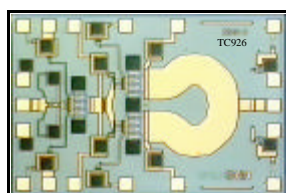




# Agilent HMMC-5034 37-43 GHz Amplifier

## 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)

## 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.

## Absolute Maximum Ratings<sup>[1]</sup>

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 <sup>[2]</sup>		175	°C
$T_{bs}$	Backside Temperature	-55	+95	°C
$T_{st}$	Storage Temperature	-65	+170	°C
$T_{max}$	Max. Assembly Temperature		300	°C

<sup>[1]</sup> Absolute maximum ratings for continuous operation unless otherwise noted.

<sup>[2]</sup> Refer to *DC Specifications / Physical Properties* table for derating information.



## DC Specifications/Physical Properties<sup>[1]</sup>

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
$V_{D1,2}$	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
$V_{det}$	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
$\theta_{ch-bs}$	Thermal Resistance <sup>[2]†</sup> (Channel-to-Backside at $T_{ch} = 150^\circ C$ )		44		$^\circ C/Watt$
$T_{ch}$	Channel Temperature <sup>[3]</sup> ( $T_{bs} \cong 90^\circ C$ , MTTF > $10^6$ hrs, $V_{D1} = V_{D2} = 4.5$ V, $I_{D1} = 100$ mA, $I_{D2} = 200$ mA)		150		$^\circ C$

<sup>[1]</sup>Backside operating temperature  $T_{bs} = 25^\circ C$  unless otherwise noted.

<sup>[2]</sup>Thermal resistance ( $^\circ C/Watt$ ) at a channel temperature  $T(^\circ C)$  can be *estimated* using the equation:

$$\theta(T) \cong \theta_{ch-bs} \times [T(^\circ C) + 273] / [150^\circ C + 273].$$

<sup>[3]</sup>Derate MTTF by a factor of two for every  $8^\circ C$  above  $T_{ch}$ .

## RF Specifications

( $T_A = 25^\circ C$ ,  $Z_0 = 50\Omega$ ,  $V_{D1} = V_{D2} = 4.5$  V,  $I_{D1} = 100$  mA,  $I_{D2} = 200$  mA)

Symbol	Parameters/Conditions	37-40 GHz			40-42.5 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
$\Delta Gain/\Delta T$	Temperature Coefficient of Gain		0.019			0.019		dB/ $^\circ C$
$P_{(-1dB)}$	Output Power at 1dB Gain Compression <sup>[1]</sup>	21	23		20	22		dBm
$P_{SAT}$	Saturated Output Power <sup>[1]</sup>	22	24		21	23		dBm
$\Delta P/\Delta T$	Temperature Coefficient of $P_{(-1dB)}$ and $P_{sat}$		0.015			0.015		dB/ $^\circ C$
$(RL_{in})_{MIN}$	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

<sup>[1]</sup>Note: 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 refer-

ence 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  $150 \pm 2^\circ\text{C}$ .

GaAs MMICs are ESD sensitive. For more detailed information see Agilent Technologies' application note #999 "GaAs MMIC ESD, Die Attach and Bonding Guidelines."

