

Two Updated Remote Active Antennas

RL-1 REMOTELY-TUNED LOOP and RW-1 REMOTELY-TUNED WHIP

Mark Connelly, WA1ION / 04 JUN 1996

Remotely-tuned antennas, operated by a controller such as DCP-2 or MWT-3, can give DX receptions that would otherwise not be possible. Operating positions in vehicles and in steel-frame buildings usually require outdoor antennas that are compact, placed away from structural shielding and electrical noise sources, and capable of delivering sufficient signal-to-noise for serious DX listening, including medium wave operation during low-signal daytime and auroral-nighttime conditions at rural sites. Furthermore, at high-signal urban locations, if amplifiers are used at the remote antenna head-ends, they must be able to deliver desired-frequency weak DX signals free of intermodulation distortion / mix spurs from local transmitters on different in-band and out-of-band frequencies. This is a "tall order" and many of the commercially-available broadband active whips are not up to the task. The "Ultralinear" active whip design by Dallas Lankford is about the best. For many, whips made by Dressler, Rohde & Schwarz, RF Systems, MFJ, and others will suffice. A broadband design offers frequency-agile listening, but for a given amount of gain, a properly-designed remotely-tuned antenna - whip or loop - will outperform a broadband active antenna in terms of freedom from spurious responses. Often the receiver itself, as it is hit with many strong signals at once, is just as likely to generate spurs as is the antenna's untuned head-end amplifier. Thus, even remotely-tuning a very "crunchproof" antenna amplifier can still improve the final "as heard" signal. The perfectionist will consider a motor-driven variable capacitor at the remotely-tuned antenna instead of more-overloadable varactors. For that matter, he will probably eschew the front-end amplifier altogether in favor of an antenna of sufficient size ... such as a 1 m. loop or 10 m. wire ... to deliver adequate drive to a 50 ohm coaxial line after having been coupled through a very efficient tuning / impedance-matching tank circuit that includes that motor-driven capacitor. Since my main interest involving remotely-tuned antennas is DXing on car trips to good DXing locations that are NOT in the shadow of multiple local-station transmitting towers, my overload immunity considerations are somewhat less stringent than those of a DXer in a Manhattan high-rise. Varactors do work well for my needs and the circuits are much simpler to implement than those supporting motorized capacitors.

The high cost and lack of common availability of some of the buffer amplifier chips (such as the National Semiconductors LH0033CG) at the heart of the RTL-2 Remotely-Tuned Loop and other prior designs led me to investigate other amplifier options. The BUF-B amplifier which uses a 40673 (or equivalent

NTE222) MOSFET followed by a 2N5109 output bipolar transistor (see RTL-2 article) did an adequate job, but I figured that further improvements were possible. Anyway, the dual gate MOSFET's seem to be getting less available and more expensive. Dallas Lankford's ultralinear whip amplifier looked good on paper, except for my own bias against those wind-'em-yourself transformers. Also, the circuit's gain seemed less than what is required for small antennas used at rural sites. After a bit of research, the BUF-D design evolved. This card uses a low-noise JFET input (2N4416 or J310 can be used) and a VMOS FET (VN10KM) for the output power amplifier. No RF transformers are required, so nagging worries about core saturation IMD on strong signals could be put aside. The 2N4416's (or J310's) are widely available and the VN10KM power FET is available at Active Electronics (and at my local Electronics Superstore in Woburn, MA). Thomson SK9155, equivalent to the VN10KM, is available from Allied and other mail-order vendors. Achieving optimum transistor biasing for lowest intermodulation distortion is a bit of a "black art" and is best done with two-tone testing on a spectrum analyzer, although the component values I've chosen (as a result of single-tone oscilloscope testing) should be reasonably close to optimum values.

To keep antenna circuitry simple, I designed one unit, the RL-1, to amplify a plug-in loophead (ferrite such as the Quantum and Palomar heads, or homebrew air-core) and I designed a second unit, RW-1, to amplify a wire or BNC-equipped whip (such as the now-unavailable 30-inch / 76 cm Radio Shack 20-008). Having two simple different-use units reduces wiring complexity and the likelihood of unexpected coupling and oscillation: these problems have occurred with the rat's nest of wiring required inside some prototype combination-loop/whip bases having high-gain amplifiers.

Each remote base (RL-1, RW-1) contains a varactor / relay card and a BUF-D amplifier card. Other contents are specific to the task of loop or whip/wire operation.

The RW-1 has bandswitch inductors that resonate with the varactor to permit tuned operation on longwave, medium wave, and tropical band ranges. Each range is divided into two sub-ranges controlled by the relay on the VRLY-B card: LW-low = 130 - 220, LW-high = 220 - 475; MW-low = 475 - 830, MW-high = 830 - 1720; TB-low = 1720 - 2700, TB-high = 2700 - 5500 (up to ~ 7500 kHz with short whips). The RW-1 also has an attenuator pot to keep overloading under control at strong-signal urban / suburban locations. RW-1 can be used for broadband whip amplification in addition to remotely-tunable operation. It works at least as well as an MFJ 1024 in this regard.

The BUF-D amplifier in both the RL-1 and RW-1 can be operated at low gain or at high gain. Low gain operation will give somewhat better freedom from mixing spurs; high gain will give the signal levels often required for successful phasing through the delay-line circuitry in a DCP-2 Dual Controller / Phaser located at the receiver - operator "shack" position.

Tank circuit Q can be reduced, if desired, on both the RL-1 and RW-1. Doing this can sometimes improve null stability and effective null bandwidth when phasing; however, reduction of signal-to-noise margin can be a trade-off.

Because of the simplicity of the RL-1 and RW-1, detailed comments and operating instructions are not included. The tables and drawings which follow should provide enough information to allow a DXer to run either unit in conjunction with a suitable controller such as MWT-3, DCP-1, or DCP-2. For more thorough discussions of remotely-tuned antennas, see the various National Radio Club and International Radio Club of America reprints of RTL and RTU style remotely-tuned antennas and of DCP and MWT style controllers. These articles refer to useful additional works by Ken Cornell, Dallas Lankford, Joe Farley, E. L. Cummins, and others.

