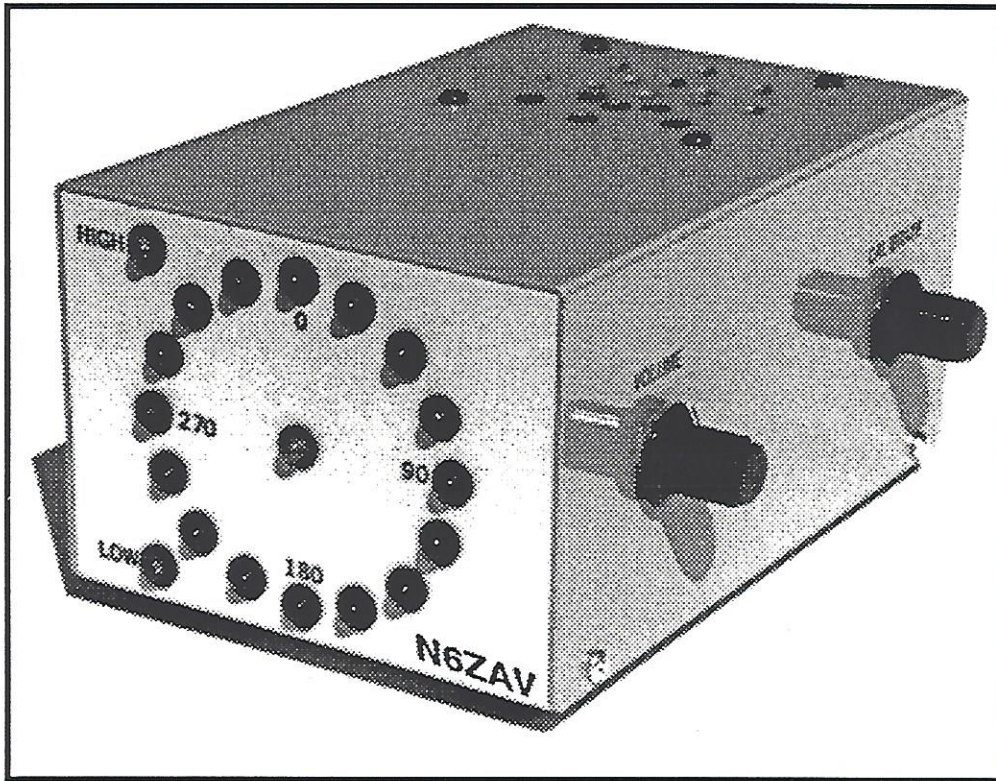


Roanoke Doppler Plus

Radio Direction Finding System



- 16 LED Display
- High/Low Level Indicators
- 146 MHz/220 MHz/440 Mhz
- External Data Port (8 bits)
- Small Remotable Display

By Marty Mitchell, N6ZAV

General Description

Roanoke Doppler Plus is the heart of a very popular radio direction finding system for VHF and UHF. It is based on the project outlined in *TRANSMITTER HUNTING - Radio Direction Finding Simplified* by Moell and Curlee. The entire system requires an antenna array, a receiver, and the Roanoke Doppler Plus.

Four vertical antennas are switched in rapid succession. This causes a received carrier to be FM modulated at a frequency equal to that of the antenna rotation speed. The Doppler compares the phase angle of the demodulated signal with that of the antenna rotation logic and is able to determine the direction of the signal's origin.

There are 16 directional indicators on the front panel - each one represents 22 1/2 degrees of a compass rose. Additional resolution is available via the DATA PORT on the rear panel. There are 8 bits of data (256 possibilities). That's about 1 1/2 degree resolution.

Mobile and base station operation are possible. A nice mobile array is described in the book mentioned above. There are some improvements to that design which have been released by the authors.

Assembly Instructions

Most components should be inserted from the component silk-screen side of the boards. The integrated circuits are static sensitive. Use standard precautions when handling these devices. Diodes, transistors, some capacitors and all integrated circuits are polarity critical. Be sure to orient these components properly prior to installation. A low wattage soldering iron (15-25 watts) with a small tip is preferable. You will also need some thin solder, small diagonal cutters and a pair of needle-nose pliers. See PARTS LIST for resistor color code and capacitor identification information. Trim leads of components AFTER soldering in place. The larger board will be referred to as the "MAIN BOARD" and the smaller board is the "DISPLAY BOARD".