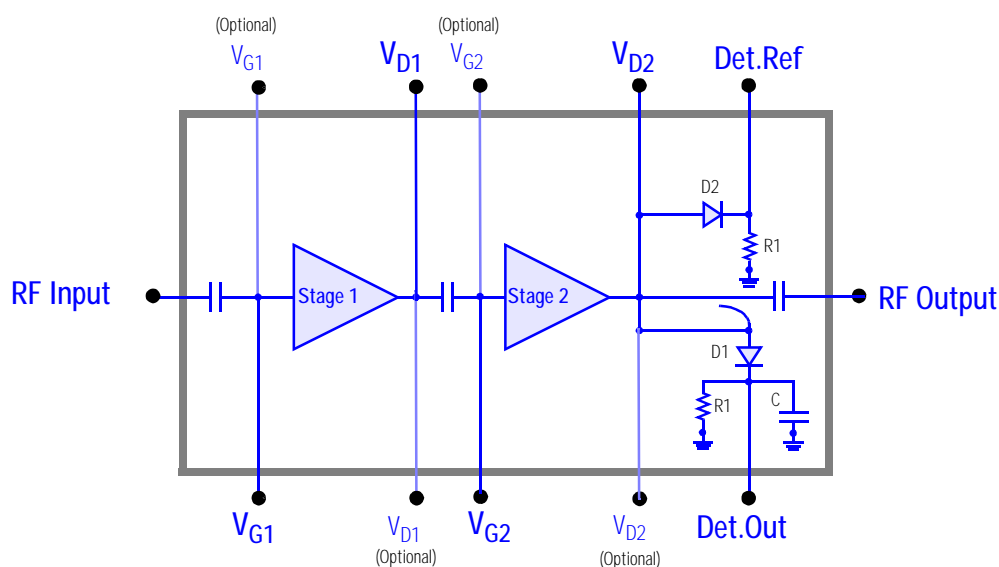


Figure 1.  
Simplified Schematic Diagram

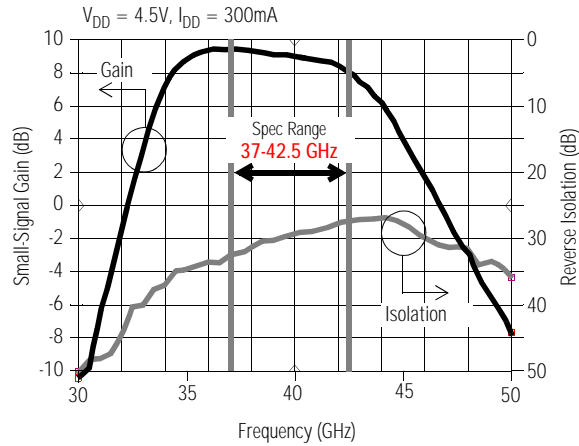


Figure 2.  
Typical Gain and Isolation  
versus Frequency\*

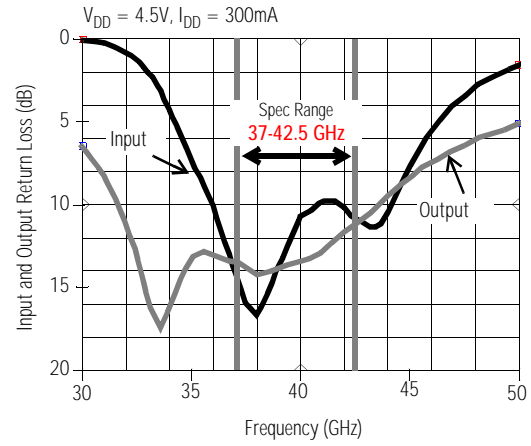


Figure 3.  
Typical Input and Output  
Return Loss versus Frequency\*

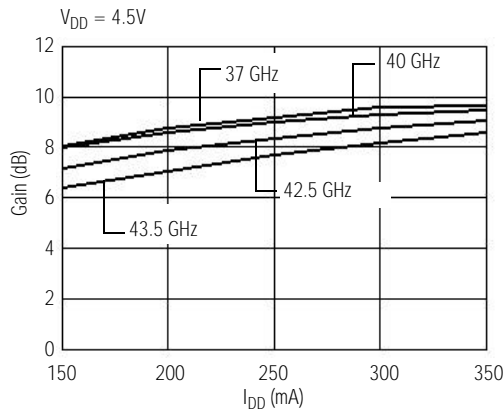


Figure 4.  
Gain vs. Total Drain Current  
as a Function of Frequency\*

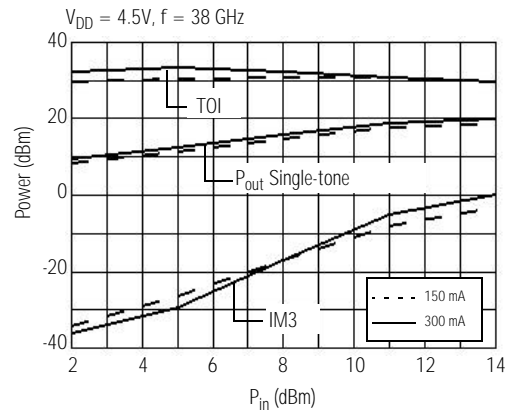


Figure 5.  
Intermodulation Distortion for 150 mA and 300 mA  
Total Drain Current  
(10 MHz Spacing)