Systems comprised of an RL-1 (with Quantum loophead), RW-1 (with BNC-plug-equipped whip), and DCP-2 Dual Controller / Phaser (with necessary "umbilical" cables and 12 VDC power source) are being used successfully by me and by Bruce Conti on car DXpeditions to beaches, salt marshes, and other advantageous DX sites. Antennas may be vehicle-mounted for use at locations not having space and/or privacy for proper longwire installations. When electrical noise and shielding are not too bad, the system can be used indoors as well. Phased loop-versus-whip systems can produce the cardioid patterns most suitable for transoceanic DX reception.

A system with a DCP-2 and two RL-1's (with loopheads aimed 60 to 120 degrees differently) also works well. At rural sites, you can use two RW-1 bases, preferably in tuned mode, each connected to a moderate-length (up to 100 m / 330 ft.) wire. The two wires (like the loopheads mentioned in the "two RL-1" case) should have a bearing difference of 90 +/- 30 degrees for best results.

An RL-1 remotely-tuned loop, if set to the lower-Q mode, can also be phased against a broadband-mode RW-1 active whip or against an untuned longwire (fed directly to the DCP-2, or through an RW-1) with reasonable results. This is commonly done on DXpeditions, as it allows "band cruising" and parallel-checking when the DCP-2 controller is switched to the untuned antenna.

All these variations on the same theme are systems which outperform a loop used alone. They are the modern (and compact) versions of the LIL (Dallas Lankford) and LSCA (Ron Schatz) loop / vertical cardioid set-ups that have worked so well in fixed "base station" home applications.

RL-1 and RW-1 CONSTRUCTION DATA

Table 1: RL-1 hole-drilling list

X = Horizontal distance, in inches, from the vertical centerline (VCL) on the side observed. Negative values of X are left of VCL, positive values of X are right of VCL.

Y = Vertical distance, in inches, from the bottom horizontal edge of the side observed.

D = Hole diameter in inches.

Hole loci are first marked on the box with a scribe and are then drilled with a .125" bit. Subsequently, as required, the holes are enlarged to the proper size by using progressively larger bits up to that corresponding to the final desired diameter.

Chassis Box = Mouser # 537-TF-779: 5" X 4" X 3"

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	G1	grounding H/W - internal lug	-1	2.5	0.125
2	S1	Gain / Q mode switch - tab	-0.5	2.125	0.125
3	S1	Gain / Q mode switch - shaft	-0.5	1.875	0.25
4	M1	VRLY-A card(mounting h/w H3)	0.5	1.5	0.125
5	M1	VRLY-A card(mounting h/w H1)	0.5	0.5	0.125
6	M1	VRLY-A card(mounting h/w H4)	1.5	1.5	0.125
7	M1	VRLY-A card(mounting h/w H2)	1.5	0.5	0.125

TOP SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J1	Loop Head In - stereo jack	0	2	0.375
2	A1	BUF-D card (mounting h/w H2)	0.875	2	0.125
3	A1	BUF-D card (mounting h/w H1)	1.875	2	0.125

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J2	control cable stereo jack	-1.125	0.5	0.375
2	G2	grounding H/W - internal lug	0	1.125	0.125
3	J3	RF out / DC pwr in- BNC jack	0	0.5	0.375

Table 2: RL-1 "upper level" parts list

*: Note follows parts list.

Vendor codes for this and subsequent parts lists:

ACT = Active Electronics / 11 Cummings Park
 / Woburn, MA 01801
 /Tel. 1-800-677-8899,
 617-932-4616

CS = Circuit Specialists / P. O. Box 3047
 / Scottsdale, AZ 85271-3047
 /Tel. 1-800-528-1417,
 602-464-2485

DC = DC Electronics / P. O. Box 3203
 / Scottsdale, AZ 85257-3293
 /Tel. 1-800-467-7736,
 602-945-7736

MCL = Mini-Circuits Lab. / P. O. Box 350166
 / Brooklyn, NY 11235-0003
 /Tel. 1-800-654-7949,
 417-335-5935

MOU = Mouser Electronics / 958 North Main Street
 / Mansfield, TX 76063-4827
 /Tel. 1-800-346-6873,
 817-483-5712 (export)

RS = Radio Shack / Many locations worldwide

Schematic = Figure 1 / Assembly = Figure 6.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	A 1	BUF-D amp. card	>>>	see Table 4	1
2	C 1,3	capacitor, 0.1 uF	MOU	539-CK05104K	2
3	C 2	capacitor, 10 uF	MOU	581-10K35	1
4	G 1,2	solder lug, #4	MOU	534-7311	2
5	G 1,2	screw, 4-40 X.375"	MOU	572-01881	2
6	G 1,2	hex nut, 4-40	MOU	572-00484	2
7	J 1,2	stereo headphone jk	DC	16PJ080	2
8	J 3	BNC jack	RS	278-105	1
9	L 1,2	inductor, 22 uH	MOU	43LR225	2
10	M 1	VRLY-A var./rly cd.	>>>	see Table 3	1
11	R 1	resistor, 1 megohm	CS	RA1.0M	1
12	R 2	resistor, 10 ohm	CS	RA10	1
13	R 3,5,6	resistor, 10K ohm	CS	RA10K	3
14	R 4	resistor, 470 ohm	CS	RA470	1
15	R 7,8	resistor, 270 ohm	CS	RA270	2
16	RFC 1	RF choke, 1.8 mH	MOU	434-05-182J	1
17	S 1	switch,DPDT,onoffon	RS	275-620	1
18		chassis box, 5X4X3"	MOU	537-TF-779	1
19	*	screw, 4-40 X .25"	MOU	572-01880	6
20	*	split lockwasher,#4	MOU	572-00649	6

Misc. items: hook-up wire, buss wire, solder, labels "AS REQUIRED"

* Item 19: two each for A1 mount; four for M1 mount

* Item 20: two each for A1 mount; four for M1 mount

Table 3: (RL-1 M1) VRLY-A Varactor & Relay Card parts list

*: Note follows parts list.

For VRLY-B (RW-1 M1) use this list, but delete RFC1, RFC2, and C2.
Assemble VRLY-B per notes on Figure 3.

See Table 2 for vendor codes.

