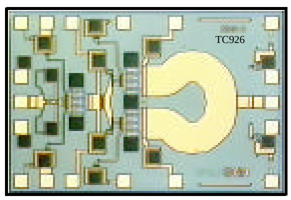
Agilent HMMC-5034
37–43 GHz Amplifier

Data Sheet



Chip Size:	1.56 × 1.02 mm (61.4 × 40.1 mils)
Chip Size Tolerance:	±10 µm (± 0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)
Pad Dimensions:	80 × 80 µm (3.2 × 3.2 mils)

Features

- **23 dBm Output $P_{(-1dB)}$**
- **8 dB Gain @ 40 GHz**
- **Integrated Output Power Detector Network**
- **50Ω 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.

Absolute Maximum Ratings[1]

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

Notes:

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

DC Specifications / Physical Properties[1]

Symbol	Parameters / Conditions	Min.	Typ.	Max.	Units
VD1,2	Drain Supply Operating Voltages	2	4.5	5	Volts
I_{D1}	Suggested First Stage Operating Drain Supply Current (V_{D1} = 4.5V)		100	165	mA
I_{D2}	Suggested Second Stage Operating Drain Supply Current (V_{D2} = 4.5V)		200	285	mA
$V_{G1,2}$	Gate Supply Operating Voltages ($I_{D1} \cong$ 100 mA, $I_{D2} \cong$ 200 mA)		-0.8		Volts
V_P	Pinch-off Voltage (V_{D1} =V_{D2} = 4.5 V, $I_{D1} + I_{D2} \leq$ 10 mA)	–2.5	–1.2		Volts
Vdet	Reference and Output Detector DC Voltage (V_{D2} = 4.5 V, No RF Output)		1.4		Volts
g	Detector Voltage Sensitivity (V_{DD} = 4.5 V, P_{out} = 20 dBm)		0.12		mV / mW
$\theta_{ch\text{-}bs}$	Thermal Resistance[2]† (Channel-to-Backside at T_{ch} = 150°C)		44		°C / Watt
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)		150		°C

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:
   $\theta(T) \cong \theta_{ch\text{-}bs} \times [T(°C)+273] / [150°C+273]$.
3. Derate MTTF by a factor of two for every 8°C above T_{ch}.

RF Specifications

(T_A = 25°C, Z_0 = 50Ω, V_{D1} = V_{D2} = 4.5 V, I_{D1} = 100 mA, I_{D2} = 200 mA)

Symbol	Parameters / Conditions	37–40 GHz			40–2.5 GHz			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
BW	Operating Bandwidth	37		40	40		42.5	GHz
Gain	Small Signal Gain	7	8	11	6	7	11	dB
ΔGain / ΔT	Temperature Coefficient of Gain		0.019			0.019		dB / °C
$P_{(-1dB)}$	Output Power at 1dB Gain Compression[1]	21	23		20	22		dBm
P_{SAT}	Saturated Output Power[1]	22	24		21	23		dBm
ΔP / ΔT	Temperature Coefficient of $P_{(-1dB)}$ and P_{sat}		0.015			0.015		dB / °C
$(RL_{in})_{MIN}$	Minimum Input Return Loss	9	10		8	10		dB
$(RL_{out})_{MIN}$	Minimum Output Return Loss	10	12		9	12		dB
Isolation	Minimum Reverse Isolation		30			27		dB

Notes:

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 preform 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.

GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

MMIC ESD precautions, handling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

Agilent application note #54, "GaAs MMIC ESD, Die Attach and Bonding Guidelines" provides basic information on these subjects.

