Power Amplifier, 0.25 W
DC - 40 GHz

MAAP-011325
Rev. V1

Features

- High Gain: 11 dB
- P1dB: 24.5 dBm
- P3dB: 25.5 dBm
- Output IP3: 33 dBm
- Bias Voltage: V_{DD} = 10 V
- Bias Current: I_{DSQ} = 250 mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- Lead-Free 5 mm 12-lead Laminate Package
- RoHS* Compliant

Description

The MAAP-011325 is a 0.25 W distributed power amplifier offered in a lead-free 5 mm 12-lead laminate package. The power amplifier operates from DC to 40 GHz and provides 11 dB of linear gain and 25.5 dBm of output power at 3 dB compression. The device is fully matched across the band and includes a temperature compensated output power detector.

The MAAP-011325 can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for test and measurement, EW, ECM, and radar applications.

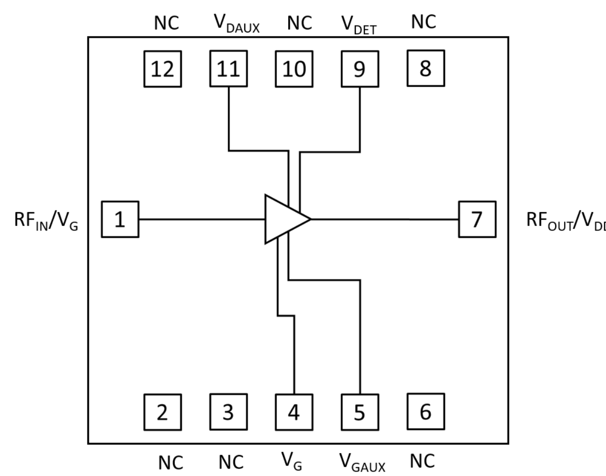
This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

Ordering Information[1]

Part Number	Package
MAAP-011325-TR0500	500 piece reel
MAAP-011325-SMB	Sample Board

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Configuration[2,3]

Pin #	Pin Name	Description
1	RF_{IN}/V_G	RF Input / V_G
2,3,6,8,10,12	N/C	No Connection
4	V_G	Gate Voltage
5	V_{GAUX}	Auxiliary Gate Voltage
7	RF_{OUT}/V_{DD}	RF Output / Drain Voltage
9	V_{DET}	Power Detector
11	V_{DAUX}	Auxiliary Drain Voltage

2. MACOM recommends connecting all no connection pins to ground.
3. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

Pin Description

Pin #	Name	Description
1	RF_{IN}/V_G	RF signal input. This pin is matched to 50 Ω and is DC coupled to V_{G1}. An external DC blocking capacitor is required on the pin. V_{G1} can be applied through this pin as described in the applications section of this datasheet
2,3,6,8,10,12	N/C	These pins are not internally connected (i.e. open circuit). It is recommended that these are connected to ground on the application PCB.
4	V_G	Power amplifier gate control. Adjust V_G from –2 V to 0 V to achieve the desired quiescent current. External bypass capacitors are required as described in the applications schematic.
5	V_{GAUX}	This pin should be terminated using a 0.1µF capacitor
7	RF_{OUT}/V_{DD}	RF signal output. This pin is matched to 50 Ω and is DC coupled to V_{DD}. An external DC blocking capacitor is required on the pin. V_{DD} can be applied through this pin using a suitable external bias tee as described in the applications section of this datasheet.
9	V_{DET}	Power detector output. This has an impedance of 35kΩ.
11	V_{DAUX}	Auxiliary drain voltage pin. If not supplying the drain voltage through the RF output pin, it can be applied through this pin using a suitable external conical choke inductor as described in the applications section of this datasheet. External bypassing capacitors are required on this pin as described in the applications section.

