Agilent Technologies
Innovating the HP Way

37–43 GHz Amplifier

Technical Data

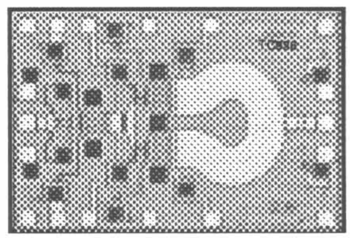
HMMC-5034

Features

- **23 dBm Output $P_{(-1dB)}$**
- **8 dB Gain @ 40 GHz**
- **Integrated Output Power Detector Network**
- **50 Ω Input/Output Matching**
- **Bias: 4.5 Volts, 300 mA**

Description

The HMMC-5034 is a MMIC power amplifier designed for use in wireless transmitters that operate within the 37 GHz to 42.5 GHz range. At 40 GHz it provides 23 dBm of output power [$P_{(-1dB)}$] and 8 dB of small-signal gain from a small easy-to-use device. The HMMC-5034 was designed to be driven by the HMMC-5040 MMIC amplifier for linear transmit applications. This device has input and output matching circuitry for use in 50 ohm environments.



Chip Size:	1.56 x 1.02 mm (61.4 x 40.1 mils)
Chip Size Tolerance:	±10 µm (±0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)

Absolute Maximum Ratings[1]

Symbol	Parameters/Conditions	Units	Min.	Max.
$V_{D1,2}$	Drain Supply Voltages	volts		5
$V_{G1,2}$	Gate Supply Voltages	volts	-3.0	0.5
I_{D1}	Input-Stage Drain Current	mA		165
I_{D2}	Output-Stage Drain Current	mA		285
P_{in}	RF Input Power	dBm		23
T_{ch}	Channel Temperature[2]	°C		175
T_{bs}	Backside Temperature	°C	-55	+95
T_{st}	Storage Temperature	°C	-65	+170
T_{max}	Max. Assembly Temperature	°C		300

Notes:
1. Absolute maximum ratings for continuous operation unless otherwise noted.
2. Refer to *DC Specifications/Physical Properties* table for derating information.

HMMC-5034 DC Specifications/Physical Properties[1]

Symbol	Parameters/Conditions	Units	Min.	Typ.	Max.
$V_{D1,2}$	Drain Supply Operating Voltages	Volts	2	4.5	5
I_{D1}	Suggested First Stage Operating Drain Supply Current (V_{D1} = 4.5 V)	mA		100	165
I_{D2}	Suggested Second Stage Operating Drain Supply Current (V_{D2} = 4.5 V)	mA		200	285
$V_{G1,2}$	Gate Supply Operating Voltages ($I_{D1} \cong$ 100 mA, $I_{D2} \cong$ 200 mA)	Volts		-0.8	
V_P	Pinch-off Voltage ($V_{D1} = V_{D2}$ = 4.5 V, $I_{D1} + I_{D2} \leq$ 10 mA)	Volts	-2.5	-1.2	
Vdet	Reference and Output Detector DC Voltage (V_{D2} = 4.5 V, No RF Output)	Volts		1.4	
γ	Detector Voltage Sensitivity (V_{DD} = 4.5 V, P_{out} = 20 dBm)	mV/mW		0.12	
$\theta_{ch\text{-}bs}$	Thermal Resistance[2] (Channel-to-Backside at T_{ch} = 150°C)	°C/Watt		44	
T_{ch}	Channel Temperature[3], ($T_{bs} \cong$ 90°C, MTTF > 10^6 hrs, ($V_{D1} = V_{D2}$ = 4.5 V, I_{D1} = 100 mA, I_{D2} = 200 mA)	°C		150	

Notes:

1. Backside operating temperature T_{bs} = 25°C unless otherwise noted.
2. Thermal resistance (°C/Watt) at a channel temperature T(°C) can be *estimated* using the equation: $\theta(T) = \theta_{ch\text{-}bs}$ x [T(°C) + 273] / [150°C + 273].
3. Derate MTTF by a factor of two for every 8°C above T_{ch}.

