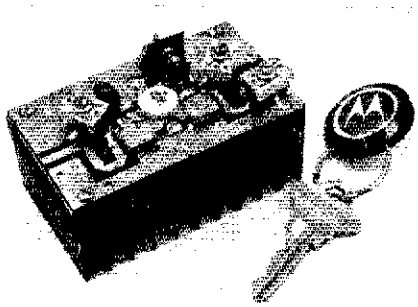
Build This Solid-State PA for 440 MHz

Is your uhf signal suffering the doldrums of power-output lassitude? The tonic effect of this compact unit will stir up a 15-watt breeze to push it along.

By Rick Olsen,* WA7CNP

Whether the application is by a person using a hand-held transceiver as a mobile rig or by an experimenter building a repeater with HT-200 boards, a medium-power amplifier would come in quite handy for increasing the effective range of his station. This article describes a compact, inexpensive, 10-dB gain power amplifier which is simple enough for nearly any experimenter to build.



This close-up view of the amplifier helps to show the relative placement of the parts. Note that the transistor emitter leads are soldered to the top of the Unelco capacitor cases.

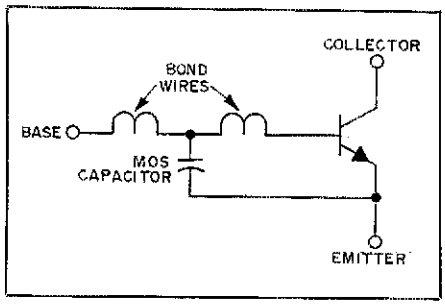


Fig. 1 — Controlled-*Q* transistors have internal-matching configurations that make it somewhat easier to design circuits for them. In the MRF618 this matching is accomplished in part by the bonding wires and the built-in MOS capacitor.

Circuit Analysis

The circuit employed is essentially a basic narrow-band amplifier capable of being tuned over a broad range of frequencies — 430 to 450 MHz. Input-match and collector-load transformations are accomplished by using multiple *L* sections comprised of 50-ohm microstrip-line and mica-compression variable capacitors. The active device is the Motorola MRF618 — an internally matched, 12.5-volt, controlled-*Q* transistor designed for application from 420-512 MHz. Fig. 1 shows a simple schematic diagram illustrating the internal-matching components on the base side of the MRF618.

Construction

The amplifier is built on double-sided G10 glass-epoxy board. Fig. 2 is a 1:1 drawing of the board layout. Care should be taken in etching to maintain the line width of the microstrip at 0.110 inch for a Z_o of 50 ohms.

After the board has been etched, the first step is to cut the hole in the board for the transistor heat sink (flange). The transistor flange can be used as a stencil for laying out the hole. When the hole has been formed, the next thing is to ensure that a good rf path is continuous from the ground plane on one side to

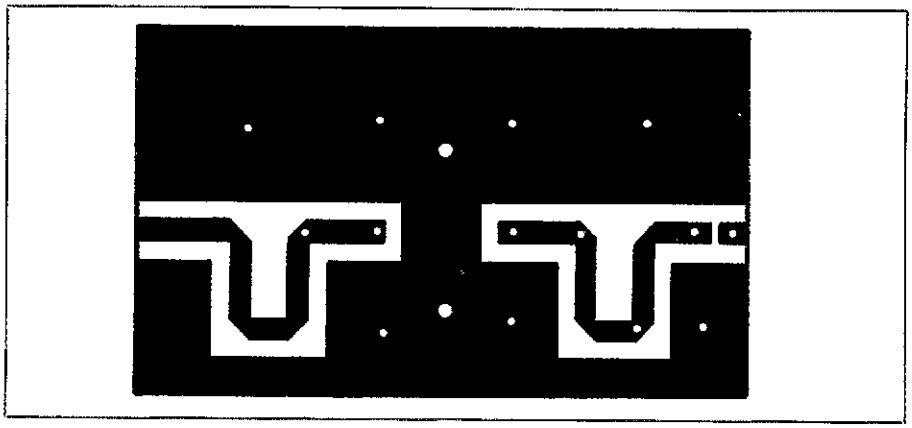


Fig. 2 — This scale drawing of the pc-board layout can be used to make a pattern for etching the board. The width of the strip-line inductors should be held very closely to 0.112 inch for best match between the transistor and 50 ohms. Material is double-sided G10 (glass-epoxy) board.

