BBL-1 Broadband Loop Antenna
Mark Connelly, WA1ION - 30 APR 1999

Part 2: BA-1 Balun / Amplifier extends versatility of the BBL-1 Loop

Part 2 gives details about the BA-1 Balun / Amplifier assembly that greatly enhances the versatility of the loop head. A coupler unit (to be used at the operator's position to feed DC and RF from the BA-1 head-end amplifier) is also documented.

Part 1 of the BBL-1 Broadband Loop article described the construction of the loop head. In that section of the article, it was stated that the ends of the single-turn winding could be coupled passively through a 1:1 transformer to a coaxial feedline back to the operating position. At night, especially in urban areas of the northeastern USA and western Europe, the passive antenna connection may provide adequate signal strengths to a good communications receiver. For daytime DX, or nighttime DX in lower signal regions (or during aurora), amplification is highly desirable.

The BA-1 Balun / Amplifier module, housed in a 5" x 4" x 3" (127 x 102 x 76 mm) chassis box, is to be situated at the base of the loop. The BA-1 is connected between the two loop leads and the coaxial cable to the receiving position. When amplification is desired, 12 to 18 volts DC (coupled to the coaxial line at the receiver end) powers a suitable amplifier in the BA-1 assembly. A switch on the BA-1 allows passive operation when amplification is not required.

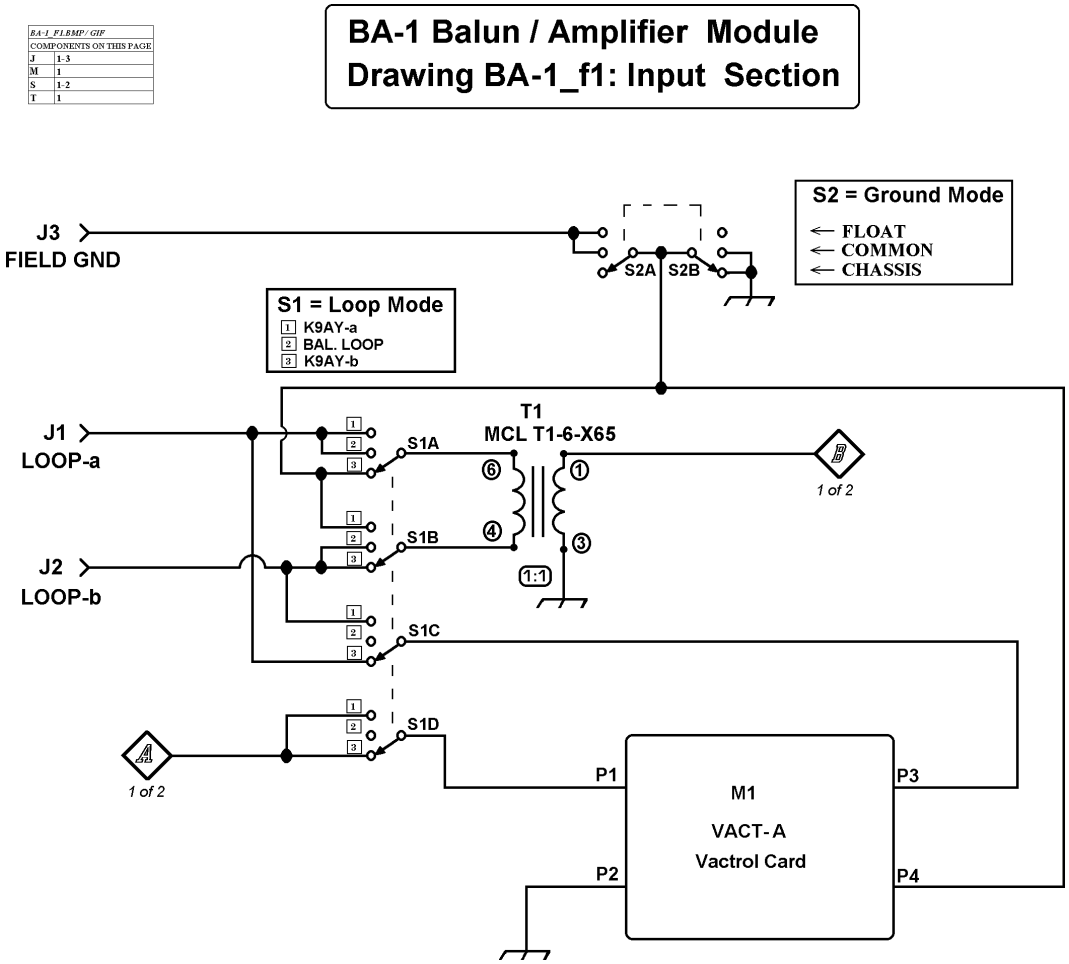
In addition to amplification, the BA-1 allows the loop to be operated not only in its "normal" balanced mode, but also in the unbalanced "K9AY" configuration. Those who have read Al Merriman's comments, or the original QST articles by Gary Breed, K9AY, know that a cardioid pattern can be generated by the interaction of the magnetic and electric fields when one end of a loop antenna is connected to ground through a variable resistance. I had my doubts that a 6-ft. per side square loop mounted atop a car (and using only the car chassis / battery negative as a "ground") could come close to providing K9AY loop operation. When field tests were performed at several coastal sites in Massachusetts, the results were often surprisingly good. As long as the loop is aligned such that stations to be

