Raytheon

RTPA5250-130

3.3V UNII Band Power Amplifier MMIC/Switch Module for WLAN

PRODUCT INFORMATION

Description

The RTPA5250-130 is a small outline, highly integrated power amplifier and switch MMIC-based module for WLAN applications in the 5.15 - 5.25, 5.25 - 5.35, and 5.725 - 5.825 GHz UNII (Unlicensed National Information Infrastructure) bands. RF inputs and outputs are matched internally to 50 ohms to reduce circuit complexity. A pair of PHEMT switches provide additional flexibility for designers of UNII band systems. The RTPA5250-130 utilizes Raytheon's low cost, advanced 0.5 µm gate length power PHEMT process.

Features

- Low Cost LTCC package (11.6 x 9.1 x 1.7mm)
- 38 dB small signal gain (typ.)
- 7 dB headroom for signals with high peak to average power ratio
- Switches included for T/R and antenna diversity functions
- RF Inputs and outputs matched to 50 Ohms
- Process tolerant active bias eliminates process variations
- Power-down mode reduces quiescent current to 9 mA when in receive mode
- Antenna, RCV or XMT ports are internally matched when not in operation

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Positive Amplifier Supply DC Voltage	V_{dd}	+4.5	V
Negative Logic Control DC Voltage	V_{ee}	-7	V
Negative Bias Control Voltage	V_{ab}	-7	V
Drain Current	I_{dd}	500	mA
Case Operating Temperature	T_{case}	-40 to +85	°C
Storage Temperature Range	$T_{storage}$	-60 to +150	°C

Electrical Characteristics

(At 25°C) 50 Ω system, Vdd=+3.3 V, Load VSWR < 1.2 : 1

Parameter	Min	Typ	Max	Unit
Frequency Range	5150	-	5825	MHz
Small Signal Gain		38		dB
Output Power[1]		16.5		dBm
Efficiency[1]		17		%
Power Out @ 1dB Comp.[2]		22		dBm
Noise Figure		5		dB
Input VSWR (50 Ω)[3]		2:1		
Output VSWR (50 Ω)[3]		2:1		
Quiescent Current (XMT)		280		mA
Quiescent Current (RCV)		9		mA
PA Ramp "on" time[4]		1		µS

Parameter	Min	Typ	Max	Unit
Vdd Voltage Range	3.0	3.3	3.6	V
Vee Voltage Range		-6		V
Vab Voltage Range		-6	-4	V
Switch Insertion Loss		1.5		dB
Switch Isolation	20	25		dB
Switch Switching Time		25		nS
Switch Amplitude Flatness 5170 - 5825 MHz		+/-1		dB
Switch Control "0" Voltage		0	0.8	V
Switch Control "1" Voltage	2.0	3.3		V

Notes:

1. Output power and efficiency is the average value measured at ANT1 or ANT2 with diversity switch set to output for corresponding antenna. Input shall be a 16QAM-modulated OFDM waveform with 52 sub-carriers spaced at 312.5 KHz. Module output power at ANT1 and ANT2 includes switch insertion loss.
2. Power out @ Idq=320 mA
3. Amplifier is unconditionally stable into all output VSWRs. Stated VSWR is required to achieve specified performance.
4. Amplifier output power and phase must settle to within 90% of final values within time specified.

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Raytheon RF Components
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Application Information

CAUTION: THIS IS AN ESD SENSITIVE DEVICE.
The following describes a procedure for evaluating the RTPA5250-130, power amplifier / switch module, in a leadless package. The package outline and the pin designations are shown in Figure 1. The functional block diagram of the packaged product is provided in Figure 2. It should be noted that RTPA5250-130 requires very minimal external passive components for DC bias and no external components for RF matching circuits. Figure 3 shows the switch logic control table. Figure 4 shows a typical layout of an evaluation board. The module contains the MMIC with bias decoupling components. The following designations, shown in Figure 1 should be noted:

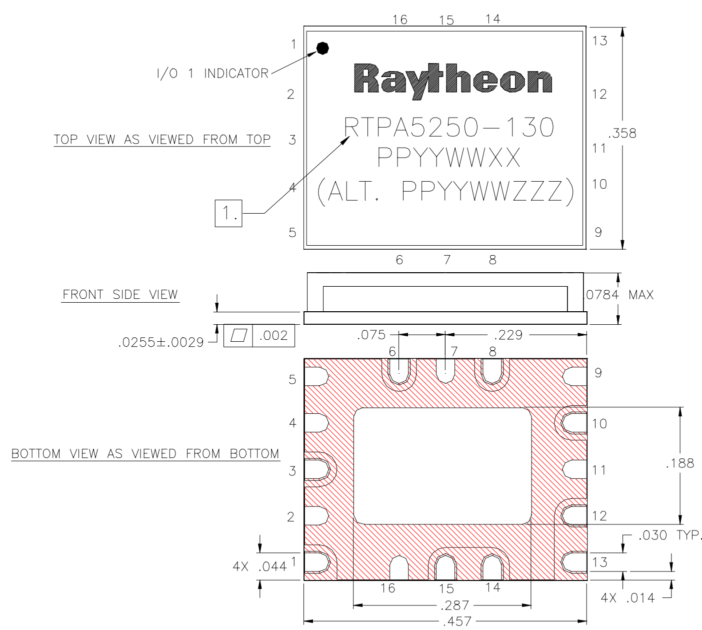
(1 V_{dd} is the Supply voltage.

(2) V_{ee} is the Logic Control voltage.

(3) V_{ab} is the Active Bias Control voltage.