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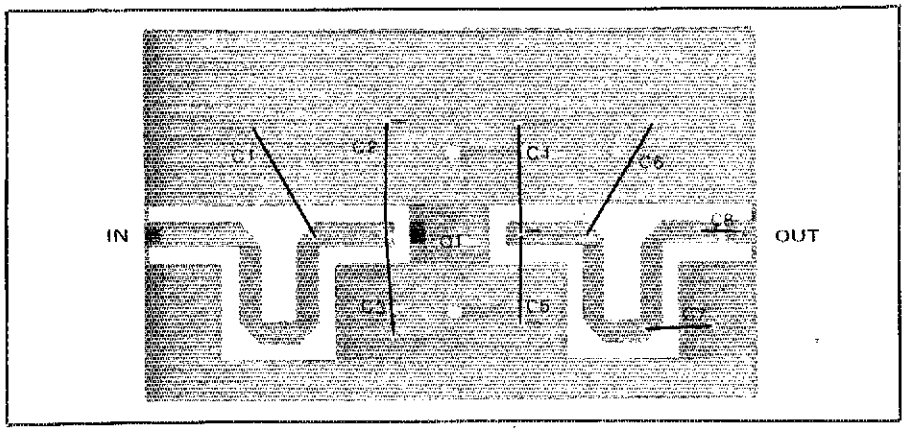

Fig. 3 — A parts-placement guide for the amplifier board. Be sure to provide rf-connecting paths between the top and bottom ground surfaces, as explained in the text.

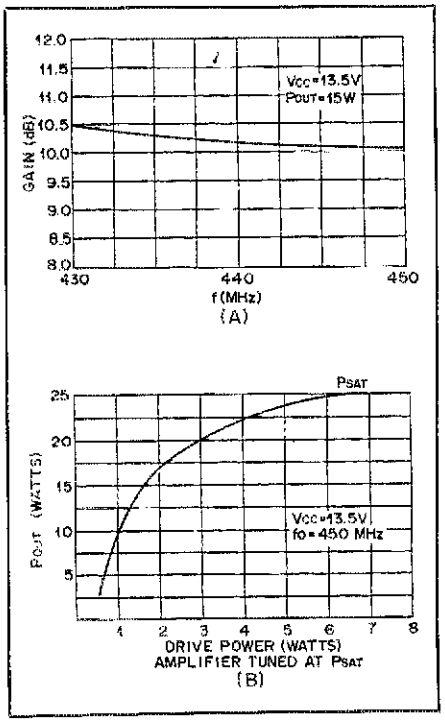

Fig. 4 — These gain and output-power graphs show what performance can be expected from an amplifier utilizing the MRF618.

that on the other. I prefer to make such connections with copper or brass eyelets crimped and soldered to both sides of the board. If no eyelets are available, these connections may be made by drilling a No. 50 hole through the board, inserting a piece of No. 18 wire through the hole, and soldering and trimming both sides flush with the board. Be sure that there is one such connection made under each Unelco capacitor and alongside the microstrip line and dc feed point.

Next, the Unelco capacitors are mounted as closely to the transistor package as possible, and at the same time they double as mounting surfaces for the transistor emitter leads. Connections to the input and output lines may be made with 2- to 5-mil copper strap or foil.

