G3WDG004 HEMT Low noise Amplifier

The G3WDG004 amplifier is an ultra low noise preamplifer intended for high performance tropo and EME applications. It uses a well-proven, reliable, HEMT device from Fujitsu to achieve a very low noise figure and high associated gain. It can be built with either SMA input or WG16 (WR90). If waveguide input is used, a slightly better system performance is possible (in a waveguide system of course), as the loss of one SMA - WG transition is eliminated. The construction of the WG version is however more difficult and considerably more time consuming, and is not recommended for those without considerable experience and a need for ultimate performance eg EME. Even then, unless equipment is available for optimising noise figure, it is unlikely that the basic performance of the WG amplifier will be any better than an SMA one plus transition for reasons of construction tolerances! Also, the WG input version has not been through our normal Beta testing Quality flow, and is therefore more of a risk. However, the author has built some 5 WG input prototypes, all of which worked very well. Details of contruction of the WG input version are available from us on request. Note that conductive epoxy has been used which may be difficult to obtain. It is very probable that the epoxy can be omitted, but THIS HAS NOT BEEN TRIED. The kit of components is applicable to either version. The small brass collar used in the WG version is available separately from the Components Service. The waveguide assembly is not available.

The circuit diagram of the amplifier is shown in Fig. 004/1. The device is operated with grounded source, and the pcb is supplied with the grounding pins for the sources already fitted. Microstrip circuits are used to provide the correct input and output impedances for the HEMT. ATC capacitors are used to as DC blocks, and one is even used in the WG input version. Do not replace this with a short circuit, as a certain amount of impedance transformation takes place in the capacitor, which is designed in!

The layout is shown in Fig 004/2. Note that some of the components are mounted on the groundplane side, together with the PSU board. A new PSU board is introduced with this kit, and uses all surface mount parts. The 7660 should have its legs cut off close to the body for maximum neatness! The layout of the new PSU board is shown in Fig 004/3.

Construction of the SMA version follows the procedure outlined elsewhere in this booklet. Note that great care is required to avoid damaging the HEMT from static discharge and/or soldering iron leakage. HEMT devices are considerably easier to damage than normal GaAs FETs and special precautions MUST BE TAKEN, as detailed below. The Microwave Committee Components Service cannot replace damaged devices free-of-charge!!

Damage from electrostatic discharge (ESD) is avoided by never allowing the possibility of the sensitive device having a different potential to any object it touches, including yourself. A simple static-free workstation should be made, such as a sheet of metal to which a wire is attached. The free end of the wire is joined to either a proprietary ant-static wristband worn at all times, or to some form of homemade body contact (such as a wire wrapped round a ring). For safety reasons it is recommended NOT to earth the workstation, and to use a high value resistor eg 100k in series with the wire if using a homemade body contact. The HEMT may than be safely unwrapped and placed on the worksurface. Source leads are cut short next using sharp sidecutters. If the sidecutters are of the type with insulated handles, touch the metal part of the cutters before allowing them to touch the HEMT leads. At all times keep the HEMT in your fingers, held in metal tweezers or on the worksurface. Dropping the HEMT at this stage anywhere off the workstation is not recommended!

The last stage in the construction of the preamp (WG or SMA) is the installation of the HEMT. The amplifier should be otherwise complete and tested for correct voltages at the ends of the lines where the HEMT is to be connected. With no power applied to the preamp, place it on the metal worksurface and connect a wire between the worksurface and the preamp box. Next. arrange some form of connection between the soldering iron bit and the worksurface, separate from the mains earth. Check that even when hot, there is a low resistance path from the soldering iron tip and the worksurface.It is also worth checking that there is no leakage in the iron by measuring resistance between the tip and the heater connections of the iron, with the iron cold and hot. The HEMT may then be placed in position and its source leads soldered as described elsewhere in this booklet. It is important to avoid touching the gate and drain leads with the iron during this operation. Before soldering the gate and drain the iron should be completely unplugged (retaining the tip-worksurface connection of course).

