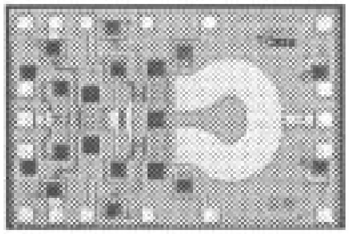
# 37–43 GHz Amplifier

## 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 | |
| $\gamma$ | 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

| | | | 37–40 GHz | | | 40–42.5 GHz | | |
|---|---|---|---|---|---|---|---|---|
| **Symbol** | **Parameters and Test Conditions** | **Units** | **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 HP application note #999, “GaAs MMIC Assembly and Handling Guidelines.”

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

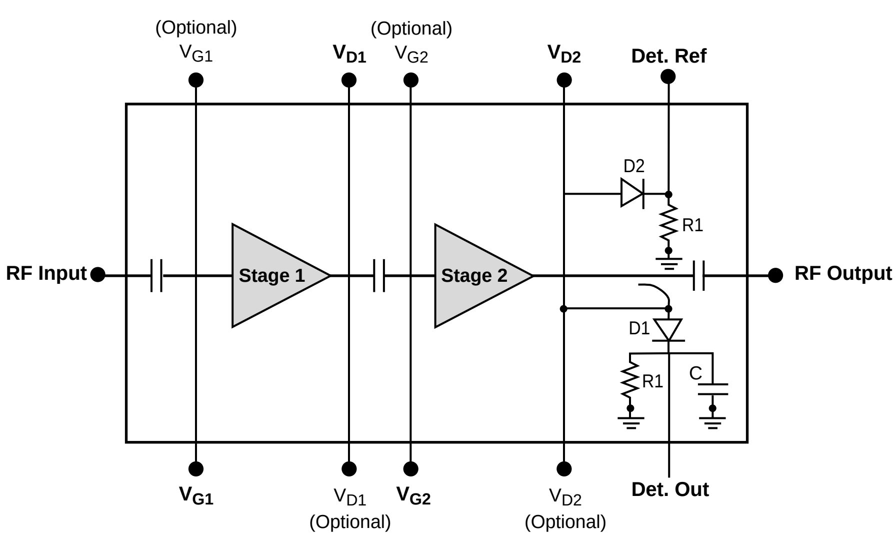



**Figure 1. HMMC-5034 Simplified Schematic Diagram.**

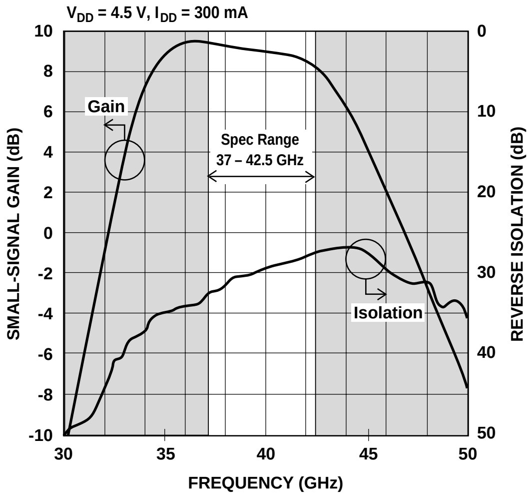



**Figure 2. Typical Gain and Isolation vs. Frequency.**[1]

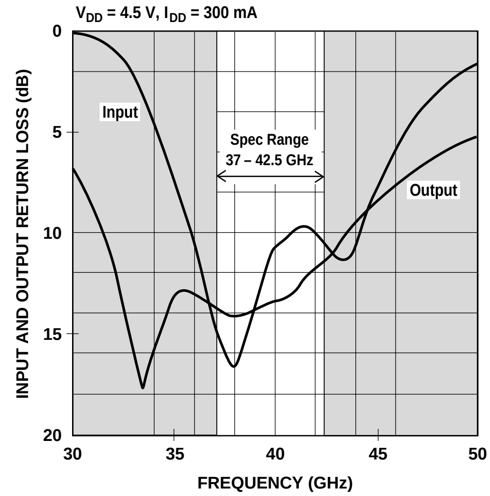



