EB104 CONSTRUCTION HINTS

The EB104 HF amplifier is designed for SSB operation in the 2-30MHz band. The following construction hints are only guidelines in the construction of the amplifier and not as a construction manual.

Heatsink Preparation

A heatsink capable of dissipating 600 watts of power should be selected. In addition, a copper heat spreader of sufficient size **(**at least 6 inches X 8 inches x 3/8 inches thick) should be used to mount the PC board and RF transistors. The RF transistors are very close physically and the copper heat spreader will remove the heat faster than aluminum. The copper heat spreader is mounted on a large piece of aluminum heatsink to dissipate the from the copper heat spreader.

The copper heat spreader and aluminum heatsink are drilled and tapped using the blank PC board as a template. Position the blank PC board on the copper spreader and mark the four (4) mounting holes. Drill and tap the four mounting holes for .4-40 screws. Then screw the blank PC board flush on the copper spreader. Then position the RF transistors in the cutouts in the PC board so that the RF transistors are sitting flush on the copper spreader. Mark the mounting holes for the RF transistors. Remove the RF transistors after marking the hole positions and remove the PC board from the copper spreader. Now drill and tap the RF transistor mounting holes in the copper spreader for 4-40 screws. Then drill and tap your mounting arrangement of the copper heat spreader to the aluminum heatsink. Connectors, chassis, etc., can now be designed for the enclosure. Be sure to apply thermal compound between the copper heat spreader and the aluminum heatsink.

PC Board Assembly

If desired, swage pins (not supplied) can be added to the PC board for the RF input and output terminals, bias input, and power input terminals. No particular order needs to be followed in the in the construction of the PC board. The following is a typical order of construction. The component layout diagram in the EB104 Engineering Bulletin is used as a guide locating the positions where the components are to be installed.

1.) Turn the PC board over (bottom side up) and mount the chip capacitors as shown in the

component layout. The chip caps are installed by first applying a small amount of solder to the PC board on one side where the chip cap is mounted. Then place the chip cap in position flush on the PC board and hold in place with a toothpick or similar device. Carefully heat the small amount of solder until the one side of chip cap is soldered. This will hold the chip cap in place while the other side of the chip cap is soldered in place. Then resolder the first side if necessary. Be careful not to overheat the chip cap! There should be a fillet of solder between the edge of the chip cap and the PC board.

2.) Turn the PC board over (component side up) and install the chip caps on the top side of the PC board.

3.) Install the 1/2 watt resistors and the 1 watt resistor (R6).

RESISTOR CHANGE OPTION

> Helge Granberg, the designer of the Motorola EB104, recommends a change in the value of resistors R14-R18. The original value for these resistors is 1.0 ohm. The recommended change is to increase this value to 2.2 or 2.7 ohm.

4.) Install the ceramic and electrolytic capacitors. Observe the polarity on the electrolytic capacitors.

5.) Install the voltage regulator IC (MC1723CP). Ensure the IC is oriented properly.

6.) Locate the mounting position of transformer T1 on the PC board. Cut and trim the wire leads to fit into their proper holes on the PC board. Mount the transformer flush on the PC board by first soldering the split foil ends of the transformer to their respective pads. The split ends of the transformer should be toward the center of the PC board. Solder the other end of the transformer to its respective pad on the PC board. Insert and solder the wire leads into their proper holes.

7.) Install and solder thermistor R25.

8.) Locate and install the four variable resistors (R1, R2, R3, and R4) on the PC board.

9.) Using the bias configuration described in the Engineering Bulletin, four jumpers need to be installed. The jumpers are to be installed in locations that are marked D1, D2, D3, and D4 in the component layout. Care must be used in locating these positions since there are two D15,

two D2s, etc. marked on the component layout. The jumpers will go in the locations parallel to C3, C4, C5 and C6. Diodes are installed in the locations at the end of C3, C4, C5 and C6. The jumpers are made from discarded resistor leads or #22 AWG bus wire.

10.) Install diodes D1, D2, D3, and D4 in their proper location. Observe the correct polarity of the diodes.

11.) Install transformer T3 with the split ends toward the center of the PC board. T3 is installed in the same manner as T1.

12.) Install the mica capacitors C11. If the amplifier is to be used for SSB operation, mount a 1200 pf silver mica on each section of the transformer T3 as shown in the component layout. If the amplifier is to be used for CW or industrial applications, C11 should be composed of a 680 pf silver mica and an ARCO 469 mica trimmer mounted on the transformer T3.

13.) The balun T2 is installed next. The phasing on this transformer is critical and will destroy the RF transistors if installed incorrectly. The single turn feedback loop is connected across the center hole spacing. Cut and trim the leads to fit. Solder the leads in their respective holes.

14.) L1 and L2 are each composed of two ferrite beads and a length of #16 AWG bus wire formed in the shape of a "U". Form the leads and install L1 and L2 in their proper locations.

15.) At this time, all components except for R19 and R20 and the RF transistors should be mounted on the PC board. The RF transistors can be mounted next. In order to properly locate and mount the RF transistors on the PC board, the PC board is first mounted on the heatsink (copper spreader) using 4-40 screws and appropriate spacers (0.10 inches thick). The RF transistors are then set inside the cutouts of the PC board and bolted to the heatsink using 4-40 screws (do not use the thermo compound at this time). If desired, the extreme 1/8 to 3/16 inch end of the transistor leads can be bent up 90 degrees to facilitate removal of the transistors later if necessary. With the PC board and the RF transistors bolted to the heatsink, solder the transistor leads to the PC board by applying heat to the leads and let the solder "wick." under the leads to the PC board.