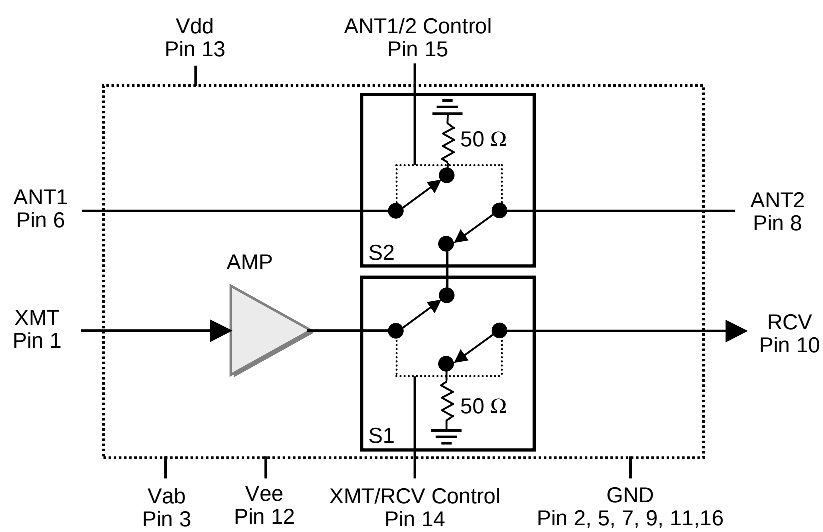
Figure 1 Package Information

Dimensions in inches



Pin #	Description
1	XMT
2	GND
3	Vab
4	NC
5	GND
6	ANT1
7	GND
8	ANT2
9	GND
10	RCV
11	GND
12	Vee
13	Vdd
14	XMT/RCV Control
15	ANT1/2 Control
16	GND

Figure 2 Functional Block Diagram



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Test Procedure
for the Evaluation Board

The following sequence must be followed to properly test the amplifier:

Step 1: Turn off RF input power.

Step 2: Connect the DC supply grounds to the GND of the evaluation board.

Step 3: Set V_{ab}= -6V, V_{ee}= -6V.
(Adjusting Vab provides quiescent current control to optimize performance, not to exceed -4V)

Step 4: Slowly apply supply voltage of +3.3 V to the board terminal V_{dd}.

Step 5: Using Switch Logic Control Table below
Set up logic for desired output.
Switch Control “0” Voltage = 0 V
Switch Control “1” Voltage= +3.3 V

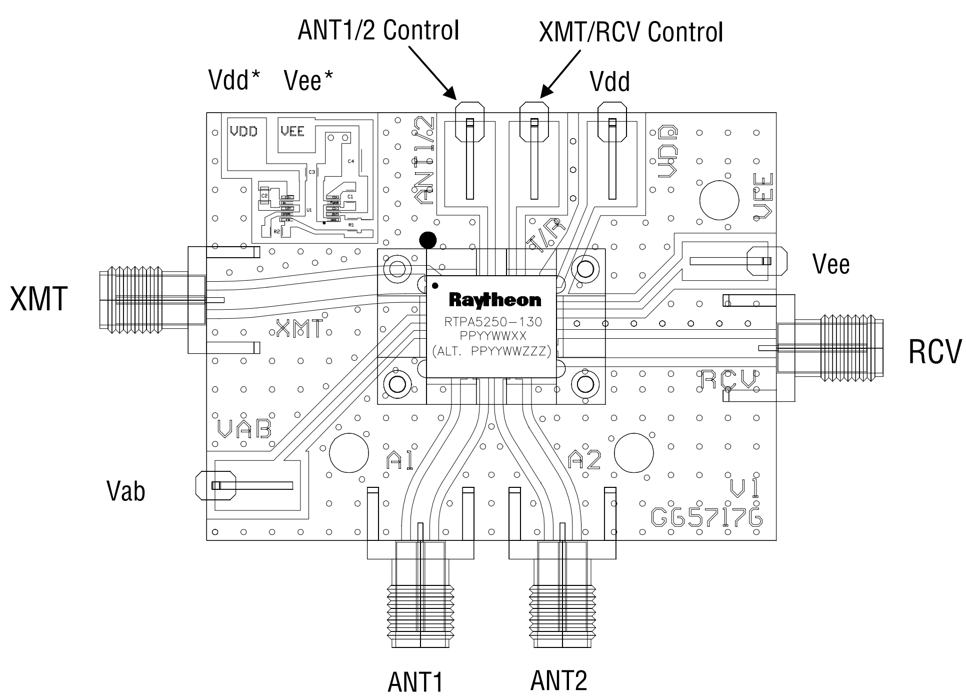
Step 6: After the bias condition is established, RF input signal may now be applied at the appropriate frequency band and power level.

Step 7: Follow turn-off sequence of:
(i) Turn down and off V_{dd}.
(ii) Turn off RF Input Power.
(iii) Set V_{ab} and V_{ee} to 0 V.

Switch Logic Control Table

ANT1/2 Control	XMT/RCV Control	ANT1/2 Mode	XMT/RCV Mode
0	0	ANT1	RCV
1	1	ANT2	XMT
0	1	ANT1	XMT
1	0	ANT2	RCV

Figure 3
Test Evaluation Board



* Voltage inverting charge pump connections

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Application Information

◆ **Precautions to Avoid Permanent Device Damage:**

– **Cleanliness:** Observe proper handling procedures to ensure clean devices and PCBs. Devices should remain in their original packaging until component placement to ensure no contamination or damage to RF, DC & ground contact areas.

– **Device Cleaning:** Standard board cleaning techniques should not present device problems provided that the boards are properly dried to remove solvents or water residues.

– **Static Sensitivity:** Follow ESD precautions to protect against ESD damage:

- A properly grounded static-dissipative surface on which to place devices.
- Static-dissipative floor or mat.
- A properly grounded conductive wrist strap for each person to wear while handling devices.

– **General Handling:** Handle the package on the top with a vacuum collet or along the edges with a sharp pair of bent tweezers. Avoiding damaging the RF, DC, & ground contacts on the package bottom. Do not apply excessive pressure to the top of the lid.

– **Device Storage:** Devices are supplied in heat-sealed, moisture-barrier bags. In this condition, devices are protected and require no special storage conditions. Once the sealed bag has been opened, devices should be stored in a dry nitrogen environment.

◆ **Solder Materials & Temperature Profile:** Reflow soldering is the preferred method of SMT attachment. Hand soldering is not recommended.