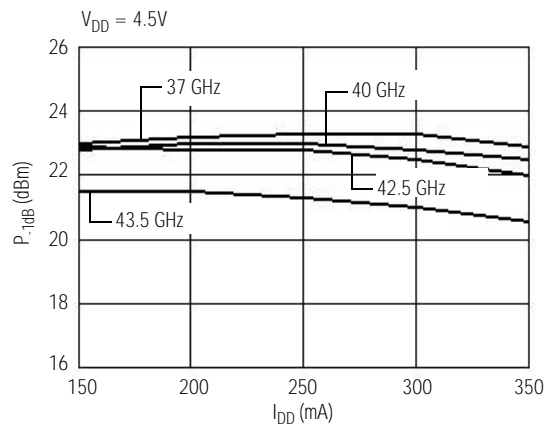


Figure 6.  
 $P_{1dB}$  vs. Total Drain Current  
as a Function of Frequency\*

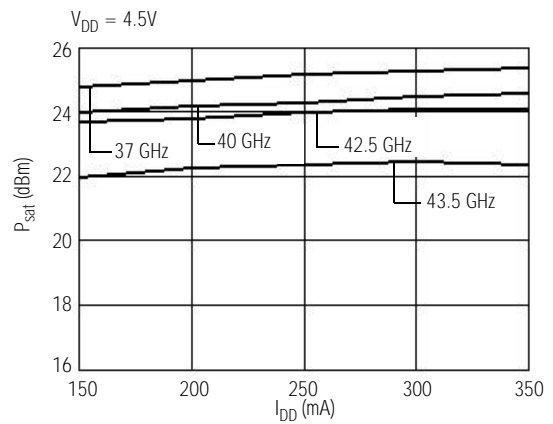
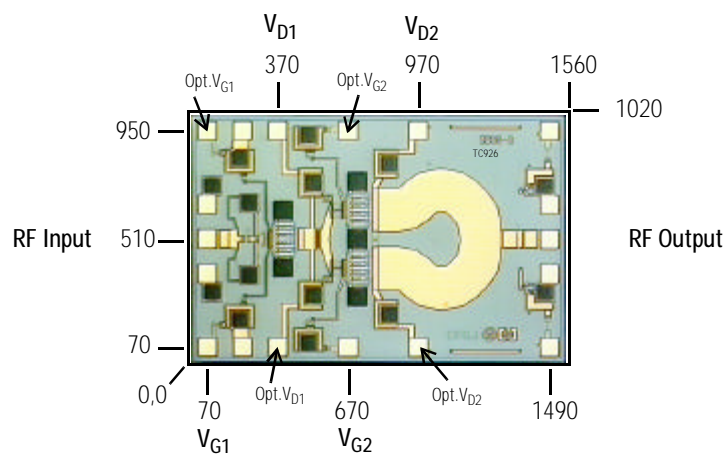
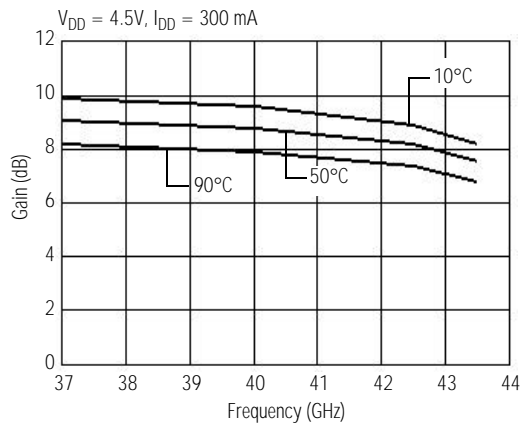
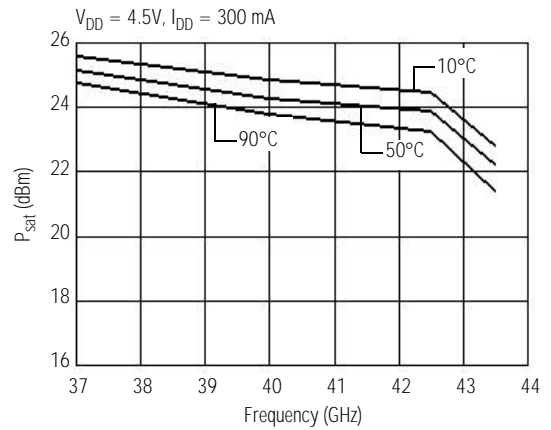
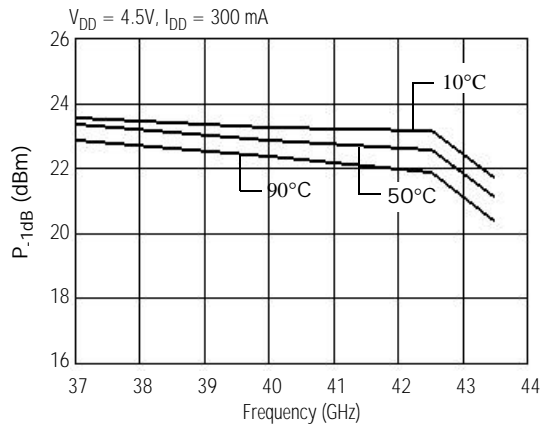


Figure 7.  
 $P_{sat}$  vs. Total Drain Current  
as a Function of Frequency\*

\* Wafer-probed measurements.



