

NEWSLETTER ARCHIVES

A Stripline 250mW RF Output Driver Amplifier For 23cm Microwave ATV

The amplifier described below, part of the on-going CARC Club ATV project, was designed to boost the nominal 50mW output of a G1MGF video transmitter board sufficiently to drive a Mitsubishi M57762 PA block to around 8 to 10W RF output. A number of Club members are currently planning to construct ATV transmitters employing a GH Engineering PA kit which uses the M57762 block. The driver amplifier is intended to be a daughter board to the GH Engineering PCB and be mounted close to it by a short coax link.

The printed circuit driver amplifier was designed around the Philips BLU98 UHF transistor which although now obsolete, is still available from several sources at about £2-50 each. There is also a Motorola equivalent the MRF581 which is still a current type. The transistor package is of the stripline SO103 type similar to the BFR91/BFR96S but with 4 legs rather than 3 so as to give better thermal conduction to the copper ground plane. The collector dissipation rating is higher than the BFR96S at 1W max. The circuit diagram of the amplifier is shown in figure1. Figure2 shows the track layout of the printed circuit and Figure3 shows a photograph of the completely assembled amplifier.

The amplifier was designed originally to use surface mount components mainly due to their potentially better RF performance, however, a prototype circuit with conventional components albeit with close-cropped leads, has been satisfactorily incorporated into the input circuit of the GH Engineering 18 watt amplifier circuit board in place of the input attenuator. It is planned that ready made double-sided PCBs will be available to club members for the daughter board version.

A number of the surface mount components are already available for those who are ready to start construction. It is also planned to build up one of the circuit boards using standard components as an example for those who may not feel confident in using the rather fiddly SM variety although it may be necessary to use the recommended trimmer capacitor for VC1 and VC2 which needs to have a low minimum capacitance such as the 1.0 to 3.0pf from Rapide Electronics (order code 71-4100). Alternatively, an RS version of 1.4 to 3.0pf (order code 832-374) could be substituted for VC1 if available.

