WPS-445133-02

4.4 - 5.1 GHz 2W High Efficiency Linear Power Amplifier

Preliminary Data Sheet and Application Note

May 2010

FEATURES

- **32 dB Gain**
- **33 dBm P1dB**
- **26.0 dBm Linear Pout @ 2.5% EVM (802.11 64QAM)**
- **Fully Matched Input and Output for Easy Cascade**
- **+8V Bias Voltage**
- **Surface Mount Package with RoHS Compliance**
- **MTTF > 100 yrs @ 85C Ambient Temperature**

APPLICATIONS

- **Telemetry**
- **Private Microwave Network**
- **Military Wireless Communications**

DESCRIPTION

The WPS-445133-02 is a linear power amplifier operating between 4.4 GHz and 4.9 GHz based on high linearity FET technology. It provides +26 dBm of average power at 2.5% EVM (error-vector-magnitude) under the same test pattern as that of 802.16 64QAM. It has 33 dB of gain. This linear power amplifier also has excellent reliability. Ideal applications include the driver and the output power stage of microwave radios that utilizes digital modulation similar to those for 802.16 and 802.11. It also can be used for PTP (Point-To-Point) radios in this band to provide saturated or linear power.

TYPICAL RF PERFORMANCE:

@ 25C, Vds=8V, Vgs=-1.5V, Vp=4.5, Idq=850mA, Z0=50ohm

PARAMETER	UNITS	TYPICAL DATA
Frequency Range	MHz	4400-5100
Gain	dB	32
Gain Flatness	+/- dB	1.5
Input Return Loss	dB	10
Output Return Loss	dB	7
Output P1dB	dBm	33
Pout @ 2.5% EVM	dBm	26.0
Operating Current	mA	870
Thermal Resistance	ºC/W	14

ABSOLUTE MAXIMUM RATINGS:

Ta=25C *

PARAMETERS	UNITS	MAX
Drain-Source Voltage	V	10
Gate-Source Voltage	V	-5
Pinch-Off Voltage	V	5
Drain Current	mA	1000
Gate Current	mA	10
Pinch-Off Current	mA	10
DC Power Dissipation	W	10
RF Input Power	dbM	+10
Channel Temperature	ºC	175
Storage Temperature	ºC	-55 to 150

Operation of this devices above any one of these parameters may cause permanent damage.

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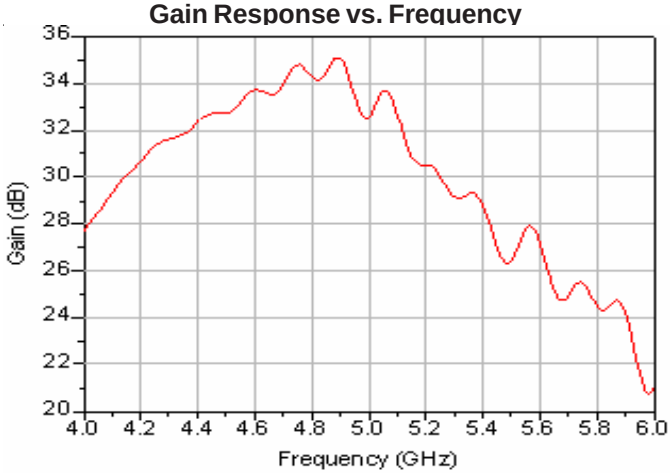
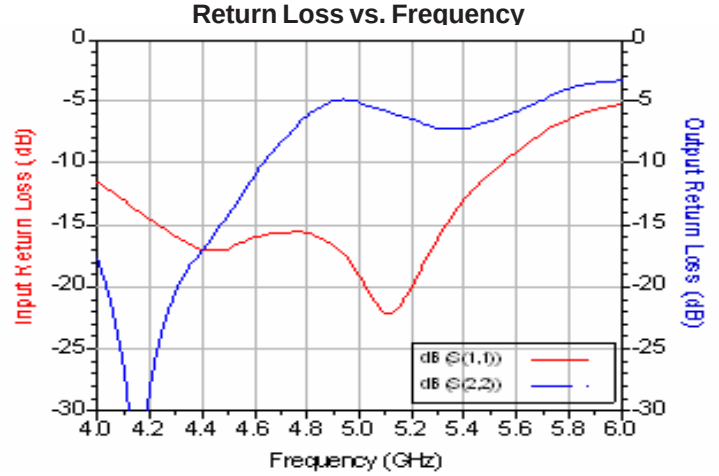
TYPICAL RF PERFORMANCE: *@ 25C, Vdd=8.5, Vgs=-1.0V*