AC Electrical Specifications: T_A = +25°C, V_{DD} = 10 V, I_{DSQ} = 250 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 22 GHz 40 GHz	dB	9.0 9.0 4.0	11.0 11.0 7.0	—
P_{OUT}	P_{IN} = +17 dBm 2 GHz 22 GHz 40 GHz	dBm	—	30.0 26.5 23.5	—
P1dB	2 GHz 22 GHz 35 GHz 40 GHz	dBm	26.5 — 22.0 —	29.5 25.0 23.0 22.5	—
OIP3	P_{out} = +15 dBm/tone (10 MHz Tone Spacing) 2 GHz 22 GHz 40 GHz	dBm	—	37.0 32.0 32.0	—
PAE	@ P3dB 2 GHz 22 GHz 40 GHz	%	—	29 24 8	—
Input Return Loss	P_{IN} = -10 dBm	dB	—	10	—
Output Return Loss	P_{IN} = -10 dBm	dB	—	10	—

DC Electrical Specifications: T_A = +25°C, V_{DD} = 10 V

Parameter	Test Conditions	Units	Min.	Typ.	Max.
DC Current (I_{DQ})	P_{IN} = -20 dBm	mA	—	300	—
DC Current (I_{DD})	P_{IN} = +12 dBm	mA	—	300	—
I_G	—	mA	—	1	—

Recommended Operating Conditions

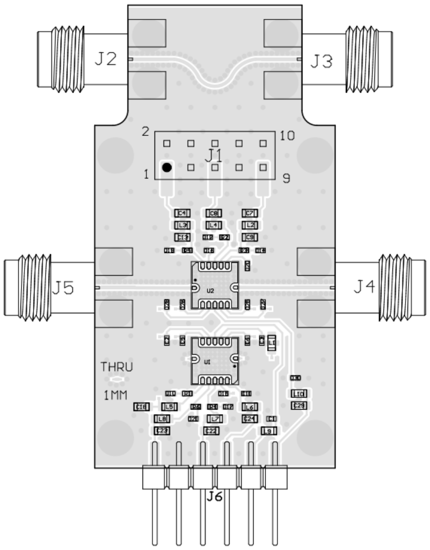
Parameter	Symbol	Unit	Min.	Typ.	Max.
RF Input Power		dBm	—	—	+22
DC Supply Voltage	V_{DD}	V	—	10.0	11.0
Junction Temperature[6, 7]	T_J	°C	—	—	+160
Operating Temperature[8]	T_C	°C	-40	—	+85

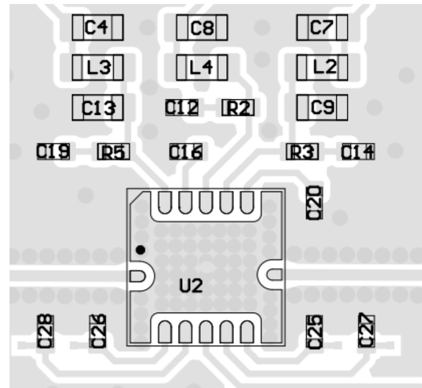
Absolute Maximum Ratings[4,5]

Parameter	Symbol	Unit	Min.	Max.
RF Input Power		dBm	—	+22
DC Supply Voltage	V_{DD}	V	—	12
Junction Temperature	T_J	°C	-55	+170
Storage Temperature		°C	-55	+150

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Operating at nominal conditions with $T_J \le +160°C$ will ensure MTTF > 1×10^6 hours.
7. Junction Temperature (T_J) = T_C + Ɵjc * (V * I)
   Typical thermal resistance (Ɵjc) = 11 °C/W.
   a) For T_C = +25°C,
      T_J = 55.8 °C @ 10 V, 280 mA
   b) For T_C = +85°C,
      T_J = 115.8 °C @ 10 V, 280 mA
8. Operating temperature is defined at the exposed paddle.