nulled by the cardioid pattern are located in, or nearly in, the plane formed by the loop, nulls of at least 15 to 20 dB should be achievable. Some very effective reduction of New York stations (to the southwest) was possible. Quite often, at local sunset, WCBS - 880 could be made weaker than the adjacent Canary Islands station on 882. Several times WBBR - 1130 was nulled below the level of the Croatia / Spain mix on 1134. Real phasing of a loop versus an active whip can get deeper nulls with less critical orientation of the loop; still, however, the miniature car-roof-mounted version of a K9AY loop, for a single-element antenna, did a creditable job of creating the cardioid pick-up pattern so useful to Trans-Atlantic DXers on either side of "the pond". The variable resistance required for the K9AY termination is provided by means of voltage-controlled resistors known as "Vactrols". These are mounted on a subassembly, the VACT-A card, inside the BA-1 enclosure. Variable DC of 0 to 10 volts is required to adjust the Vactrol card resistance from a low of 50 ohms to a high value in excess of 10K. When the amplifier is in use, the Vactrol control voltage must be passed up a separate cable; during passive operation, the 0 to 10 volt control may be sent up the main coaxial feed.

Al Merriman’s discussion of the K9AY Terminated Loop may be found at “ http://home.inforamp.net/~funk/termloop.html ” and Vactrol data may be obtained from EG&G Vactec at “ http://www.egginc.com/Opto-110/vtl5c3.htm ”.

There are several amplifier circuits that will perform well in the BA-1. I tried several and I considered factors such as noise floor / minimum discernable signal, strong-signal handling / spur & intermod rejection, current drain, stability, and the availability and cost of components. BBA-C1 and BBVA-A, used on other antenna projects, were usable but had more noise, intermodulation distortion, or instability (tendency to oscillate) than deemed optimum. Best noise figure appeared to be when using a step-up transformer to a high-impedance buffer-type amplifier. Certain parts, such as LH0033CG buffers and 40673 MOSFET's have become either expensive or difficult to obtain. Several new-generation buffer chips were evaluated. National's LM6221 / LM6321 series did well in several noise and IMD evaluations. The Harris HA3-5002-5 also delivered promising results. I've developed an amplifier card, the BUF-E, around the LM6221. To match the input impedance of the amplifier, a 1:36 transformer (Mini-Circuits T36-1-X65) is placed, in step-up configuration, between the signal line and the BUF-E amplifier input.

Drawings in this part of the article include schematics of the BA-1 module, including its subassemblies BUF-E and VACT-A. Also there's a sketch of a coupler to be used at the operator's position.