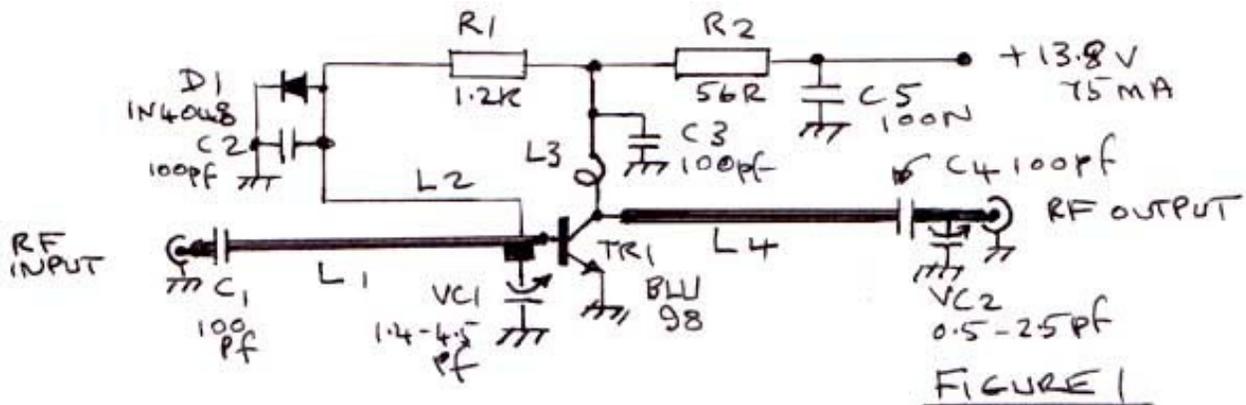


Fig 1

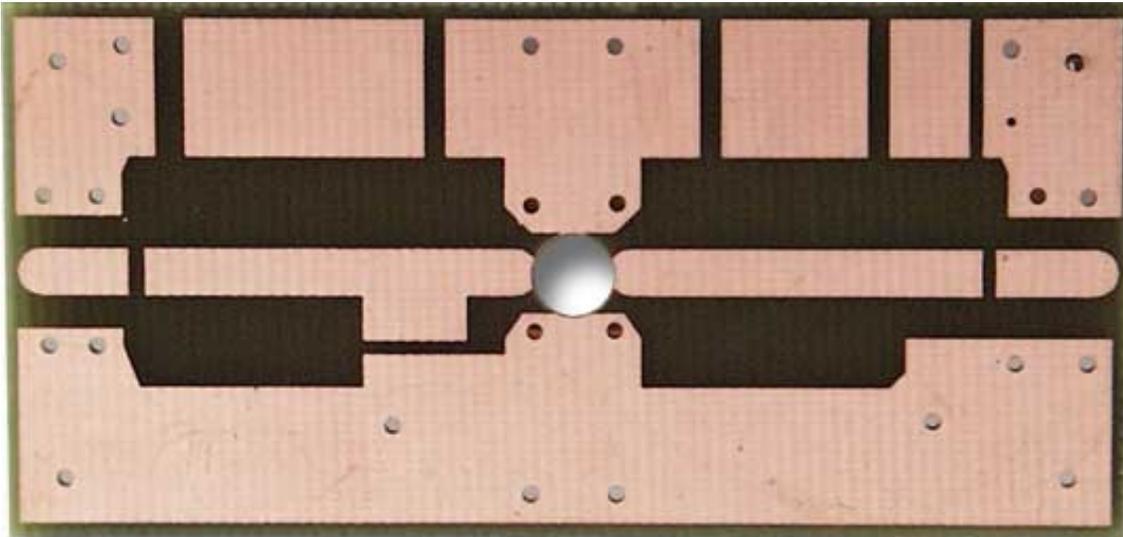


Fig 2

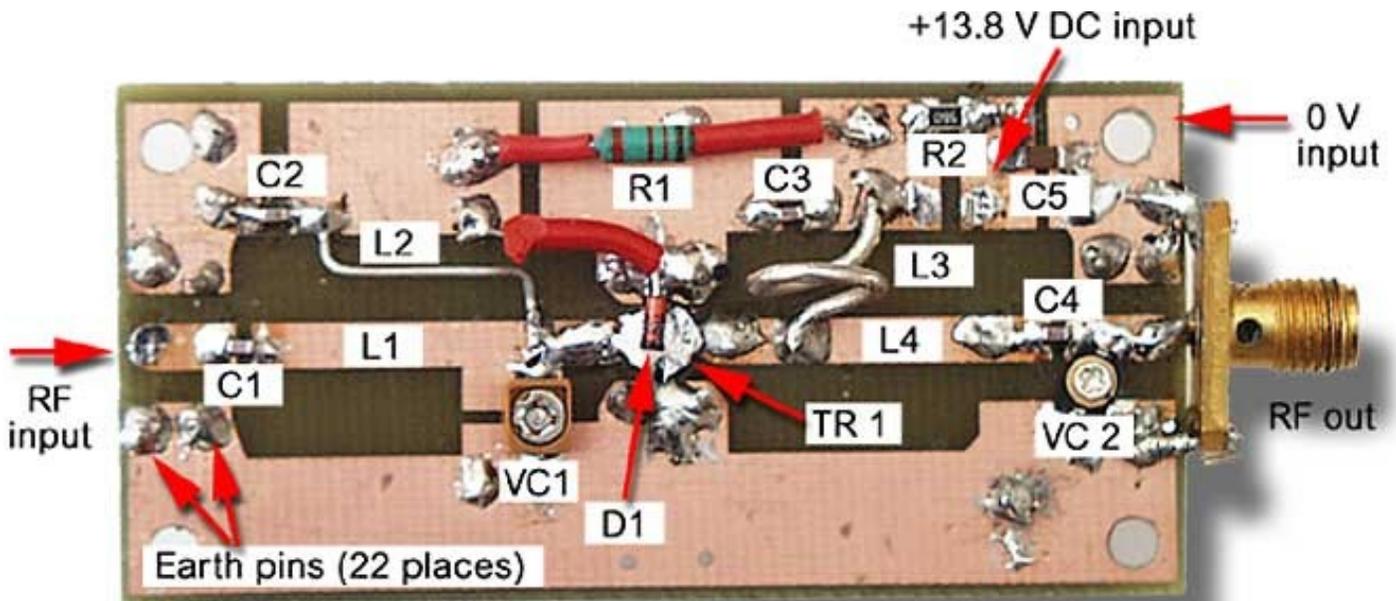


Fig 3

Component List

C1;C2;C3;C4 = 100pf 5m chip

C5 = 100n 5m

R1 = 1K2 0.25W

R2 = 56 Ohm 5m chip

TR1 = BLU 98 (leads trimmed)

D1 = IN4048

VC1 = 1.4 - 4.5pf 5m

VC2 = 1 - 2.5pf 5m

L2 = 2cm 28 gauge wire (aprox)

L3 = 1 turn 6mm ID, 1.3mm dia. wire (silver plated)