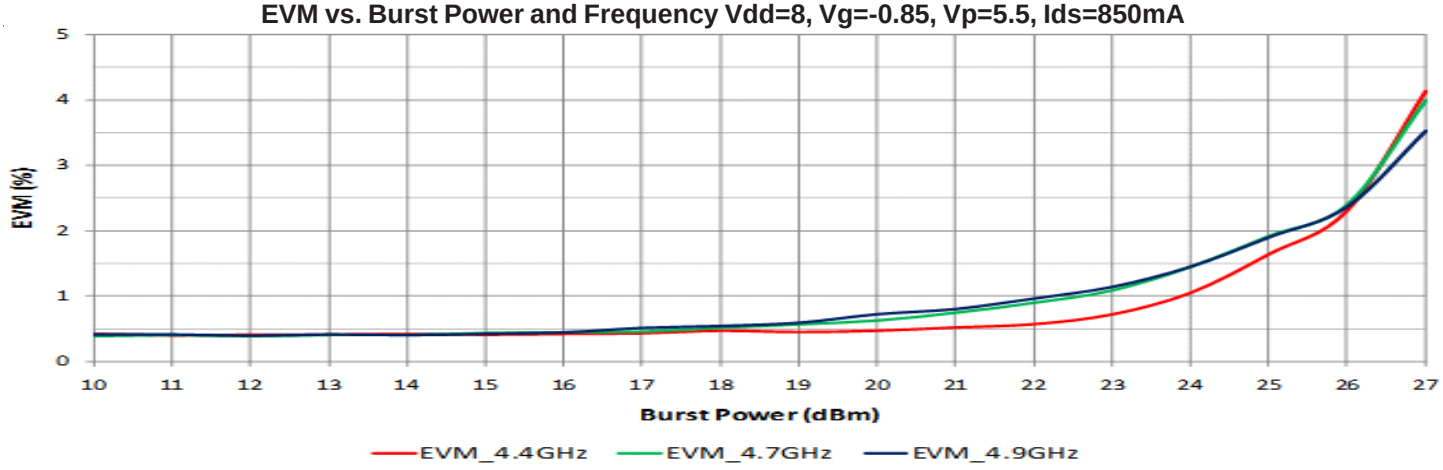
Gain Response vs. Frequency



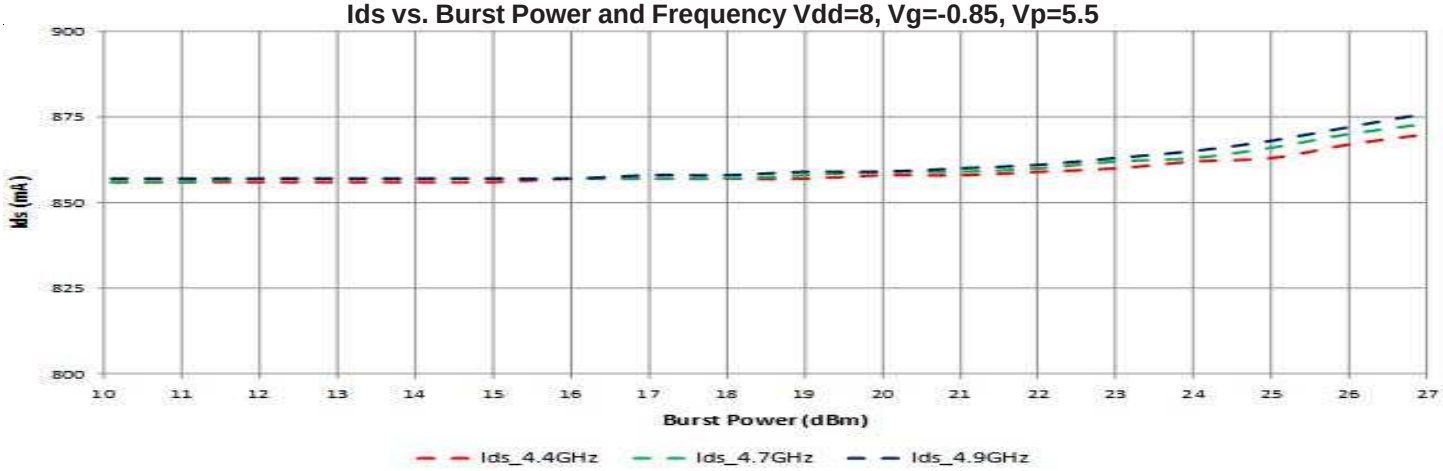
Return Loss vs. Frequency



EVM vs. Burst Power and Frequency Vdd=8, Vg=-0.85, Vp=5.5, Ids=850mA



Ids vs. Burst Power and Frequency Vdd=8, Vg=-0.85, Vp=5.5



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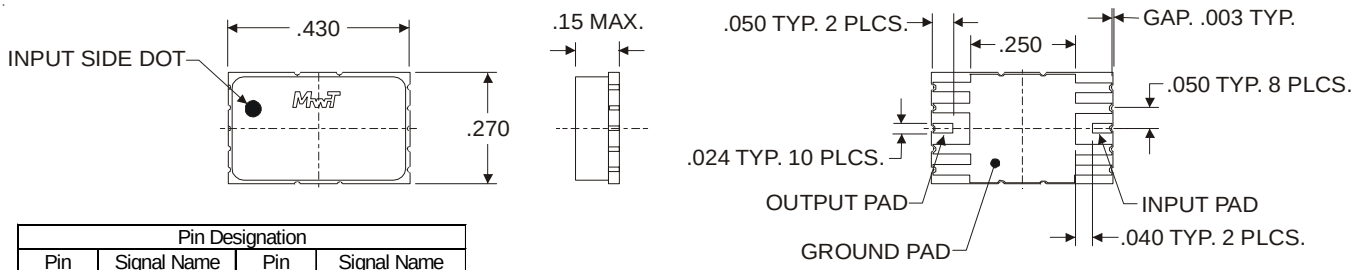
OUTLINE DRAWING: All dimensions are in inches



Pin Designation			
Pin	Signal Name	Pin	Signal Name
1	NC	6	Vgate
2	GND	7	GND
3	RF In	8	RF Out
4	GND	9	GND
5	Vp	10	Vdd

TYPICAL SCATTERING PARAMETERS: *Vdd=8, Vds=8V, Vgs=-1.5V, Idq=850mA, Ta=25C, Z0=50ohm*

freq	magS11	AngS11	dBS21	AngS21	magS12	AngS12	magS22	AngS22
4.00 GHz	0.36	-44.33	27.19	158.30	3.62E-4	-28.96	0.12	-133.97
4.10 GHz	0.34	-55.45	28.67	130.21	4.68E-4	-98.72	0.18	-149.59
4.20 GHz	0.34	-68.12	30.61	97.45	4.69E-4	-156.21	0.25	-159.48
4.30 GHz	0.33	-82.17	32.05	72.07	6.14E-4	-179.65	0.31	-166.54