PCB Layout

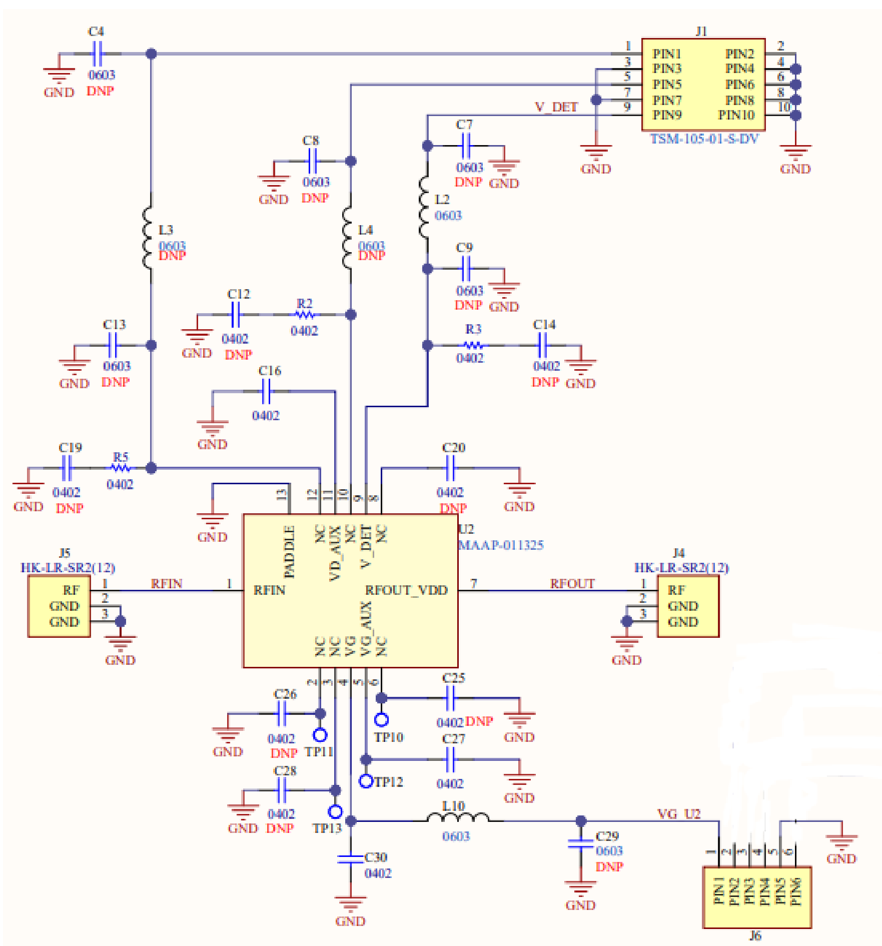




Design notes:

- RO4003C, 8 mil thick, 1/2 copper, soft Au plating
- RF Trace: 14 mil width and 6.5 mil spacing
- Edge wrap on J3, J4, J5, J6

Application Schematic



Parts List

Part	Value	Case Style
L2, L10	0 Ω	0603
C16,C27,C30	0.1 µF	0402

Operating the MAAP-011325

Turn-on

1. Apply V_G -2 V.
2. Increase V_{DD} to 10 V.
3. Set I_{DSQ} by adjusting V_G more positive. (typically -0.5 V for I_{DSQ} = 250 mA).
4. Apply RF_{IN} signal.

Turn-off

1. Remove RF_{IN} signal.
2. Decrease V_G to -2 V.
3. Decrease V_{DD} to 0 V.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1B devices.

Biasing Conditions

Recommended biasing conditions are V_{DD} = 10 V, I_{DSQ} = 250 mA (controlled with V_G).

By-pass capacitor C1 for the auxiliary pad is for a low frequency operation extension (below 1 GHz).

There are 2 possible methods to bias the drain:

1. The required V_{DD} is applied at RF_{OUT}/V_{DD} through the bias tee. This provides wide band performance of 100 kHz - 40 GHz (depending on the bandwidth of the bias tees).

2. The required V_{DD} is applied at the V_{DD} pad through a wideband conical inductor. No external bias tee is required at the RF_{OUT}/V_{DD} but an external DC block is required. This provides wide band performance of 100 kHz - 40 GHz (depending on the bandwidth of the bias tee).

There are 2 possible methods to bias the gate:

1. V_G is applied through a wideband conical inductor at the V_G pad and set to provide the required current bias (I_{DSQ}). No external bias tee is required at the RF input but an external DC block is required. This provides wide band performance of 100 kHz - 40 GHz (depending on the bandwidth of the bias tee).

2. V_G is applied at the RF input (pin 2) through an external bias tee on the RF input line and set to provide the required current bias (I_{DSQ}). This provides wide band performance of 100 kHz - 40 GHz (depending on the bandwidth of the bias tees).