HMMC-5034 RF Specifications,

T_A = 25°C, Z_O = 50 Ω, $V_{D1} = V_{D2}$ = 4.5 V, I_{D1} = 100 mA, I_{D2} = 200 mA

Symbol	Parameters and Test Conditions	Units	37–40 GHz			40–42.5 GHz		
			Min.	Typ.	Max.	Min.	Typ.	Max.
BW	Operating Bandwidth	GHz	37		40	40		42.5
Gain	Small Signal Gain	dB	7	8	11	6	7	11
ΔGain/ΔT	Temperature Coefficient of Gain	dB/°C		0.019			0.019	
$P_{(-1dB)}$	Output Power @ 1 dB Gain Compression[1]	dBm	21	23		20	22	
P_{sat}	Saturated Output Power	dBm	22	24		21	23	
ΔP/ΔT	Temperature Coefficient of $P_{(-1dB)}$ and P_{sat}	dB/°C		0.015			0.015	
$(RL_{in})_{MIN}$	Minimum Input Return Loss	dB	9	10		8	10	
$(RL_{out})_{MIN}$	Minimum Output Return Loss	dB	10	12		9	12	
Isolation	Minimum Reverse Isolation	dB		30			27	

Note:

1. Devices operating continuously at or beyond 1 dB gain compression may experience power degradation.

Applications

The HMMC-5034 MMIC is a broadband power amplifier designed for use in communications transmitters that operate in various frequency bands within 37 GHz and 42.5 GHz. It can be attached to the output of the HMMC-5040 increasing the power handling capability of transmitters requiring linear operation.

Biasing and Operation

The recommended DC bias condition is with both drains (V_{D1} *and* V_{D2}) connected to single 4.5 volt supply (V_{DD}) and both gates (V_{G1} *and* V_{G2}) connected to an adjustable negative voltage supply (V_{GG}) as shown in Figures 12 or 13. The gate voltage is adjusted for a total drain supply current of commonly 300 mA or less.

The RF input and output ports are AC-coupled.

An output power detector network is also supplied. The *Det.Out* port provides a DC voltage that is generated by the RF power at the *RF-Output* port. The *Det.Ref* pad provides a DC reference voltage that can be used to nullify the effects of temperature variations on the detected RF voltage. The differential voltage between the *Det.Ref* and *Det.Out* bonding pads can be correlated to the RF power emerging from the *RF-Output* port. A bond wire attaching both V_{D2} bond pads to the supply will assure symmetric operation and minimize any DC offset voltage between *Det.Ref* and *Det.Out* (at no RF output power).

No ground wires are needed because ground connections are made with plated through-holes to the backside of the device.

Assembly Techniques

Electrically and thermally conductive epoxy die attach is the preferred assembly method. Solder die attach using a fluxless gold-tin (AuSn) solder pre-form can also be used. The device should be attached to an electrically conductive surface to complete the DC and RF ground paths. The backside metallization on the device is gold.

It is recommended that the electrical connections to the bonding pads be made using 0.7-1.0 mil diameter gold wire. The microwave/millimeter-wave connections should be kept as short as possible to minimize inductance. For assemblies requiring long bond wires, multiple wires can be attached to the RF bonding pads.

Thermosonic wedge is the preferred method for wire bonding to the gold bond pads. A guided-wedge at an ultrasonic power level of 64 dB can be used for the 0.7 mil wire. The recommended wire bond stage temperature is 150 ± 2°C.

For more detailed information see Agilent application note #999, "GaAs MMIC Assembly and Handling Guidelines."

GaAs MMICs are ESD sensitive. Proper precautions should be used when handling these devices.

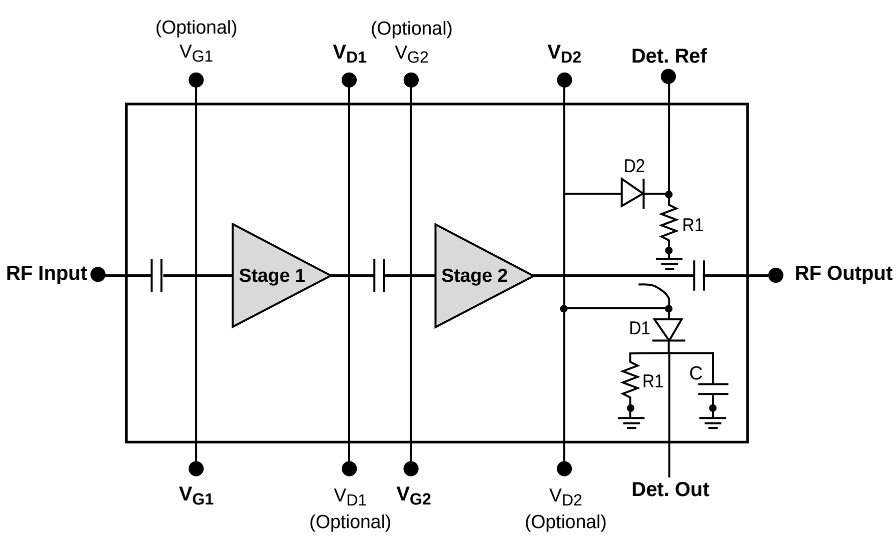


Figure 1. HMMC-5034 Simplified Schematic Diagram.