– **Reflow Profile**

- Ramp-up: During this stage the solvents are evaporated from the solder paste. Care should be taken to prevent rapid oxidation (or paste slump) and solder bursts caused by violent solvent out-gassing. A typical heating rate is 1- 2°C/sec.
- Pre-heat/soak: The soak temperature stage serves two purposes; the flux is activated and the board and devices achieve a uniform temperature. The recommended soak condition is: 120-150 seconds at 150°C.
- Reflow Zone: If the temperature is too high, then devices may be damaged by mechanical stress due to thermal mismatch or there may be problems due to excessive solder oxidation. Excessive time at temperature can enhance the formation of inter-metallic compounds at the lead/board interface and may lead to early mechanical failure of the joint. Reflow must occur prior to the flux being completely driven off. The duration of peak reflow temperature should not exceed 10 seconds. Maximum soldering temperatures should be in the range 215-220°C, with a maximum limit of 225°C.
- Cooling Zone: Steep thermal gradients may give rise to excessive thermal shock. However, rapid cooling promotes a finer grain structure and a more crack-resistant solder joint. Figure 1 indicates the recommended soldering profile.

◆ **Solder Joint Characteristics:** Proper operation of this device depends on a reliable void-free attachment of the heatsink to the PWB. The solder joint should be 95% void-free and be a consistent thickness.

◆ **Rework Considerations:** Rework of a device attached to a board is limited to reflow of the solder with a heat gun. The device should not be subjected to more than 225°C and reflow solder in the molten state for more than 5 seconds. No more than 2 rework operations should be performed.

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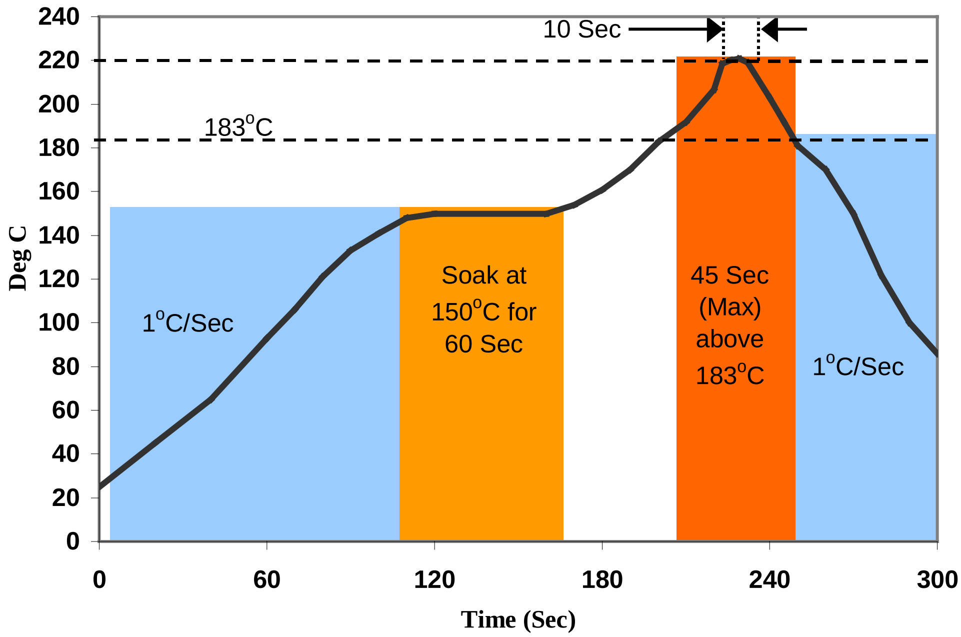
Figure 4
Recommended Solder Reflow Profile



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Bias Considerations
for the RTPA5250-130

The Raytheon RTPA5250-130 Integrated Power Amplifier features a patented active bias and bias shut down circuit that eliminates two classic problems in power amplifiers. While pHEMT designs are known to offer superior linearity, efficiency and ability to integrate switches, normal process variations normally require Digital to Analog Convertors (DACs) to adjust device bias voltages. The RTPA5250-130 uses an on chip “Easy as PIE (Process Invariant Efficient)” biasing circuit where the device current is held constant over manufacturing variations. The PIE biasing also provides a solution for the other classic PA design problem of reducing device currents when not transmitting. The amplifier current is automatically reduced to less than 10 milliamps when the chip enters the receive mode. Since the WLAN is in the receive mode a high percentage of the time (like a cell phone), this is a huge current and battery saving.

In practice, the externally provided negative bias, Vab, offers the possibility of the user selecting a wide range of operating conditions and enables trade offs to be made between quiescent current, output power and gain. Figure 5 illustrates the change in Idd obtainable by changing Vab. Figure 6 shows the typical changes in power and gain as Vab is varied from –4.50 V to –6.0 V.

