A 2.5 Watt LDMOS Driver for the 1.3GHz band

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Introduction

Since I published the design for the 35 Watt LDMOS PA back in June 2009 RadCom a number of people have asked me if I had a driver circuit to go up from a few tens of mW up to a level sufficient to drive it. Then the two combined amplifiers could become a replacement for the "brick" modules that were popular a number of years ago.

This article describes a simple 2.5 Watt driver amplifier covering the 1.3GHz band requiring around 50-100mW of drive for full output. It can be added after low power transverter designs such as that by G4DDK [1] to boost the power output to a couple of Watts, sufficient to drive a larger PA device if necessary.

The design is very simple and based around a single cheap SOT-89 plastic PD85004 13.6V LDMOS device from ST [2]. The device is rated to give 17dB gain and 4 watts out at 870MHz but it performs well with reduced gain of 15-16dB and output power of up to 2.5 Watts at 1.3GHz.

The PCB is designed to fit in to a readily available 37 x 74 x 30mm tinplate box [3], and if the PCB design is copied should need no heatsink

Circuit description

The amplifier uses 50 ohm microstrips and capacitor matching and requires no adjustment. Two big advantages of using just 50 ohm lines during development is that a PCB with a single width of matching line is required and capacitors can be moved up and down the line for trimming. Secondly the PCB becomes a general purpose board for SOT-89 50 ohm in/out modamps

In this amplifier, device input and output impedances are matched to 50 ohms using low pass networks consisting of series, lines, TRL 1-4, and C8, 9, 11 and 12.

The 13.6 volt supply is connected to the drain via a network of two chokes and a 120pF capacitor to ground, and is decoupled over a wide range of frequencies by C3, C4 and C5.

Positive gate bias is also fed via a choke B1 from the 13.6 supply and potential divider to set the standing drain current to 50mA. The gate supply is decoupled by C1. Without gate bias the amplifier takes very little current so that switching the gate supply from the press to talk (PTT) line is a convenient way to switch the amplifier out of standby.

Note that the 13.6 supply to the board must be regulated unless a separate regulated supply is provided for the gate bias!

Construction

The PA is built on 0.8mm thick standard FR4 PCB material. The PD85004 used in the design is in a SOT-89 solder-down plastic package which is now becoming more popular and eliminates the need for hazardous Beryllium Oxide. Under the device tab there must be either six plated through holes to connect the tab both thermally and electrically to the ground plane underneath, which then acts as a heatsink for the device. An alternative to the plated through holes for a home made PCB is to use 5 subminiature copper rivets. [4]. The other grounding holes can be made up with either rivets or hand soldered copper wire vias.

Checking the completed PCB

Connect the output from your low power 1.3GHz transverter to the amplifier input after first ensuring that the input power does not exceed 100mW (+20dBm). Connect the amplifier output to a power meter/dummy load capable of dissipating at least 3 Watts.

Connect the drain to 13.6 volts via an ammeter on the 100mA amp range. Connect the gate bias supply, starting with minimum volts on the gate and VERY carefully increase the gate voltage until the device begins to take current. This onset is very sharp, so be very careful, as the drain current can easily swing up to many Amperes if you are not careful. Set the drain current to 50mA. Switch off and then switch the ammeter to the 1 Amp range. Switch back on. Apply drive and check that the output power is in the order of 2 Watts depending on drive level. Typical test results for my prototype amplifier are shown in Figure and Figure .

Conclusions

This inexpensive driver is relatively easy to build, with readily available components and produces a useful increase in output power for low power transverters such as those based on modamps. It covers the whole of the 1.3GHz narrow band section, and could be adapted to cover the ATV band or the 1240MHz section of the band if band planning eventually forces a move of 1.3GHz narrowband lower in the band.