Schematic = Figure 2 / Assembly = Figure 3.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	-	perfboard:1.4"X1.4"	RS	276-1396 (cut)	1
2	C 1,2,4	capacitor, 0.1 uF	MOU	539-CK05104K	3
3	C 3	capacitor, 270 pF	MOU	232-1900-270	1
4*	D 1,2	varactor, MVAM109	DC	MVAM109	2
5	D 3	zener,1N4733 (5.1V)	RS	276-565	1
6	H 1,2,3,4	screw, 4-40 X .25"	MOU	572-01880	4
7	H 1,2,3,4	spacer, 4-40 X .5"	MOU	534-1450C	4
8	H 1,2	split lockwasher,#4	MOU	572-00649	2
9	H 3,4	solder lug, #4	MOU	534-7311	2
10*	K 1	relay (5V DIP SPST)	MOU	528-171-2	1
11	(for K1)	DIP socket, 14 pin	RS	276-1999	1
12	P 1-6	flea-clip/.042"hole	MOU	574-T42-1/100	6
13	R 1	resistor, 1K	CS	RA1.0K	1
14	R 2	resistor, 270 ohm	CS	RA270	1
15	RFC 1,2	inductor, 4.7 mH	MOU	434-1120-473K	2

Misc. items: hook-up wire, buss wire, solder "AS REQUIRED"

* Item 4: Motorola MVAM108 or Siemens BB112 may be substituted directly. NTE618 may be substituted if the maximum control voltage is raised from +10 VDC to approximately +11 VDC.

* Item 10: equivalent to Magnecraft W171DIP-2.

Table 4: (RL-1 & RW-1 A1) BUF-D Buffer Amplifier Card parts list

See Table 2 for vendor codes.

Schematic = Figure 4 / Assembly = Figure 5.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	-	perfboard:1.4"X2.0"	RS	276-1396 (cut)	1
2	C 1,3,9	capacitor, 0.01 uF	MOU	539-CK05103K	3
3	C 2,4-7	capacitor, 0.1 uF	MOU	539-CK05104K	5
4	C 8	capacitor,10uF tant	MOU	581-10K35	1
5	H 1,2	screw, 4-40 X .25"	MOU	572-01880	2
6	H 1,2	spacer, 4-40 X .5"	MOU	534-1450C	2
7	H 1,2	solder lug, #4	MOU	534-7311	2
8	P 1-11	flea-clip,.042"hole	MOU	574-T42-1/100	11
9	Q 1	FET, 2N4416	CS	2N4416	1
10	Q 2	FET, VN10KM	ACT	19002	1
11	R 1	resistor, 1 megohm	CS	RA1.0M	1
12	R 2,7	resistor, 2.7K	CS	RA2.7K	2
13	R 3	resistor, 1K	CS	RA1.0K	1
14	R 4	resistor, 75 ohm	CS	RA75	1
15	R 5	resistor,4.7 megohm	CS	RA4.7M	1
16	R 6	resistor,2.2 megohm	CS	RA2.2M	1
17	R 8	resistor, 4.7 ohm	CS	RA4.7	1
18	R 9	resistor, 10 ohm	CS	RA10	1
19	R 10	resistor, 470 ohm	CS	RA470	1
20	R 11,12	resistor, 2.2 ohm	CS	RA2.2	1
21	RFC 1	inductor, 1.8 mH	MOU	434-05-182J	1
22	VR 1	9V regulator, 7809	MOU	513-NJM7809FA	1

Misc. items: hook-up wire, buss wire, solder "AS REQUIRED"

See notes on Figures 4 and 5 for information regarding possible alternative component usages.

Table 5: RW-1 hole-drilling list

See Table 1 for meanings of X, Y, D parameters and for drilling notes.

Chassis Box = Mouser # 537-TF-779: 5" X 4" X 3"

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	S1	Function Select swt. - tab	-1.375	2.125	0.125
2	S1	Function Select swt. - shaft	-1.375	1.875	0.25
3	G1	grounding H/W - internal lug	-0.9375	2.5	0.125
4	R1	Input Atten. pot - tab	-1.125	0.75	0.14
5	R1	Input Atten. pot - shaft	-0.8125	0.75	0.3125
6	S3	Gain / Q mode switch - tab	-0.5	2.125	0.125
7	S3	Gain / Q mode switch - shaft	-0.5	1.875	0.25
8	M1	VRLY-B card(mounting h/w H3)	0.5	1.5	0.125
9	M1	VRLY-B card(mounting h/w H1)	0.5	0.5	0.125
10	S2	Bandswitch - shaft	1	2.25	0.25
11	S2	Bandswitch - tab	1.25	2.25	0.125
12	M1	VRLY-B card(mounting h/w H4)	1.5	1.5	0.125
13	M1	VRLY-B card(mounting h/w H2)	1.5	0.5	0.125

TOP SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J1	Whip / Wire In - BNC jack	0	2	0.375
2	A1	BUF-D card (mounting h/w H2)	0.875	2	0.125
3	A1	BUF-D card (mounting h/w H1)	1.875	2	0.125

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
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1	J2	control cable stereo jack	-1.125	0.5	0.375
2	G2	grounding H/W - internal lug	0	1.125	0.125
3	J3	RF out / DC pwr in- BNC jack	0	0.5	0.375

Table 6: RW-1 "upper level" parts list

*: Note follows parts list.

See Table 2 for vendor codes.

Schematic = Figure 7 / Assembly = Figure 8.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	A 1	BUF-D amp. card	>>>	see Table 4	1
2	C 1,4,5	capacitor, 0.1 uF	MOU	539-CK05104K	3
3	C 2	capacitor, 43 pF	MOU	21CB043	1
4	C 3	capacitor, 10 uF	MOU	581-10K35	1
5	DS 1	NE-2 neon bulb	MOU	36NE002	1
6	G 1,2	solder lug, #4	MOU	534-7311	2
7	G 1,2	screw, 4-40 X.375"	MOU	572-01881	2
8	G 1,2	hex nut, 4-40	MOU	572-00484	2
9	J 1,3	BNC jack	RS	278-105	2
10	J 2	stereo headphone jk	DC	16PJ080	1
11	L 1	inductor, 1.5 mH	MOU	434-1120-153K	1
12	L 2	inductor, 82 uH	MOU	43LR825	1
13	L 3	inductor, 6.8 uH	MOU	43LR686	1
14	M 1 *	VRLY-B var./rly cd.	>>>	see Table 3 +notes	1
15	R 1	pot,1K,linear,w/swt	MOU	31CQ301	1
16	R 2,3	resistor, 270 ohm	CS	RA270	2
17	R 4,6,7	resistor, 10K ohm	CS	RA10K	3
18	R 5	resistor, 10 ohm	CS	RA10	1
19	R 8	resistor, 470 ohm	CS	RA470	1
20	RFC 1	RF choke, 1.8 mH	MOU	434-05-182J	1
21	S 1	switch,DPDT,on/on	MOU	10TA560	1
22	S 2	switch,SPDT,onoffon	MOU	10TA535	1
23	S 3	switch,DPDT,onoffon	RS	275-620	1
24	(for R1)	knob, 0.94" black	MOU	45KN013	1
25		chassis box, 5X4X3"	MOU	537-TF-779	1
26	*	screw, 4-40 X .25"	MOU	572-01880	6
27	*	split lockwasher,#4	MOU	572-00649	6

Misc. items: hook-up wire, buss wire, solder, labels "AS REQUIRED"

* Item 14: VRLY-B is an unbalanced version of the VRLY-A. It is built per Figures 2 & 3 and Table 3 with associated notes.