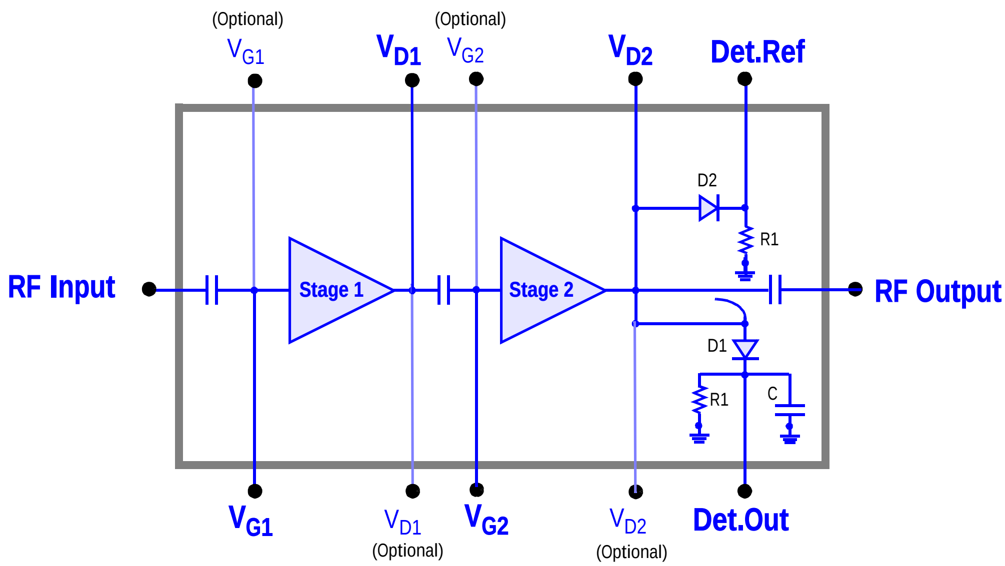


Figure 1.
Simplified Schematic Diagram

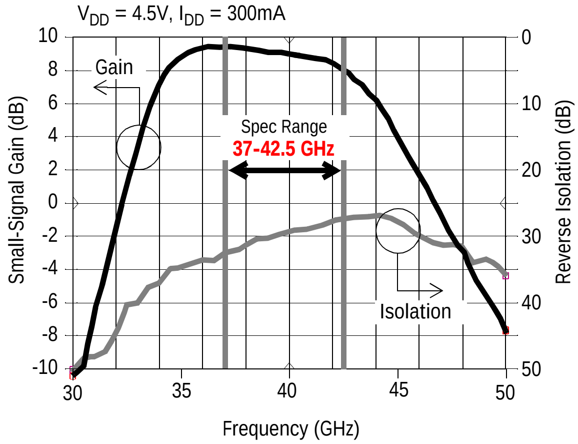


Figure 2.
Typical Gain and Isolation vs. Frequency*

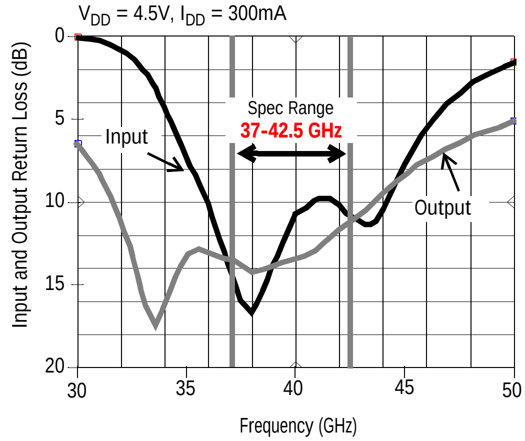


Figure 3.
Typical Input and Output Return Loss vs. Frequency*

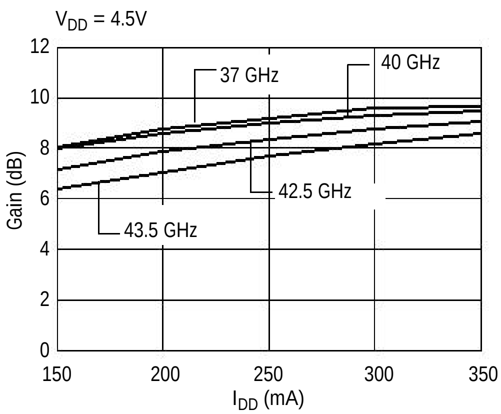


Figure 4.
Gain vs. Total Drain Current as a Function of Frequency*

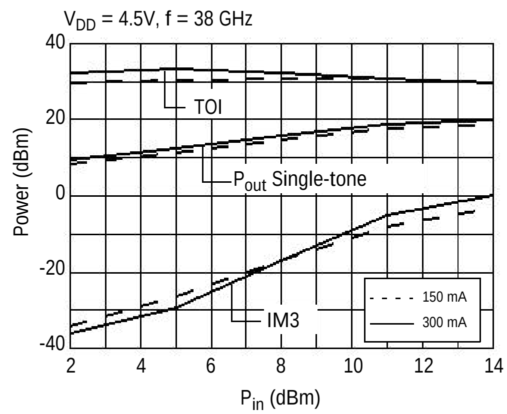


Figure 5.
Intermodulation Distortion for 150 mA and 300 mA Total Drain Current
(10 MHz Spacing)