16.) R19 and R20 can be installed now. First remove the RF transistor and PC board assembly from the heatsink. If the amplifier is to be used for SSB operation, use the value and wattage specified in the parts list for R19 and R20 and install the resistors. IF the amplifier is to be used in the CW mode or industrial applications, the wattage of R19 and R20 should be increased. An alternative is

to parallel five (5) each 68 ohm 2 watt resistors for a total of 13.6 ohms at 10 watts. Install a parallel combination each for R19 and R20 on the PC board.

This completes the assembly of the amplifier PC board and the amplifier may be mounted on the heatsink using thermal compound under each RF transistor.

Brookfield
Forest Green
Surrey
UK
RH5 5SG

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Dear ARRL

I read with interest the construction article "Homebrew Solid-state 600 W HF Amplifier" by K0GKD published in the most recent copy of QST.

Having recently constructed the same Motorola design from a set of components from the US based company Communication Concepts I do have a number of extra construction hints (in no particular order) that may aid future builders.

1. The generic diagram shown in the QST article from the EB104 Engineering Bulletin differs slightly from the actual circuit used when constructed on the PCB supplied. Also, the EB104 Bias Configuration as redrawn by Communication Concepts is slightly in error.
2. The value of R15-R18 has been changed to 2.7 ohms (supplied by Communication Concepts). R19 and R20 may have to be up rated for heavy key down applications
3. Due to the very close spacing between the PCB and the copper heat spreader, ensure that all solder joints are cropped to within 2mm on the lower side of the PCB board.
4. C 17 and C 18 are the four physically thickest 0.1 chip capacitors and sit on the top surface of the PCB. Only thin chip capacitors are fitted to the underside.
5. M3 bolts and nuts can be used to mount the PCB to the copper spreader. M3 nuts used as spacers provide the correct clearance between the two surfaces.
6. Fit a socket for ICI to allow easy replacement.
7. The four-ferrite beads (L1, L2) are electrically conductive and must be mounted so that they do not touch the earth plane, otherwise you will have a fire on your hands!
8. The phasing on T2 is critical; the red and orange leads need to be on opposite sides at the top and bottom of the transformer. If in any doubt, phone Marlis at Communication Concepts for advice before proceeding with the construction.
9. Trim pots R1-R4 need to be fitted slightly up in the air to ensure clearance for other components.
10. When all components are fitted to the PCB, double test that there are no shorts on the 50-volt rail. You may have to remove a very small section of the PCB copper in close proximity to the MRF150 FET'S etc to avoid this problem.
11. Only use silver loaded heat sink compound to ensure maximum heat transfer and, fit two large diameter (120mm) 1400-RPM fans to provide adequate cooling and low noise.

12. The current bias stability of the MRF150 FET'S is greatly improved if the output of the voltage regulator (IC 1) is reduced from 7volts to 5-5.5volts (via R5) and the thermistor (R25) is mounted in close thermal contact with one of the MRF150 transistors. I clamped the lead of one end of the thermistor close to its body under an extra nut on one of the securing bolts of the output transistors.
13. The Motorola data sheet suggests 0.25 amps per device as a suitable bias current.
14. The bias voltage for the amplifier may be derived from the 50 volt supply and, any relays and control circuitry powered by the existing 13.8 volt power supply used by your transceiver.
15. For those in Europe a suitable toroidal mains transformer (40 v + 40 v @ 12.5 amp each winding 1000VA) can be sourced at a very reasonable sum from Clairtronic Ltd in the UK sales@clairtronic.co.uk on +44 (0) 1234 330775. Use 63 volt capacitors in the power supply, as the supply will be approximately 57 volts without a load.
16. Provide a suitable 20-25 Amp fuse in the +50 volt lead and, fit a rectifier diode (of adequate surge rating) with its cathode connected to the amplifier side of the fuse and its anode to earth to protect the amplifier from reversed power supply leads.
17. When testing for the first time ensure that pots RI-R4 have their sliders at earth potential, and that a low current fast blow fuse (2 Amp) is substituted for the normal one during the initial test phase. If the fuse blows at turn on, test for shorts, however, if it blows when setting up the bias current you may have the phasing of T2 incorrect, turning the amplifier into a high powered oscillator!
18. Do not forget that due to the high power gain you will require only around six watts or so to drive the amplifier to 600watts output.
19. Extra circuitry for ALC control etc may be required depending on usage. A 50-ohm input attenuator (5-7dB) feeding the amplifier is desirable, and can be protected from gross overload by a suitable fuse. A peak reading power meter needs to be incorporated either internally or externally to the amplifier.
20. If the RF unit and power supply are constructed as separate units (my preference), the power supply will sit very neatly under the bench alongside the transceiver supply. The Solid State Amplifier with output filters is small and light enough to stand on the back of the average transceiver if required.
21. Communication Concepts also supply suitable LP output filters at reasonable cost that are simple to construct. These appear to be perfectly satisfactory at least up to the 400-watt legal limit imposed in the UK.
22. Have fun!

Colin Darby... M0OTT

Email . ColinDarby@FatRose.fsnet.co.uk