* Item 26: two each for A1 mount; four for M1 mount

* Item 27: two each for A1 mount; four for M1 mount

/* end of text; drawings follow */

REMOTE ANTENNAS

FIGURE 1

SCHEMATIC: RL-1 REMOTELY - TUNED LOOP

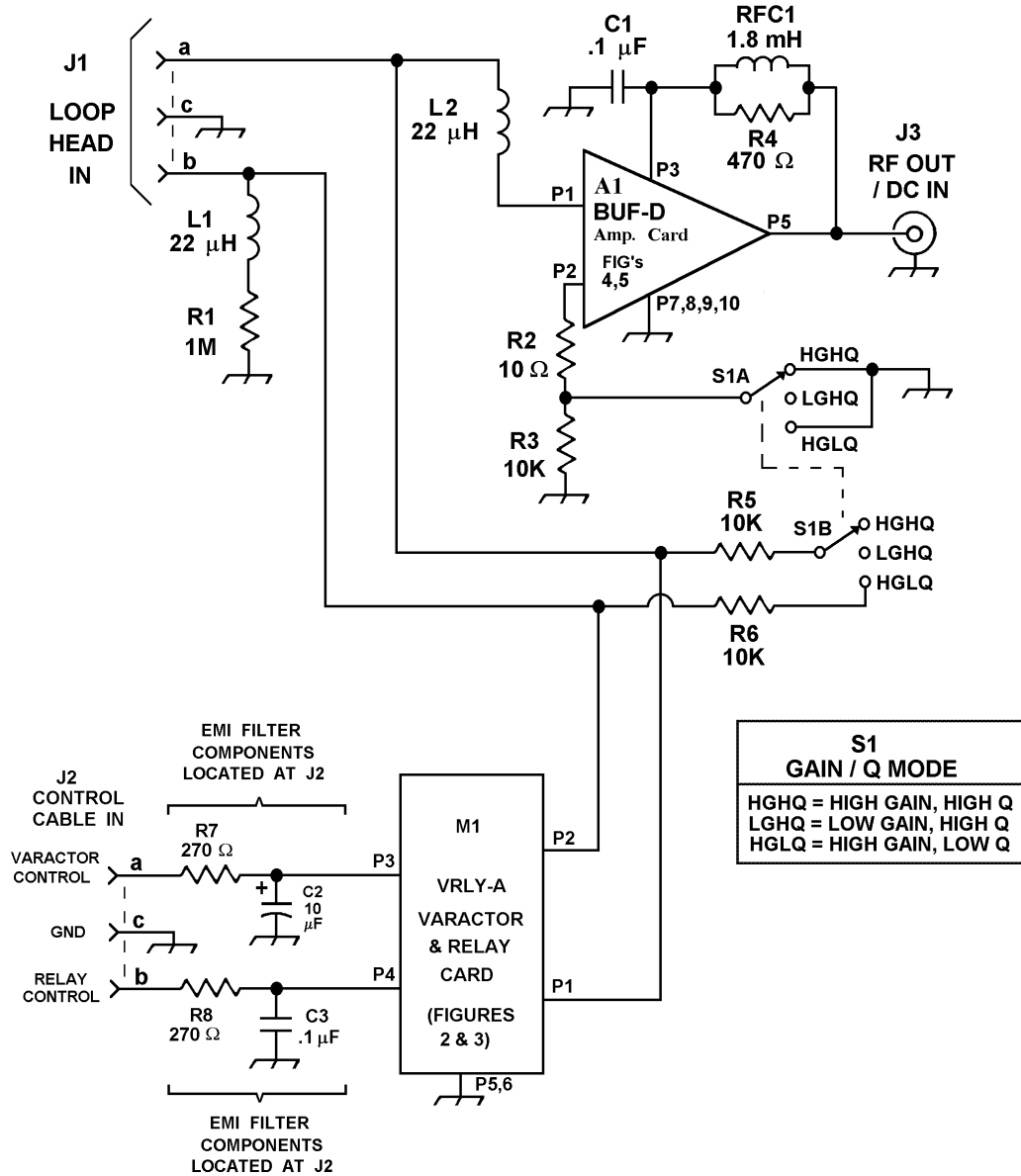


figure 1 above

REMOTE ANTENNAS

FIGURE 2

SCHEMATIC: VRLY-A VARACTOR / RELAY CARD

* = For VRLY-B, see notes on Figure 3.