MAIN BOARD ASSEMBLY

- Insert and solder into place all 11 integrated circuit sockets on the MAIN BOARD only. Do not install DISPLAY BOARD socket yet. Be sure to install with orientation notch as indicated on silk-screen. This notch indicates where pin 1 of each IC will be plugged in later.
- Install 1/8" AUDIO IN jack (J3).
- Install 5 pin DIN ANTENNA JACK (J1).
- Install 10 pin right angle DATA JACK (J2).
- Install POWER SWITCH (S3).
- Install DC POWER JACK (P1). You may need to file the bottom pin or hole to improve the fit.
- Install VOLTAGE REGULATOR (U11). Be sure to align metal backing with stripe on silk-screen.

- Install gold posts at CALIBRATE (R36), VOLUME (R1), PHASE INVERT (S1), SPEAKER, and DISPLAY (J3).
- Install diodes D1, D3, D301 and D303. Be sure to match the cathode stripes with those on the silk-screen. Bend one lead of each diode so that they install vertically.
- Install transistor Q1. Orient emitter tab on can with "e" printed on silk-screen.
- Install capacitors C22,C24,C26. Be sure to orient the "+" with that indicated on the silk-screen.
- Install capacitor C301. Orient with "+" towards the top of the board (where C301 is marked).
- Install AUDIO LEVEL trimmer pot (R34).
- Install all remaining resistors and capacitors on the MAIN BOARD only. Resistors should be mounted vertically (one lead bent 180 degrees). See the printed SILKSCREEN attached.
- Install jumper shunts (hats) to each right pair of S1 pins (see silk-screen).



- Install jumper wires on BOTTOM (trace) side of board between common letters (i.e. A-A, B-B. . . S-S). Use the solid wire provided. Use the paper copy of silk-screen as a reference if you are unable to read the silk-screen printed on the board.

DISPLAY BOARD ASSEMBLY

- Install the directional indicators. These are 16 RED LEDs. Mount these on the SOLDER or TRACE side of the board 1/8" to 1/4" above the board. **DO NOT MOUNT THESE LEDs ON THE SILK-SCREEN SIDE OF THE BOARD.** Be sure to orient the flat side (short lead cathode) of each LED with that indicated on the silk-screen.
- Install the HIGH and LOW yellow LEDs in same manner as above.
- Install the center POWER ON green LED in the same manner as above.
- All LEDs should be mounted the same distance from the board.
- Install R20 on SOLDER/TRACE side of board.
- Install IC socket for U201 on silk-screen (component) side of board. Be sure to orient the socket notch with that indicated on the silk-screen.
- Install 2 x 5 gold post array into J4 on silk-screen side of the board.

PRELIMINARY TEST

- Verify that no short circuits exist between +12 VDC and GND and between +5 VDC and GND.
- Connect 12 volts to P1 and verify 5 volts at lower pin of regulator U11 (pin 3).
- Remove power.
- Insert all integrated circuits. Be sure to TRIPLE check orientation with silk-screen.
- Apply 12 VDC again. Look for smoke.

DISPLAY CABLE

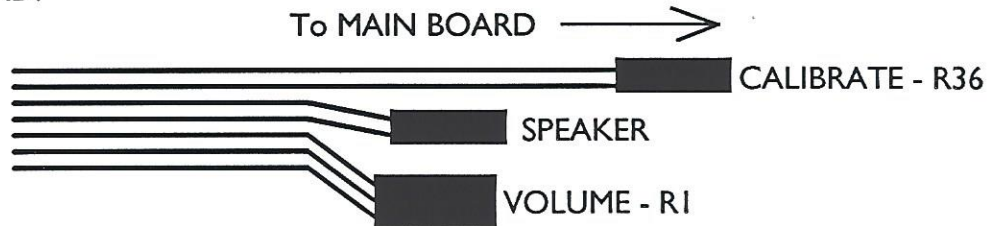
- Cut a piece of grey 10 conductor ribbon cable long enough to reach between the display jacks J3 and J4 when installed in the chassis. If you are using an LMB CR 643 chassis, the correct length is 5".
- Crimp one ribbon cable plug onto each end of the cable. Be sure to align the cable's red stripe with the triangle stamped on the connector. Each connector should be pointed down when the cable is horizontal. A vise works well to insure an even crimp.