\*Wafer-probed measurements.

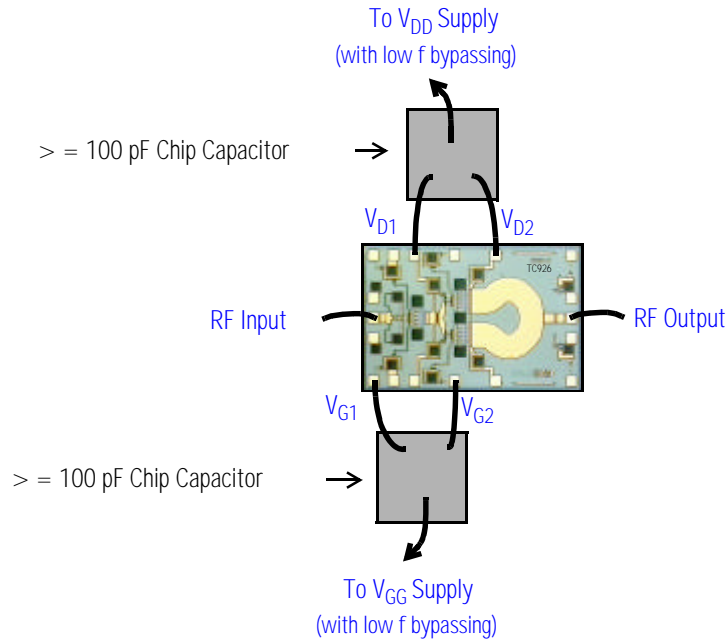


Figure 12.  
Common Assembly Diagram  
(Shown with/out optional output detector connections)

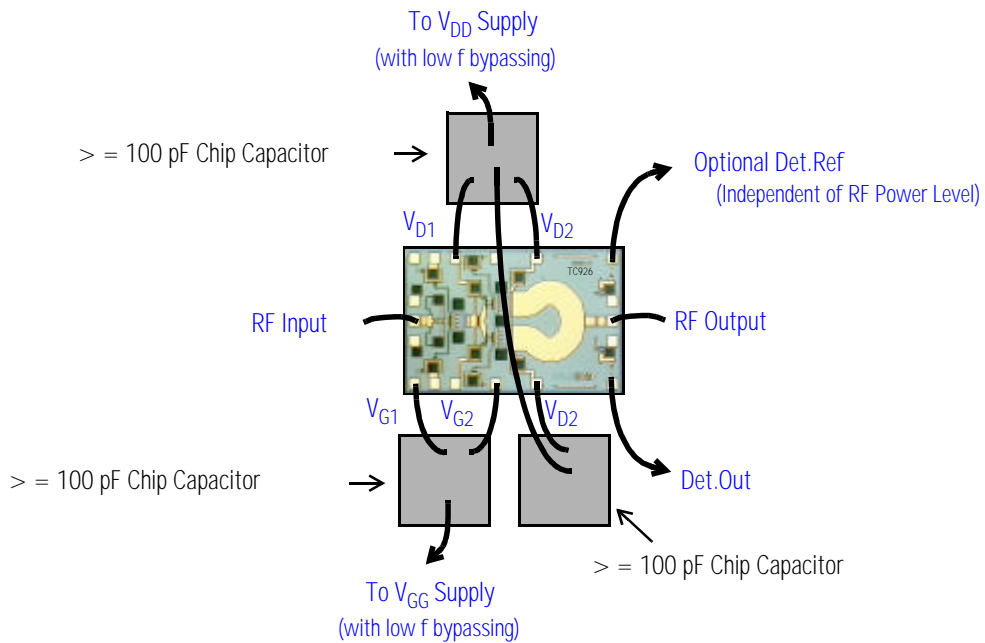


Figure 13.  
Common Assembly Diagram with Detector  
(Shown with output detector connections and optional  $V_{D2}$  "balancing" connection)

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.