One assembled into the circuit, the device is safe. However if for any reason soldering operations are required in the future, be sure to repeat the precautions. The author has damaged several HETs in the course of developing this unit when soldering in tuning stubs and forgetting to connect the iron-worksurface link, and/or unplugging the iron. Some irons claim to have an ESD connection - I would not trust this! Sometimes after zapping devices do not fail catastrophically - the noise figure rises by a few tenths of a dB but otherwise the amplifier seems to behave normally. Poor final performance may therefore be related to device damage. This has happened to the author.

Tuning up of the amplifier is straightforward, the only adjustment required is to set the drain current to 10mA using VR1. If noise figure measurement kit is available, try adjusting VR1.
Performance of the amplifier should be NF approx. 1dB, gain 12dB. For the WG amplifier, tuning crews may be inserted into the tapped holes and adjusted for best performance (unlikely to get more than .1 - .2dB improvement), retaining with locknuts. The last point concerns the need for lossy rubber. Some protoype amplifiers work very well with no lossy rubber in the lid, others have shown a degradation (sometimes serious). All prototypes performed well with a small piece mounted centrally on the lid, and this is recommended.

HEMTs are more sensitive than normal GaAs FETs to damage from high RF inputs. The FHX06 should be quite happy with 1-10mW input, but higher levels could cause catastrophic damage. In use therefore care should be taken in the design of the T/R system to avoid high levels of RF from reaching the preamp. Relays with poor isolation could be a problem, and if relays have a sense contact, this should be wired to interlock the T/R control to prevent transmitting until the relay has changed over. Users of TWTs should take particular care! It should be noted that a lot of the small SMA relays around on the surplus market are unsuitable for powers above a few watts, and damage to the relay and hence to the preamp is a definite risk.

Parts List

Part	QTY
G3WDG004 pcb	**1**
FRE023A	**1**
ATC 2.2p chip	**2**
Veropins	**6**
FHX06	**1**
2k2 preset	**1**
2k2 1206 chip	**1**
47R 0805 chip	**2**
180p 0805 chip	**2**
1u chip	**2**
10u chip	**1**
22u chip	**2**
7660	**1**
78L05	**1**
.2 mm wire (remove insulation)	**1**
silver loaded solder	**1**
6.8u tant wire ended	**2**
3.3V zener	**2**
2.4V zener	**2**
lossy rubber	**1**
booklet	**1**
warning leaflet	**1**
sma connectors	2
1000p FT cap	1
tinplate box type 7750	1

