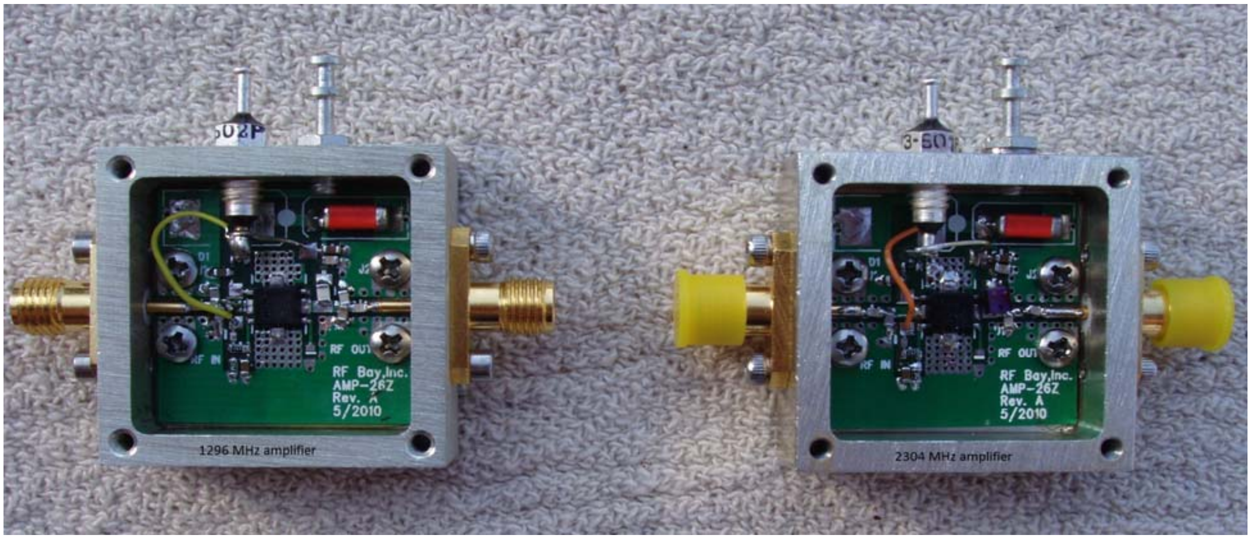
A 2 WATT DRIVER AMPLIFIERS FOR 1296/2304MHZ

by Chuck Steer WA3IAC



Just like my 3456MHz. Amplifier, the 2304 and 1296MHz amplifier use the same pcb layout. Most of the parts remain the same. All that change is the matching networks and the device. This two watt amplifiers described in this article will work for anyone needing a low level, class AB driver or just QRP power amplifier for roving or microwave beacon. Weather your needs are for CW, SSB, FM, or digital mode this amplifier will most likely work for you.

About MMIC's in general

Micro monolithic integrated circuit have been with us for sometime now. Low power ones work up to 8 or 10GHz. with only 10 or 15 mW of output power in a '086 package. The gain of most of the MMIC's became lower as frequency increased about 1000MHz. The major advantage was that little or on tuning was needed. Add to this the lower cost, MMIC's became very popular with most builder. The main drawback was that the quiescent current was a bit higher than when using a FET for the same power output. Even so, MMIC's still found there way into most projects, and most were match to about 50 Ohms in and out. As the years moved on and so did MMIC's and we saw power increase and noise figures decrease. Now finding one watt at 2 or 3GHz is not uncommon. Most of these devices now are +5 volt and come in new packages ('089, SOIC-8, SOF-26). With very little tuning it was an easy using MMIC were easy to build and test.

About the SPB-2026Z device

The SPB-2026Z is a high linearity .7 to 2.2GHz 2W single stage Class AB Hetero junction Bipolar Transistor (HBT) amplifier housed in a proprietary surface-mountable plastic encapsulated package. The HBT amplifier is made with InGaP on GaAs device technology and fabricated with MOCVD for an ideal combination of low cost and high reliability. Unlike the lower power MMIC's the SPB-2026Z is per-matched to approximately 5 ohms on the input for broadband performance and ease of matching at the board level. It features an in output power detector, on/off power control, ESD protection, excellent overall robustness, and a proprietary hand re workable and thermally enhanced SOF-26 package.

General Specifications:

Frequency Ragne: 700MHz to 2200MHz
Gain: 13.6dB at 1842MHz; 13.7dB at 1960MHz; 13.6dB at 2140MHz
Noise Figure: 5.2dB at 1960MHz
P1 dB: +33.9dBm at 1842MHz, +33.8dBm at 1960MHz; +32.8dBm at 2140MHz
IMD3: -49dBc at 1842MHz; -45dBc at1960MHHz; -48dBc at 2140MHz
(+22dBm per tone at 1MHz spacing)
In/Out Return Loss: -14dB/-12dB at 1960MHz
SOF-26 Package

pin 1 active bias circuit

pin 2 RF input, and has a DC voltage present

pin 3 power up/down.