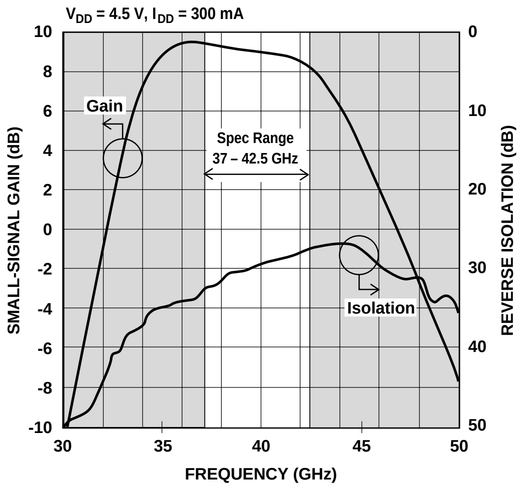


Figure 2. Typical Gain and Isolation vs. Frequency.[1]

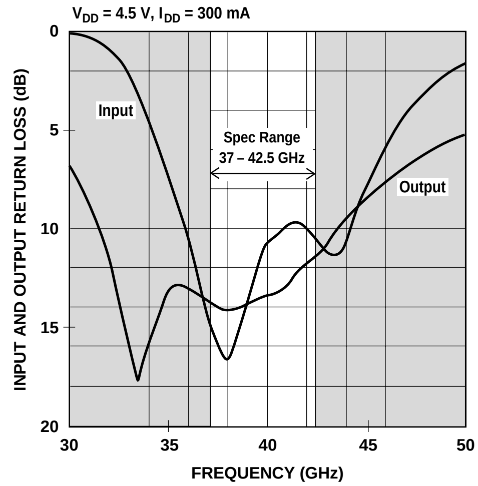


Figure 3. Input and Output Return Loss vs. Frequency.[1]

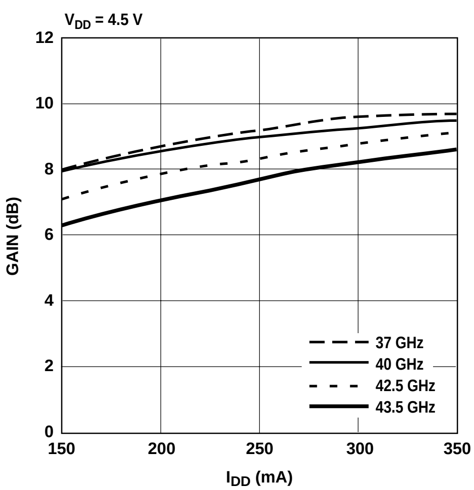


Figure 4. Gain vs. Total Drain Current as a Function of Frequency.[1]

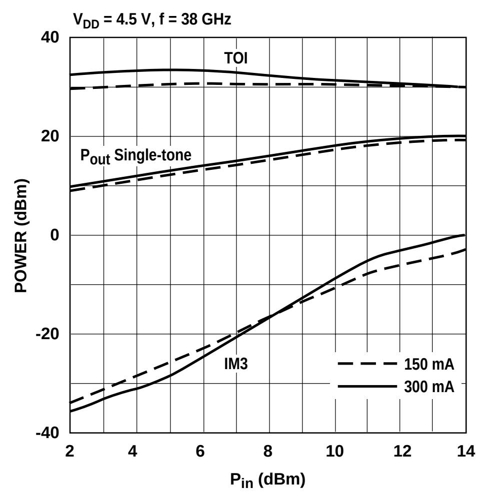


Figure 5. Intermodulation Distortion for 150 mA and 300 mA Total Drain Current. (10 MHz Spacing)