Figure 5

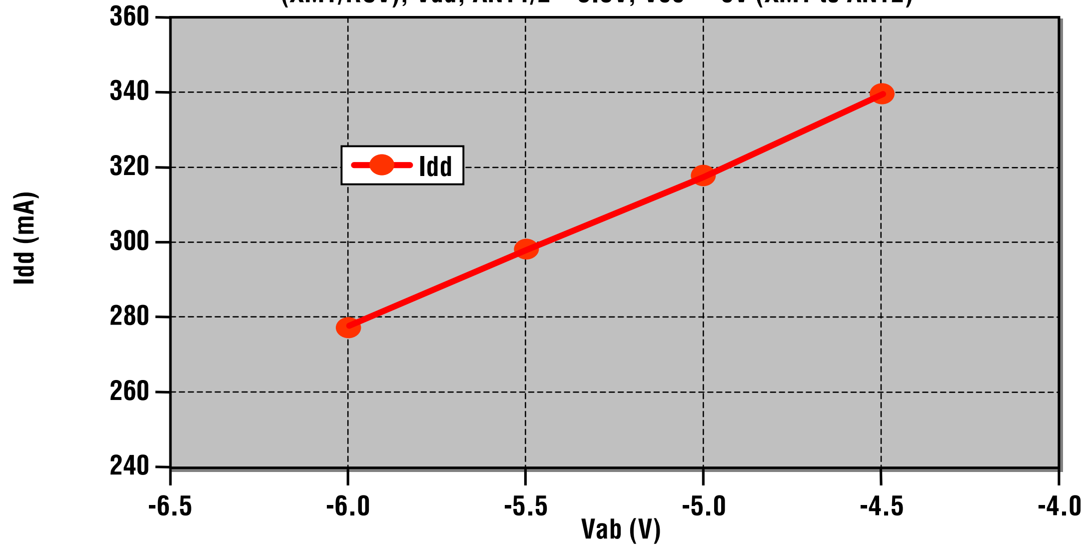
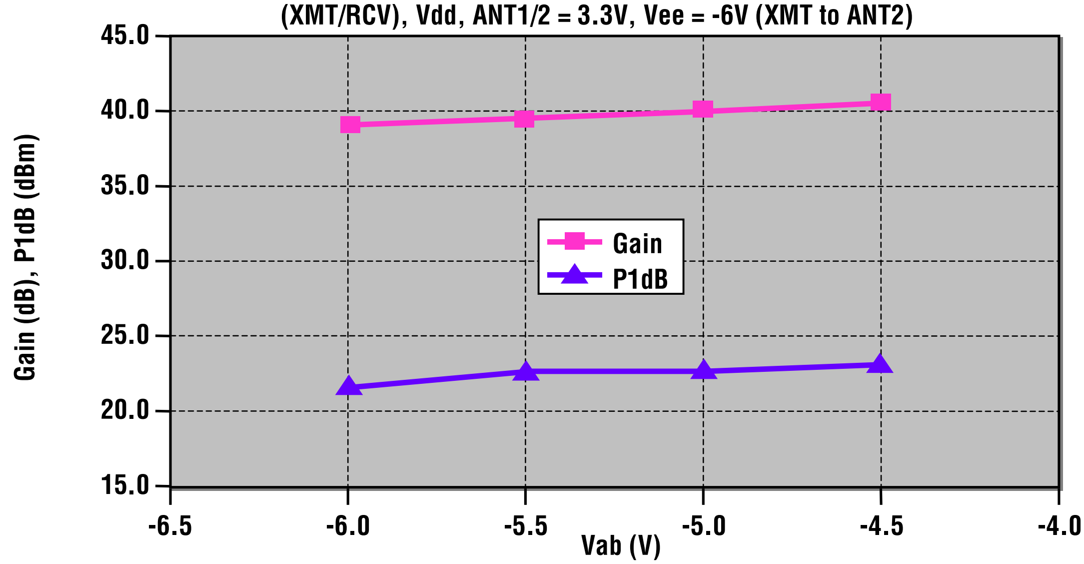


Figure 6



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Generation of Negative Voltages

For systems that do not have negative voltages available, this voltage may be generated using inexpensive off the shelf components. Figure 7 shows a schematic using the Maxim Max868 regulated adjustable –2x inverting charge pump.

A suggested layout is shown in Figure 8. The negative voltage is set by the ratio of R2 to R1. As shown, this results in a voltage of –5.5 V derived from the 3.3V Vdd supply. This is the recommended operating point for the RTPA5250-130 when used with the Maxim 868. The maximum current obtainable from the 868 is a direct function of the positive supply voltage, in this case, 3.3V.

Figure 7

Typical Operating Circuit

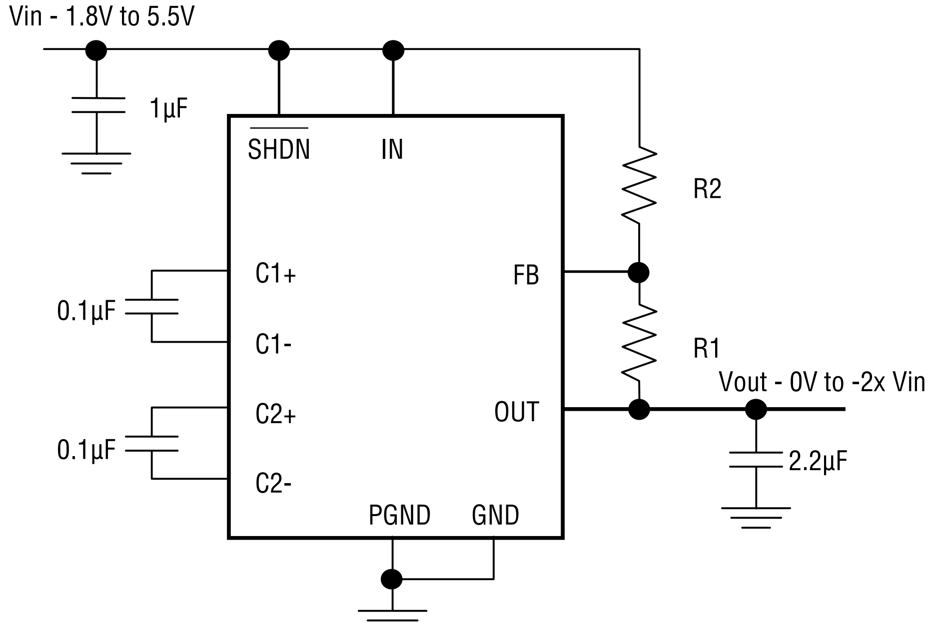
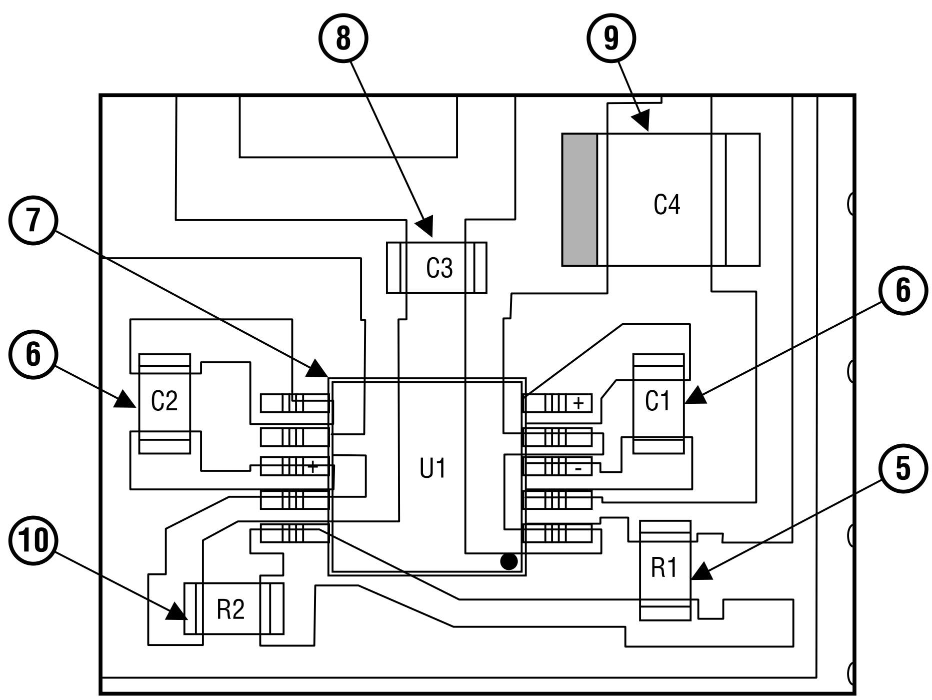