4.40 GHz	0.33	-99.04	33.73	31.76	9.44E-4	167.77	0.41	-173.36
4.50 GHz	0.32	-122.53	35.67	-2.47	1.11E-3	157.71	0.53	174.35
4.60 GHz	0.25	-154.26	36.06	-40.95	1.27E-3	135.78	0.62	157.00
4.70 GHz	0.14	163.15	36.24	-93.01	1.14E-3	109.03	0.65	140.01
4.80 GHz	0.06	63.22	36.11	-130.37	7.87E-4	71.32	0.59	124.59
4.90 GHz	0.14	-12.26	34.15	-162.01	1.66E-4	19.71	0.49	116.30
5.00 GHz	0.24	-40.51	33.33	155.83	2.26E-4	-95.61	0.43	116.93
5.10 GHz	0.31	-62.08	31.97	135.43	3.96E-4	-134.48	0.41	119.17
5.20 GHz	0.38	-80.73	31.14	97.37	9.34E-4	-137.31	0.42	122.72
5.30 GHz	0.43	-95.19	30.18	66.76	1.30E-3	-170.11	0.47	123.85
5.40 GHz	0.47	-110.98	29.30	45.94	1.24E-3	-171.89	0.52	120.04
5.50 GHz	0.50	-125.23	28.15	-0.70	1.96E-3	173.96	0.56	114.50
5.60 GHz	0.52	-140.07	27.93	-13.37	1.46E-3	159.25	0.60	107.78
5.70 GHz	0.51	-154.61	25.97	-58.74	1.47E-3	140.26	0.62	99.61
5.80 GHz	0.49	-168.37	25.45	-85.52	1.68E-3	141.09	0.62	92.02
5.90 GHz	0.46	178.14	25.20	-111.13	1.44E-3	131.95	0.62	83.98