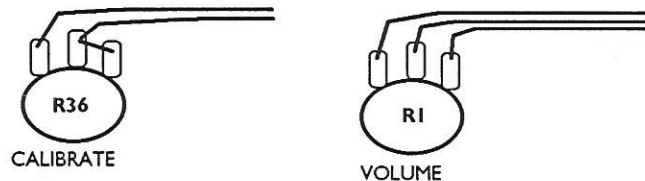
CHASSIS

- Attach the included display template to the chassis with tape. Use a center punch to mark the hole locations for all 19 LEDs. Be very accurate with your marks to insure that the board will mate with the chassis.
- Attach (4) 3/8" standoffs to the main board using (4) 4-40 screws. Cut the back side of the chassis to accommodate the switch and jacks on the back of the board.
- Drill 4 holes in the bottom of the chassis to secure the MAIN BOARD.
- If you plan to place labels on the chassis for UP, DOWN, 0, 90, 180, 270, etc., this would be a good time to do so.
- Install the MAIN BOARD.
- Insert 19 LED grommets into the front of the chassis.
- Insert the DISPLAY BOARD into the grommets. Standoffs are not necessary, but may be used.
- Attach the display cable between J3 and J4. Pin 1 on J3 is where "J3" is indicated.

- Install SPEAKER, R1 and R36 into top half of LMB CR643 chassis. Be sure to check for internal real estate problems when halves are mated prior to drilling any holes. I recommend installation of the SPEAKER toward the rear of the top, VOLUME (R1) on the right side towards the front, CALIBRATE (R36) on the right side towards the rear.
- Attach black Amp connectors to one end of the colored ribbon cable. There should be (2) two conductor and (1) three conductor connectors. You may wish to cut off 4 inches of 5 conductors before attaching the Amp connectors to provide a better mate to the MAIN BOARD.



- Solder wires and corresponding plugs to SPEAKER, R1 and R36. The center contact of the 3-pin volume plug should connect to the wiper of POT R1. Since there are only two wires that connect to R36, the center contact (wiper) of R36 needs to be bridged to one of the ends as shown below.



- Attach these plugs to the appropriate gold pin jumpers on the MAIN BOARD. Polarity is not important on the SPEAKER and CALIBRATE connections, but will reverse the VOLUME control performance if connected backwards.

CHECK-OUT PROCEDURE

- Apply 12 volts to P1. Verify illumination of three LEDs (the yellow LOW signal, the green POWER ON, and one of the red directional indicators). Verify proper polarity of LEDs if there is a problem. Remember to align the cathodes with the flat area indicated on the silk-screen.
- Using an oscilloscope, verify 75% duty cycle, approximately 500 hertz, square wave from antenna jack (J1), pins 1, 3, 4, 5. These are all of the pins except the middle one (GND).
- Connect an audio source, such as your receiver speaker output, to AUDIO IN (J3) via a 1/8" plug. Set VOLUME POT (R1) for maximum volume. Turn up your audio source volume as loud as you would ever want it to be for doppler monitoring applications. Adjust VOLUME POT (R1) to a comfortable level. Place scope probe at U1 pin 1. Adjust AUDIO LEVEL POT (R34) to as high a level as possible with only occasional clipping at the lower portion of the wave.
- Confirm that the yellow HIGH level LED turns on during peaks in audio or when you turn up the volume of the audio source.

