READ THIS FIRST

A few last minute changes that you need to know about.....

My supplier of variable capacitors sent me two shipments of variable caps that were not the same as the sample I had been given earlier. This is not a problem, however, it means that a few changes must be made to the circuit to get the desired frequency coverage. The capacitor that is included with the kit is a smaller value than the original circuit used. For 40 meters, if the variable is connected to the source tap on L1 as shown in the schematic you will be able to cover about 25 Khz of the band. I built a unit using an additional tap at 18 turns for the variable capacitor, and was able to cover 140 Khz. Connecting the variable capacitor across the entire L1 resulted in a 500 Khz coverage. I have not yet built up units on the other bands to determine frequency coverage.

One other difference between the supplied variable capacitor and the sample I had is the mounting holes. There are still three holes on the rear of the frame that line up with three holes in the PC board for mounting, but they are not tapped - you will need to carefully tap these yourself if you want to mount the capacitor to the board in this fashion. The four holes on the bottom of the capacitor now have pins pressed in the holes. KK7B and I both tried to pull the pins from the holes and succeeded only in twisting off the small part of the pin. I was able to use the pins to solder the capacitor to the PC board using the four mounting holes in the PC board. The pins are much smaller than the holes, but I was able to hold the pins against the front of all the holes and solder is solidly in place. You still have the option of mounting the capacitor off the board.

The documentation also states that components are included so that the Binaural receiver can be built on 40, 30, or 20 meters. The frequency dependent components are enclosed in separate plastic bags in the Binaural kit and the Universal VFO kit. You will also find three shanks of wire in the kit. Each is #28 wire and can be used to wind any and all of the toroids.

I took some quick digital pictures of my first completed PC boards. By the time you receive the kit I should have them on my web page.

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April 17, 1999

Thanks for purchasing the **KK7B Binaural Receiver Kit** from Kanga US.

You should find the following documentation in your package:

- Copy of the original QST article
- Binaural Receiver Schematic
- Binaural Receiver Parts Layout
- Binaural Receiver Parts List - less frequency dependent components
- Binaural Receiver Parts List - frequency dependent components
- Binaural Receiver Construction Notes
- Universal VFO Schematic
- Universal VFO Schematic - receive only
- Univerals VFO Parts Layout
- Universal VFO Parts List - less frequency dependent components
- Universal VFO Parts List - Frequency dependent componenets
- Universal VFO Construction Notes

The parts designators on the Receiver schematic/parts list correspond to the designators in the QST article (page 44 March 1999). Notice that several parts used in the receiver in the article are NOT used in the kit receiver. They are C11, C31, C41, C42, R11, R33, RFC1 and RFC2.

I kept the frequency dependent components on separate parts list. Parts are supplied so that you can build the receiver for 40, 30, or 20 meters - your choice. You will notice that two schematics are supplied for the Universal VFO. It has been designed so that is can be used as the VFO for a transceiver driving both the receiver and transmitter. If you are going to use it only as part of the Binaural Receiver, you can build it using only the parts on the “Receive Only” Schematic.

If you have comments, questions, or need help, the best way to contact me is using e-mail via the address above. If you call you will probably get my answering machine - leave a message and I will call back.

Have fun!
73 - Bill - N8ET

Value	Quantity	Description	Reference
		Capacitors	
220 pf	6	50 v C0G cap	C1, 15, 18, 21, 35, 38
.1 uf	8	Panasonic V series 50V	C13, 14, 17, 20, 33, 34, 37, 40
1.0 uf	6	Panasonic ECQ-E(F)	C2. 9, 10, 22, 29, 30
1.5 uf	2	Panasonic ECQ-E(F)	C3, 23
6.8 uf	2	Panasonic KG Series Electrolytic 16V	C4, 24
10 uf	8	Panasonic KA Series Electrolytic 16V	C6, 7, 8, 16, 26, 27, 28, 36
33 uf	4	Panasonic KA Series Electrolytic 16V	C5, 19, 25, 39
100 uf	2	Panasonic KA Series Electrolytic 16V	C12, 32
		Resistors	
51 ohm	2	5 % 1/4 w carbon film	R1, 23
100 ohm	1	5 % 1/4 w carbon film	R46
150 ohm	8	5 % 1/4 w carbon film	R9, 10, 12, 22, 31, 32, 34, 44
470 ohm	4	5 % 1/4 w carbon film	R7, 13, 29, 35
2.7k	2	5 % 1/4 w carbon film	R2, 24
3.3k	2	5 % 1/4 w carbon film	R3, 25
4.7k	6	5 % 1/4 w carbon film	R8, 14, 18, 30, 36, 40
5.6k	2	5 % 1/4 w carbon film	R5, 27
10k	10	5 % 1/4 w carbon film	R4, 15, 17, 19, 21, 26, 37, 39, 41, 43