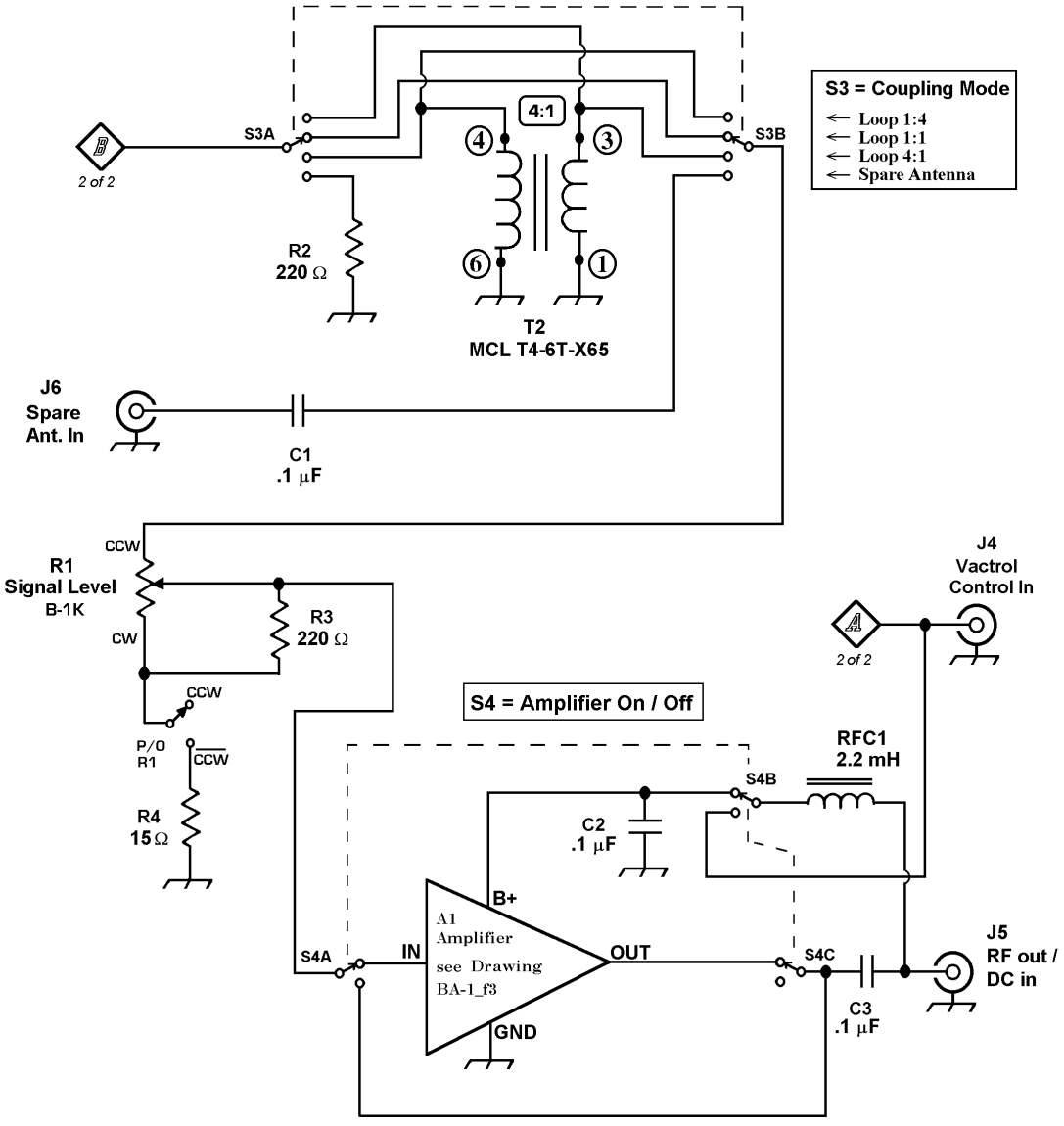


BA-1 Balun / Amplifier Figure 1 above

BA-1_F2.BMP / GIF	
COMPONENTS ON THIS PAGE	
A	1
C	1-3
J	4-6
R	1-4
RFC	1
S	3-4
T	2

T3, if used, appears on Drawing BA-1_f3.

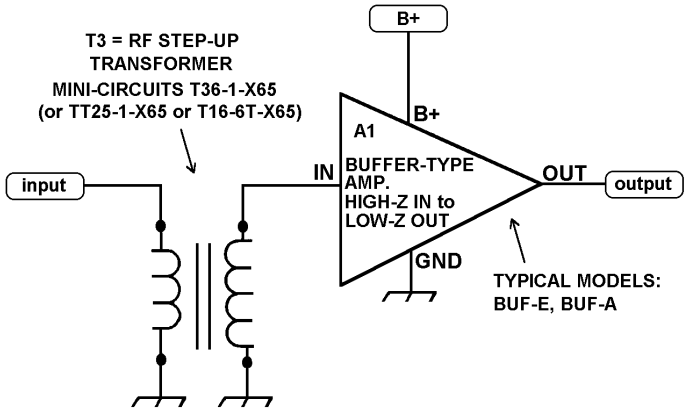
BA-1 Balun / Amplifier Module
Drawing BA-1_f2: Output Section