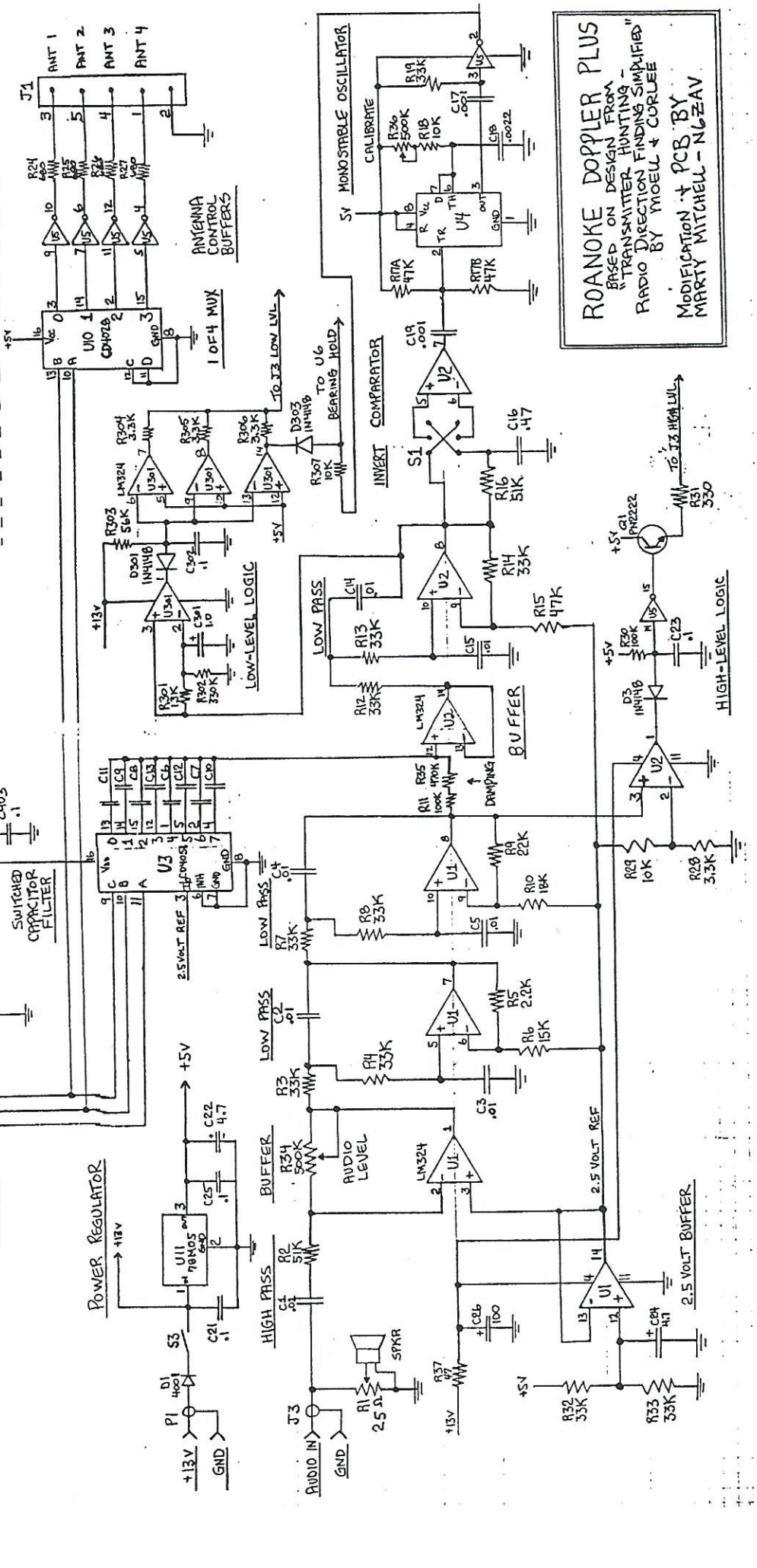
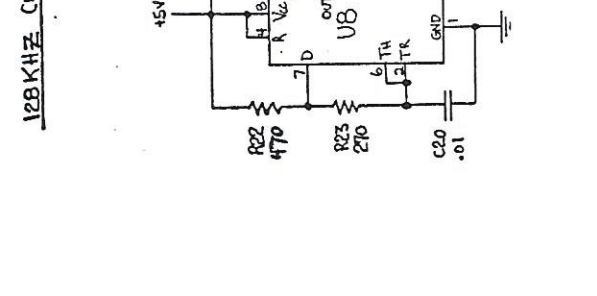
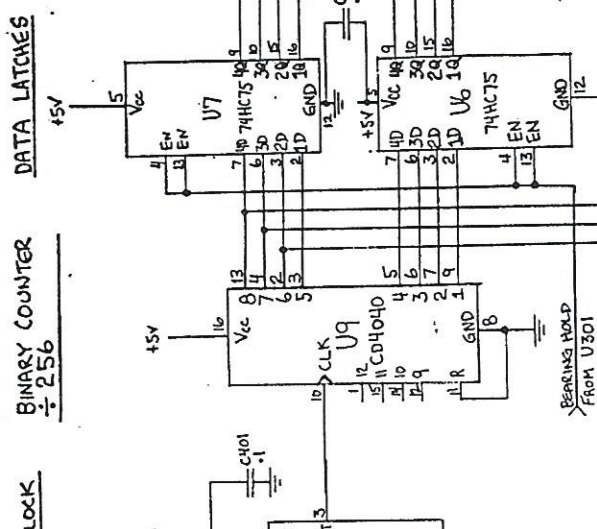
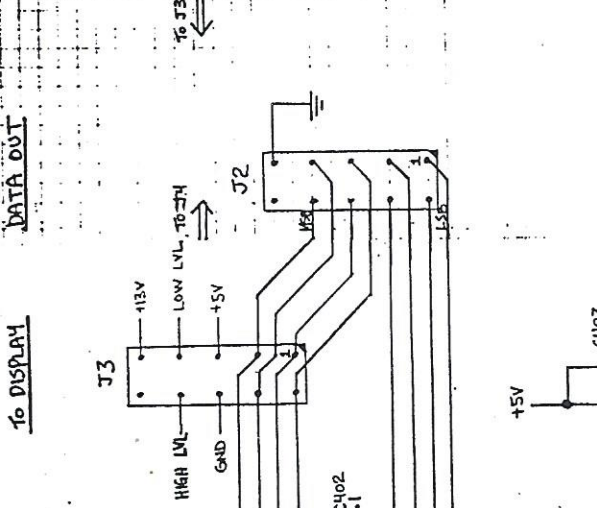
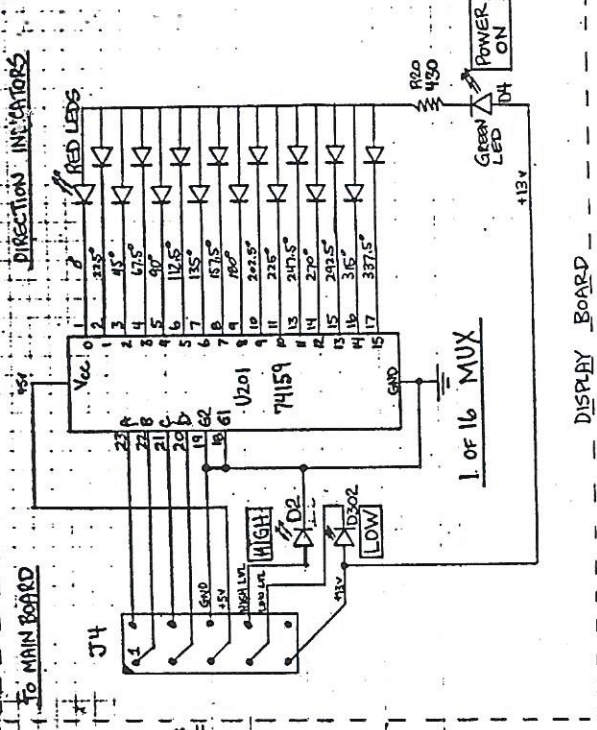
- Verify clock rate at U8 pin 3 to be approximately 124-132 KHz (128 KHz is ideal). You may wish to fine tune this by adjusting the values of R22, R23 and C20. Use higher values to slow down clock, lower ones to speed up clock.