100k	6	5 % 1/4 w carbon film	R6, 16, 20, 28, 38, 42
500 ohm	1	500 ohm pot used as RF gain control	not shown on schematic. R45 (1K) in original article.
		Transistors	
2N3904	6		Q1, 2, 3, 4, 5, 6
		IC's	
NE5532	2		U1, 2
TUF-1	2	mixer	U3, 4
		Inductors	
3.9 mh	2	Toko type 10RB or equiv.	L1, 3
120 mh	2	Toko type 10RB or equiv.	L2, 4

Binaural Receiver - Frequency Dependent Components

Reference	Qty	Xc or X_L	40 m	30 m	20 m
Capacitors					
C45, 46	2	70 ohms	330	220	150
C43	1	50 ohms	470	330	220
C44	1	21 ohms	1000	680	560
Inductors					
L5 (T37-6 toroid)	1	100 ohms	24 turns	20 turns	17 turns
L6, 7 (T37-6 toroid)	2	70 ohms	20 turns	17 turns	14 turns

Turns are the number of turns of #28 or smaller wire on a T30-6 or T37-6 powdered iron toroid. Space turns evenly around the core. If an L meter is available, squeeze or spread turns to achieve the inductance shown in the table. For other ranges, use A_L = 39 and calculate the number of turns using the formula:

$$N=100[\text{desired uH}/A_L]^{1/2}$$

Note that the approximate A_L value is different than the Amidon data sheet and includes corrections appropriate for this number of turns of #28 to#36 wire in this frequency range. The cross section area of the T37 and T30 toroids is very similar, so the same number of turn is used for either core.

The input filter and splitter is a low-pass structure. It provides a good match to 50 ohms at the design frequncy and a reasonable match at lower frequencies. Power splitting is well balanced and low-pass at all frequencies from the design frequency on down. The 20 meter input circuit may be used on 30 m, 40 m, and below, but the 40 m circuit will be lossy above 40 meters. With a direct conversion receive using broad band mixers, signals may be received at odd harmonics of the VFO. Thus a receiver with a 40 meter VFO and a 15 meter low-pass input network will receive both bands at once. FM broadcast and TV signals are particularly troublesome as they may be received on the higher odd harmonics of the VFO. The input circuit in the Binaural receiver schematic provides good attenuation of FM and TV signals when designed for 20 meters and below. For higher frequency use, additional low-pass or band-pass filtering is recommended.

The basic noise figure of each channel of the binaural receiver is 12 or 13 db. This is good for 40 meters, marginal for 30 meters, and not quite good enough for 20 meters. About 10 db of preamp gain is recommended for use on 20 meters and above. For other bands use the X_C and X_L values to calculate the appropriate capacitor and inductor values.

Construction Notes - KK7B Binaural Receiver

Check to be sure all the parts that are in the parts list are in the kit! If any are missing, let me know and I will send the missing part.

I have built up one BIQR kit so far. I started at one end of the PC board and stuffed and soldered the parts one at a time. The two signal paths through the receiver have the same components in each path, so I built each path at the same time. For example, I mounted C1, and then did the corresponding C21.

The diagram that is included is looking down on the parts side of the board. The parts are mounted on the side away from the copyright notice “copyright 1999 KK7B\K7TAU” Watch the orientation of the electrolytic capacitors. The square pad on the PC board is the “+” side of the electrolytic. Be sure to orient the two NE5532 IC’s correctly. The TUF-1 mixers (U3 and U4) also need to be oriented correctly. The blue glass bead on the TUF-1 is pin 1 which is the square pad on the PC board. Note that this will cause pin 3 (which is the case ground) to connect to the pad on the PC board that is grounded.

The only frequency dependent components are the front end filter (C43, 44 and L5) and the power divider (L6, 7 and C45, 46) Components are included so that you can build the receiver for 20, 30, or 40 meters.

Universal VFO - less frequency dependent components

Value	Quantity	Description	Reference
		Capacitors	
10 pf	3	100 V C0G	C4,6,28
.1 uf	19	Panasonic V Series 50 V	C5, 7, 9, 10, 11, 14, 15, 19, 21, 29, 30, 32, 33, 34, 35, 36, 37, 41, 43
10 uf	4	Panasonic KA Series Electrolytic 16 V	C8, 20, 31, 42
		Variable capacitor	C1
		Resistors	
10 ohm	1	5 % 1/4 w carbon film	R6
22 ohm	2	5 % 1/4 w carbon film	R8, 29
51 ohm	5	5 % 1/4 w carbon film	R5, 10, 11, 28, 31
180 ohm	3	5 % 1/4 w carbon film	R2, 7, 27
270 ohm	3	5 % 1/4 w carbon film	R4, 9, 30
3.3 k	2	5 % 1/4 w carbon film	R13, 15
4.7 k	3	5 % 1/4 w carbon film	R18, 20, 23
10 k	7	5 % 1/4 w carbon film	R17, 19, 21, 22, 24, 25, 26
33 k	1	5 % 1/4 w carbon film	R16
100 k	1	5 % 1/4 w carbon film	R3
1 M	2	5 % 1/4 w carbon film	R1, 12
10k	1	Potentiometer	R14
		Transistors	