Recommended PCB Information

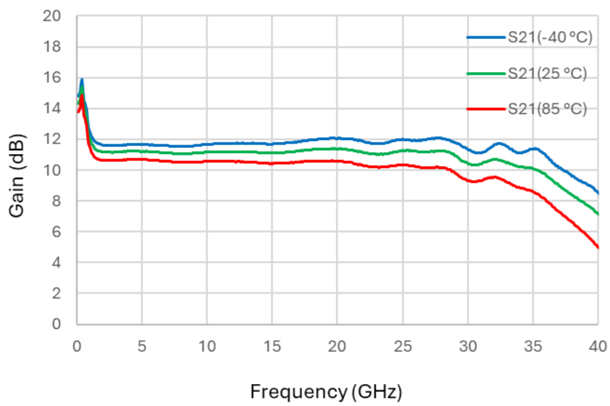
RF input and output are 50 Ω transmission lines.
Single layer 8 mil Rogers RO4003C with 1/2 oz. Cu.
Use copper filled vias under ground paddle.

Grounding

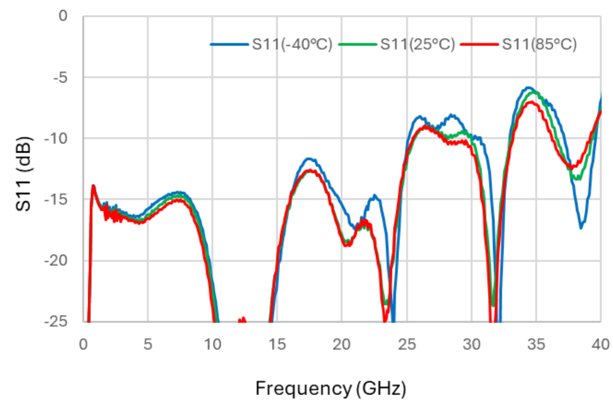
It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200-µm) diameter vias under the device, assuming an 8-mil (200-µm) thick RF layer to ground.

Typical Performance Curves: V_D = 10 V, I_{DSQ} = 250 mA

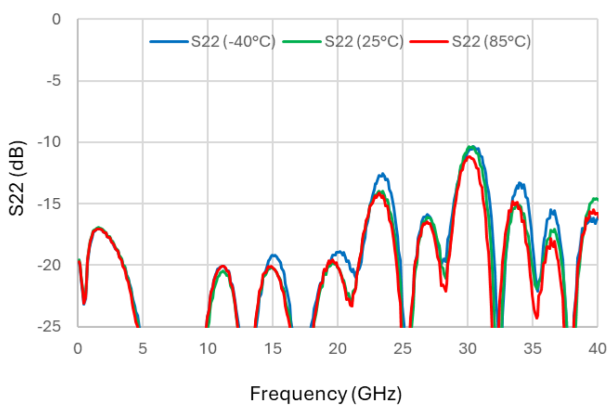
Small Signal Gain vs. Frequency and Temperature



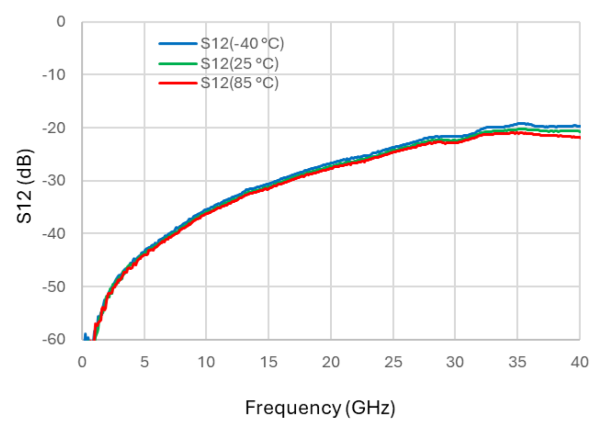
Input Return Loss vs. Frequency and Temperature



