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DOUG'S DESK

CONSTRUCTION PROJECTS, TECHNIQUES, AND THEORY

Build A 25 Watt QRP Booster

Having been a QRP enthusiast and operator for some 35 years I fully appreciate and endorse the 5 watt maximum output power rule that separates the QRP purist from his or her QRO counterpart In fact, for many years I limited my output power on 20 and 40 meter CW to 2 watts, and I was able to enjoy worldwide QSOs most of the time However, there are occasions when 5 watts is not sufficient for maintaining a 'solid' QSO This is especially true when band conditions are substandard, and/or when QRN is a problem At such times it is convenient to add "shoes" to one's QRP transmitter in order to make the copy less difficult at the other end of the circuit. The 6.1 dB signal increase from 5 watts to 25 watts can provide a marked improvement when the going is rough.

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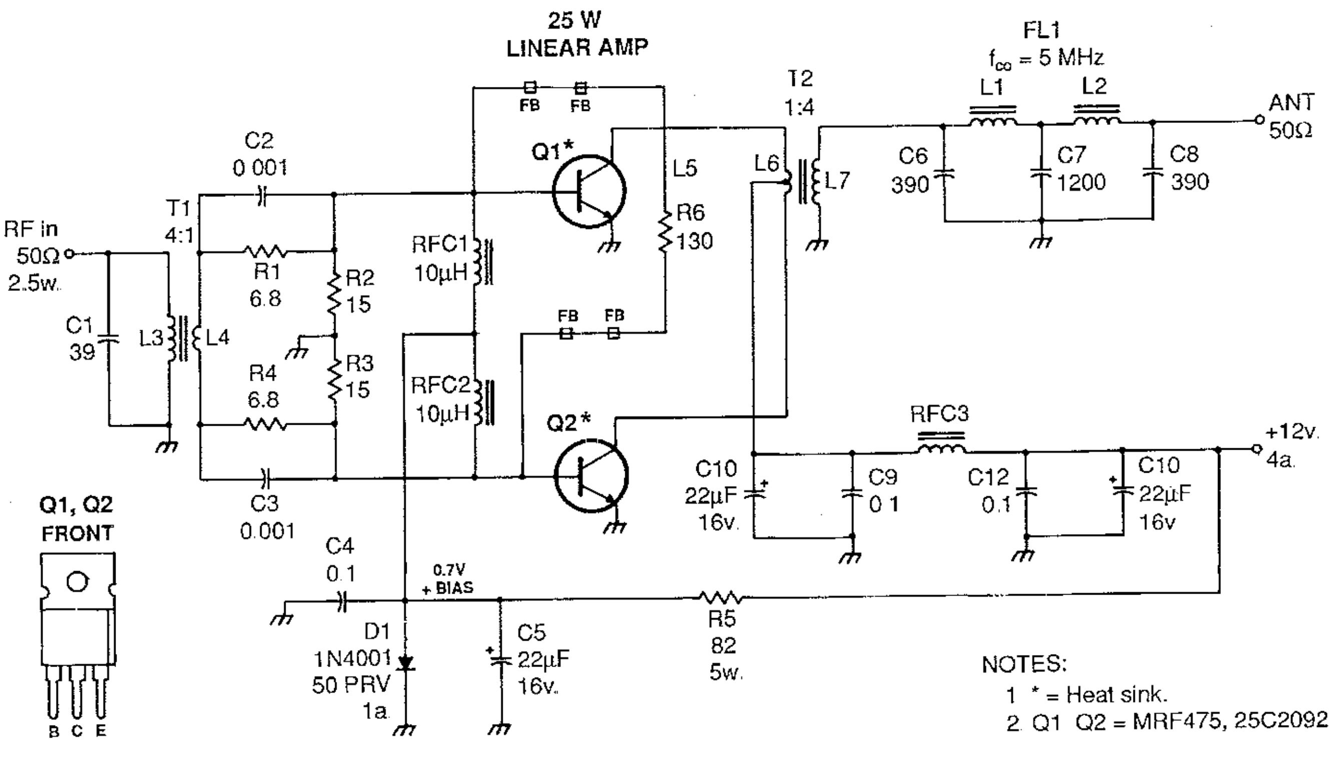
In this article I will describe a 25 watt linear amplifier that can be driven to full output with 2 5 watts of power Since the amplifier is linear, you may use it for CW or SSB operation It is suitable also for use with homemade or commercial QRP transmitters. The circuit may be utilized as a driver for a high-power solid-state RF amplifier should you choose to use it in that manner