J310	4		Q1, 2, 3, 9
2N3906	2		Q4, 5
2N3904	3		Q6, 7, 8
		IC's	
78L06	1		U1
78L09	1		U2
		Diodes	
1N4148	4	or equiv	D1, 2, 4, 5
MV2207 or MV2209	1	or equiv (22 pf at 4V)	D3
		Toroids	
FT37-43	3	8 Turns Trifilar	T1, 2, 3

Universal VFO - Frequency Dependent Components

Reference	Quantity	80	40		30		20	
C16, 38	2	220	100 pf		68 pf		56 pf	
C22, 23	2	470	220 pf		150 pf		100 pf	
C18, 40	2	560	270 pf		180 pf		150 pf	
C2	1	330	330 pf		390 pf		390 pf	
C17, 39	2	820	390 pf		270 pf		220 pf	
C24, 25, 26, 27	4	820	470 pf		330 pf		220 pf	
C12, 13	2	1800	1000 pf		680 pf		560 pf	
C1 (variable)	1		10-190 pf		10-190 pf		10-190 pf	
Toroids	**type**		**value/turns**		**value/turns**		**value/turns**	
L1	T50-6	T68-2 42T	37 T tap at 9 T from gnd		22T tap at 5 T from gnd		18 T tap at 5 T from gnd	
L2	T37-6	T50-2 35T	2.6u	28T	1.6u	20T	1.1u	16T
L3, 7	T37-6	T50-2 40T	4.7u	36T	3.3u	30T	2.4u	26T
L4, 8	T37-6	T37-2 23T	1.4u	19T	.98u	16T	.70u	13T
L5, 6	T37-6	T37-2 21T	1.1u	16T	.78u	13T	.56u	11T
T4	T37-6	T37-2 22T	1.1u	17T	.78u	14T	.56	12T

Turns are the number of turns of #28 or smaller wire on T- 30 or T-37 powered iron toroids. Space the turns evenly around the core. If an L meter is available squeeze or spread the turns to achieve the inductance shown in the table. For other ranges, use A_L = 39 and calculate the number of turns using:

$$N = 100[\text{desired uH}/A_L]^{1/2}$$

Note that the approximate A_L value is different from the one supplied on the Amidon data sheets and includes corrections appropriate for the number of turns of #28 to #36 wire for this frequency range. The cross section of T30 and T37 toroids is very similar, so the same number of turns is used.

L1 the main tuning inductor is wound on a T50-6 core using #28 wire. The highest frequency is determined by the inductance of L1, the distributed capacitance between the turns, and the band set capacitor C2. Different variable capacitors may be used. The tuning range is determined by the total capacitance change and where the tuning capacitor is connected to L1. Connecting a variable capacitor across all of L1 results in a wide tuning range. Connecting the same variable capacitor at the source tap (to ground) results in a narrower tuning range. Other ranges may be selected by adding a tap to L1, since L1 acts as a nearly ideal autotransformer. The final frequency range of the VFO is set by squeezing or spreading the turns. After the final range is set, apply a liberal coat of clear nail polish to L1 to fix the turns in place.

Construction Notes - Universal VFO

Check to be sure that all the parts are in the kit! If any are missing, let me know and I will send the missing part.

The diagram that is included is looking down on the parts side of the board. The parts are mounted on the side away from the copyright notice “copyright 1999 KK7B\K7TAU”. There is nothing too critical. Be sure to insert the transistors and voltage regulators correctly. Also be sure that the electrolytic capacitors are inserted with the “+” lead in the square pad. The 4 diodes are mounted vertically, and the banded end is UP on D1 and D2, but is DOWN on D4 and D5 if they are mounted as shown in the layout diagram. The flat side of the MV2109 (or MV2107) is mounted towards the edge of the board - the curved side faces the variable capacitor. It looks like a two legged transistor.

The variable capacitor C1 can be mounted several ways:

A) There are three mounting holes on the rear of the capacitor frame that line up with three holes on the PC board so that the board can be mounted on the capacitor. A stiff piece of hookup wire (like a scrap resistor lead) is used to connect PD3 on the PC board to the variable capacitor..