L1;L4 = 50 Ohm line

RF Design

The amplifier uses a stripline configuration on double-sided G10 fibreglass circuit board with RF input and output lines of 50ohm impedance. The RF input line L1 to the input of the BLU98 (TR1) has a 100pf DC blocking capacitor close to the RF input. No RF impedance data were available for the BLU98 but it was assumed to be very similar to the BFR96S which seems to have been borne out in practice. Inspection of the Smith chart impedance diagram shows the input is conveniently close to 50 ohms impedance but with a small amount of shunt inductance at 1300Mhz. A small matching capacitance (about 2pf) is therefore connected from base to ground to cancel the inductive component. This is provided by trimmer capacitor VC1 connected to ground from a small pad on the input line (L1) close to the base of the BLU98 and adjusted for best input match in the middle of the operating frequency band.

The DC return for the base of TR1 is via L2, a short hair-pin section of high impedance line effectively forming an RF choke connection to a small copper pad on the circuit board. This pad is grounded for RF via C2 (100pf) to an adjacent earth pad which has several earth pins through to the copper ground-plane side of the PCB. The two emitter leads of TR1 are grounded to earthed pads on either side of the 50 ohm input/output lines. These pads are also connected to the ground-plane side of the board via several earth pins at each pad close to the emitter leads.

The optimum output impedance of TR1 is close to 50 ohms resistive but slightly capacitive at the design frequency. A small single-turn inductor L3 is therefore connected in shunt across the output line L4 close to the collector of TR1 to provide a first-order cancellation of the shunt capacitance. An RF by-pass capacitor C3 (100pf) is connected between the DC supply end of L3 and one of the emitter ground pads of TR1. Output matching adjustment is provided by a small trimmer capacitor VC2 (about 1pf) mounted across the output line L4 at a distance of 24mm from TR1. A DC blocking capacitor C4 (100pf) is inserted close to the end of the RF output line L4. Grounding pads are located on either side of the RF input end of L1 and the RF output end of L4 to allow grounding of the screens of the input and output coax connections . Each of these ground pads has several ground pins through to the ground plane.

DC Circuit Design

The amplifier is primarily intended for ATV operation with wide-band FM input which would allow class C or zero-bias class B operation. However, for this application the BLU98 is operated in class B with a small amount of forward bias current since this gives higher gain than the zero bias condition and hence higher RF output power with the limited drive available from the G1MGF video transmitter source. The +13.6V DC supply is first fed to a bypass capacitor C5 (100N) which is connected from a small isolated pad to a ground pad (again with several grounding pins) and then via R2 (56 ohm) to the collector bypass C3. From there the DC feed also goes via the forward bias resistor R1 to C2 and hence via line L2 to the base of TR1.

A shunt diode D1 (1N4048) is connected across the base of TR1 from C2 to ground to set the base emitter voltage of TR1. This arrangement gives a measure of self-protection against thermal run away or over drive. As the collector current increases under drive, the voltage drop across R2 increases thus tending to reduce the forward bias. Diode D1 is physically mounted across the top of TR1 with a dab of thermal heat-sink compound to provide good thermal contact with the top of TR1. Resistor R1 sets the standing current of TR1 and is selected to give about 5 to 10mA of collector current with no drive. Under these conditions the total standing current including that through R1/D1 should be about 15 to 20mA. Under RF drive conditions of 50mW input the total input current is about 75mA and RF output of approximately 250mW depending on frequency. Under these conditions the DC collector voltage at C3 will be approximately +10V

With higher drive input, the amplifier is capable of giving up to 0.5W at about 150ma DC input current Be careful however not to overdrive the BLU98 and induce thermal runaway which can result in the device self-destructing. After removing drive, the standing current should go virtually immediately back to its standing current of around 20mA and not drift upwards.