**Figure 3. Input and Output Return Loss vs. Frequency.**[1]

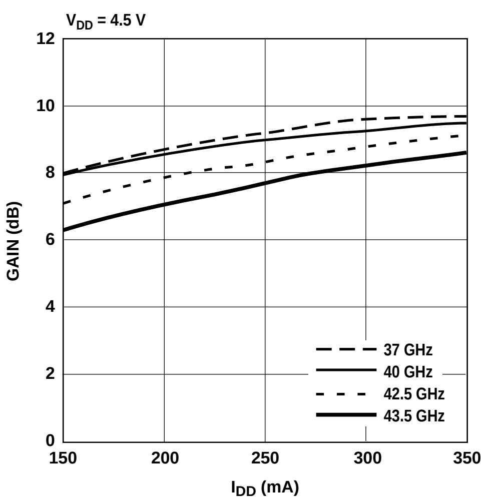



**Figure 4. Gain vs. Total Drain Current as a Function of Frequency.**[1]

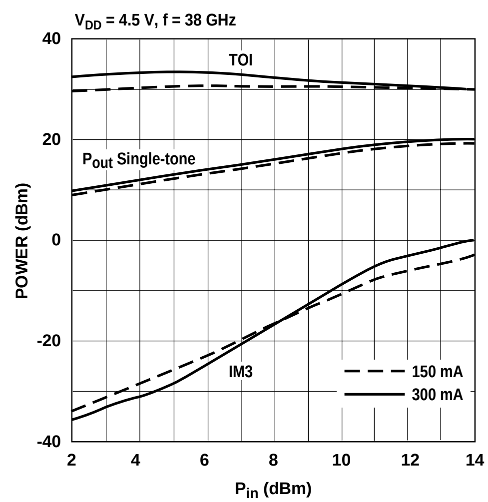



**Figure 5. Intermodulation Distortion for 150 mA and 300 mA Total Drain Current.** (10 MHz Spacing)

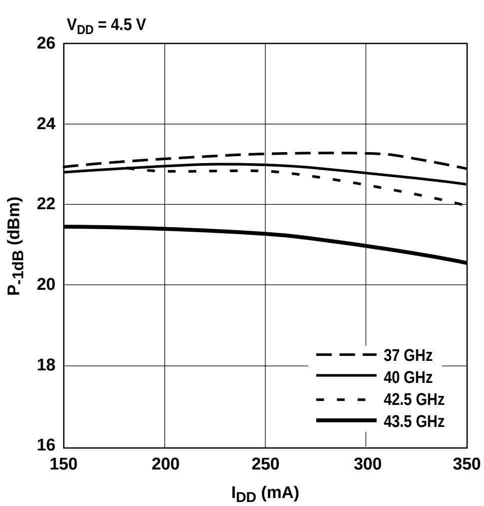



**Figure 6. $P_{-1dB}$ vs. Total Drain Current as a Function of Frequency.**[1]

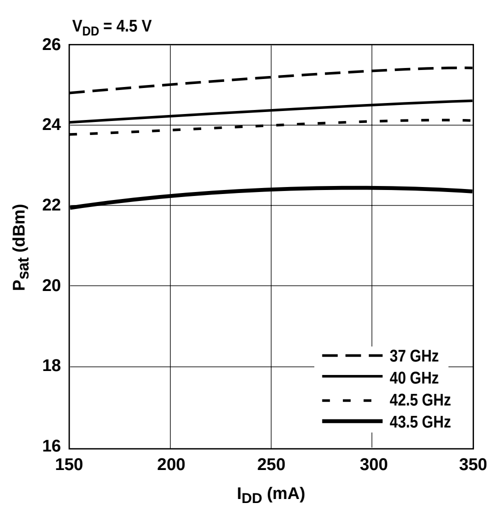



**Figure 7. $P_{sat}$ vs. Total Drain Current as a Function of Frequency.**[1]

**Note 1**: Wafer-probed measurements

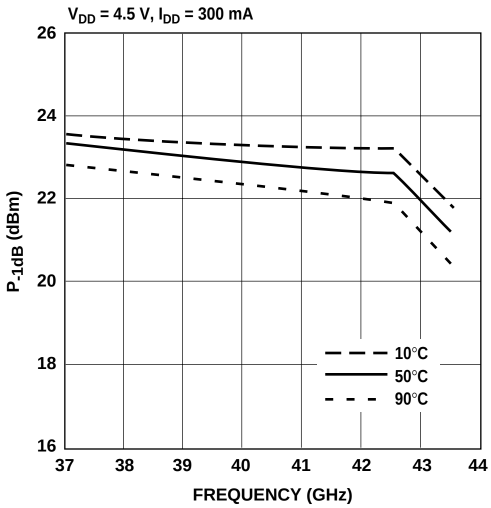



**Figure 8. $P_{-1dB}$ vs. Frequency as a Function of Temperature.**[1]

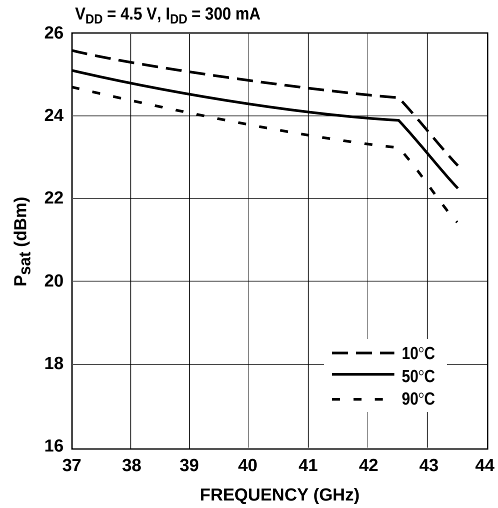



**Figure 9. $P_{sat}$ vs. Frequency as a Function of Temperature.**[1]

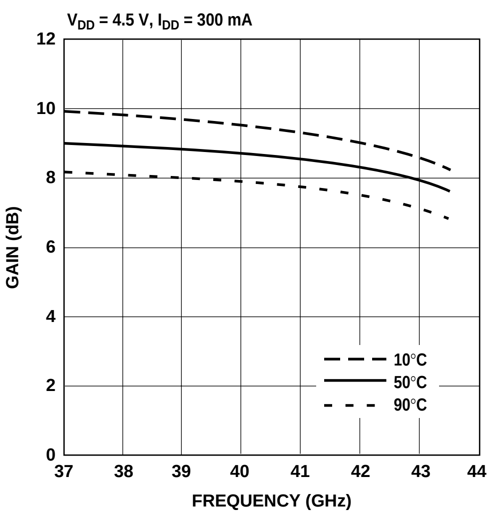