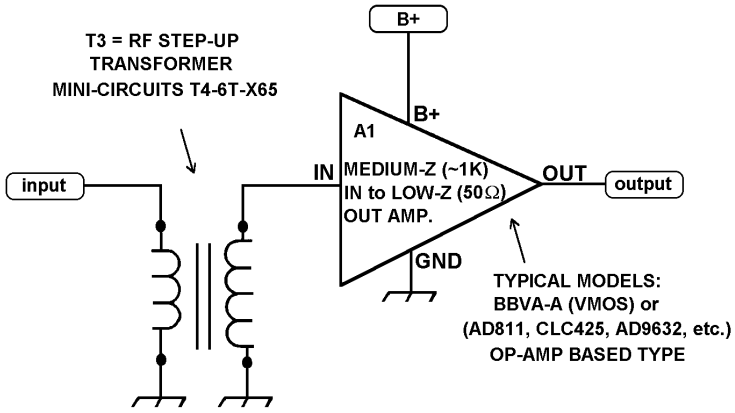
BA-1 Balun / Amplifier Figure 2 above

BA-1 Balun / Amplifier Module
Drawing BA-1_f3: Possible Amplifier Configurations

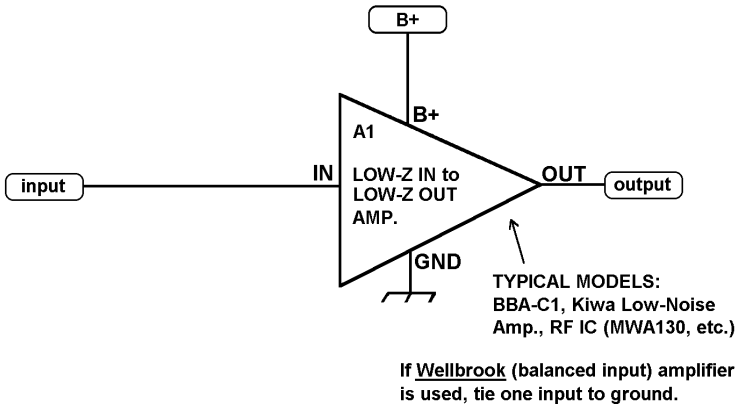
CASE 1: USE OF STEP-UP TRANSFORMER AND BUFFER AMPLIFIER



CASE 2: USE OF STEP-UP TRANSFORMER AND MEDIUM-IMPEDANCE-IN AMP.



CASE 3: LOW-IMPEDANCE IN & OUT AMPLIFIER



BA-1 Balun / Amplifier Figure 3 above

BA-1 Balun / Amplifier module Revised: Monday, May 10, 1999

BA-1 Revision: A

Bill Of Materials May 10,1999
12:00:00

Item	Quantity	Reference	Vendor: Stock Number	Part Description	Notes
1	1	A1	* separate parts list *	BUF-E Buffer Amplifier card	
2	3	C1 - C3	CS: CK05104K	Capacitor, 0.1 uF	
3	1	H_BX1	MOU: 537-TF-779	Chassis Box, 5" * 4" * 3"	
4	4	H_KN1 - H_KN4	MOU: 45KN013	Knob, 0.94" dia.	for R1, S1, S2, S3
5	3	H_LW1 - H_LW3	MOU: 5721-LWS-4	Split lockwasher, #4	to mount A1, M1
6	2	H_N1 - H_N2	MOU: 5721-440	Hex Nut, 4-40	grounds G1, G2
7	3	H_SC1 - H_SC3	MOU: 5721-440-1/4	Screw, 4-40 * .25"	to mount A1, M1
8	2	H_SC4 - H_SC5	MOU: 5721-440-3/8	Screw, 4-40 * .375"	grounds G1, G2
9	3	H_SL1 - H_SL3	MOU: 534-7311	Solder lug, #4, internal tooth	grounds G1 (2), G2 (1)
10	2	J1 - J2	RS: 274-662	Banana jack binding post, red	
11	1	J3	RS: 274-662	Banana jack binding post, black	
12	1	J4	RS: 274-346	RCA phono. jack	
13	2	J5 - J6	RS: 278-105	BNC jack	
14	1	M1	* separate parts list *	VACT-A Vactrol card	
15	1	R1	MOU: 31CQ301	Potentiometer, 1K linear taper with switch	
16	2	R2 - R3	CS: RA220	Resistor, 220 ohm	
17	1	R4	CS: RA15	Resistor, 15 ohm	
18	1	RFC1	TA: 900-4895	RF Choke, 2.2 mH, rated to 270 mA DC	
19	2	S1 - S2	CS: 10YX043	Rotary switch, 4 poles * 3 positions	
20	1	S3	CS: 10YX034	Rotary switch, 3 poles * 4 positions	
21	1	S4	CS: 8305	Toggle switch, 3PDT	
22	1	T1	MCL: T1-6-X65	RF transformer, 1:1 ratio	
23	1	T2	MCL: T4-6T-X65	RF transformer, 1:4 ratio	
24	1	T3	MCL: T36-1-X65	RF transformer, 1:36 ratio	

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

Vendor Codes

CS: Circuit Specialists: http://www.cir.com
MCL: Mini-Circuits: http://www.minicircuits.com
MOU: Mouser Electronics: http://www.mouser.com
RS: Radio Shack: http://www.radioshack.com
TA: Tech America: http://www.techam.com

Table BA-1_HL: BA-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 scriber 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 - int.&ext.lug	-1	1.25	0.125
2	J1	Loop-a in (banana jack)	-0.75	0.4375	0.3125
3	J2	Loop-b in (banana jack)	0	0.4375	0.3125
4	J3	Field GND in (banana jack)	0.75	0.4375	0.3125
5	M1	VACT-A card mounting H/W	1	1.25	0.125