B) There are 4 mounting holes on the bottom of the capacitor frame. These four holes line up with four holes on the PC board so that the board and capacitor can be mounted together. The sample capacitors I had did not have threads tapped in these four holes however, so you will have to *carefully* tap them yourself! A stiff piece of hookup wire can be used to connect the capacitor to PD3 on the PC board

C) The variable capacitor can also be mounted separately from the PC board and a stiff wire used to connect the capacitor to PD3.

Note that two schematics are included with the Universal VFO. One (labeled “Receive Only UVFO”) shows only the parts necessary to use the VFO for receive only. If you are going to use the Universal VFO for the Binaural Receiver, you can construct the VFO using only the parts shown on this schematic. Be sure to insert the jumper between the collector and emitter holes of Q8. J2 and J3 are the output pads. You can solder directly to the pads or use small pins and connectors (not supplied). Note that the pads are labeled “I” and “Q” on the bottom of the PC board.

The second schematic shows all the parts necessary to provide an output for a transmitter, for RIT, and switching of the transmit and receive outputs from the UVFO.

Components are included so you can build the UVFO for 20, 30, or 40 meters. 40 meter values are shown on the schematic.

Toroids

For some reason toroids seem to scare a lot of homebrewers. They are actually quite simple to use, and work as well or better than most of the commercially available “IF can” type of inductors that are so popular today.

A turn is counted every time the wire passes through the center hole in the toroid. A straight piece of wire passing through the toroid is one turn. Bring the end of the wire back around and through the center hole again and you have two turns..... The wire should be wound neatly and on the toroid and the turns spaced evenly around the core. I make a tap by removing the enamel from about ½" of the wire, twisting a small loop in the wire and tinning the loop. Then I wind from that point out to each end of the inductor. For example, the 40 meter version of L1 is wound 9 turns from the tap in one direction, and 27 turns the other direction from the tap.

For the T37 cores provided with the kit, you can determine how much wire you will need to wind a toroid by multiplying the number of turns time ½" and then adding about 2 to 4 inches so have some wire to work with when you are done. The T50 used for L1 will use slightly more.

Bifilar and trifilar toroids are constructed by twisting two (or three for trifilar) equal length pieces of enameled pieces of wire together until they have 6 - 8 turns per inch twisted in the wire. I fasten one end of the two wires in a vise, and the other end of the pair in a drill, and let the drill do the twisting while keeping a little tension on the wire. After winding the twisted pair on the toroid the proper number of turns, untwist the ends and strip off the enamel. Use an ohm-meter to determine the ends of each winding. The PC board is laid out so that each winding goes in an adjacent pair of holes. For example, the first winding on T1 goes in the two holes closest to C10. The second winding goes in the pair of holes that is equidistant between C10 and C11, and the last winding goes in the pair of holes closest to C11. I found that 5" of the twisted wire (3 wires) was needed to make the 8 turns for each of T1, 2, and 3, so make at least 15" of twisted (3) wire.

The enamel can be scraped of (carefully) with a knife, and the wire tinned with solder. I prefer to take it off by pinching the end of the wire between the hot tip of a soldering iron and a piece of wood, and pulling the wire out from under the soldering iron. Lay the wood on the table, lay the wire on the wood, press down with the tip of your iron on the wire, and pull the wire out from under the tip, This cleans the enamel off nicely.

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June 2, 1999

Enclosed is a 10k pot which is to be used as the RIT pot on the VFO. It is R14 on the VFO schematic.

Also enclosed is a 10 pf capacitor. It can be used in place of the 100 pf capacitor at C28 which is the RIT coupling capacitor. The original circuit was designed with a much larger main tuning capacitor, and C28 = 100 pf gave a reasonable RIT range. When the circuit was re-designed with the 65 pf variable supplied, the RIT section was not re-designed. As a result, the RIT pot covers a much larger range than it should! Changing C28 to 10 pf solves the problem.

Other items which have come up since the kit was shipped include:

When positioned as shown in the layout, the banded end of D1 and D2 is UP. The banded end of D4 and D5 is DOWN.

D3 looks like a “two legged transistor”. The flat side of the package goes toward the edge of the PC board.

On the schematic for the complete VFO - the 51 Ohm resistor that is connected to +12 near “TX out” on the right side of the diagram is R31, not R1 as labeled.

The 78L09 is U2, not U1.

The schematic indicates that the trifilar transformers are wound on FB 43-2401 beads. They are actually wound on the FT 37-43 toroids supplied - 8 turns for each.

The Universal VFO Parts List indicates R8 and R9 are the two 22 ohm resistors. It should say R8 and R29 are the two 22 ohm resistors.

The Parts list indicates an MV2107 is used for D3 - it should be an MV2207. The 1N4148 diodes are actually supplied as 1N4151 diodes.

Sorry for any problems this may have caused!