On request, I will make the PCB mask available on my website [5]

References

[1] "A Modern 1.3GHz transverter Module" Sam Jewell G4DDK. International Microwave Handbook, 2nd Ed. Chapter 9 p305. http://www.arrl.org/shop/International-Microwave-Handbook

[2] PD85004 Datasheet http://www.mouser.com/ds/1/389/CD00178461-55263.pdf

[3] Tinplate boxes can be obtained from Alan Melia G3NYK at http://g3nyk.ham-radio-op.net/componen.htm

[4] Copper rivets from www.megauk.com part number 700-025-4

[5] www.g4bao.com

Table 1 - Component list

Component	Value	Type
R1, R3	2k7	SMD 0805
R2	10k	SMD preset
C1, C2	120pF	Murata ceramic 0603
C3	1nF	Murata ceramic 0603
C4	10nF	Murata Ceramic 0805
C5	10uF 35V	SMD electrolytic

C6,C7	39pF	Murata ceramic 0603
C8	3p3	Murata ceramic 0603
C9	6p8	Murata ceramic 0603
C11	4p7	Murata ceramic 0603
C12	1p5	Murata ceramic 0603
U$1	PD85004	LDMOS power
L1	12.5nH	Coilcraft 0805 air core
B1, B2	Dual ferrite bead	Panasonic EXCELDRC35C
TL1	50Ω 1.43 mm x 15mm	Microstrip line, matching
TL2	50Ω 1.43 mm x 4mm	Microstrip line, matching
TL3	50Ω 1.43 mm x 7.6mm	Microstrip line, matching
TL4	50Ω 1.43 mm x 8.2mm	Microstrip line, matching