Circuit Information

There is nothing unique about the circuit in fig 1 It is based in part on a design found in Motorola application note AN-779 Q1 and Q2 are Motorola MRF475 devices in the application note I used 2SC2092s in my version since they are inexpensive and have slightly more gain than the MRF475s

This broadband amplifier is suitable for use from 1 8 through 30 MHz The only component values that must be changed for operation on any given HF band are those in the harmonic filter, FL1 (Table I) The diagram shows a 5-element filter which offers marginal harmonic suppression, but FL1 is entirely adequate when the circuit is used as a driver. A 7-element filter is my recommendation for direct operation into an antenna L and C values for 5- and 7-element low-pass 50 ohm filters may be obtained from the filter tables in *The ARRL*



C6, C7 C8—Dipped silver mica or polystyrene capacitors.
D1—1-A, 50 or 100 PRV rectifier diode.
FB—Miniature 850 μ_i Amidon No FB-43-301 ferrite bead over a short length of No 24 wire.
L1, L2—Toroidal inductor, 2 86 μH Use 24 turns of No 26 enam wire on an Amidon T50-2 powdered-iron core (see Table I)
Q1 Q2—Motorola MRF475 2SC2092 or equivalent NPN RF device
R5—82 ohm 5 watt resistor
RFC1, RFC2—Miniature 10 μH RF choke (Mouser Electronics)
RFC3—8 turns of No 24 enam. wire on an Amidon FT-37-43 toroid core
T1—4:1 Z ratio broadband transformer L3 has 6 turns of No. 24 enam wire through an Amidon BN-43-2402 balun core. L4 has 3 turns of No 24 enam wire An FT-50-43 toroid may be substituted for the BN-43-2402 core
T2—4:1 Z ratio broadband transformer L5 (see text) is a one-turn loop inside an Amidon BN-43-7051 balun core L6 has 3 turns of No 22 enam wire L7 has 6 turns of No 24 enam wire

Fig 1– Schematic diagram of the 25 watt linear amplifier Decimal value capacitors are in μF Others are in pF. Polarized capacitors are electrolytic or tantalum 16 volts or greater Resistors other than R5 are 1/4 watt carbon-composition or carbon-film units

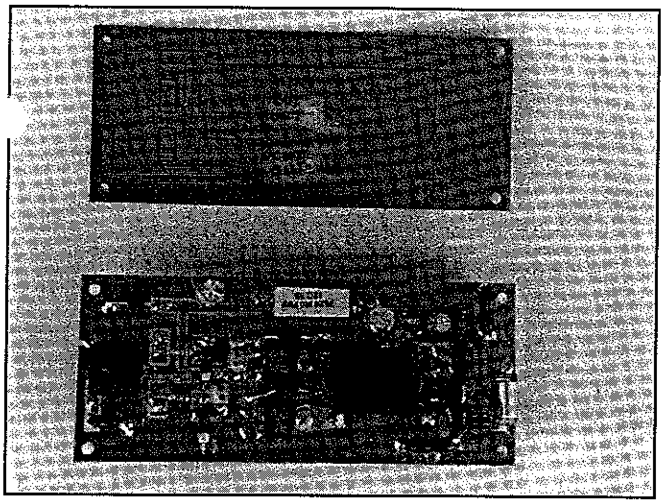


Fig 2– Photograph of the etched PC board (top) before the parts are mounted on the foil side The lower part of the picture shows the assembled amplifier. Cutouts are required for Q1 and Q2 to facilitate coupling them to the heat sinks atop the PC board