Top Side

Hole #	***Comp. Desig.***	***Description***	***X***	***Y***	***D***
1	S1	Ground Mode switch - tab	-2	3.125	0.125
2	S1	Ground Mode switch - shaft	-1.5	3.125	0.375
3	G2	grounding H/W - int.lug	-0.625	3.125	0.125
4	S3	Loop Mode switch - shaft	-0.5	0.75	0.375
5	S3	Loop Mode switch - tab	0	0.75	0.125
6	S2	Amplifier switch - tab	0	3.625	0.125

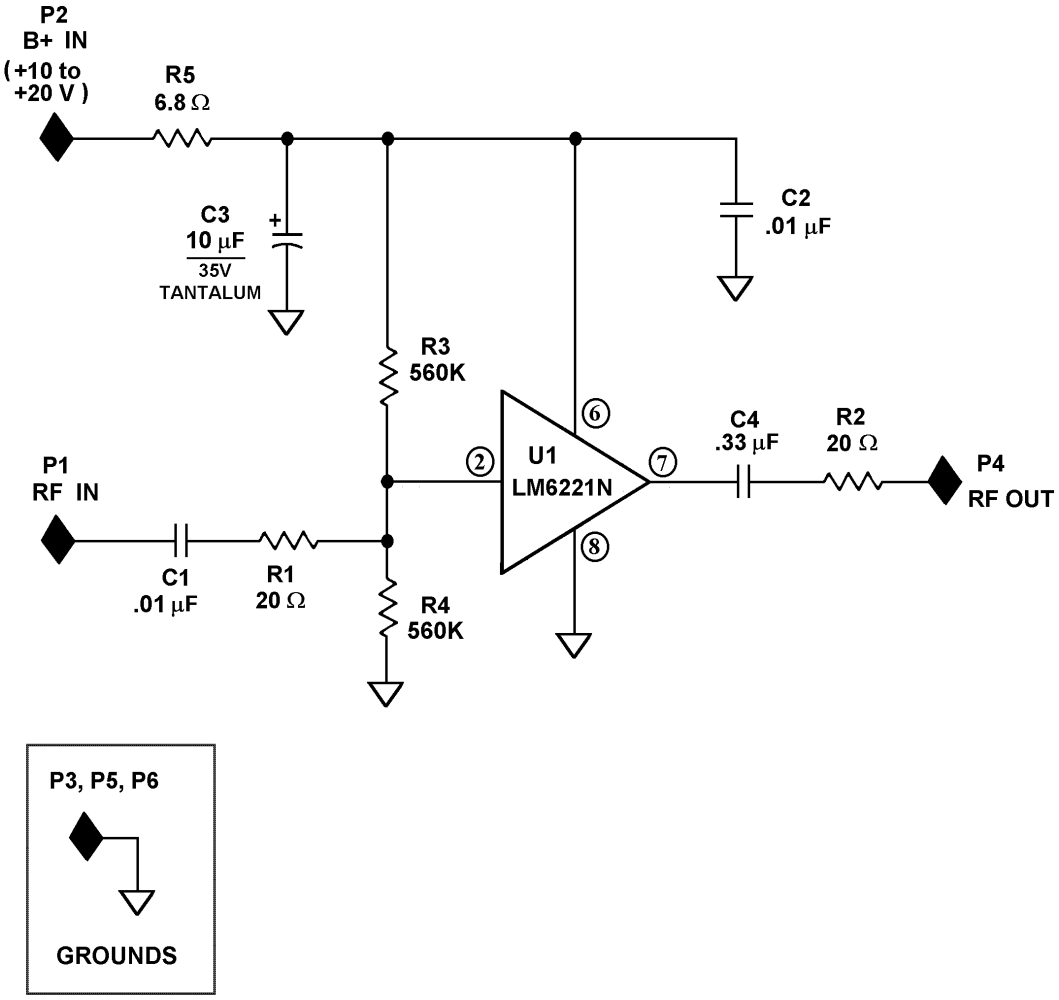
7	S2	Amplifier switch - shaft	0	3.375	0.25
8	J6	Spare Antenna in (BNC jack)	0.125	2	0.375
9	S4	Coupling Mode switch - shaft	0.75	0.75	0.375
10	S4	Coupling Mode switch - tab	1.25	0.75	0.125
11	R1	Signal Level pot - tab	0.9375	3.375	0.3125
12	R1	Signal Level pot - shaft	1.25	3.375	0.125

Right Side

Hole #	***Comp. Desig.***	***Description***	***X***	***Y***	***D***
1	A1	BUF-E amplifier card- H/W 2	-1.3	1.5	0.125
2	A1	BUF-E amplifier card- H/W 1	-0.7	0.5	0.125
3	J5	RF Out / Remote B+ In (BNC-f)	0	0.5	0.375
4	J4	Vactrol Control in (RCA)	0.875	0.5	0.25