Figure 8

Typical Operating Circuit



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Generation of Negative Voltages
(cont'd)

To supply the negative supply current drawn by the RTPA5250 the most negative voltage should be limited to –5.5V . Note that the limitation is in the charge pump circuitry not the RTPA5250-130. The equation for the output of the Maxim 868 in terms of the input Vdd is: *Vout=(R1÷R2)xVdd*

In our example Vdd=3.3V and R1=169k, R2=100k. A bill of materials with suggested components is shown in Figure 9.

Figure 9
Materials List

QTY	Item No.	Part No.	Description	Vendor
1	1	G657176-1	PC. Board	Raytheon
4	2	J1, J2	SMA Connector	Johnson
5	3	P1 or P2	Terminals	SAMTEC
1	4	G656998-1	RTPA5250 Substrate	Raytheon
1	5 (R1)	311-169KHGT-ND	169K Res. (.06 x .03)	Digi-Key
2	6 (C1, 2)	GRM39C0G224J16 ref#GRM37X7R224K16	0.220 µF Capacitor (.06 x .03)	Murata
1	7 (U1)	MAXB68	Charge Pump	Maxim
1	8 (C3)	GRM39C0G224J16 ref# GRM37X7R224K16	1 µF Capacitor (.06 x .03)	Murata
1	9 (C4)	TPSB106K016R06000	10 µF Capacitor (.12 x .08)	AVX
1	10 (R2)	311-100HTR-ND	100K Res. (.06 x .03)	Digi-Key

(For additional details see the Maxim MAX868 data sheet at www.maxim-ic.com)

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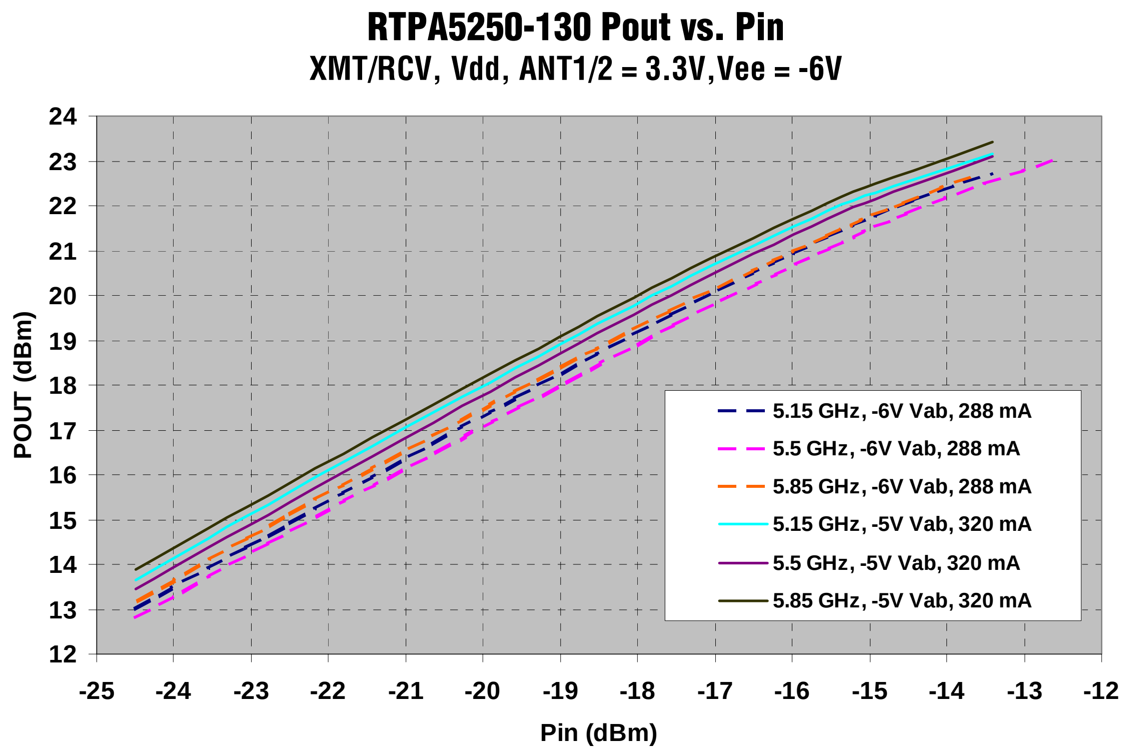
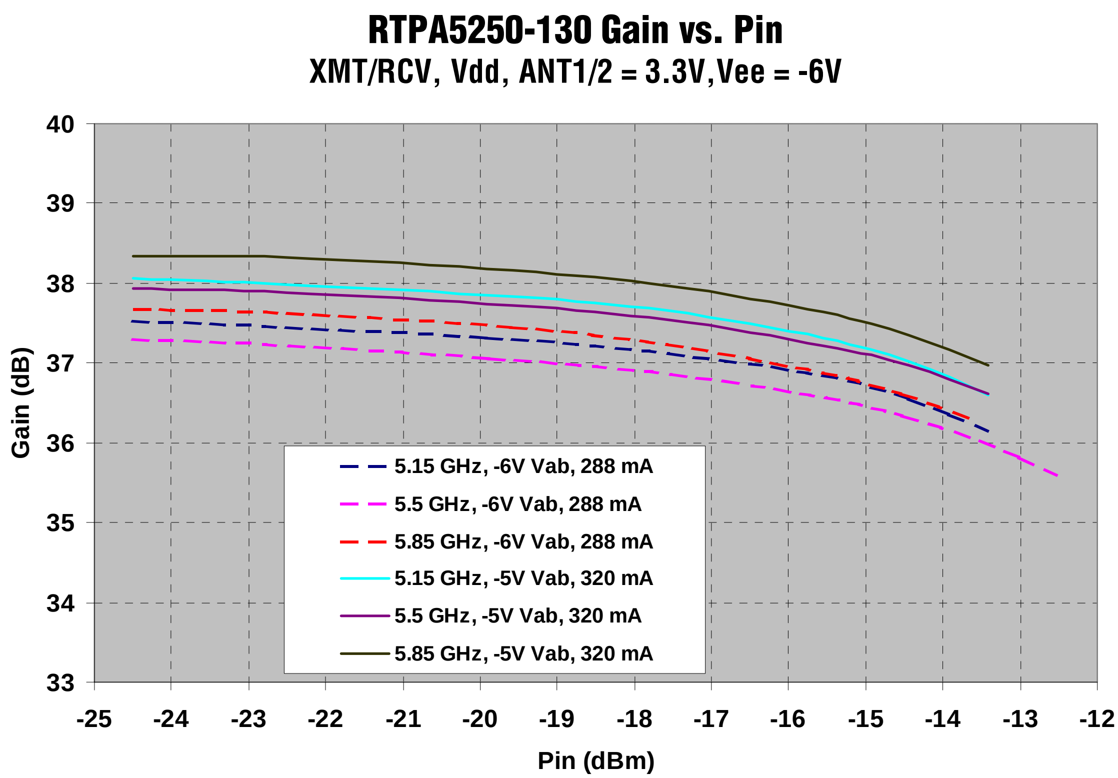
Performance Data