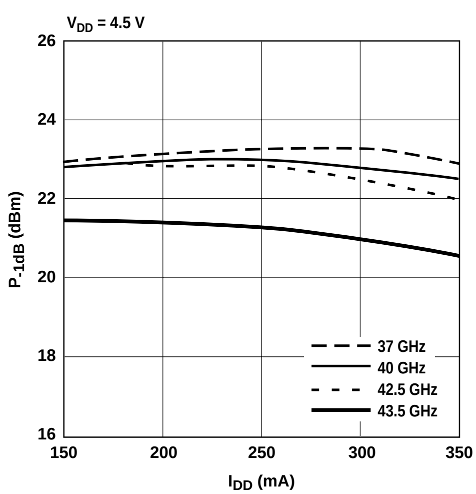


Figure 6. P_{-1dB} vs. Total Drain Current as a Function of Frequency.[1]

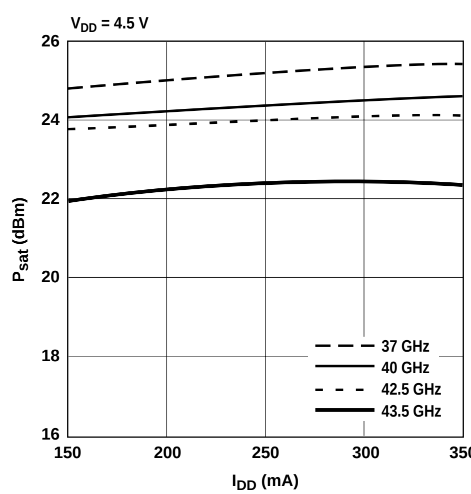


Figure 7. P_{sat} vs. Total Drain Current as a Function of Frequency.[1]

Note 1: Wafer-probed measurements

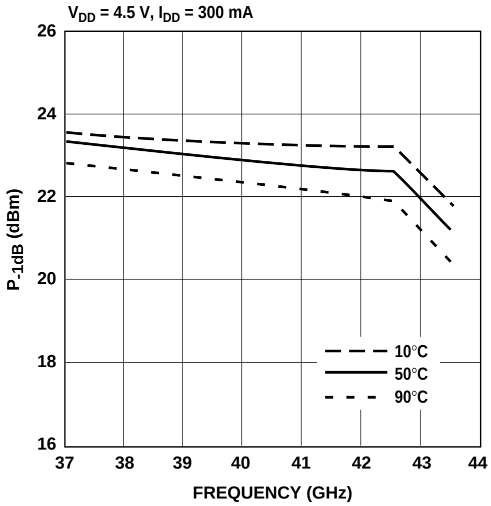


Figure 8. P_{-1dB} vs. Frequency as a Function of Temperature.[1]

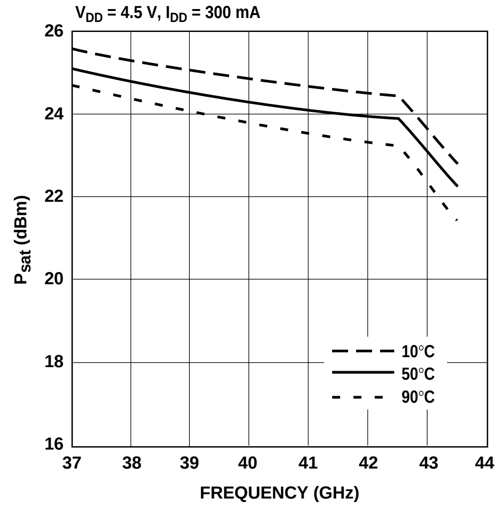


Figure 9. P_{sat} vs. Frequency as a Function of Temperature.[1]

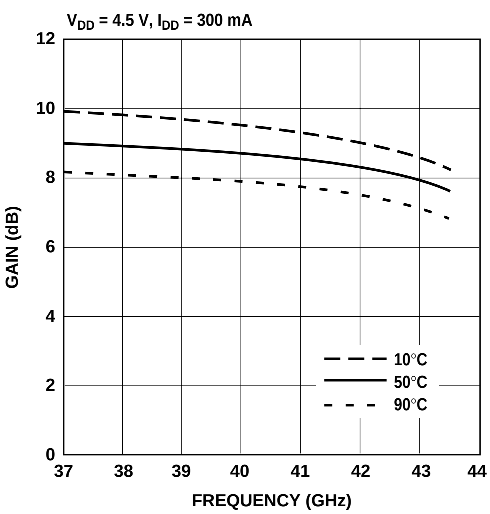


Figure 10. Gain vs. Frequency as a Function of Temperature.[1]