Figs 1,2, 3 separate JPEGS

Results

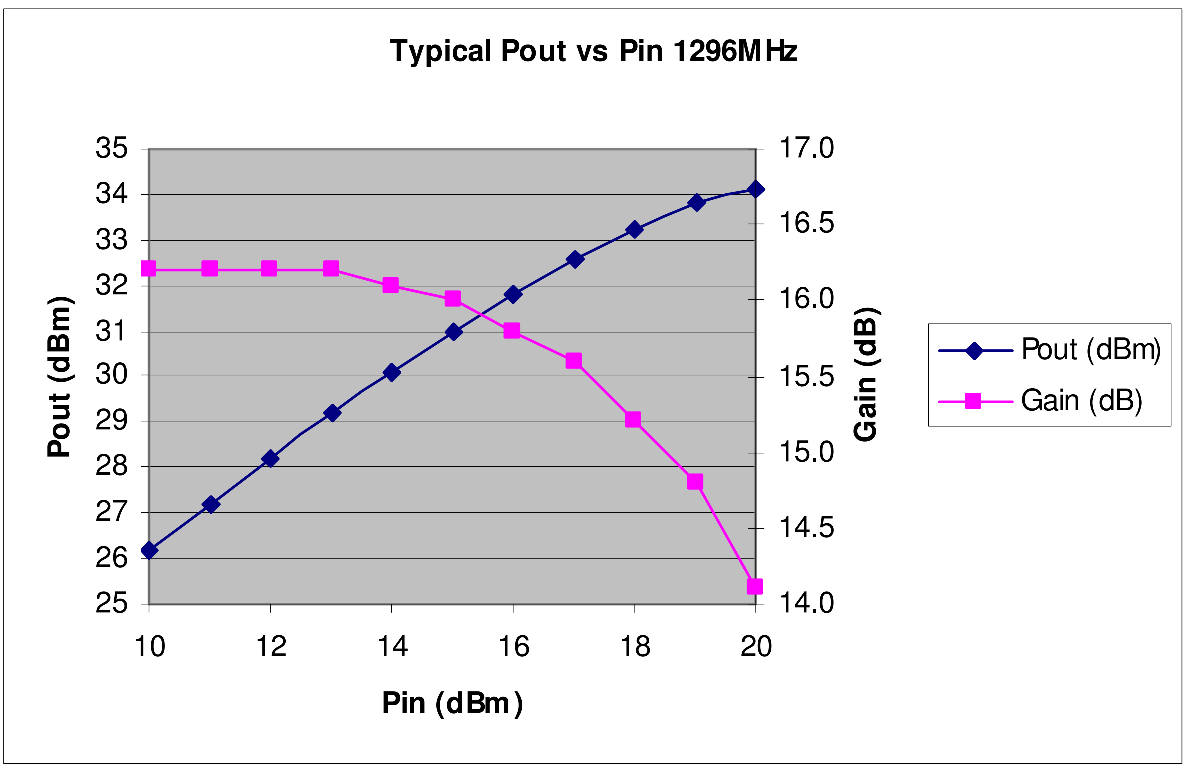

Figure 4 Prototype Amplifier Gain and Power out vs Power in

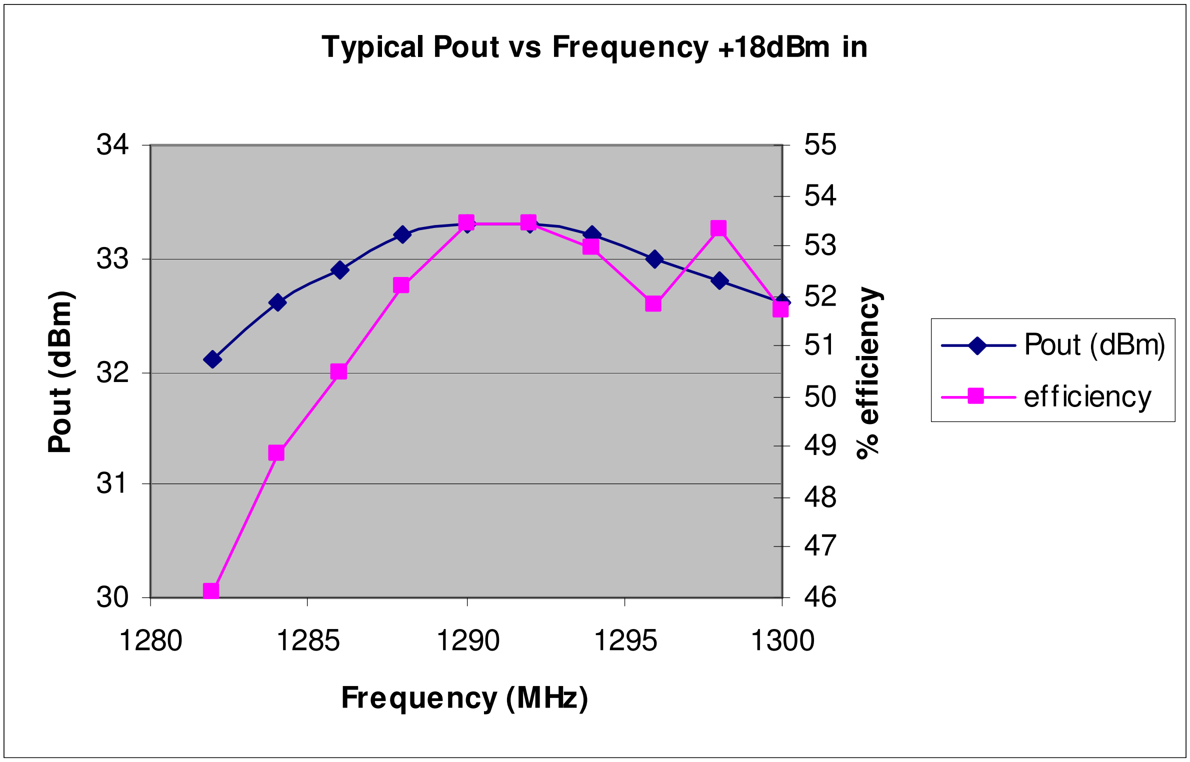

Figure 5 Prototype Amplifier Gain and Efficiency