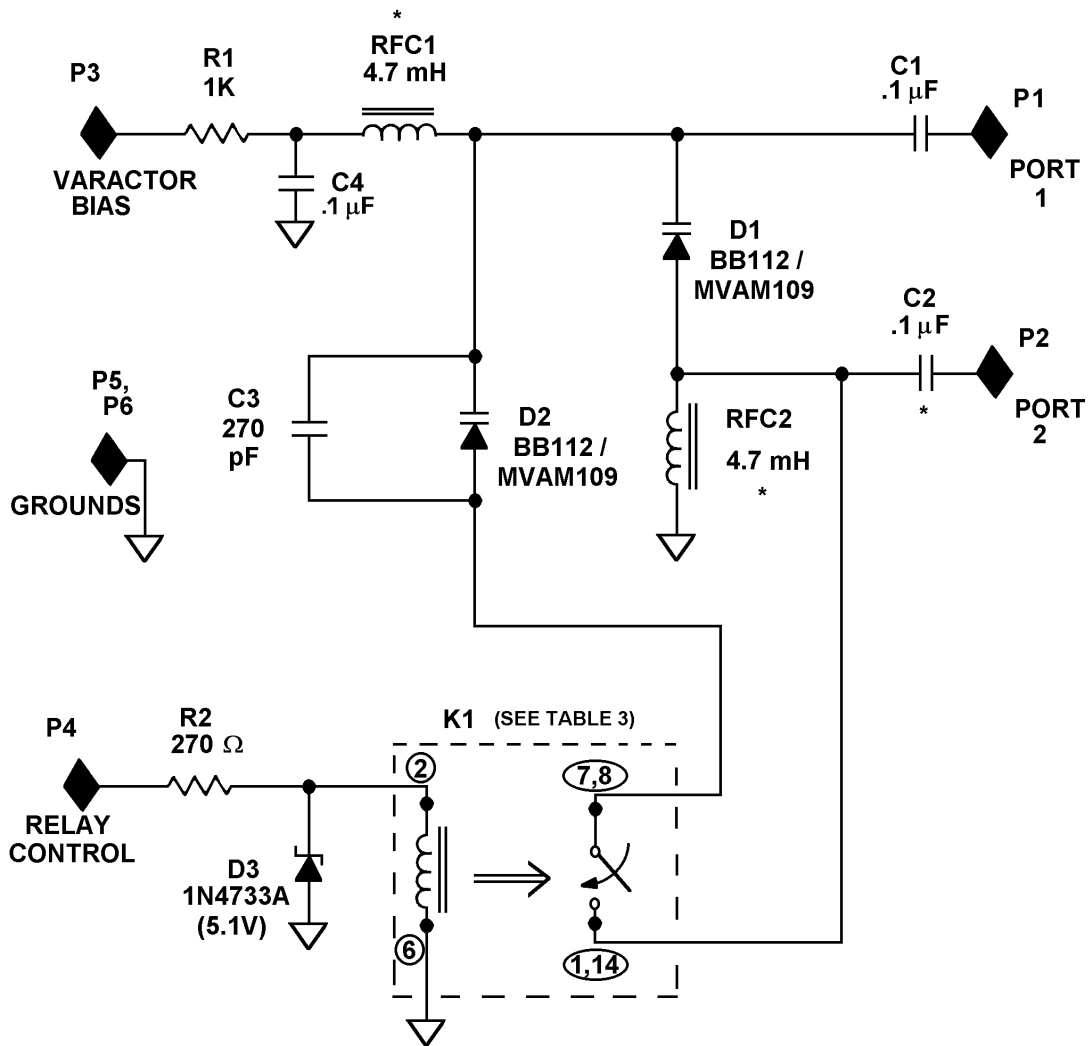
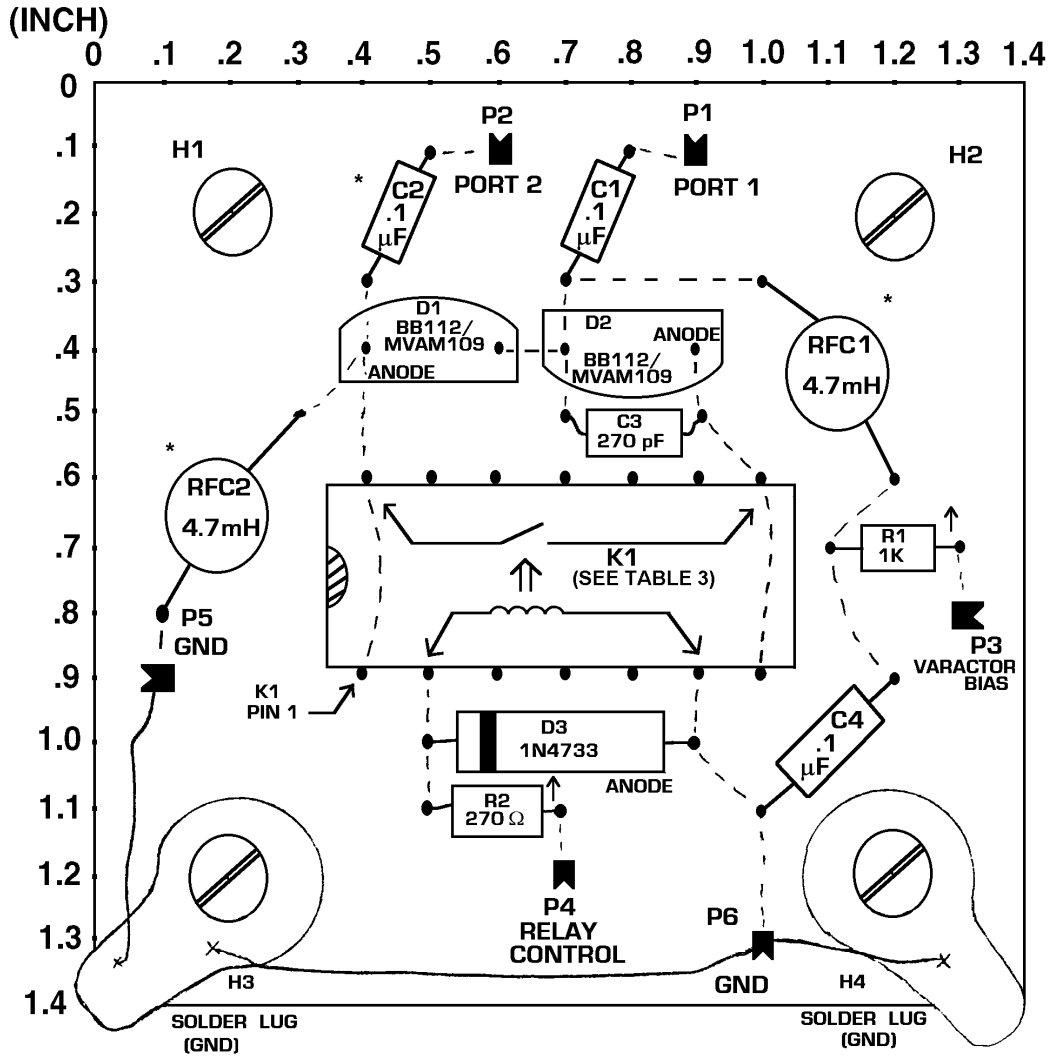


figure 2 above

REMOTE ANTENNAS
FIGURE 3
ASSEMBLY: VRLY-A VARACTOR / RELAY CARD

For VRLY-B adaptation, see notes.