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APPLICATION NOTE

The evaluation board, shown in Figure 1, is fabricated with Rogers's 4003 material which is 20 mil in thickness, and has 2 oz copper. It has multiple DC input connections and two RF lines. The WPS-445133-02 shown in the center of board is a 2 watt amplifier with high gain and high linearity amplifier. The amplifier chips assembly is attached to the modified '02' package and includes three bias entries and two RF connections. The bias tees are built-in to the package. Due to the size limitation in the package only small bypass capacitor is included inside the package. Additional large external bypassing capacitors are still required on the DC lines. The amplifier can operate up to approximately 85℃.

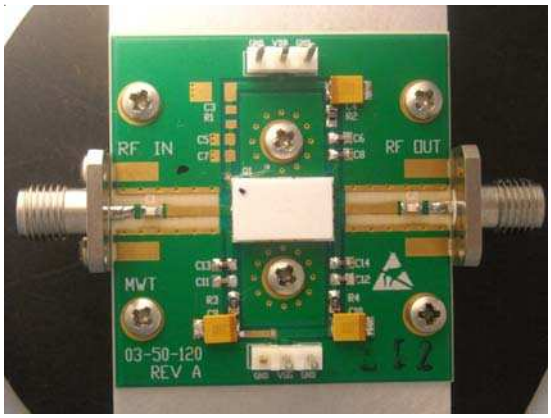

FIGURE 1 Evaluation Board

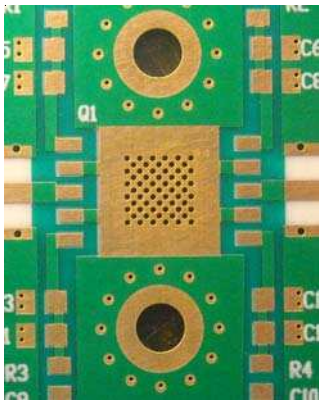

FIGURE 2 Hole Layout

An earless flange or flange package is offered with better Tjc to be used at much higher temperatures. Please consult the factory for your specific application. For best thermal performance, the PCB requires via holes with a diameter of 20 mils placed uniformly in the center pad. They also reduce RF impedances to the ground as shown in Figure 2. The via holes can be filled with conductive epoxy for best thermal performance. The bypassing capacitor near the amplifier should have a short circuit resonance at the frequency of operation. A 3.9pf 0603 capacitor from AVX has a series resonance at 5.5 GHz and will make a good choice as the first bypass capacitor.

Adjacent larger value capacitors, such as 100pf, 1000pf and 2.2uF can be used to maintain voltage stability under peak current conditions. The DC ground via holes should be laid out to minimize inductive returns associated with ground loops. Use of stitch ground via holes can help control the return current and also maintain ground continuity between the top and the bottom ground layers. Two mounting holes are used near the PA assembly to secure the board to the chassis; this also minimizes ground current loops and improves thermal conductivity in case the board is not soldered to the chassis.