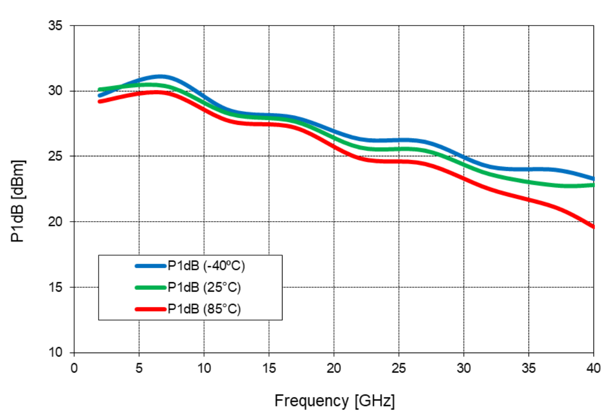
Output Return Loss vs. Frequency and Temperature



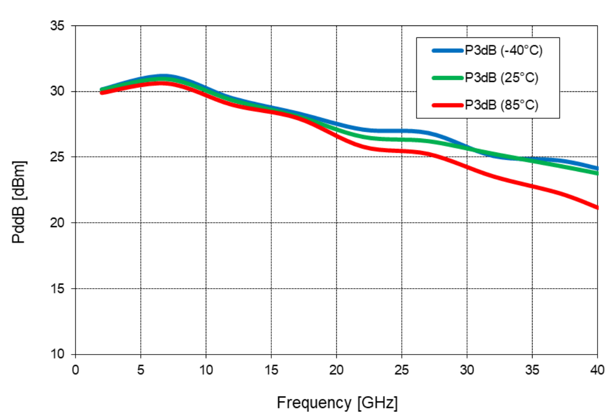
Isolation vs. Frequency and Temperature



P1dB vs. Frequency and Temperature

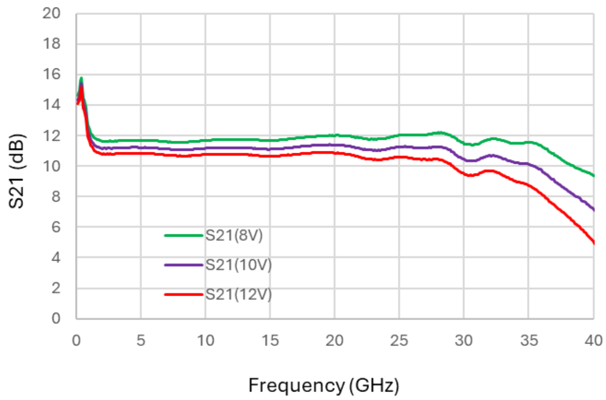


P3dB vs. Frequency and Temperature

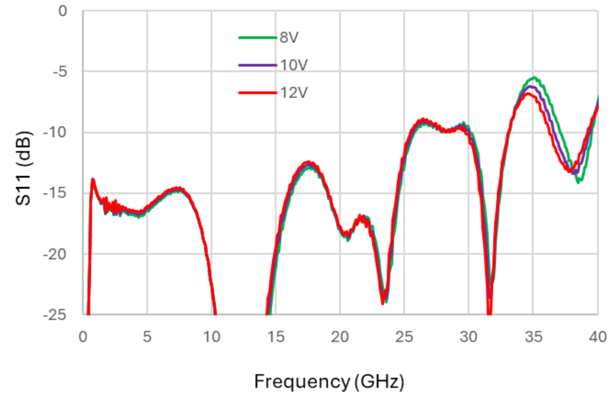


Typical Performance Curves: I_{DSQ} = 250 mA, T_A = +25°C

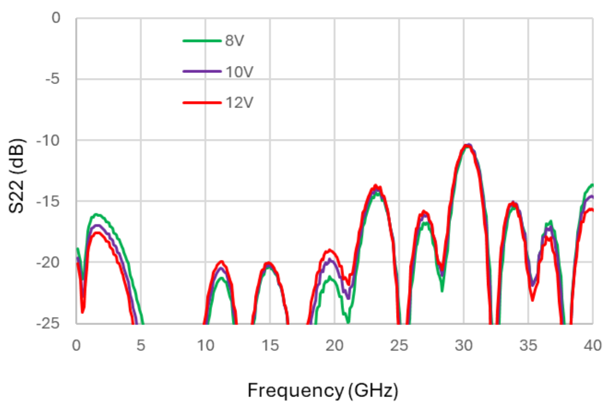
Small Signal Gain vs. Frequency and Voltage