This voltage should be at but not over +5 volts at pin 1 and limited to less then 10mA

pin 4 power detector.

Voltage samples the power at the input of the amplifiers not the output.

Pin 5 RF output and Vcc.

Pin 6 n/c

Assembling components on the printed circuit board

Mount the SPB-2026z device first by first tinning the bottom then heating the board to between 180 and 190deg to flow the solder. Having done that, solder the body of the device to the board leads to the pads. A good ground connection is essential not only for the return but for the device to disperse the heat within.

The board layout is for a 0402 size component but I used 0603 that just fit on the pads. The 10pf capacitors used in the RF path were ATC600S found on Ebay. Although 0402 ceramic capacitors seem to work OK at 1296 and 2304MHz. All other capacitors were 0603 and the chock was 0805 size.

As for soldering, I use the three-second rule. That is not to apply heat for more then three seconds. If retouching is needed, let the component cool down before re-soldering. My solder is thin, 015 inch as well as my solder wick.

SOF-26 package

Unlike the first generation of low power MMIC's, this one requires a bias line (pin 1). This isn't a problem because in this amplifier the bias is +5 volts. The power up/down (pin 3) must be at or less then +5 volts so just adding a simple resistor divider works fine. Pin 4 power detector voltage samples the power at the input of the amplifiers not the output. All that is needed is some by passing capacitors. One note, on the board layout, L1 was omitted and a jumper was used to connect to +5volts (figure 4a) L1 was then used for the input inductor in the 1296MHz amplifier.

2304 test and tune up:

The SPB-2026z is rated from 700 to 2200MHz. I decided to try and tune it up at 2304MHz and see just how well it would work. With +5 volts the quiescent current (Idq) should be between 320 and 420mA. I used a network analyzer to get the best S11 and S22 before applying RF drive. With +21dBm input (125mW) I tuned for 2-watt (33dbm) output. That was saturated power, not liner. At full drive the current was just under 1 Amp. The values in the parts list were the values used, but could vary a little having only built one. In my case I did not have the idle values and so I paralleled two capacitors. I used 0603 size, but 0402's would make an easy fit.

1296 test and tune up:

The approach was the same as with the 2304 version. Quiescent current was in the same range as well as gain. However, a small inductor was needed in the input line to improve the match. I used a hair pin wire about 0.2 inches long of #30 wire, but an SMT 0805 inductor of 1.2 to 1.8nH could be used and reselect the capacitors. In order to do this, the input line was cut just after C7, C8 junction and the solder mask was removed. As in the 2304 version, the capacitor I had on hand were between the values so another capacitor was added in parallel. The match on the output was fine without adding an inductor.