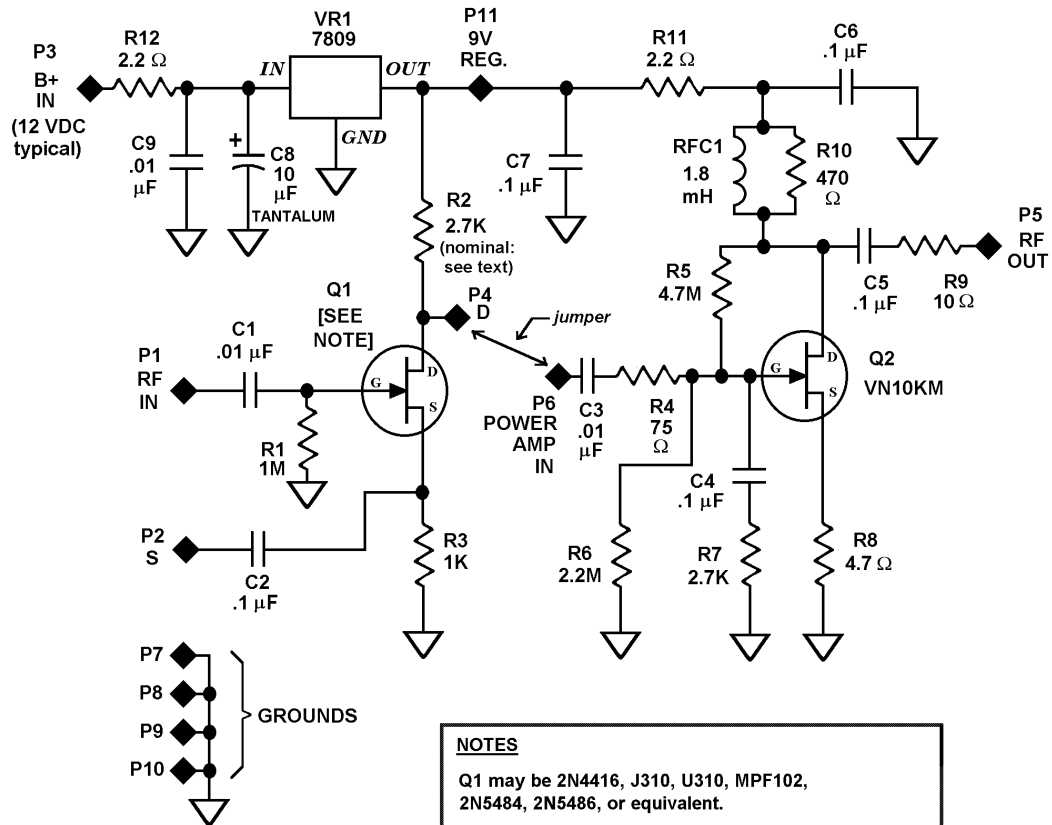


Notes

- ↑ = Long lead side of vertically-mounted component
 - - - = Buss wire on solder side of board
 - = Buss wire on component side of board
 - ◀ = "Flea clip" terminal pin
 - ◀ = OPEN SIDE
- * = For VRLY-B, as used in RW-1 whip, change RFC1 & C2 to shorts (jumpers) and delete RFC2 (change to open).

figure 3 above

**REMOTE ANTENNAS
FIGURE 4
SCHEMATIC: BUF-D BUFFER AMPLIFIER CARD**



NOTES

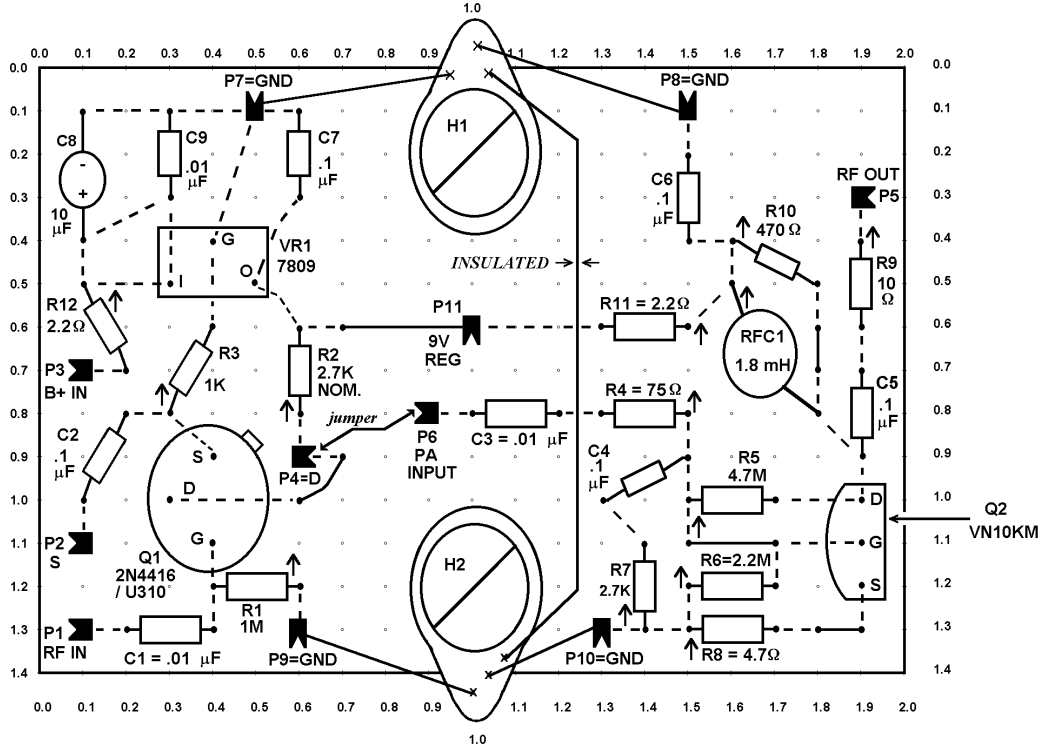
Q1 may be 2N4416, J310, U310, MPF102, 2N5484, 2N5486, or equivalent.

Set R2 to 2.7K nominal value with 2N4416. For other Q1 types, adjust R2 value to get minimum large-input-signal distortion as observed with an AC-coupled high-impedance (e.g. 10X) oscilloscope probe on P4, with P4-P6 jumper removed.

RFC1 is Mouser type 434-05-182J (rated 200 mA DC).

figure 4 above

**REMOTE ANTENNAS
FIGURE 5
ASSEMBLY : BUF-D BUFFER AMPLIFIER CARD**



NOTES: REMOVE FOURTH LEAD (CASE: OPPOSITE DRAIN) IF 2N4416 IS USED FOR Q1.