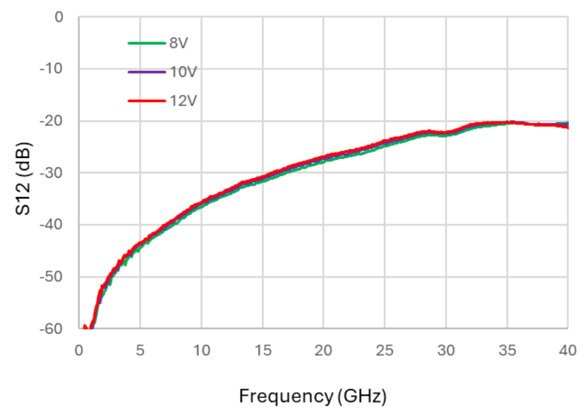
Input Return Loss vs. Frequency and Voltage



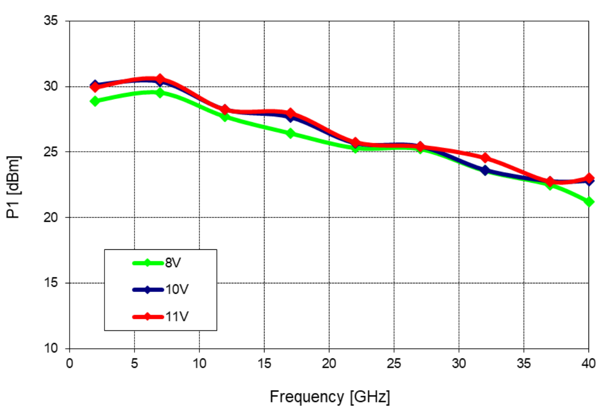
Output Return Loss vs. Frequency and Voltage