BUF-E BUFFER AMPLIFIER CARD

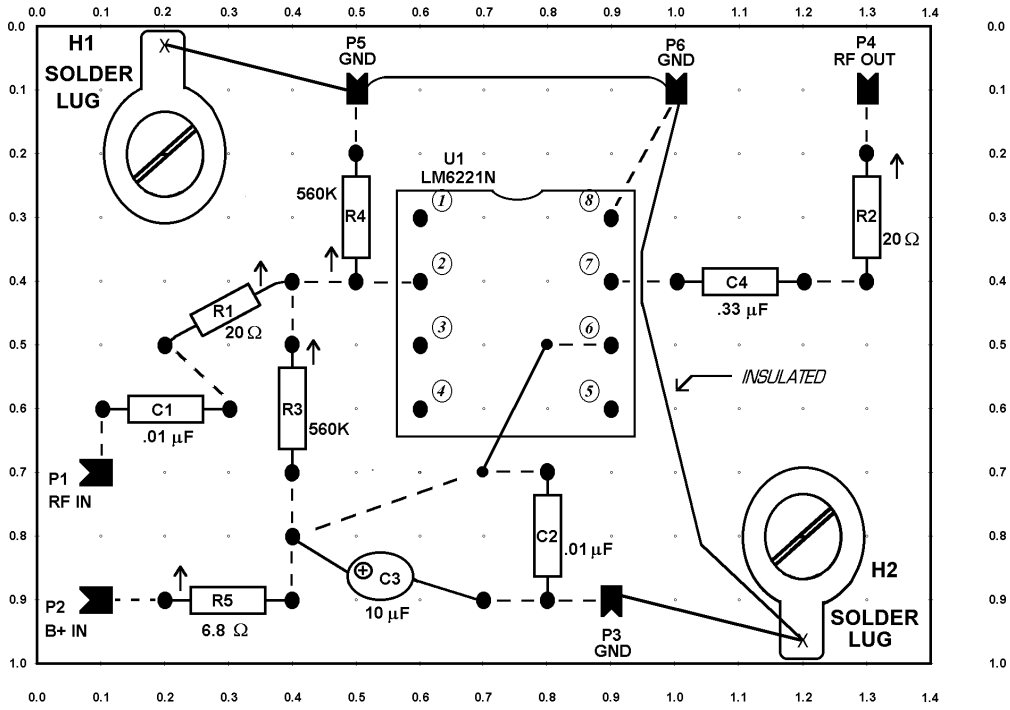
Drawing BUF-E_F1: Schematic



BUF-E Buffer Amplifier card Figure 1 [schematic] above

BUF-E BUFFER AMPLIFIER CARD

Drawing BUF-E_F2: Assembly



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

BUF-E Buffer Amplifier card Figure 2 [assembly] above

BUF-E Buffer Amplifier Revised: Thursday, February 25, 1999
BUF-E_f1 Revision: A

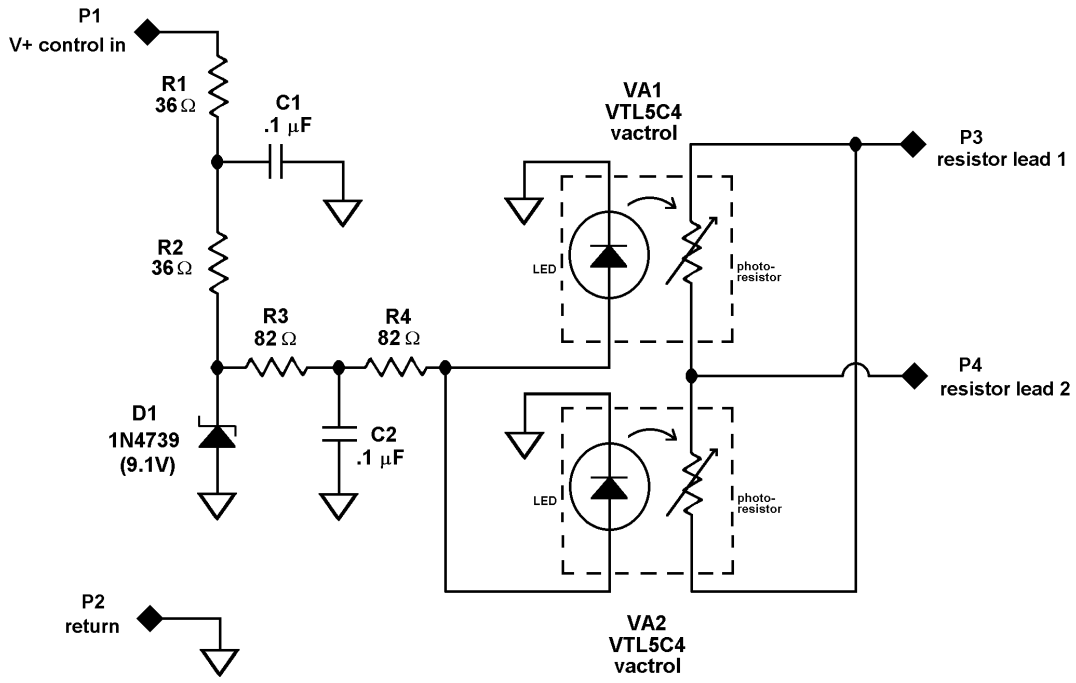
Bill Of Materials February 25,1999 13:29:59