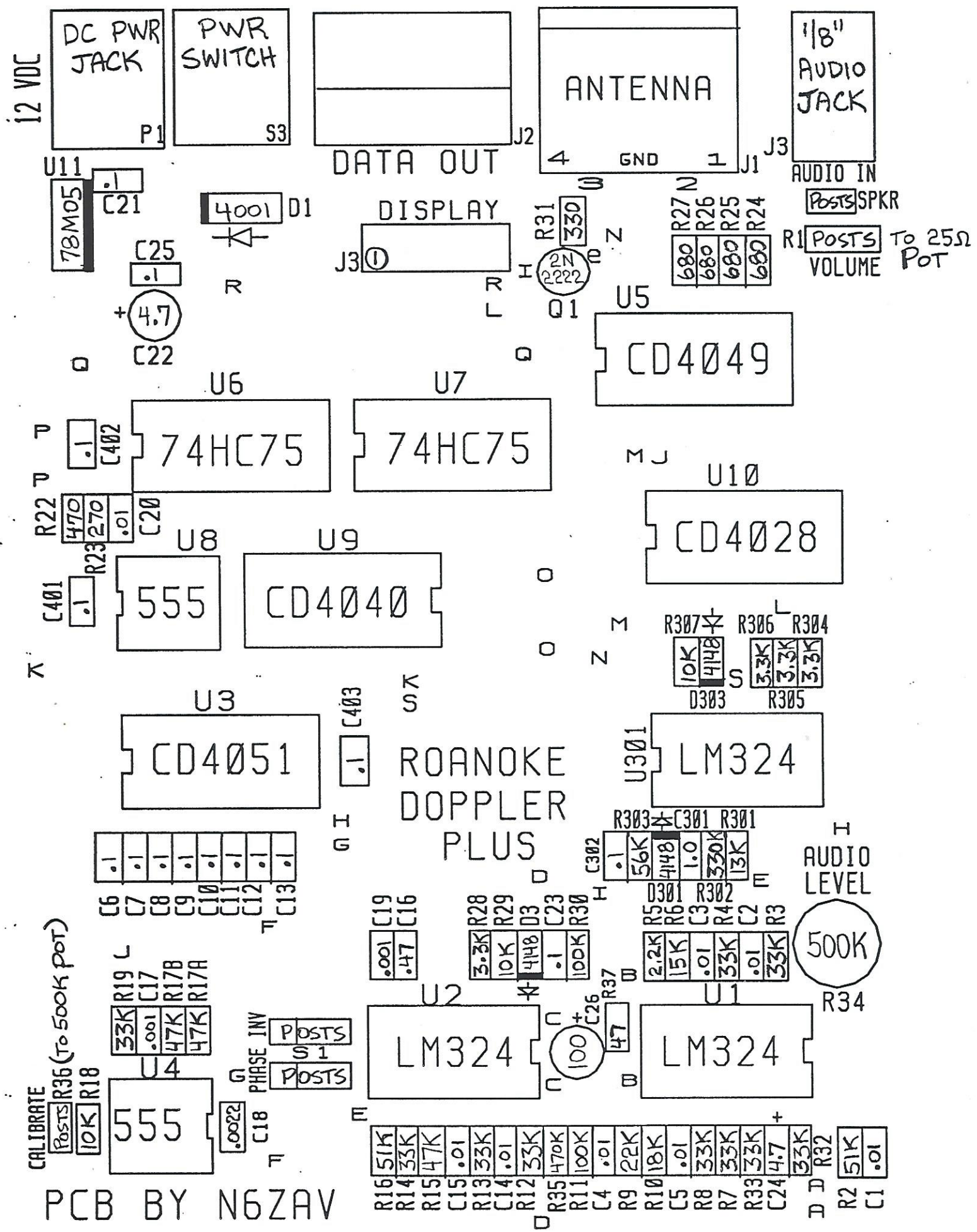
- Connect to antenna array (see *TRANSMITTER HUNTING* book referenced above for details)