Evaluation Board

Power/Gain Transmit Mode





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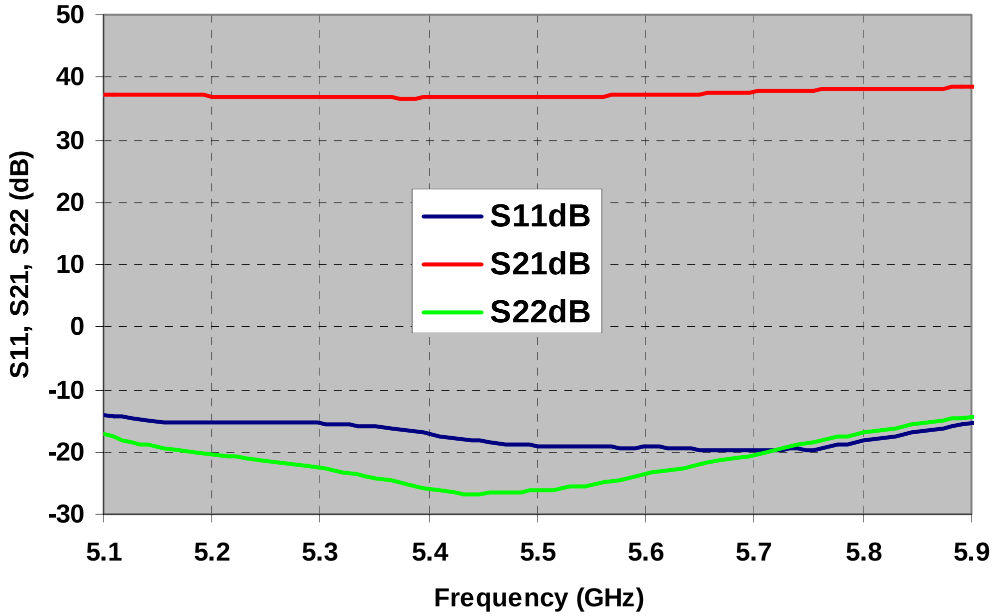
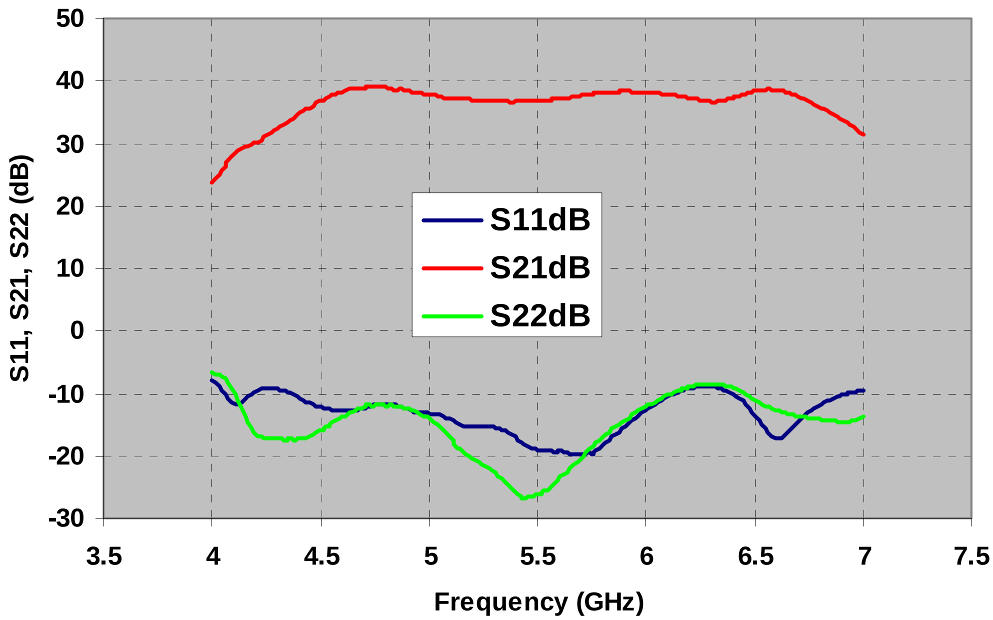
Performance Data

S-Parameters Transmit Mode

RTPA5250-130, S11, S21, S22 vs. Frequency
(XMT/RCV), Vdd = 3.3V, ANT1/2 = 0V, Vee = -6V
Vab = -6V Id = 278mA (XMT to ANT1)



RTPA5250-130, S11, S21, S22 vs. Frequency
(XMT/RCV), Vdd = 3.3V, ANT1/2 = 0V, Vee = -6V
Vab = -6V Id = 278mA (XMT to ANT1)



