQ Receiver* for a very simple loop to build.