Parts List

NUM	DESC	REF
3	LM324	U1,U2,U301
1	CD4051	U3
2	555	U4,U8
1	CD4049	U5
1	CD4040	U9
1	CD4028	U10
1	LM78M05	U11
2	74HC75	U6,U7
1	74159	U201 (display board)
1	ROANOKE DOPP PCB	
1	ROANOKE DISP PCB	
16	LED (RED)	HEADING INDICATORS
2	LED (YELLOW)	D2,D302
1	LED (GREEN)	D4
1	1/8" PHONE JACK	J3
1	DIN JACK 5 PIN F PCB	J1
1	10 PIN RT ANG PCB	J2
1	MINI SW RT PCB	S3
1	COAXIAL PWR JACK PCB	PI
1	10 COND RIBBON 6"	
2	10 COND RIBBON PLUGS	
1	2N2222	Q1
1	4001	D1
3	1N4148	D3,D301,D303
1	500K TRIMMER	R34
1	500K POT CHASSIS	R36
1	25 OHM POT CHASSIS	R1
1	47 OHM yel/pur/blk	R37
1	270 OHM red/pur/brn	R23
1	330 OHM org/org/brn	R31
1	430 OHM yel/org/brn	R20 (display board)
1	470 OHM yel/pur/brn	R22
4	680 OHM blu/gry/brn	R24,R25,R26,R27
1	2.2K red/red/red	R5
4	3.3K org/org/red	R304,R305,R306,R28
3	10K brn/blk/org	R29,R18,R307
1	13K brn/org/org	R301
1	15K brn/grn/org	R6
1	18K brn/gry/org	R10
1	22K red/red/org	R9
10	33K orn/org/org	R3,R4,R7,R8,R12,R13,R14,R19,R32,R33
3	47K yel/pur/org	R15,R17a,R17b
2	51K grn/brn/org	R2,R16
1	56K grn/blu/org	R303
2	100K brn/blk/yel	R11,R30