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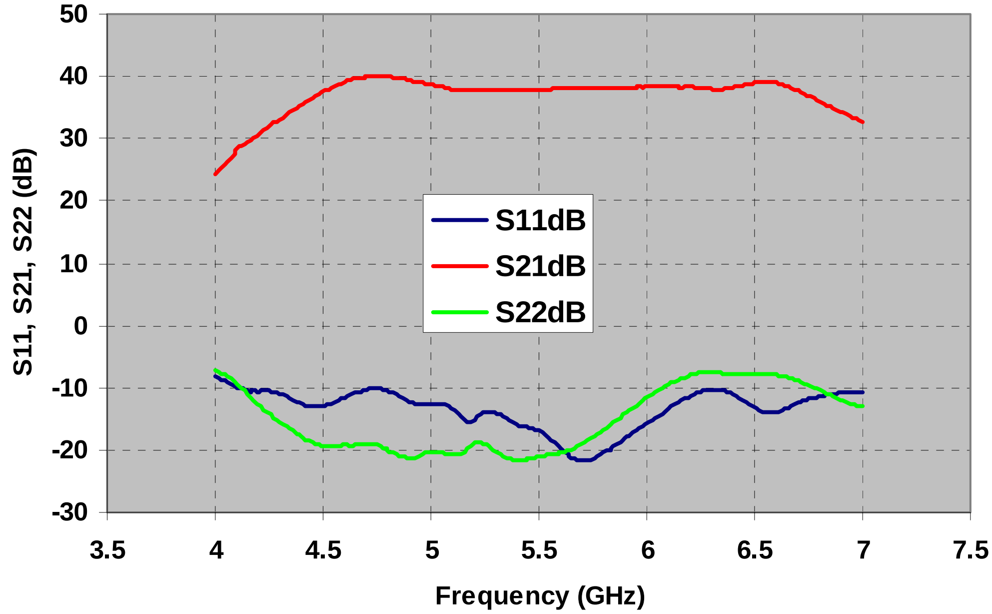
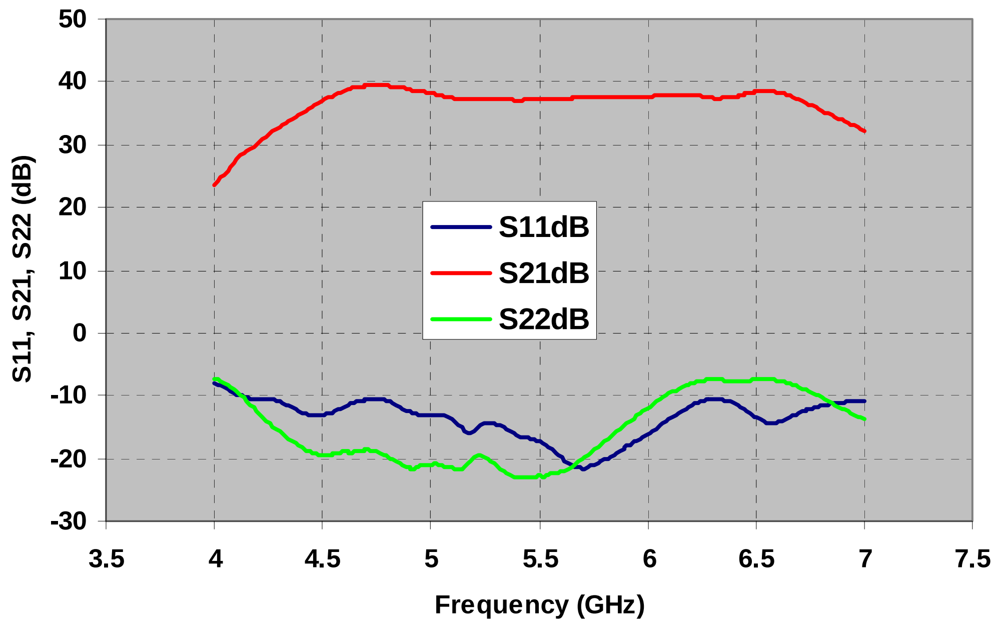
Performance Data

S-Parameters
Transmit Mode

RTPA5250-130, S11, S21, S22 vs. Frequency
(XMT/RCV), Vdd, ANT1/2 = 3.3V, Vee = -6V
Vab = -5V Id = 318mA (XMT to ANT2)



RTPA5250-130, S11, S21, S22 vs. Frequency
(XMT/RCV), Vdd, (ANT1/2) = 3.3V, Vee = -6V
Vab = -6V Id = 280mA (XMT to ANT2)



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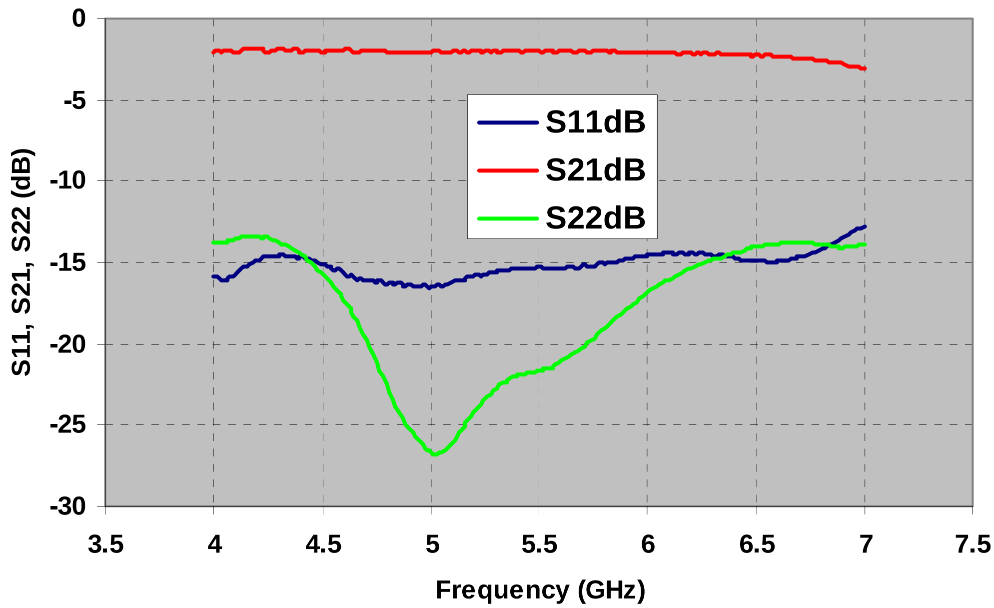
Performance Data