↑ = LONG-LEAD SIDE OF VERTICALLY-MOUNTED AXIAL-LEADED COMPONENT.

VALUE OF R2 (NOMINALLY 2.7K) MAY BE VARIED: SEE FIGURE 4 NOTES.

**DETAIL: SECTION OF LAYOUT ALTERED FOR TO-92 CASE FET'S
(J310, MPF102, 2N5484, 2N5486, ETC.)**

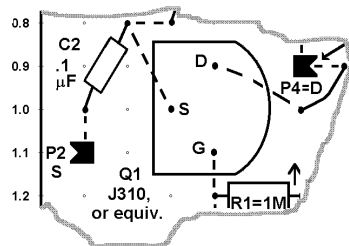


figure 5 above

REMOTE ANTENNAS FIGURE 6

ASSEMBLY / WIRING PICTORIAL, RL-1 REMOTELY-TUNED LOOP
(SCALE IS APPROXIMATE)

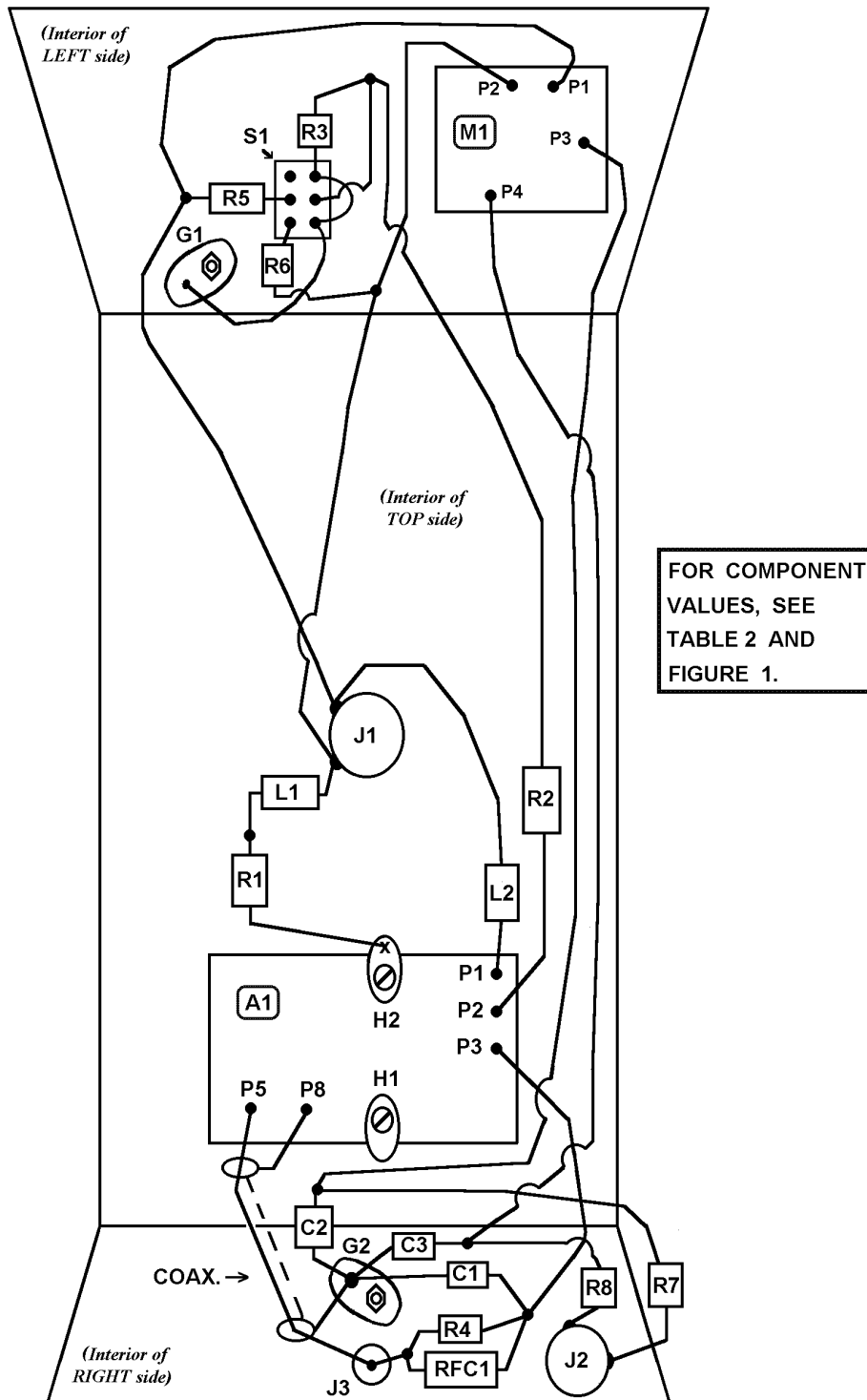


figure 6 above

REMOTE ANTENNAS
FIGURE 7
SCHEMATIC: RW-1 REMOTELY - TUNED WHIP

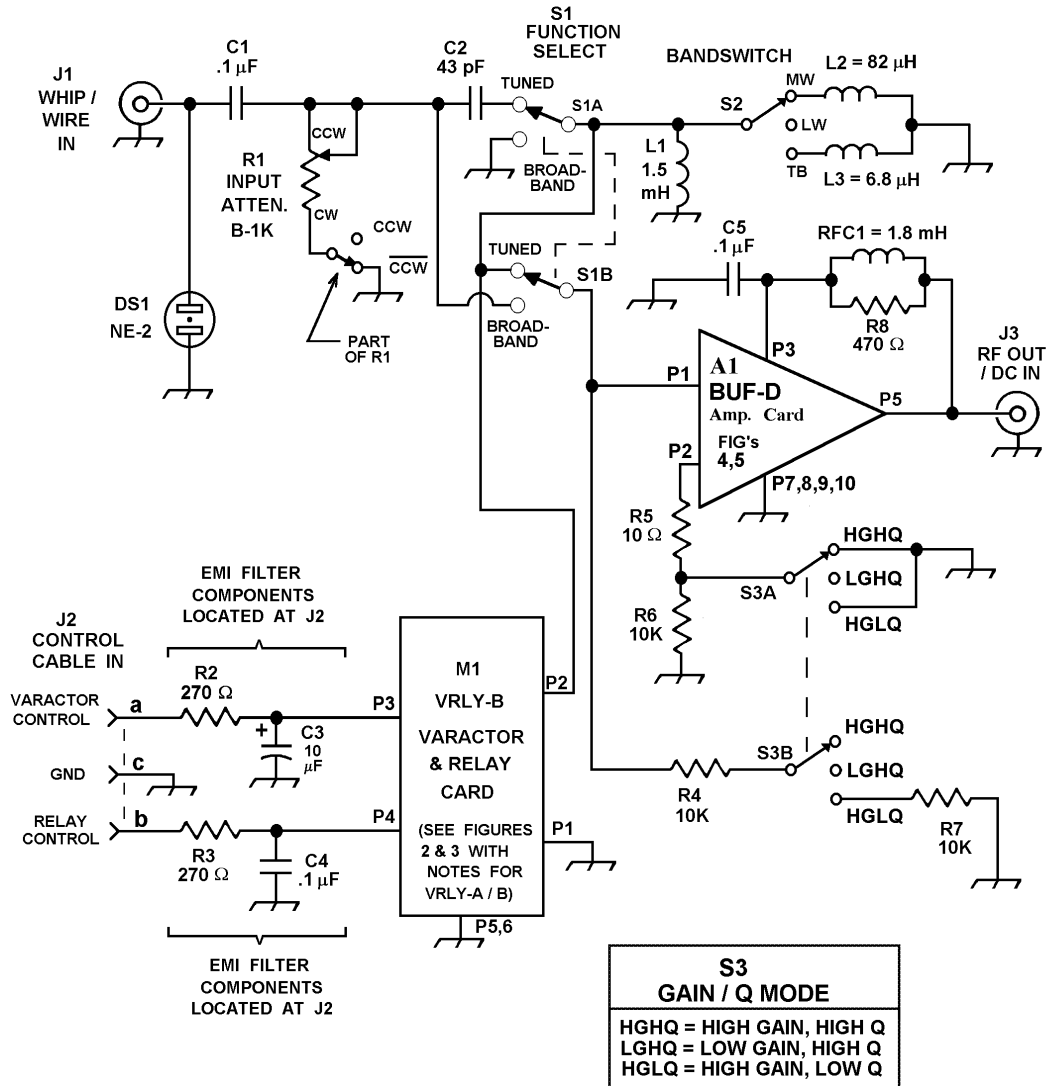


figure 7 above

REMOTE ANTENNAS FIGURE 8

ASSEMBLY / WIRING PICTORIAL, RW-1 REMOTELY-TUNED WHIP

(SCALE IS APPROXIMATE)

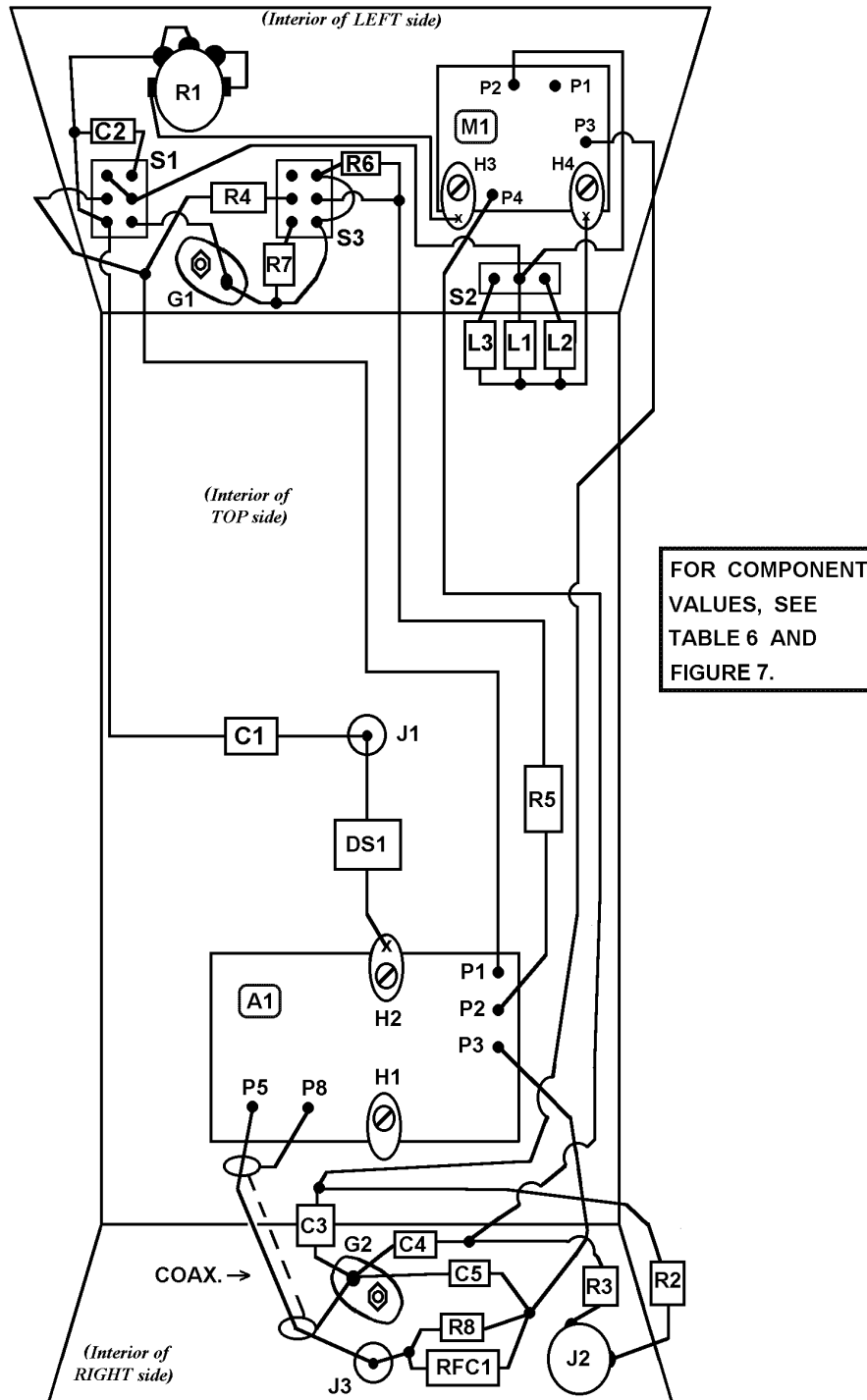


figure 8 above

/* end */