1 330K org/org/yel	R302
1 470K yel/pur/yel	R35
2 0.001 mf (102)	C17,C19
1 0.0022mf (222)	C18
8 0.01 mf (103)	C1,C2,C3,C4,C5,C14,C15,C20
15 0.1 mf (104)	C6,C7,C8,C9,C10,C11,C12,C13,C21,C23,C25,C302,C401 C402,C403
1 0.47 mf (474)	C16
1 1 mf (105)	C301
2 4.7 mf	C22,C24
1 100 mf	C26
2 SHORTING JUMPERS	SI
2 1 x 2 GOLD POSTS	SPEAKER, CALIBRATE
3 1 x 3 GOLD POSTS	VOLUME, SI (2)
2 2 x 5 GOLD POSTS	J3, J4
1 16 OHM SPEAKER	SPKR
2 2 CONDUCTOR SIP PLUG	SPEAKER, CALIBRATE
1 3 CONDUCTOR SIP PLUG	VOLUME
2 8 PIN DIP SOCKETS	
3 14 PIN DIP SOCKETS	
6 16 PIN DIP SOCKETS	
1 24 PIN DIP SOCKET	
1 CHASSIS 6x4x3	LMB PART #CR643
19 LED HOUSINGS	LEDS
14 INCHES 7 COND WIRE	MAIN BOARD TO POTS & SPKR
36 INCHES SOLID WIRE	JUMPERS ON TRACE SIDE
2 KNOBS FOR 1/4 SHAFTS	POTS R1, R36
4 3/8" STANDOFFS	MAIN BOARD
8 4-40 x 1/4" SCREWS	STANDOFFS

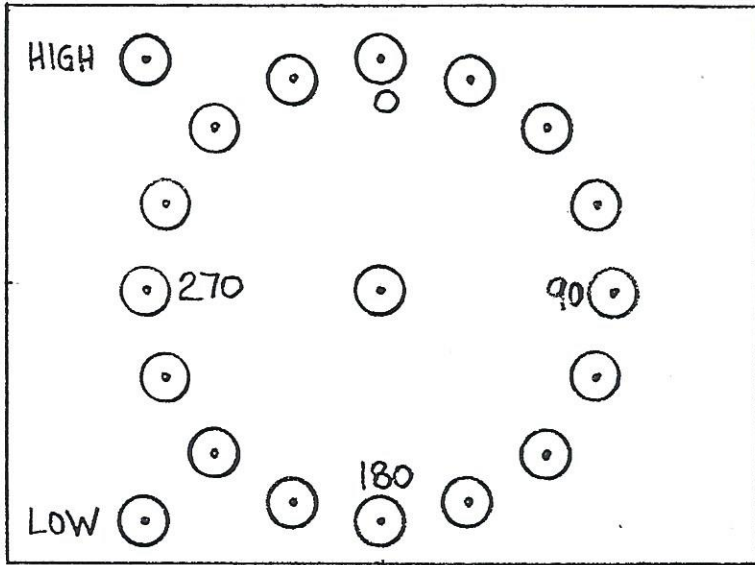




PCB BY N6ZAV

- R16 51K
- R14 33K
- R15 47K
- C15 .01
- R13 33K
- C14 .01
- R12 33K
- R35 470K
- R11 100K
- C4 .01
- R9 22K
- R10 18K
- C5 .01
- R8 33K
- R7 33K
- R33 33K
- C24 4.7
- R32 33K
- R2 51K
- C1 .01