S-Parameters
Receive Mode

Fixture losses
of 0.4 dB included

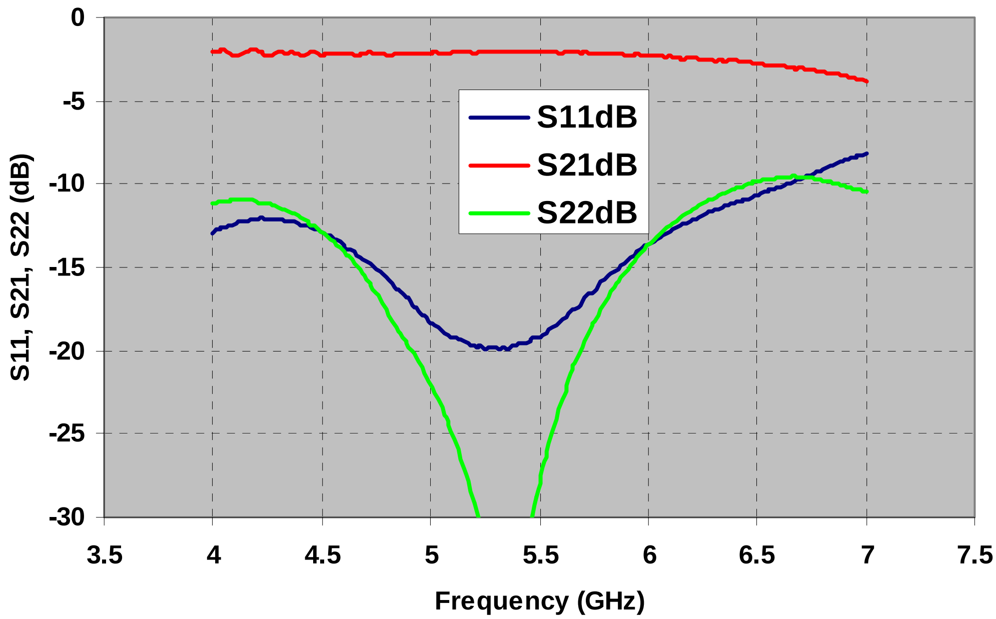
RTPA5250-130, S11, S21, S22 vs. Frequency

Eval Board 006 Vdd = 3.3V, (XMT/RCV), (ANT1/2) = 0V, Vee = -6V
Vab = -6V Id = 9.5mA (ANT1 to RCV)



RTPA5250-130, S11, S21, S22 vs. Frequency

Vdd, (ANT1/2) = 3.3V, (XMT/RCV) = 0V, Vee = -6V
Vab = -6V Id = 9.5mA (ANT2 to RCV)



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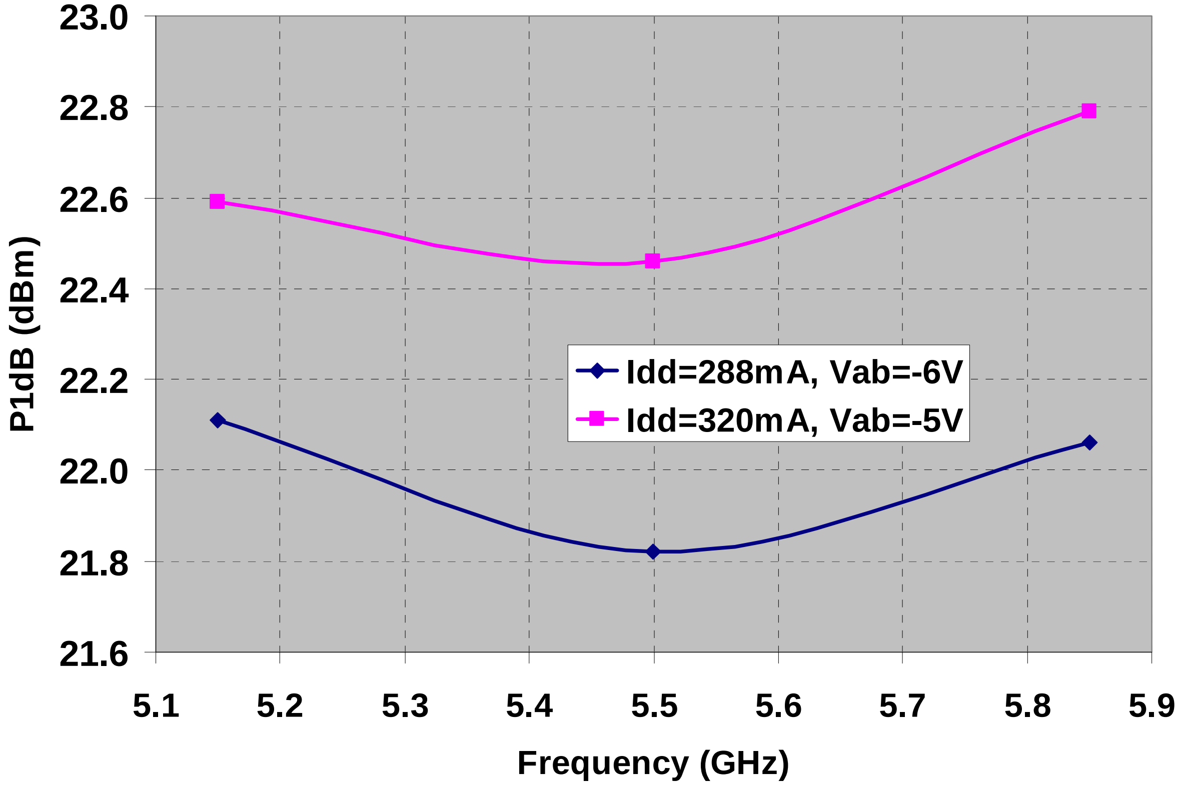
Performance Data

RTPA5250-130, P1dB vs. Frequency
(XMT/RCV), Vdd = 3.3V, ANT1/2 = 0V
Vee = -6V (XMT to ANT1)



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