Item	Quantity	Reference	Vendor: Stock Number	Part Description	Notes
1	2	C1 - C2	CS: CK05103K	Capacitor, 0.01 uF	
2	1	C3	CS: TAC008	Capacitor, Tantalum, 10 uF, 35 V	
3	1	C4	DK: P4959-ND	Capacitor, 0.33 uF	
4	1	H_PB1	RS: 276-1396	Perfboard	cut size 1.1" * 1.5"
5	2	H_SC1 - H_SC2	MOU: 5721-440-1/4	Screw, 4-40 * .25"	stock num.= 100 pieces
6	2	H_SL1 - H_SL2	MOU: 534-7311	Solder lug, #4, internal tooth	
7	1	H_SO1	CS: CA-8	Socket, 8-pin DIP	for U1
8	2	H_SP1 - H_SP2	MOU: 534-1450C	Spacer, 4-40 * .5"	
9	6	P1 - P6	CS: T42-1/100	Flea-clip Terminal Pin for .042" hole	
10	2	R1 - R2	CS: RA20	Resistor, 20 ohm	
11	2	R3 - R4	CS: 560K	Resistor, 560K	
12	1	R5	CS: RA6.8	Resistor, 6.8 ohm	
13	1	U1	DK: LM6221N-ND	National LM6221N Buffer Amplifier, 8-pin DIP	

Vendor Codes

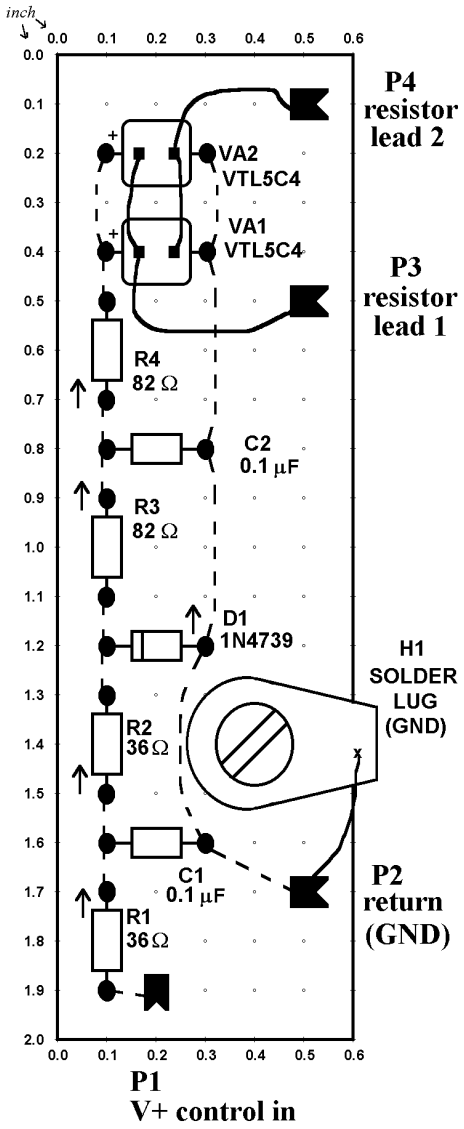
CS: Circuit Specialists: http://www.cir.com
DK: Digi-Key: http://www.digikey.com
MOU: Mouser Electronics: http://www.mouser.com
RS: Radio Shack: http://www.radioshack.com