DISPLAY DRILL TEMPLATE



ROANOKE DOPPLER IMPROVEMENTS

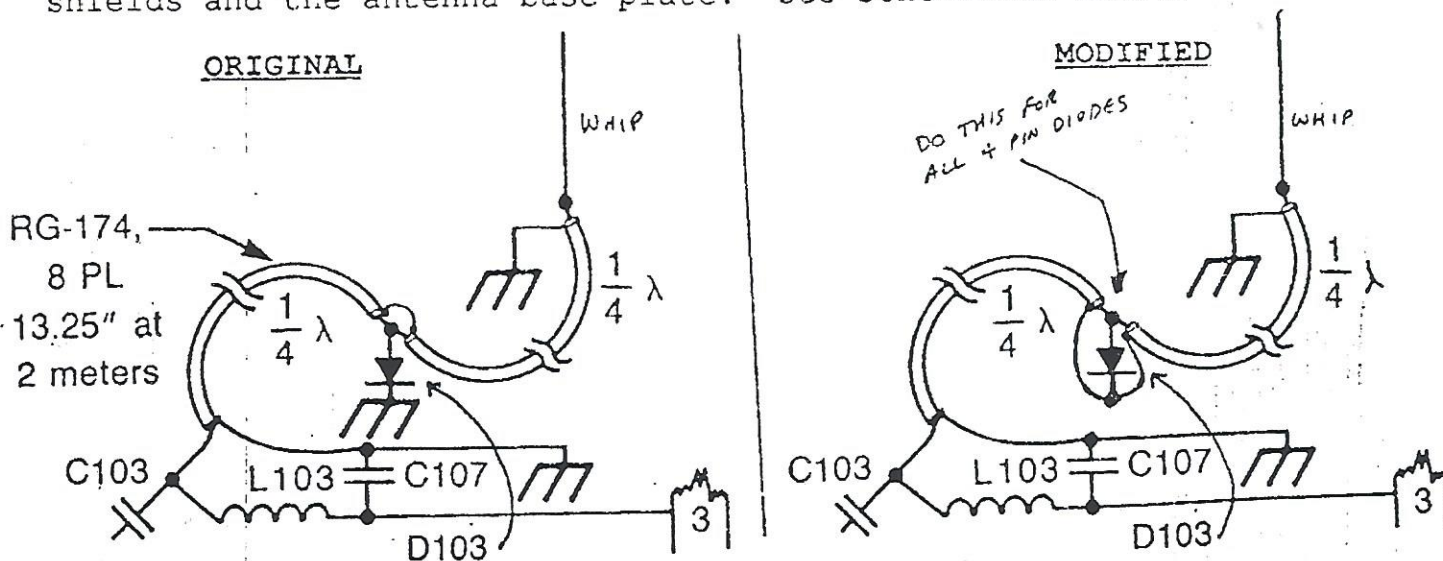
I have recently developed two modifications for the Roanoke Doppler antenna system. The RF choke mod improves the sensitivity and gives better performance on weak signals. The shield connection modification gives better isolation between whips and thus helps stabilize the display. Here are details of the mods:

1. RF Choke mod. Miniature 6.8 microhenry rf chokes typically have iron cores. The distributed capacitance of these chokes give them self-resonant frequencies in the 60 MHz range. This is lower than the two meter operating frequency, so some chokes actually act like capacitors at two meters, instead of inductors. Replacing L101-L104 with lower inductance air-core chokes solves this problem. Note that the air core inductors are somewhat larger (about the size of a 1-watt resistor), even though they are smaller in inductance. I recommend Miller #4602 (1.0 μH) or #4604 (1.5 μH). You can also make your own 1 μH chokes. Here are two possible methods:

a. Wind 24 turns of AWG 26 enameled wire onto a 3/16-inch polystyrene rod, one inch long. (Winding should be in single layer, close-spaced) Coat with Q-dope, strip leads, and install.

b. Strip ends of 19-1/2 inch length of AWG 26 enameled wire. Wind tightly in single 24-turn layer on 3/16" mandrel. (The shaft of a drill bit works well for this) Coat the winding with Q-dope. When dry, slide the coil off the mandrel and install.

2. Shield mod. Delete the ground connections on the four PIN diode cathodes. This eliminates a ground loop between the coax shields and the antenna base plate. See schematics below.



Your comments and suggestions are invited. 73, de Joe KØOV

5/15/92

