Wideband preamplifier & bias tee

An economical 30MHz to 3GHz design that will liven up many a receiver

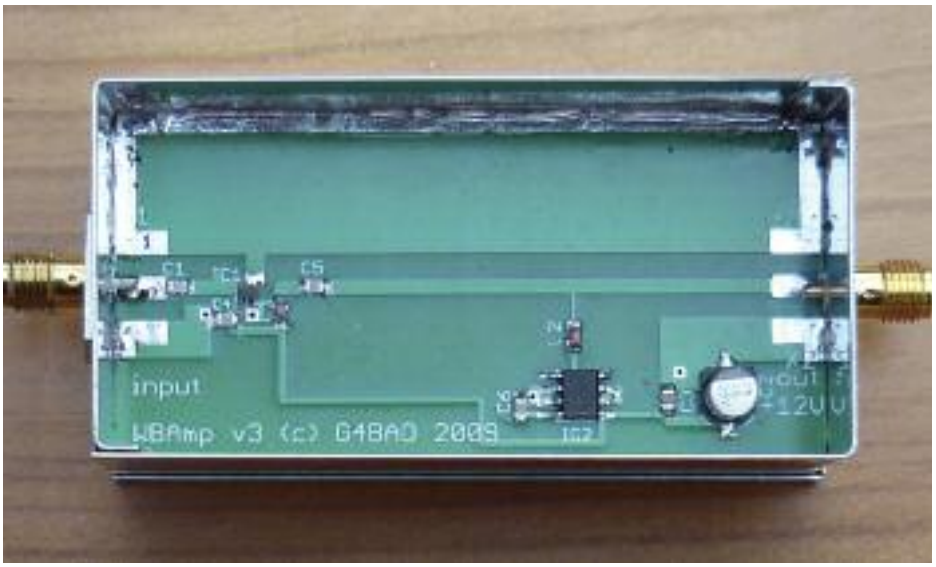

PHOTO 1: Completed preamplifier fitted in its tinplate box.

PARTS LIST

Preamp components (all SMD)

C1, C4, C5	1nF npo ceramic (0805)
C2	10µF 16V
C3	100nF X7R ceramic (0805)
C6	330nF X7R ceramic (0805)
L1	680nH inductor (0805)
L2	1µH inductor (0805)
IC1	ABA52563Avago Modamp
IC2	UA78L05ACDG4 5V regulator (SO8)

Bias tee components (all SMD)

C1	330pF npo ceramic (0805)
C2	1nF npo ceramic (0805)
C3	10nF X7R ceramic (0805)
L1	820nH inductor (0805)
L2	220µH Bourne CM453232-221KL

INTRODUCTION. This article describes a wideband preamplifier that offers useable gain between 30MHz and 3GHz. It gives typically <3.5dB noise figure and >20dB gain between 30MHz and 1500MHz, falling to around 19dB gain and 4.6dB noise figure at 3GHz. While it is not designed to compete on noise figure and gain with the narrow band preamplifiers of the type designed by G4DDK **[1]** et al, it can make a very useful addition to a wideband receive system, or as a general purpose test amplifier.

The preamp can be powered up the coax via the companion bias tee, so it can be placed at the masthead and will 'liven up' many a wideband receiver by overcoming coax cable losses. The amplifier itself is linear but, that said, care should be taken if you already suffer from strong local signals. Putting a lot of very wideband gain at the masthead may make this worse.

The design is very simple and based around a single Avago ABA52563 **[2]**, 3.5GHz 'modamp' device, and is realised in surface mount components on inexpensive 0.8mm FR4 PCB material.

The preamp PCB is designed to fit in to a readily available 37 x 74 x 30mm tinplate box. The bias tee fits a similar box of 37 x 37 x 30mm **[3]**. SMA or N connectors can be fitted, according to taste. See **Photo 1** and **Photo 2**.

PREAMP CIRCUIT DESCRIPTION. The circuit is shown in **Figure 1**. No real originality is claimed for the RF circuit, as the Avago application circuit was followed fairly closely. The preamplifier requires no tuning and has a built-in 5V regulator and bias tee to allow the supply to be fed up the receive coaxial cable from the second bias tee at the shack end.

As the device is nominally 50Ω in and out, only DC blocking capacitors (C1, C5), a bias feed L1 and decoupling, C2-4 are needed. The power supply (from the output connector) feeds into a familiar 78L05 regulator, putting 5V onto the active device via RF choke L2.

BIAS TEE CIRCUIT DESCRIPTION. The circuit is shown in **Figure 2**. For a bias tee you should aim to produce as little loss in series to the RF over as wide a bandwidth as possible and as high a loss to RF through the DC port. A 330pF capacitor C1 is a good compromise to give reasonably low loss at the LF end. The DC feed consists of two inductors and bypass capacitors. The small RF inductor L1 is effective at higher frequencies; the larger L2 works well at the low frequency end.