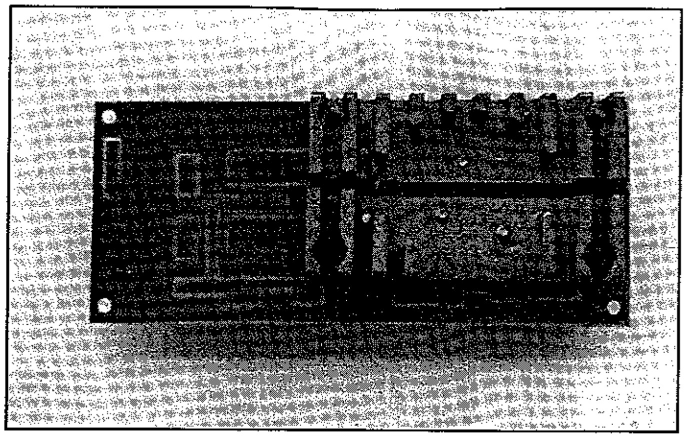


Fig 3– Photograph of the top side of the amplifier PC board showing the heat sinks A single heavy-duty, extruded heat sink has been cut in half to provide individual sinks for Q1 and Q2 of fig 1 The heat sinks and their mounting screws must be isolated from circuit ground (see text)

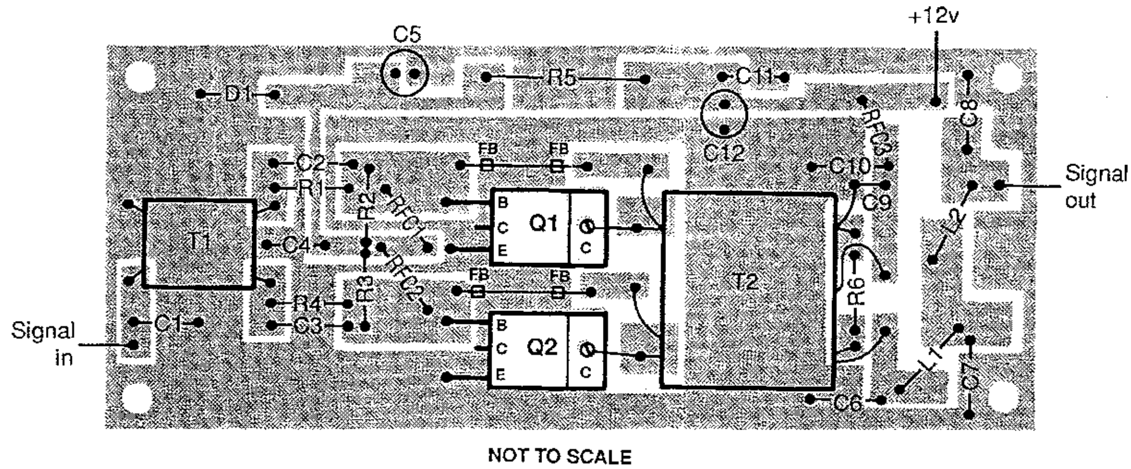


Fig 4– Expanded view (not to scale) of the parts placement on the etched-foil side of the amplifier PC board

Band (m)	C6, C8 (pF)	C7 (pF)	L1, L2 (µH)/Winding Data)
160	820	2500	5 36 uH 33 turns No 26 enam wire on a T50-2 toroid
75/80	390	1200	2 86 uH 24 turns No 26 enam wire on a T50-2 toroid
40	270	820	1 72 uH 19 turns No 22 enam wire on a T50-2 toroid
30	180	560	1 15 uH 16 turns No 22 enam wire on a T50-6 toroid
20	130	400	0 83 uH 14 turns No 22 enam wire on a T50-6 toroid
17	100	300	0 65 uH 12 turns No 22 enam wire on a T50-6 toroid
15	82	270	0 56 uH 11 turns No 22 enam wire on a T50-6 toroid
12	75	240	0.49 uH 10 turns No 22 enam wire on a T50-6 toroid
10	56	180	0 37 uH 9 turns No 22 enam wire on a T50-6 toroid