The transistor can be mounted at this time. The holes in the transistor flange are made to clear No. 4-40 screws. Drill and tap two No. 42 holes in the heat sink, using the flange as a drill guide. Next, clean the heat sink and bottom of the transistor flange so that foreign matter will not prevent the transistor from seating properly on the heat sink. Apply a very small amount of thermal compound to the flange and bolt it firmly to the heat sink. The transistor leads may then be soldered to the circuit.

The base-return choke and dc collector-feed circuit may now be put into place. C10 may easily be installed by drilling a 0.192-inch hole in a small copper strap (0.02-inch thick) and then putting a right-angle bend in the strap so that the capacitor can be mounted upright above the board. Be sure to make the base return and dc-feed connections as close to the transistor package as possible.

Now comes the remaining tuning elements and output dc-isolation capacitor. Fig. 3 shows the mounting position. Care should be taken to solder the ground tabs of the trimmers to the ground plane to reduce the amount of lead inductance inherent in these capacitors at uhf. C8 should be mounted after cutting a small break in the output line near the end. This capacitor need not be a 0.018-μF chip, but care should be taken in choosing a substitute that will not grossly effect the output load characteristic of the circuit (see parts list). Depending upon your application, any 50-ohm outside-world connection may be used, ranging from a piece of coax to RCA phono plugs.

Tune-up

Tuning is simple: Apply low power (about 3/4 watt) to the input and tune the input capacitor until a small amount of collector current begins to flow. Then tune the output capacitors for peak output. Switch back and forth between input and output, and tune until the desired operating conditions are achieved. Fig. 4 shows examples of typical data taken in the lab. You will find that operating frequencies greater than 1 MHz away from the tune-up frequency can be used without the necessity of further adjustment. QST

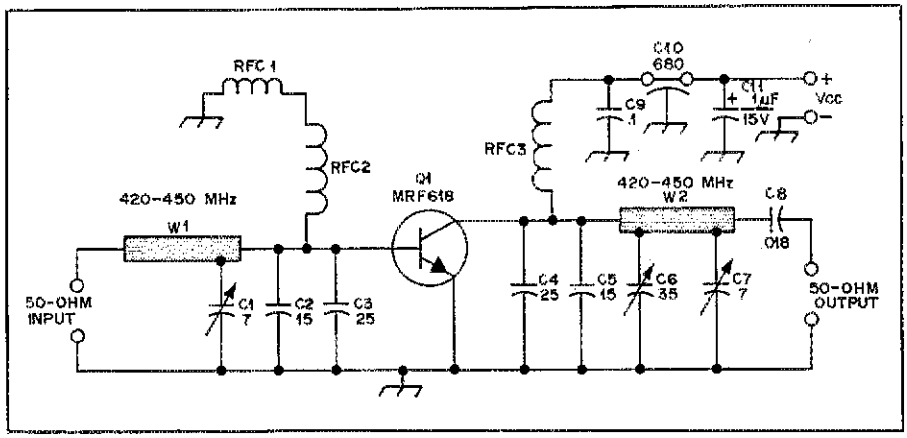

Fig. 5 — Schematic diagram of the 15-watt amplifier.
C1, C7 — 0.9- to 7-pF mica compression trimmer, ARCO 400.
C2, C5 — Unelco 15-pF mica.
C3, C4 — Unelco 25-pF mica.
C6 — 3- to 35-pF mica compression trimmer, ARCO 403.
C8 — 0.018-μF chip capacitor, ATC or equiv. (a 250-pF Unelco mica or a 0.001-μF Erie Redcap may work as a substitute).
C9 — 0.1-μF disk ceramic.
C10 — 680-pF feedthrough capacitor.
C11 — 1-μF, 15-V tantalum.
L1, L4 — 50-ohm microstrip line, 2.3-inches long, 0.112-inch wide.
RFC1 — Ferrite bead on cold lead of L2.
RFC2 — 8 turns No. 22 enam., 1/8-inch ID, close wound.
RFC3 — 4 turns No. 22 enam., 1/4-inch ID, close wound.