CONSTRUCTION. Construction should be fairly straightforward. Rather than duplicate information, readers are invited to read the construction notes accompanying G4DDK's downconverter article (p58) for basic

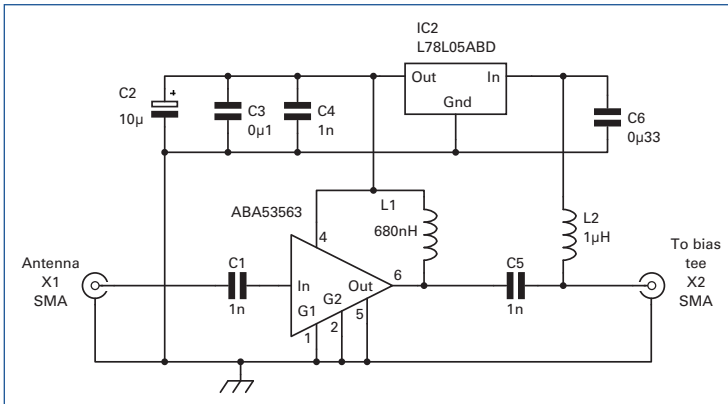

FIGURE 1: Circuit diagram of the wideband preamplifier.

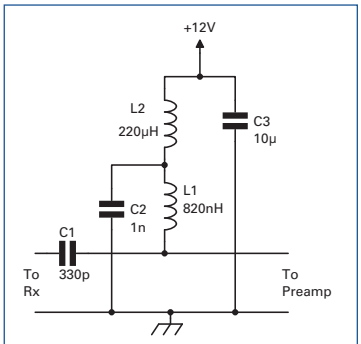

FIGURE 2: Bias tee circuit schematic.

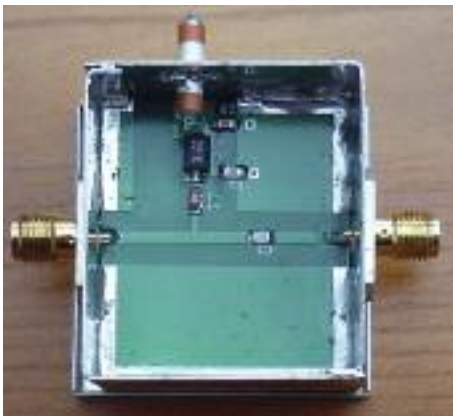

PHOTO 2: Completed bias tee.

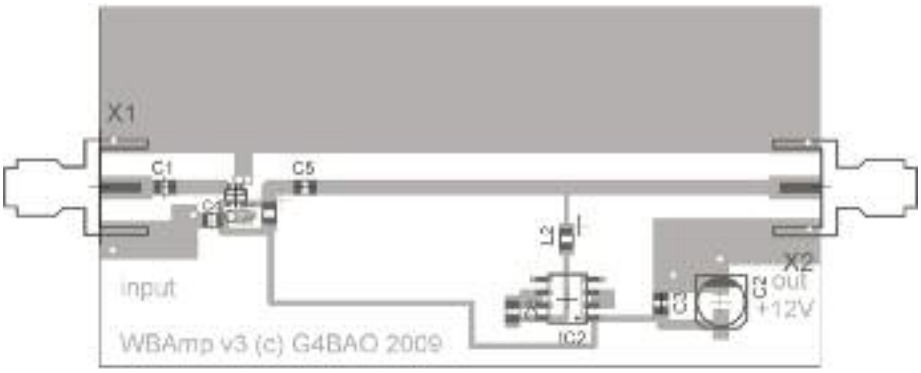

FIGURE 3: Preamplifier PCB overlay.

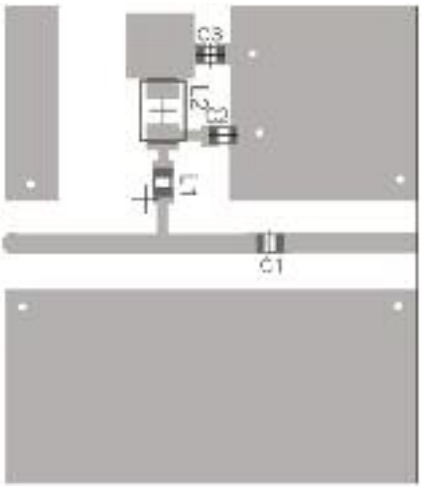

FIGURE 4: Bias tee PCB overlay.