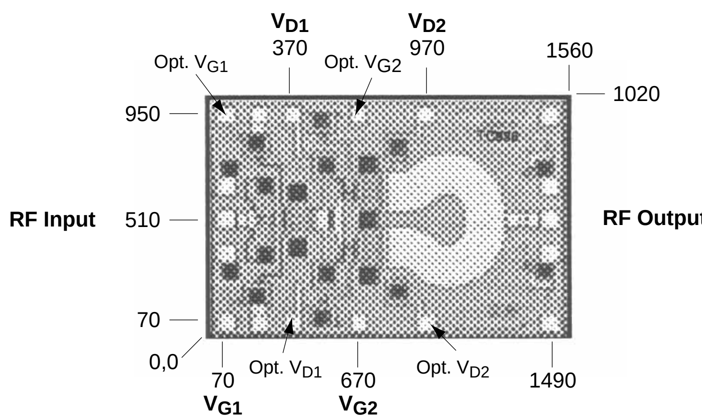


Figure 11. HMMC-5034 Bonding Pad Positions. (Dimensions are in micrometers)

Note 1: Wafer-probed measurements

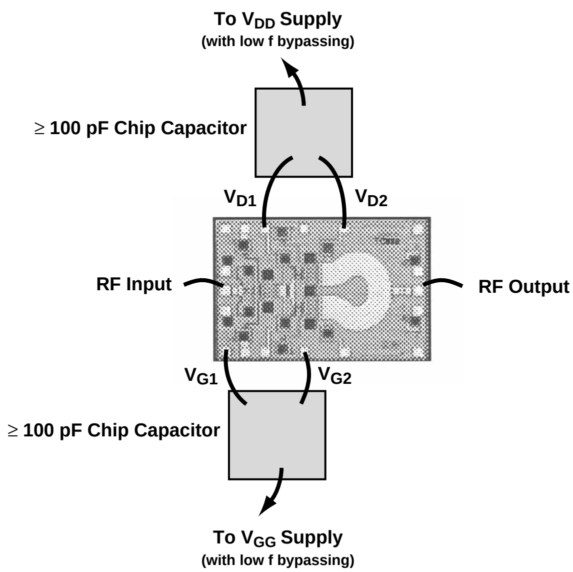


Figure 12. HMMC-5034 Common Assembly Diagram.
(Shown with/out optional output detector connections)

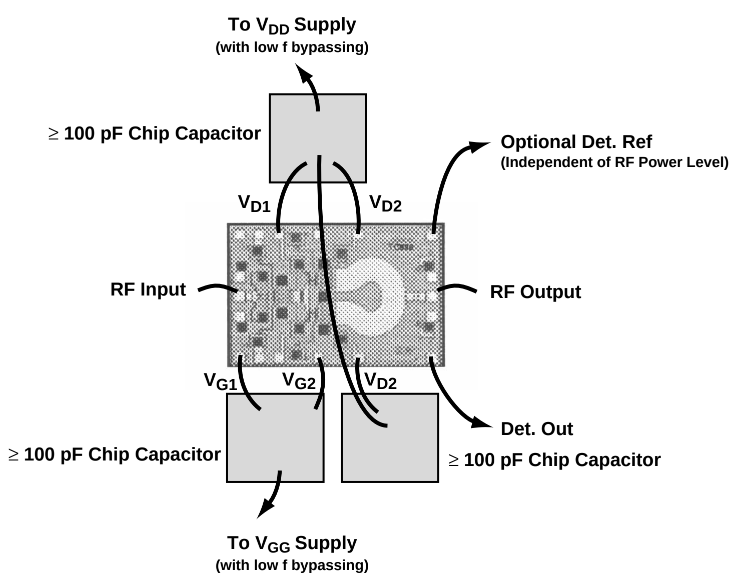


Figure 13. HMMC-5034 Common Assembly Diagram with Detector. (Shown with output detector connections and optional V_{D2} "balancing" connection)

This data sheet contains a variety of typical and guaranteed performance data. The information supplied should not be interpreted as a complete list of circuit specifications. In this data sheet the term *typical* refers to the 50th percentile performance. For additional information contact your local Agilent sales representative.

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Data subject to change.

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