**Figure 10. Gain vs. Frequency as a Function of Temperature.**[1]

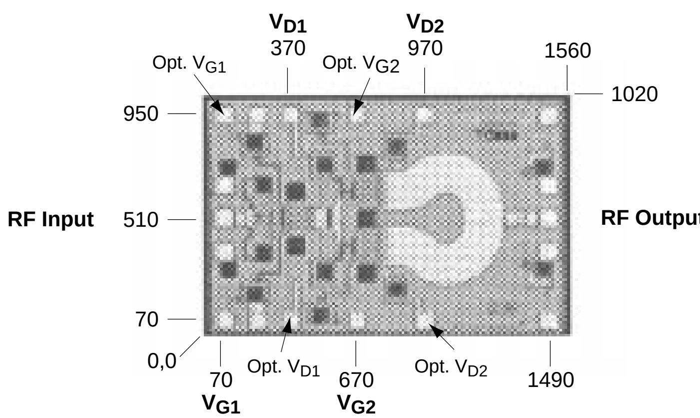



**Figure 11. HMMC-5034 Bonding Pad Positions.** (Dimensions are in micrometers)

**Note 1**: Wafer-probed measurements

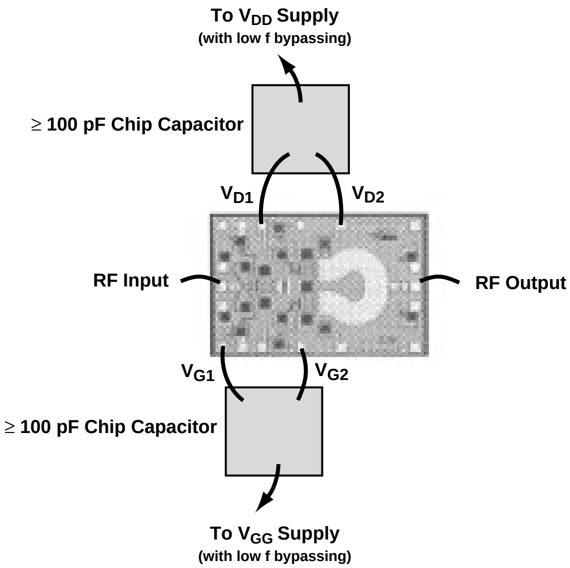



**Figure 12. HMMC-5034 Common Assembly Diagram.**
(Shown with/out optional output detector connections)

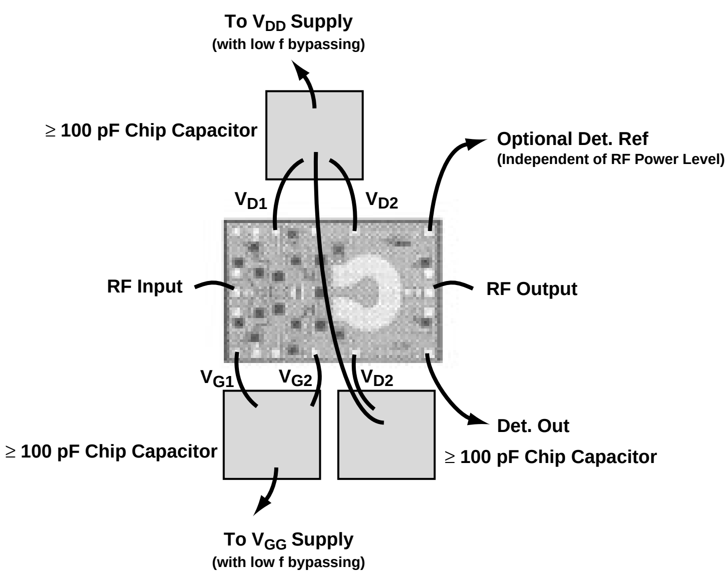



**Figure 13. HMMC-5034 Common Assembly Diagram with Detector.** (Shown with output detector connections and optional $V_{D2}$ "balancing" connection)

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 HP sales representative.

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Data subject to change.


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