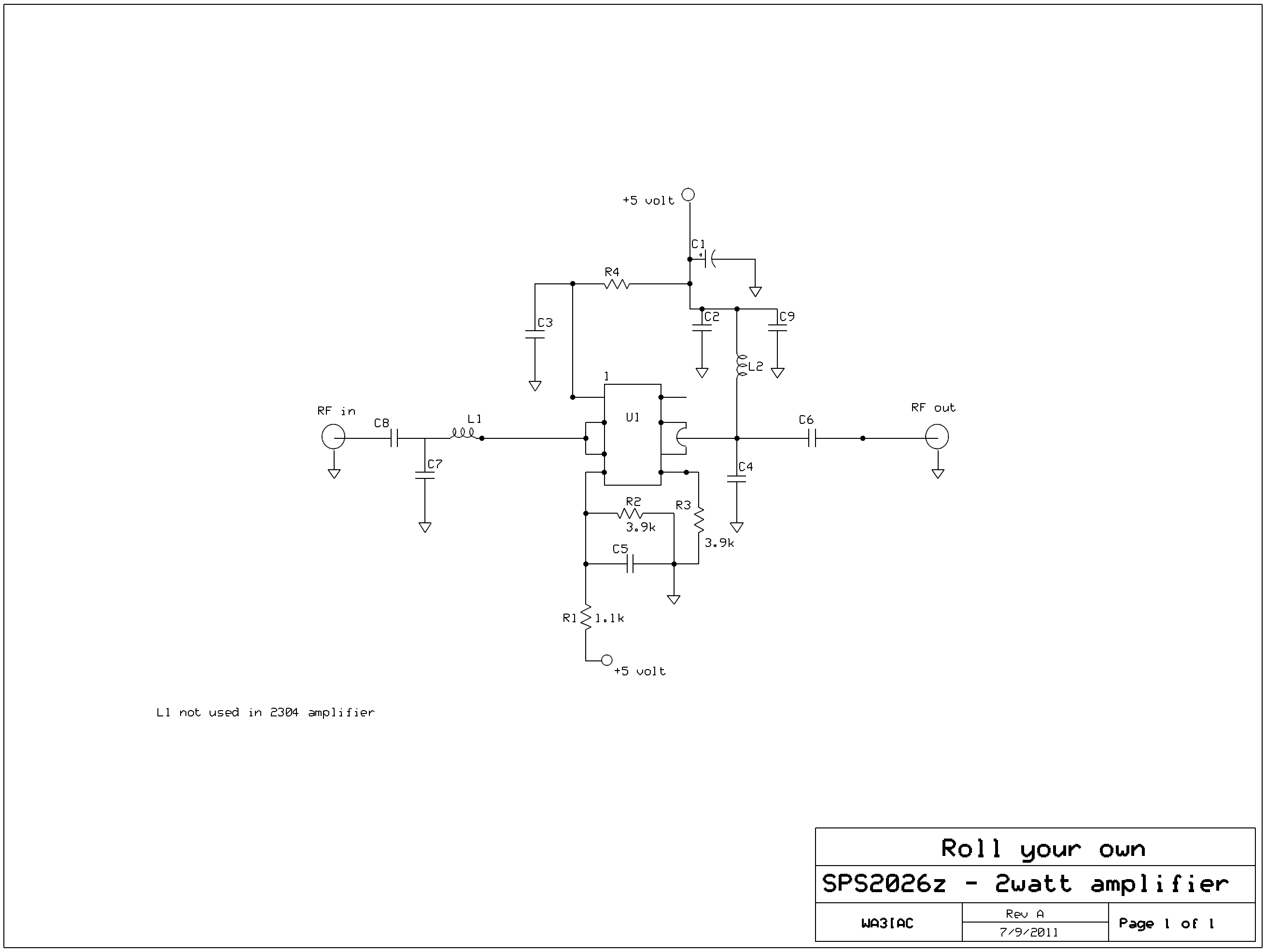


Figure 1

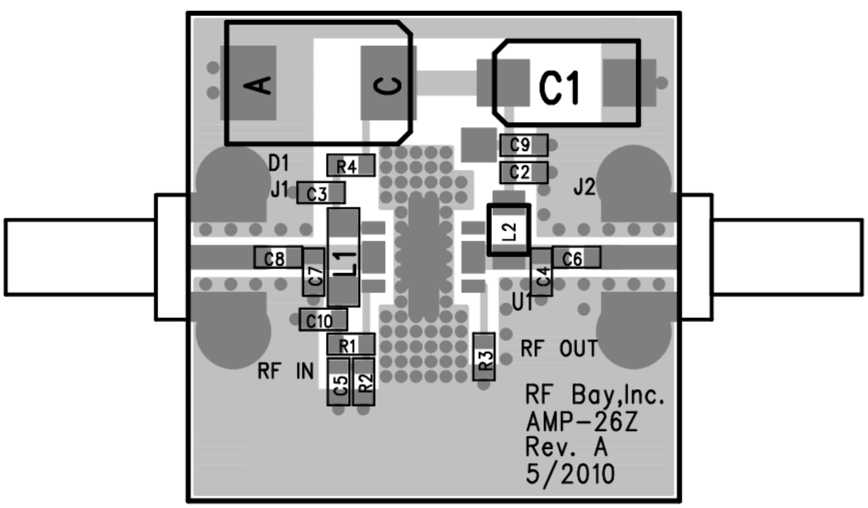


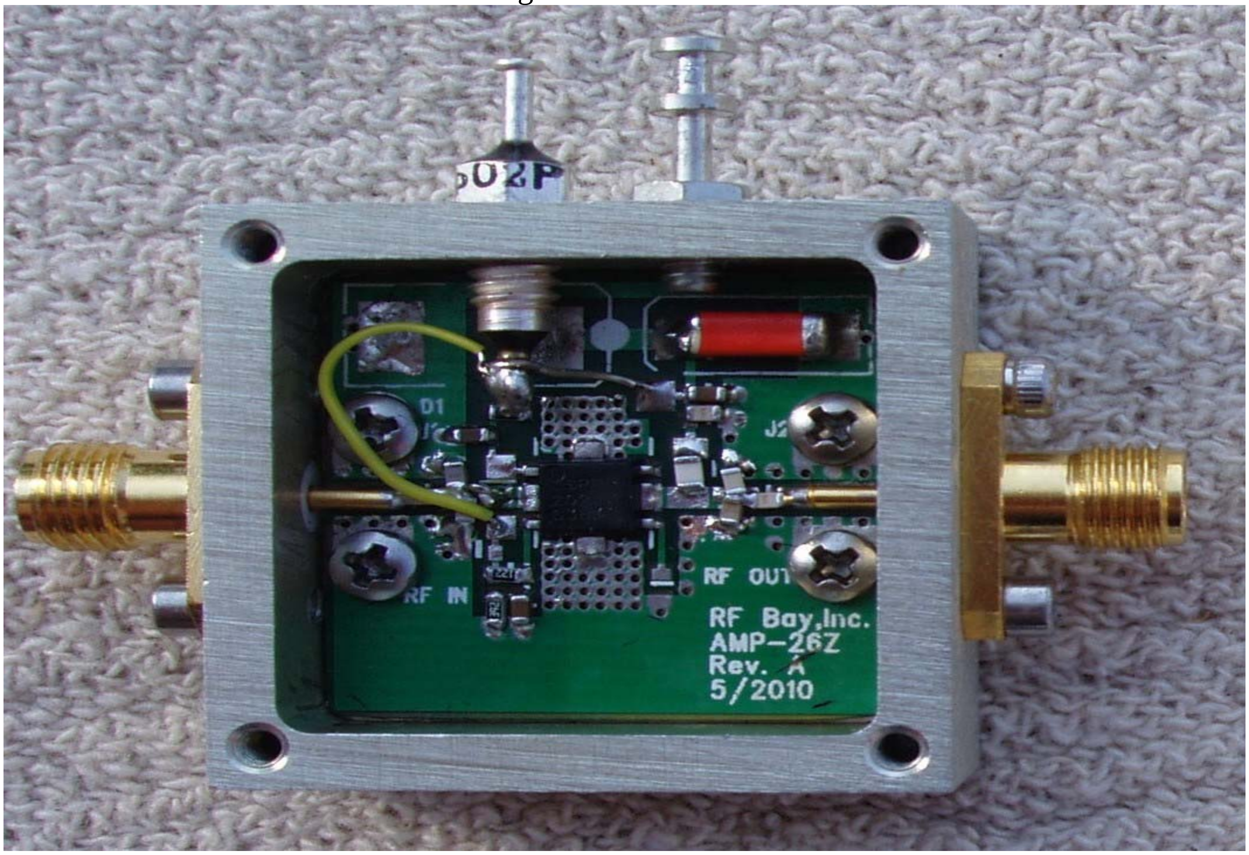
Figure 2

	1296MHz	2304MHz	

C1	10uF @ 25v	10uF @ 25v	Size "C", "D", 1206, 1008 Tantalum
C2	27pf	27pf	0402 or 0603 ceramic
C3	.1uF	.1uF	0402 or 0603 ceramic
C4	5.6 +0.7pf	1.2pf	0402 or 0603 ATC 600s or ceramic
C5	.1uF	.1uF	0402 or 0603 ceramic
C6	10pf	1.5pf	0402 or 0603 ATC 600s or ceramic
C7	2.7 + 3.3pf	1.5pf	0402 or 0603 ATC 600s or ceramic
C8	10pf	1.0pf	0402 or 0603 ATC 600s or ceramic
C9	.1uf	.1uf	0402 or 0603 ceramic
L1	1.2nH	n/a	.2 inch long, #30AWG, hair pin see text
L2	33nH	33nH	Coilcraft
R1	1.1K	1.1K	0402 or 0603
R2	3.9K	3.9K	0402 or 0603
R3	3.9K	3.9K	0402 or 0603
R4	0 Ohm	0 Ohm	0402 or 0603