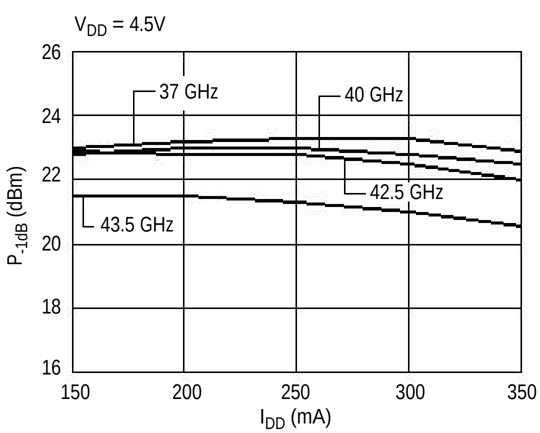


Figure 6.
P_{-1dB} vs. Total Drain Current as a Function of Frequency*

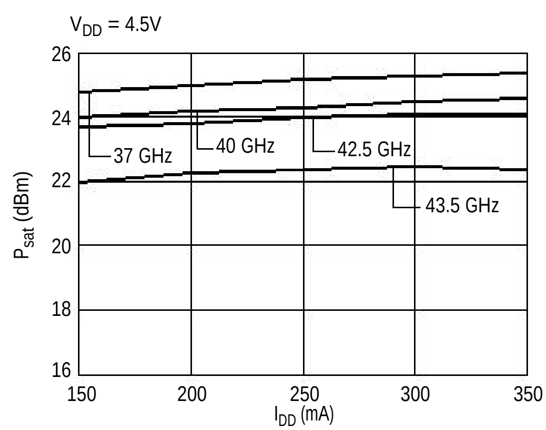


Figure 7.
P_{sat} vs. Total Drain Current as a Function of Frequency*

*Wafe–-probed measurements.

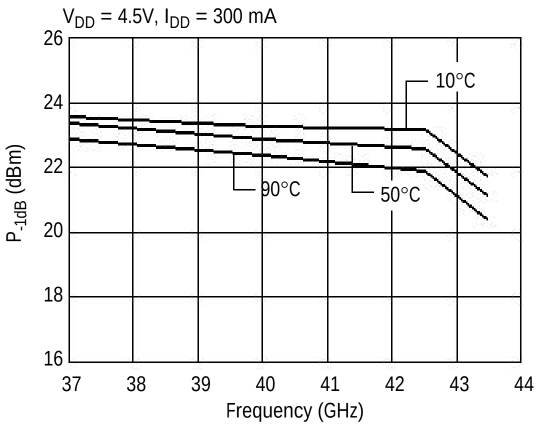


Figure 8.
P_{-1dB} vs. Frequency
as a Function of Temperature*

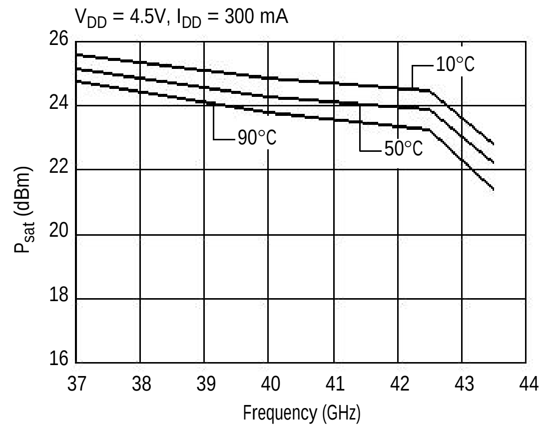


Figure 9.
P_{sat} vs. Frequency
as a Function of Temperature*

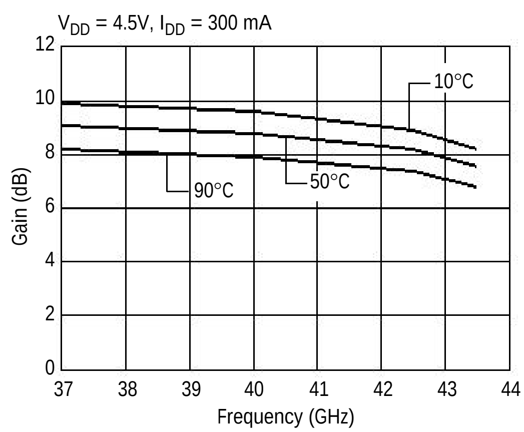


Figure 10.
Gain vs. Frequency
as a Function of Temperature*

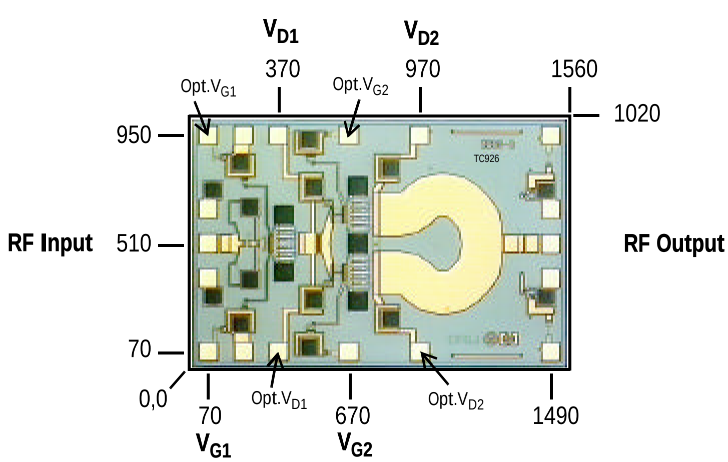


Figure 11.
Bonding Pad Positions
(Dimensions are in micrometers)

*Wafer–probed measurements.