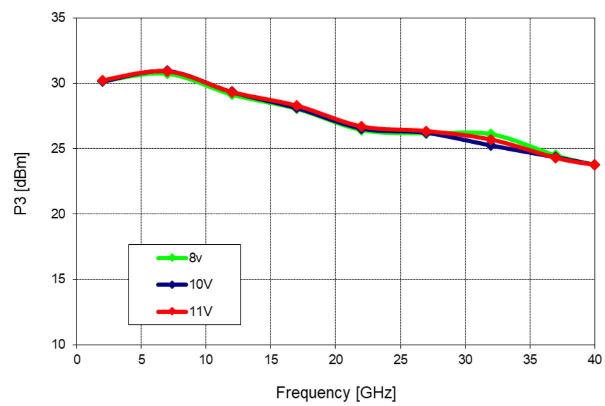
Isolation vs. Frequency and Voltage



P1dB vs. Frequency and Voltage

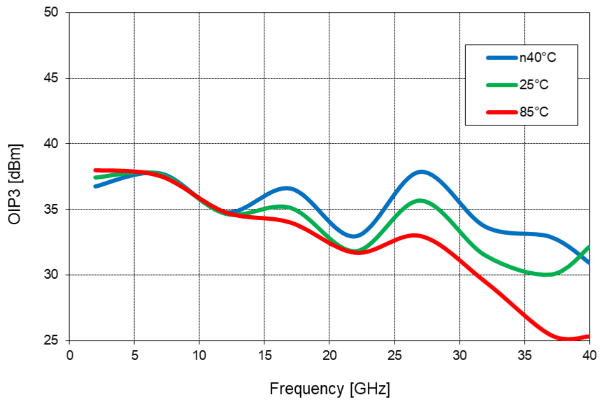


P3dB vs. Frequency and Voltage

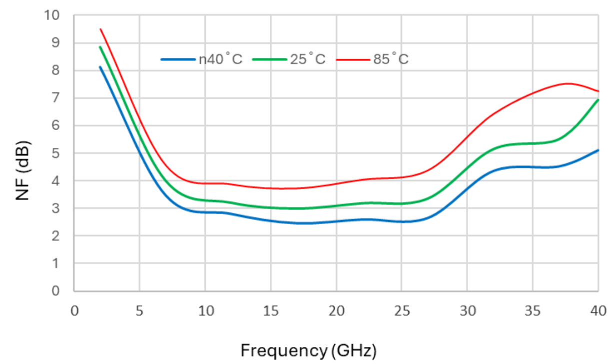


Typical Performance Curves: V_D = 10 V, I_{DSQ} = 250 mA

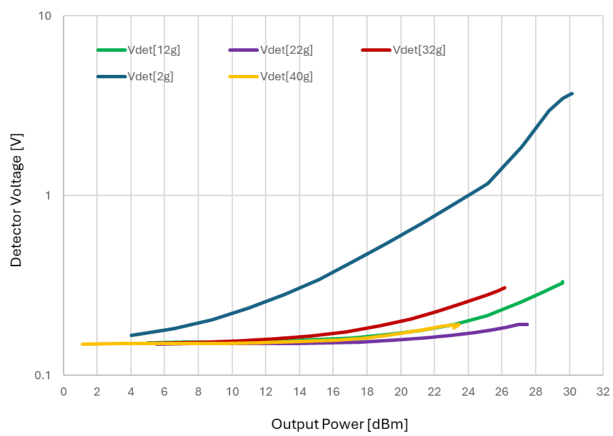
OIP3 vs. Frequency and Temperature (10 MHz separation and +18 dBm P_{OUT} per tone)



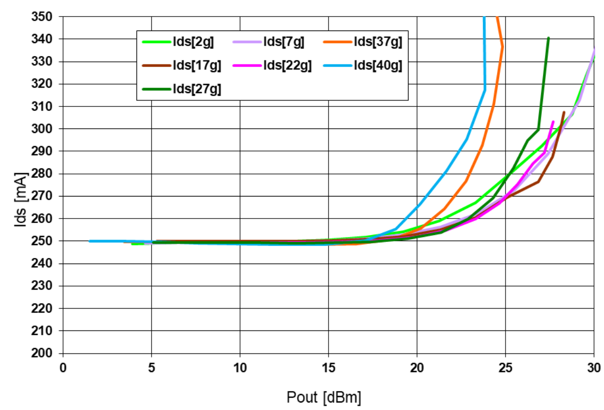
Noise Figure vs. Frequency and Temperature



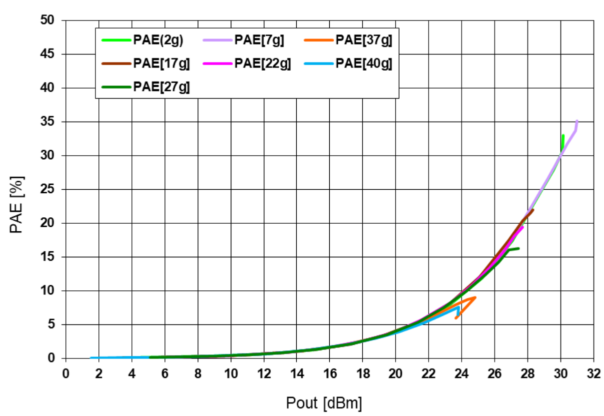
Detector Voltage vs. Pout and Frequency @ +25 C