U1	SPB-2026z	SPB-2026z	SOF-26 package

Figure 3

Figure 4a 1296 MHz



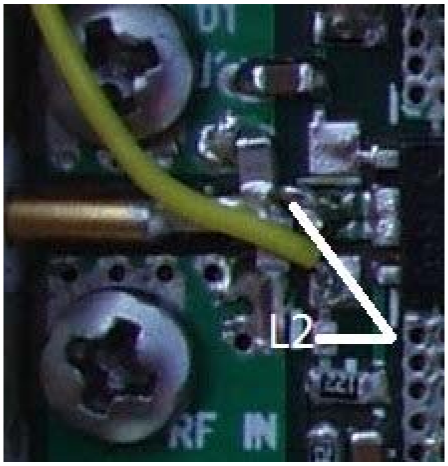


Figure 4b 1296 MHz look at L2 coil

NOTES:

Detail Spec on Web as follows:

http://www.rfmd.com/CS/Documents/SPB-2026ZDS.pdf http://www.rfmd.com/CS/Documents/SPB-2026ZSPACEAmplifierSPACEApplicationSPACECircuitsSPACEApplicationSPACENote.pdf

Digi-Key: www.digikey.com/

Mouser : www.mouser.com/

Milled housing: www.rfmicrowave.it/

Complete kits are not available.

pc board was from RF Bay, Inc. They do not have kits or tested amplifier assembles.

I have a limited supply of printed circuit boards and/or SPB-2026Z (903 to 2304MHz.)
same board layout difference device: SZP-3026Z (3456MHz)

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