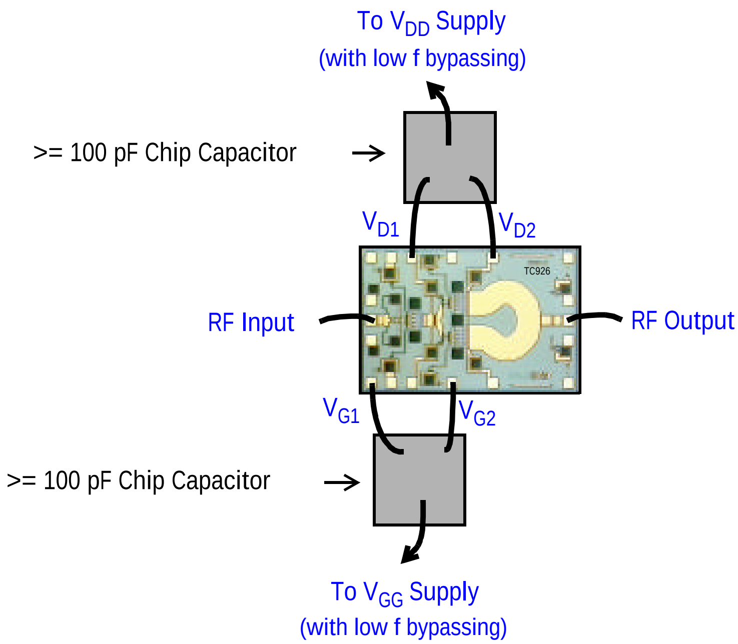


Figure 12.
Common Assembly Diagram
(Shown with/out optional output detector connections)

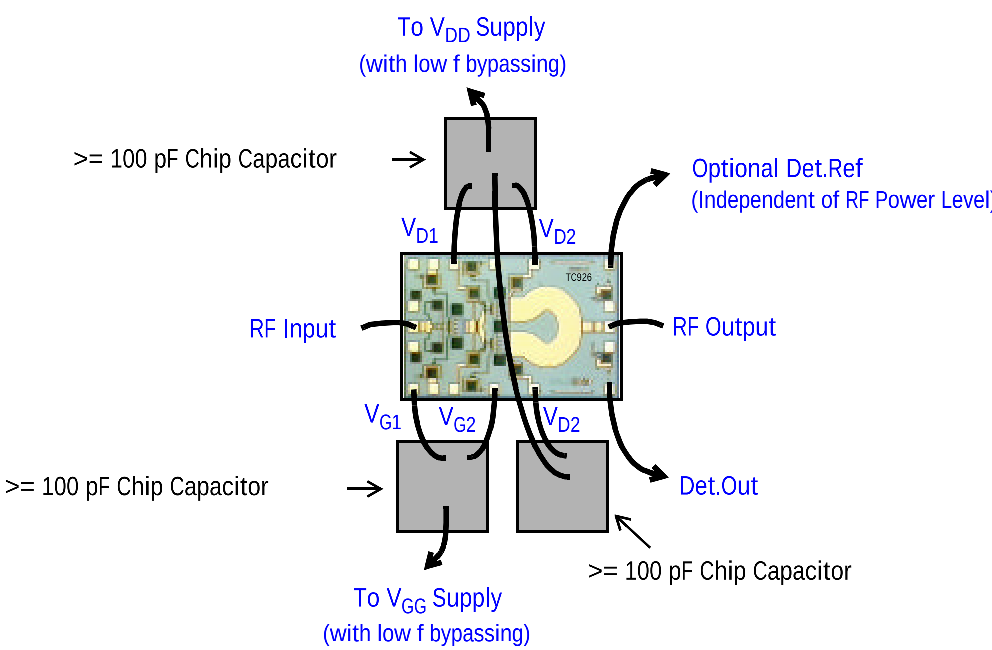


Figure 13.
Common Assembly Diagram with Detector
(Shown with output detector connections and optional V_{D2} "balancing" connection)

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 Technologies' sales representative.

www.agilent.com / semiconductors

For product information and a complete list of distributors, please go to our web site.

For technical assistance call:

Americas / Canada: +1 (800) 235-0312 or (408) 654-8675

Europe: +49 (0) 6441 92460

China: 10800 650 0017

Hong Kong: (+65) 6271 2451

India, Australia, New Zealand: (+65) 6271 2394

Japan: (+81 3) 3335-8152(Domestic / International), or 0120-61-1280(Domestic Only)

Korea: (+65) 6271 2194

Malaysia, Singapore: (+65) 6271 2054

Taiwan: (+65) 6271 2654

August 30, 2002
5988-3203EN

Agilent Technologies