The internal bias tees inside the PA are quarter-wave stubs at the gate and drain inputs. A series 56 ohm resistor is connected to the gate and Vp bias supply to increase the effective impedance and reduce the risk of oscillations. The RF lines are DC blocked internally; two zero ohm resistors are used at the input and output 50 ohms traces. The WPS-445133-02 has a noise figure less than 7.0 dB. A plot of noise figure versus frequency at Idq is shown in Figure 2. The amplifier behaves like a class 'A' amplifier. At small signal levels the amplifier operates at Idq. A plot of P1dB versus frequency from 4.4 to 5.1 GHz is shown in Figure 3. The drain current Idd increases to 880 mA to 950 mA from Idq of 850 mA as power increases.

The gain versus temperature has a negative slope of -0.07 dB/!

The two tone linearity shown in Figure 4 is swept across a power range from 15 to 25 dBm per tone at the output of the amplifier from 4.4 to 4.9 GHz. At 22 dBm per tone the IMD3 is 50 dBc and OIP3 is 47 dBm. The Burst power shown in Figure 5 is measured across the frequency range from 4.4 to 4.9 GHz at error vector magnitudes equal to 2% and 2.5%. The modulation is 802.16x and each frame cycle has a 10 msec duration and runs continuously. Equalization is enabled when measuring EVM performance. The WPS amplifier bias condition is Vdd=8V and the gate voltage is -0.85V and voltage power control 4.5V for an Idq=850 mA. A diagram of test setup is shown in Figure 7 and includes the frame information about the test pattern. The gain stability over temperature is shown in Figure 6 and 7. The temperature range was taken at 10 C to 85 C deg and varies 3 dB at a fix frequency.