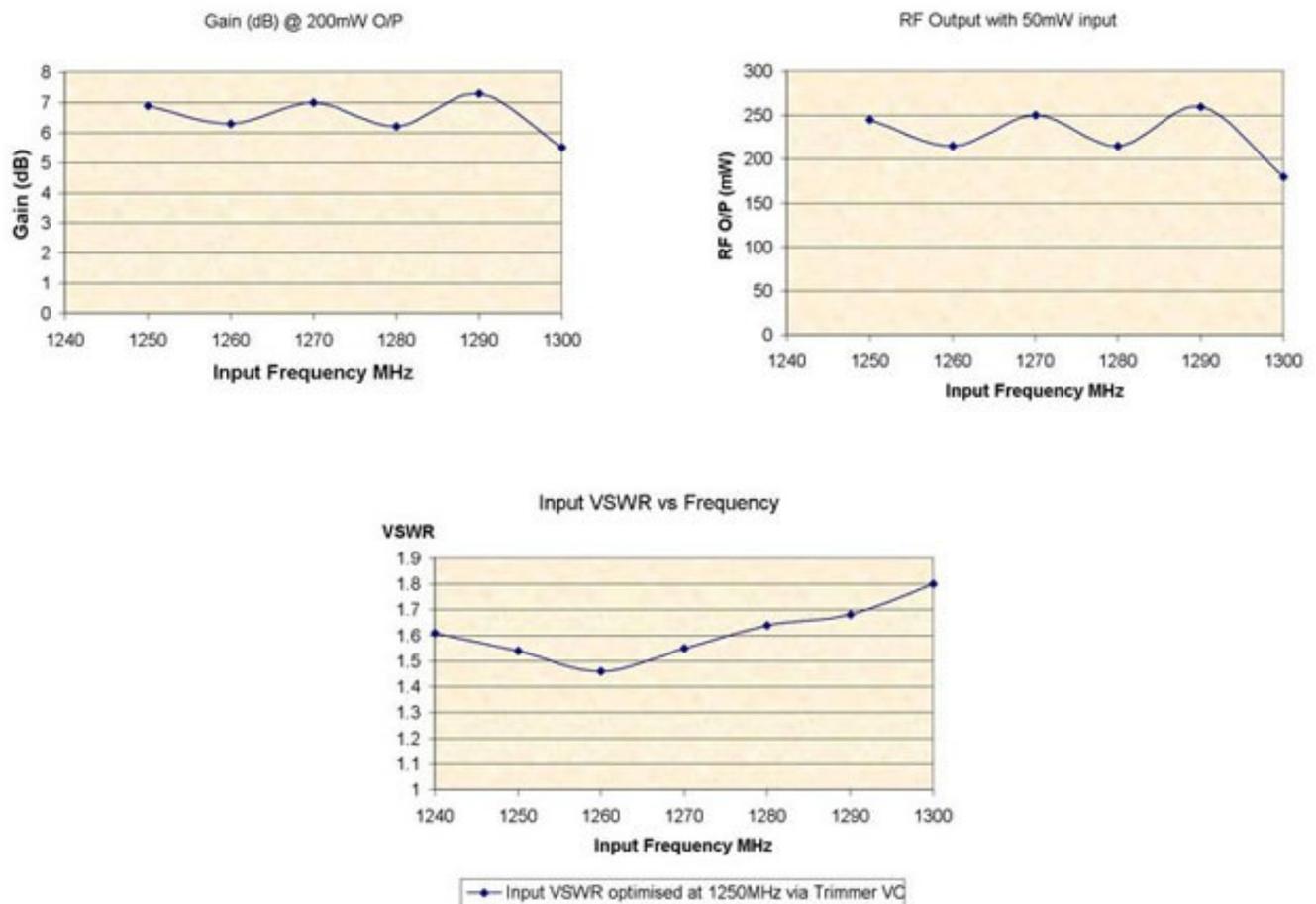
The amplifier is mainly intended for FM operation but if operation on SSB is also intended, then it would be advisable to connect a capacitor of 47uF or 100uf from C3 to ground to smooth out any fluctuations at voice frequency in the DC voltage

at that point which otherwise would cause distortion and adjacent channel inter-mod. products.

Performance

The input VSWR was measured at 50mW RF input using a directional coupler and power meter to derive forward and return loss. The input VSWR was optimised at 1250MHz by adjusting trimmer VC1 assuming that the intended use was for ATV repeater input access. The input match was around 1.5 over a 20MHz band and less than 1.8 over at least a 60MHz band as shown in the graphs below. If operation is mainly concentrated at the SSB end of the band around 1296MHz or as a repeater transmitter the VRWR would be better adjusted at the HF end of the band.

The graphs below show that the measured power output was essentially flat between 200 and 250mW over a 60MHz band for 50mW input. The maximum output was around 0.5 watts when full driven.



Final Comments

Anyone needing a blank PC board and components or help in construction and testing, contact Derek G3GRO (Tel: 01293 520 424) where test gear for 23cm is available.

Thanks are due to Lech G3KAU in preparing the negative of the PC board and Adrian G3VJM for manufacturing the circuit boards for the prototypes and also Mike Guest G0VYN and Stuart G3YSX in helping to prepare this newsletter article with photographs etc.

Derek G3GRO - Derek can be contacted [by email](#)

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