Table I– These 50 ohm, 5-element low-pass filters are for use in the fig 1 circuit Filter constants are derived for a Butterworth response Capacitance values listed are the nearest standard ones to the calculated values within 10 percent

Handbook The FL1 values listed in fig. 1 are for operation in the 75 meter band There is sufficient room on the circuit board to add one more capacitor and toroid inductor to form a 7-element filter. This means cutting a PC board pad to accommodate the additional two parts

Shunt feedback is provided by L5 R6, and the four ferrite beads The feedback network serves to level the gain from 1 8 to 30 MHz by reducing the amplifier gain gradually as the operating frequency is lowered. The feedback circuit also helps to ensure stable operation by preventing the amplifier gain from being excessively high from 1 8 through 7 MHz, in particular L5 is a single turn of wire that is passed through the core of T2 The center of the turn is opened to accommodate R6, which controls the amount of feedback from the transistor collectors to the bases C2, C3, R1, and R4 are also used to level the amplifier gain. They allow maximum drive at the high end of the 1 8 to 30 MHz range but reduce the effective drive at the lower end of the amplifier range. C1 is used to cancel unwanted T1 inductive reactance at the upper end of the amplifier operating range

Forward bias (+0 7 V) is supplied to Q1 and Q2 from D1, which also acts as a "sorta" regulator This forward bias places the amplifier in the class B linear mode The bias circuit may be eliminated for CW-only operation If this is done ground the junction of RFC1 and RFC2

Construction Tips

An etched PC board for this amplifier is available from FAR Circuits [1] Fig 2 shows the

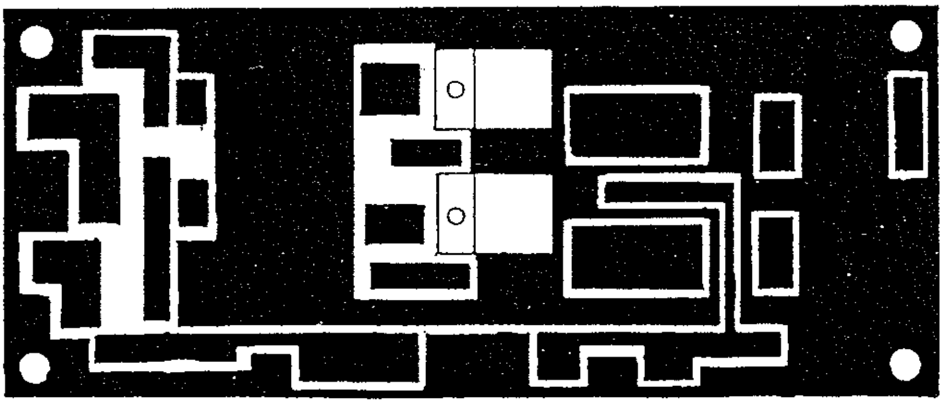


Fig 5– Scale etching pattern for the 25 watt amplifier, as seen from the etched side

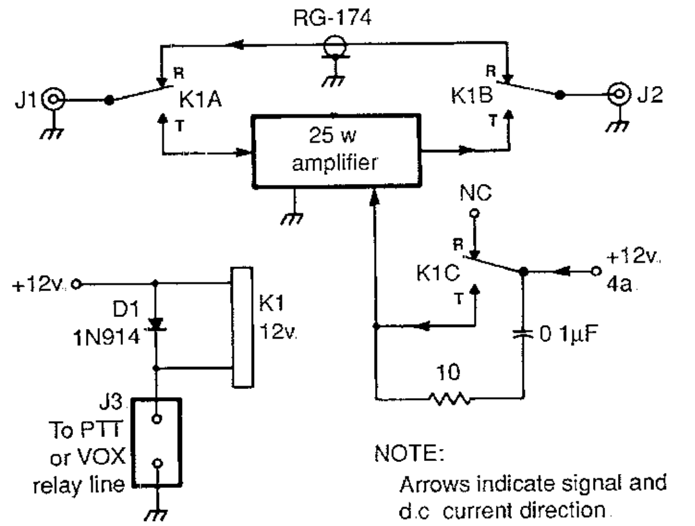


Fig 6– Details for adding a relay type of TR circuit to permit amplifier use with a transceiver. K1 is a 12 volt, 4-pole double-throw relay (one section not used) with 1-A or greater contact rating, such as an All Electronics No. 4PRLY-12 (1-800-826-5432). See text for information on building a solid-state TR switch for full QSK operation.