VACT-A Vactrol Card
Drawing VACT-A f1 : Schematic



VACT-A Vactrol card Figure 1 [schematic] above

VACT-A Vactrol Card
Drawing VACT-A f2: Assembly



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

VACT-A Vactrol card Figure 2 [assembly] above

VACT-A Vactrol Card Revised: Monday, May 10, 1999
VACT-A Revision: A

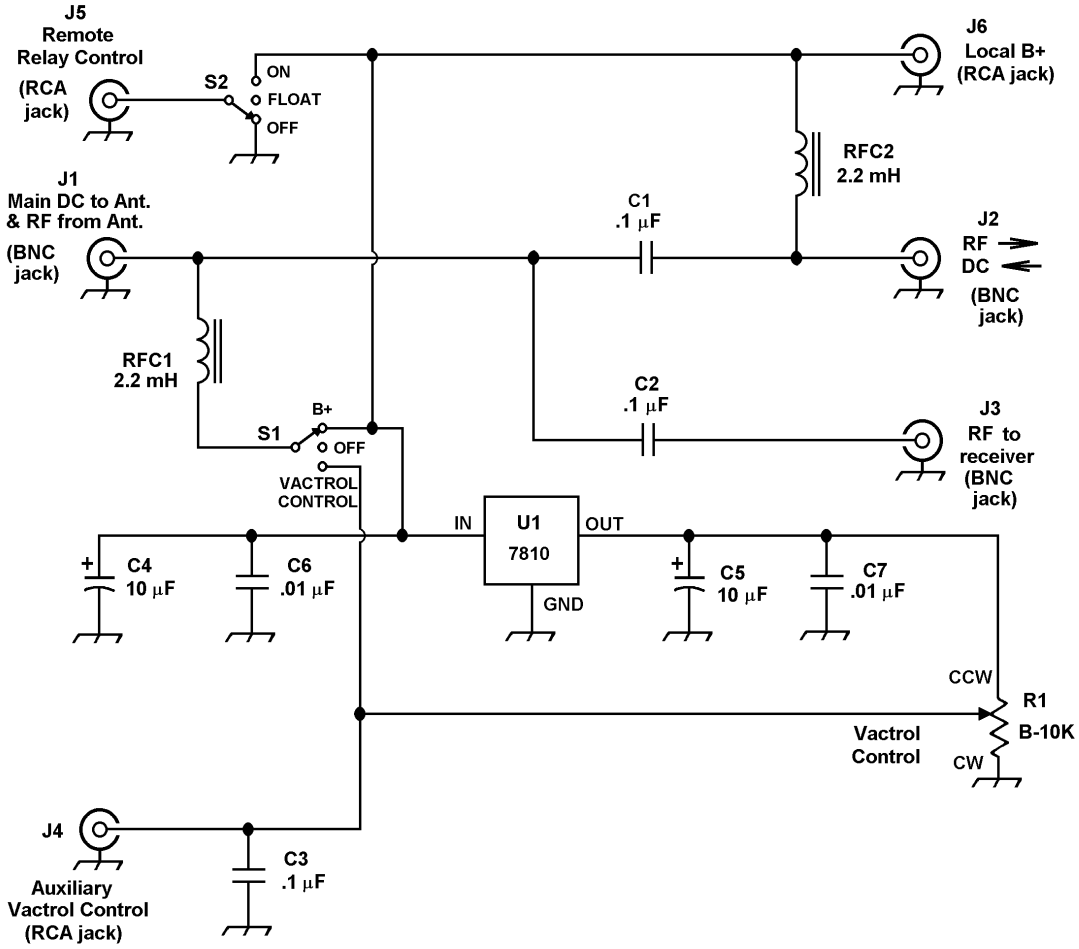
Bill Of Materials May 10,1999 12:00:00

Item	Quantity	Reference	Vendor: Stock Number	Part Description	Notes
1	2	C1 - C2	CS: CK05104K	Capacitor, 0.1 uF	
2	1	D1	MOU: 583-1N4739A	Zener Diode, 1N4739, 9.1 VDC	
3	1	H_PB1	RS: 276-1396	Perfboard	cut size 0.6" * 2.0"
4	1	H_SC1	MOU: 5721-440-1/4	Screw, 4-40 * .25"	stock num.= 100 pieces
5	1	H_SL1	MOU: 534-7311	Solder lug, #4, internal tooth	
6	1	H_SP1	MOU: 534-1450C	Spacer, 4-40 * .5"	
7	4	P1 - P4	CS: T42-1/100	Flea-clip Terminal Pin for .042" hole	
8	2	R1 - R2	CS: RA36	Resistor, 36 ohm	
9	2	R3 - R4	CS: RA82	Resistor, 82 ohm	
10	2	VA1 - VA2	NEW: 43F888	EG&G Vactec VTL5C4 Vactrol	

Vendor Codes

CS: Circuit Specialists: http://www.cir.com
MOU: Mouser Electronics: http://www.mouser.com
NEW: Newark Electronics: http://www.newark.com
RS: Radio Shack: http://www.radioshack.com

Coupler (Controller)
Drawing COUP1_f1: Schematic



NOTES

Chassis box = Radio Shack 270-238.

RFC1, RFC2 should be capable of handling at least 100 mA DC.

Detailed assembly and parts list documentation is not supplied for this simple unit.

A more complex coupler may be developed and documented subsequently.

J5 and S2 are included for use with other designs (not required for BBL-1 operation).

Coupler Figure 1 above

(end)