Bias Current vs. P_{OUT} and Frequency @ +25°C

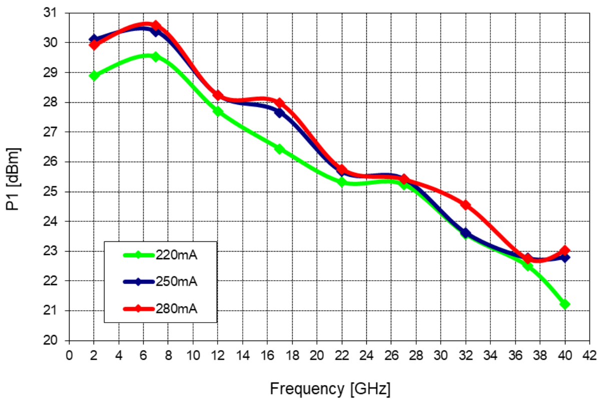


PAE vs. P_{OUT} and Frequency @ +25°C

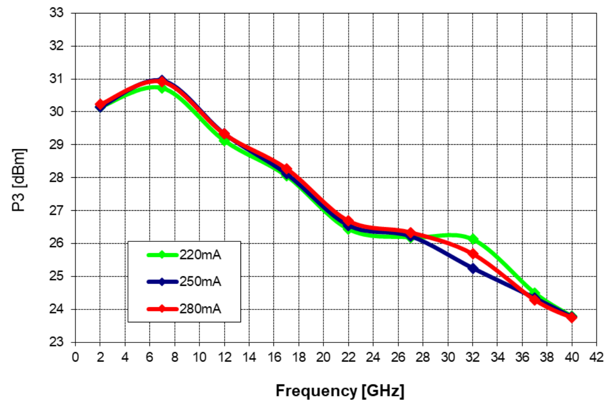


Typical Performance Curves: V_{BIAS} = 10 V, T_A = +25°C

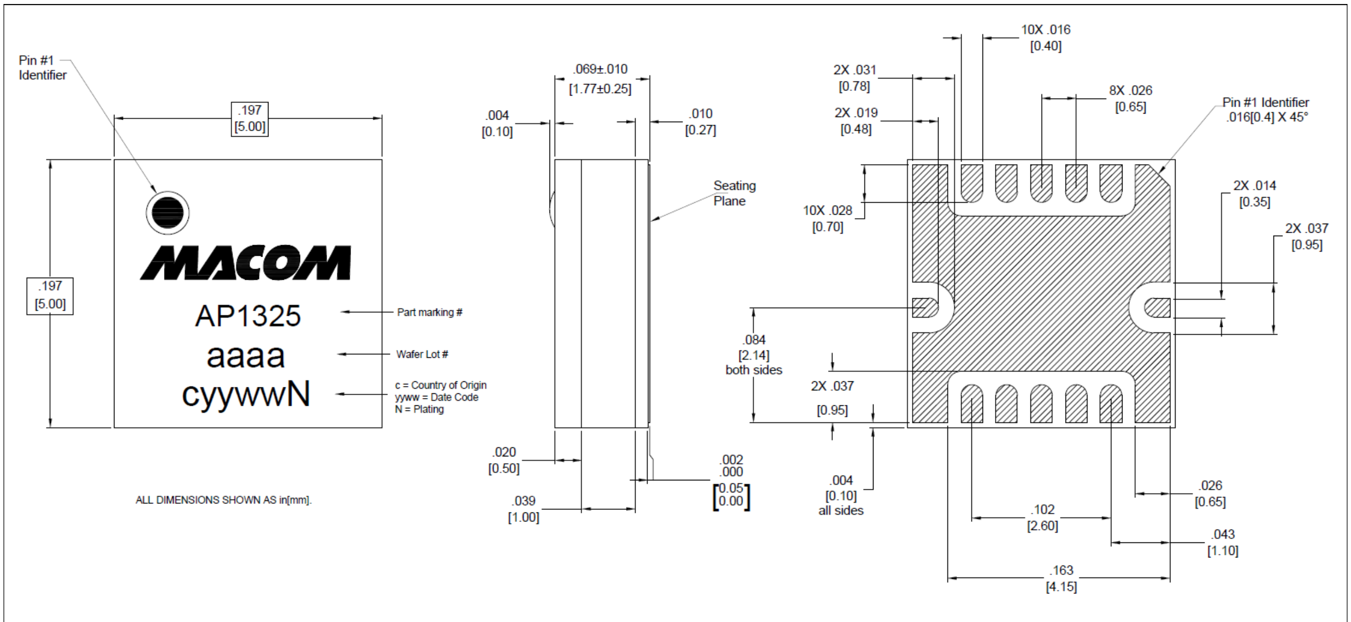
P1dB vs. Frequency and Current



P3dB vs. Frequency and Current



Lead-Free 5 mm 12-Lead SMT†



† All units in in(mm), unless otherwise noted, with a tolerance of .xxxx = ±.0005 in and .xxx = ±.005 in.
Lead finish: NiPdAu plating
Marking: line 2 part number; line 3 wafer lot number; line 4 c = country of origin (T = Thailand), yyww = date code, N = Nickel/Palladium/Gold plating
Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 3 requirements.

Revision History

Rev	Date	Change Description
V1	3/28/24	Original release