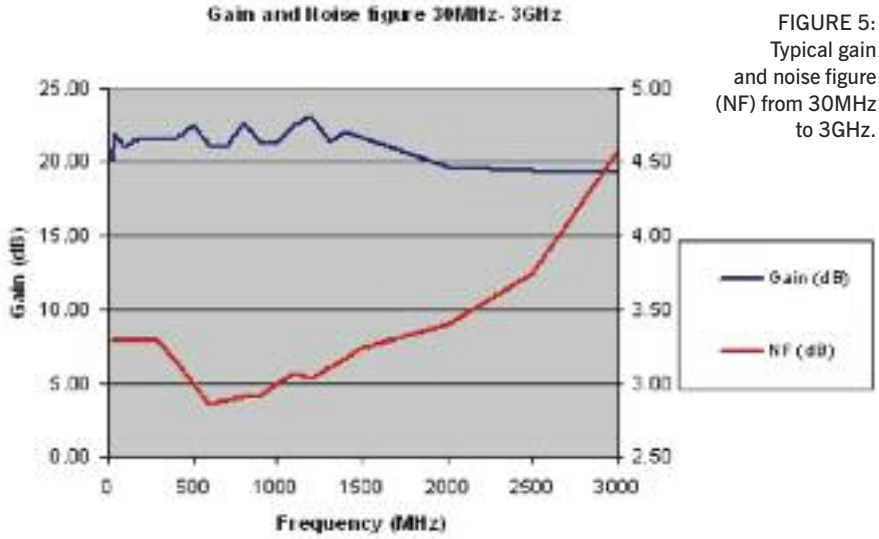

FIGURE 5: Typical gain and noise figure (NF) from 30MHz to 3GHz.

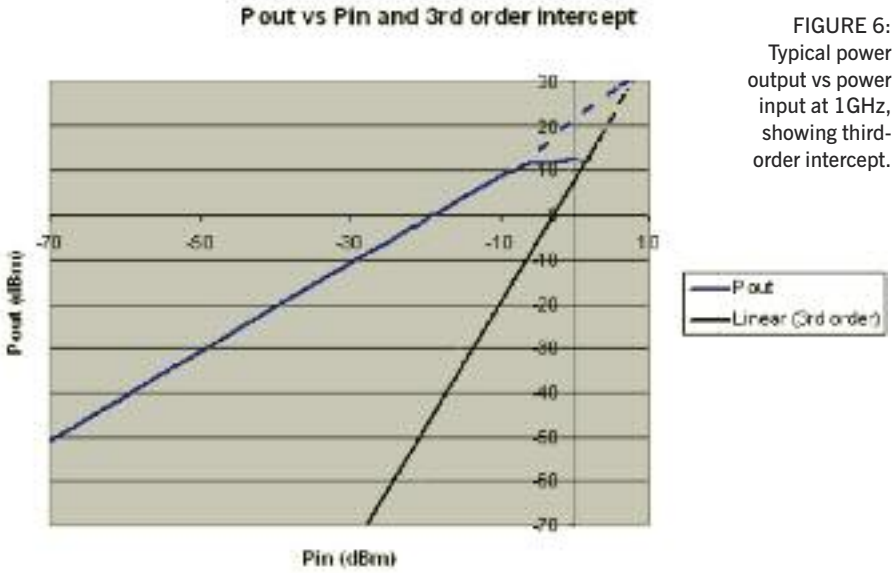

FIGURE 6: Typical power output vs power input at 1GHz, showing third-order intercept.

construction information including how to construct the tinplate boxes, mount connectors etc. The preamplifier overlay is shown in **Figure 3** and the bias tee overlay in **Figure 4**.

Neither the preamplifier or bias tee require any tuning.

RESULTS. Test results of gain and noise figure for a prototype preamplifier are shown in **Figure 5**. **Figure 6** shows the power output and linearity of the preamplifier at 1GHz. The amplifier saturates at an output power of around +12dBm, and its third order intercept is +30dBm. This was determined using two signals 10kHz apart and measuring the level of third order intermodulation products. Note that third order intercept is a measure of linearity: the amplifier will not produce +30dBm output!

The bias tee has an insertion loss of 1dB or less between 30MHz and 3GHz; this is negligible, given the preamplifier gain.

CONCLUSIONS. This preamp uses readily available, inexpensive components and is relatively easy to build by someone with a steady hand, small soldering iron and a good magnifier. I use it at the masthead with my Icom ICR8500 and a not very broadband 'white stick' antenna, originally designed for 900MHz. It is fed by 20m of UR67 coax, which not exactly ideal! The preamp makes the GB3MHL beacon on 23cm readable when nothing is detectable with just the antenna alone and makes a noticeable improvement to the not-so local repeaters on VHF and UHF.

PCB AVAILABILITY. Kits for this project, including PCBs, are available from the author. E-mail john@g4bao.com or see www.g4bao.com for details.

WEBSEARCH

[1] Details of G4DDK preamplifiers can be found at www.g4ddk.com/VLNAcontents.html.
[2] Data sheet for the ABA-52563 3.5GHz Broadband Silicon RFIC Amplifier is at www.avagotech.com/docs/AV02-1785EN.
[3] Suitable tinplate boxes can be obtained from Alan Melia, G3NYK, see www.alan.melia.btinternet.co.uk/componen.htm