assembled amplifier and the PC board before the parts were soldered to the foil side of the unit. Note the cut-out areas for Q1 and Q2. They are required to allow the transistors to be attached to the heat sinks on the non-foil side of the board. Make certain that the heat-sink mounting screws do not touch circuit ground. The tabs (collectors) of the transistors and the heat sinks are hot with +12 volts. Therefore, the center lead (collector) on each transistor is snipped off near the body of the device. The tabs of Q1 and Q2 are connected to the appropriate PC board pads by means of solder lugs under the screws that attach the devices to their heat sinks. This can be seen in the pictorial drawing of fig. 4. Details concerning the heat sinks are shown in fig. 3. I made them by cutting a large extruded heat sink into two sections. The sinks are drilled and tapped for 4-40 screws to facilitate mounting them to the PC board and for attaching the transistors to the sinks. There are three tapped holes in each heat sink. Be sure to use heat-sink compound between the transistors and their heat sinks.

You can make your own PC board from the scale pattern in fig. 5. The unwanted copper may be removed by means of ferric chloride etchant or you may remove it with a small motorized craft tool and router or cone-shaped grinder bit.

Although I used balun (binocular) cores for T1 and T2, you may use ferrite toroids of the same permeability (850 μ_i) and approximate cross-sectional area. Both core styles are available from Amidon, Inc.[2] Most of the remaining components may be purchased from Mouser Electronics[3] or Hosfelt Electronics.[4] Q1 and Q2 are available from RF Parts.[5]

TR Circuit

If you plan to use the fig. 1 amplifier with a transceiver, it will be necessary to employ a switch-around circuit that routes the antenna to the receiver during standby periods. Fig. 6 contains details for using a relay to accomplish this action. It is triggered by the PTT line or VOX relay in the transceiver. The action of K1 must be rapid in order to prevent "hot switching" the amplifier. In other words, the amplifier must be actuated after or at precisely the same time the antenna is switched to its output port: The amplifier must not be driven by the exciter until the antenna is connected to the amplifier. Cold switching will prevent damage to Q1 and Q2. Furthermore, hot switching can cause momentary spurious products to be transmitted. The fig. 5 TR circuit is unsuitable for full QSK operation. However, a 25 watt solid-state TR circuit for full break-in operation is described in *W1FB's QRP Notebook*, 2nd edition, page 141 (available from The ARRL).

Summary Comments

The fig. 1 amplifier draws between 4 and 5 amps at maximum output power. The current is determined by the power supply voltage, which may range from 12 to 13.6 volts. A well-regulated DC supply or an automobile battery can be used as the amplifier power source.

The heat sinks for Q1 and Q2 must be large enough to prevent overheating of the transistors. Q1 and Q2 draw idling current between words or CW characters. Therefore, the transistors do not have an opportunity to cool down as they would during class-C operation. You should be able to hold your finger against the heat sinks without discomfort after an extended key-down period. Air vents on the enclosure walls and cover or housing the amplifier in a perforated-metal cabinet, will help to reduce heating. Inclusion of a small circulating fan is suggested for operation in tropical regions.

Footnotes

1. Far Circuits (N9ATW), 18N640 Field Court, Dundee, IL 60118 (708-426-2431 after 6 PM).
2. Amidon, Inc., 3122 Alpine Ave., Santa Ana, CA 92704 (714-850-4660). Catalog on request.
3. Mouser Electronics, 2401 Hwy. 287 N., Mansfield, TX 76063 (1-800-346-6873). Catalog on request.
4. Hosfelt Electronics, Inc., 2700 Sunset Blvd., Steubenville, OH 43952 (1-800-524-6464). Catalog on request.
5. RF Parts, 435 S. Pacific St., San Marcos, CA 92069 (1-800-737-2787).