bold = in kit

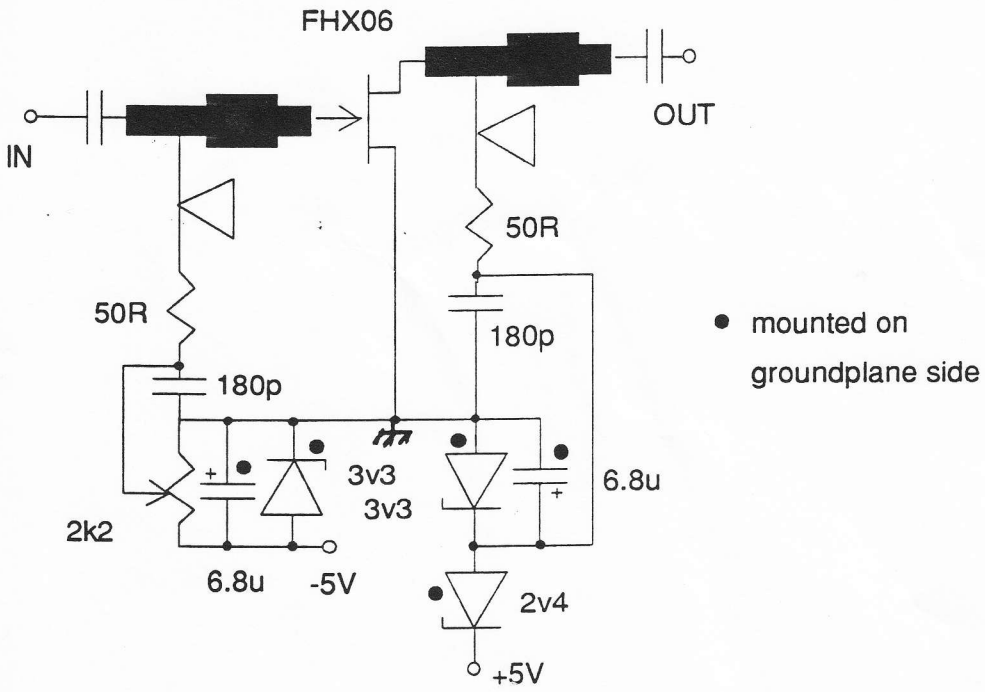
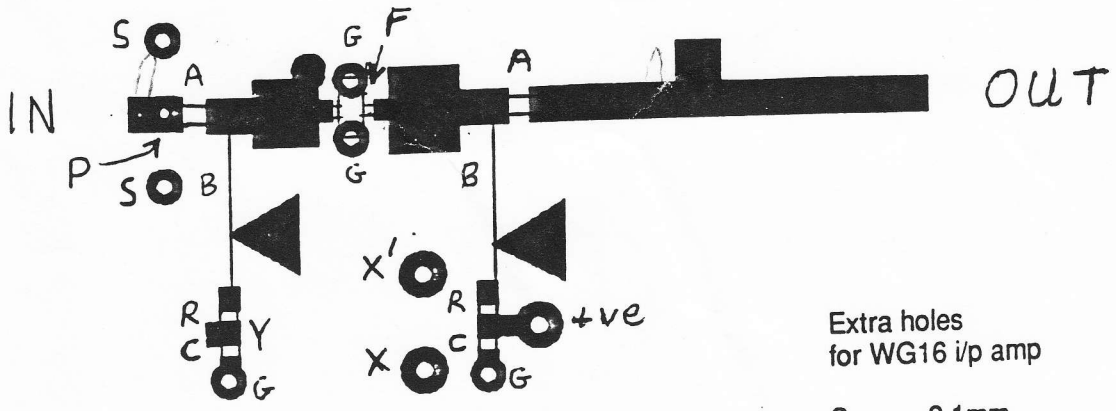


Fig 004/1 Circuit diagram of G3WDG004

G3WDG004

1.3dB WITH LID
29 SEP 93



Extra holes
for WG16 i/p amp

S: 2.1mm
P: 0.9mm

Fig 004/2 Layout of G3WDG004 preamp

Key to components

A	2.2pF ATC (mounted with lettering on top)
B	bias wire, mounted flat to the board, soldered to tip of triangular element
C	180pF chip cap
F	HEMT (cut lead is gate)
G	grounding veropin
R	47R chip res
X,Y	position of connections to bias pot (**X'** is -ve input)

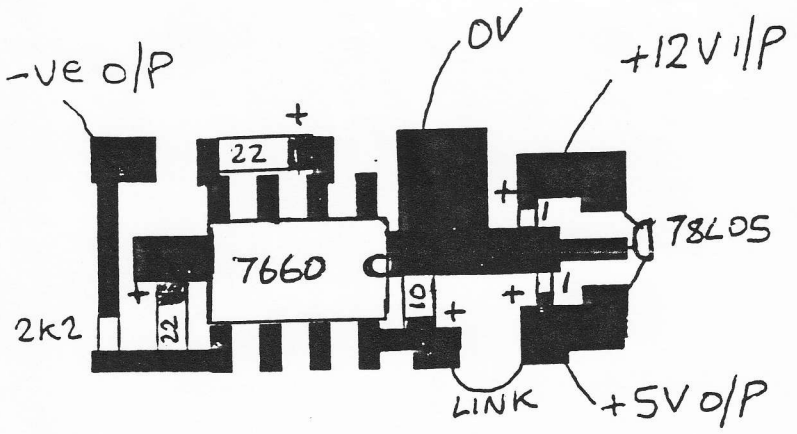


Fig 004/3 Layout of SMT power supply

Notes

Tantalum chip capacitors have white mark to denote +ve end
78L05 regulator mounted with flat away from board.
Test correct operation of regulator **before** connecting link!