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APPLICATION NOTE CONTINUED

FIGURE 3 Noise Figure

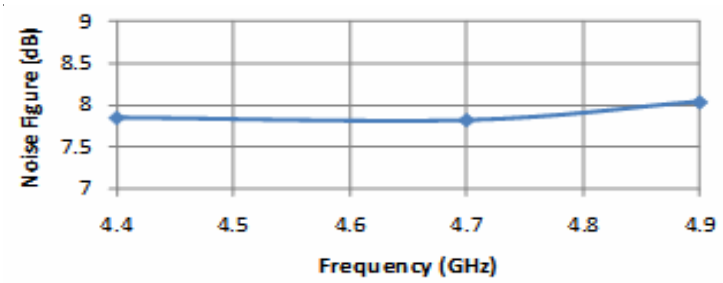


FIGURE 4 P1dB and Ids vs. Frequency

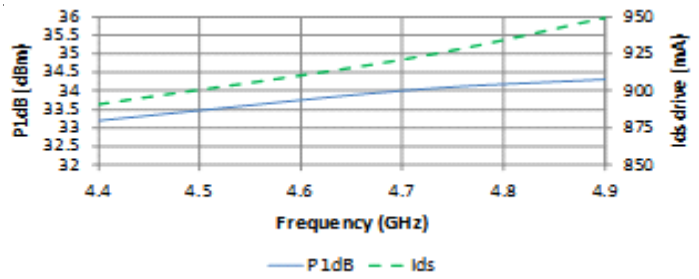


FIGURE 5 Two Tone IMD3 vs. Tone Power

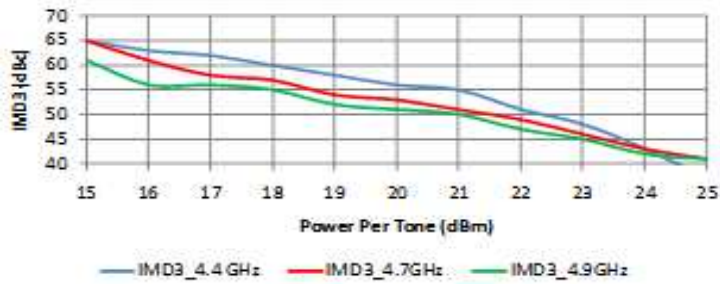


FIGURE 6 Burst Power vs. Frequency

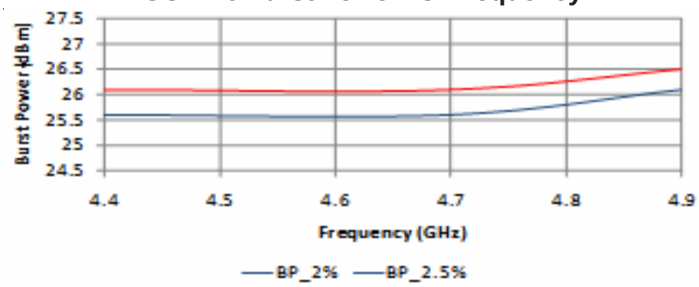


FIGURE 7 Gain and Temperature vs. Frequency

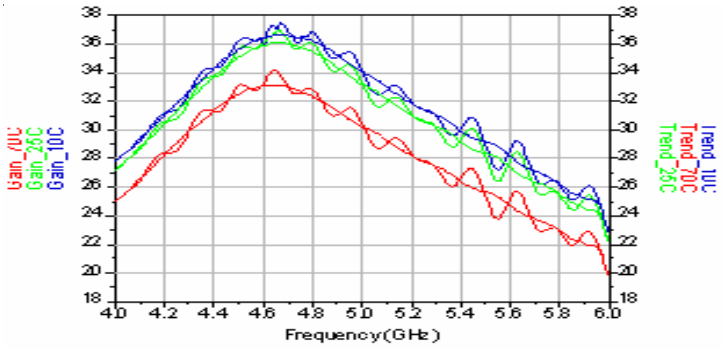


FIGURE 8 Gain Temperature Coefficient vs. Frequency

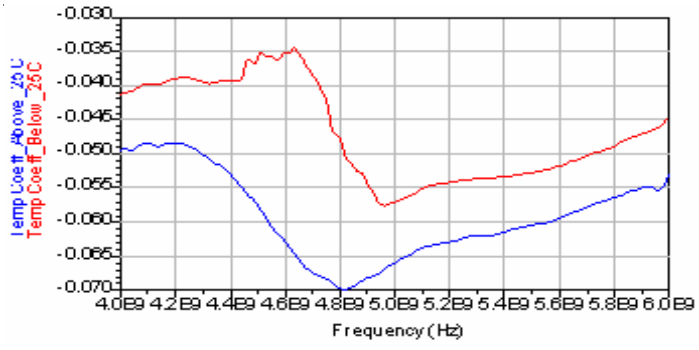


FIGURE 9 EVM vs. Burst Power and Temperature

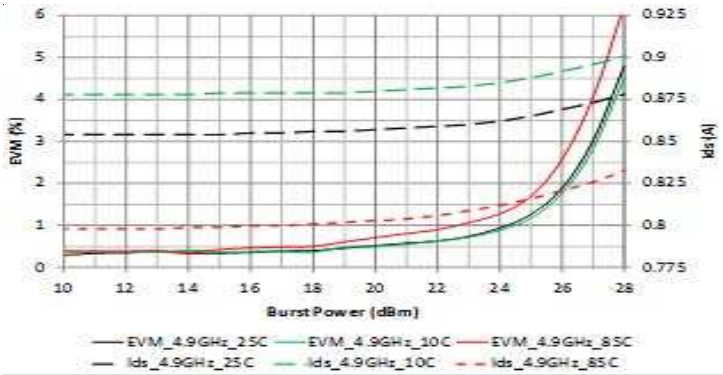
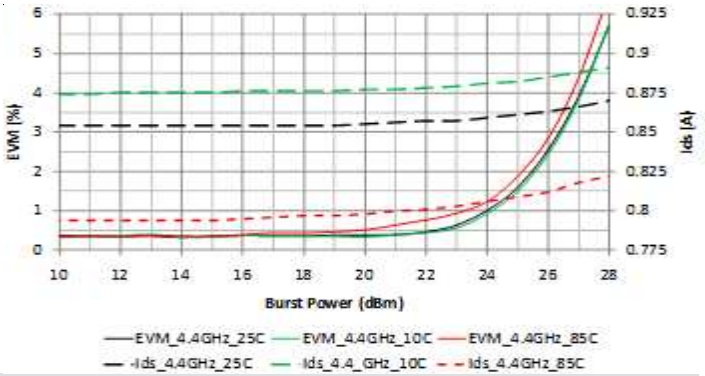


FIGURE 10 EVM vs. Burst Power and Temperature



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