HEWLETT® PACKARD

17.7-32 GHz Power Amplifier

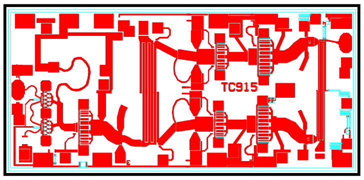
HMMC-5033

Features

- 26 dBm Output $P_{(-1dB)}$ at 28 GHz
- High Gain: 18 dB
- 50 Ω Input/Output Matching
- Small Size

Description

The HMMC-5033 is a MMIC power amplifier designed for use in wireless transmitters that operate within the 17.7 GHz to 32 GHz range. At 28 GHz it provides 26 dBm of output power (P-1dB) and 18 dB of small-signal gain from a small easy-to-use device. The HMMC-5033 was designed to be driven by the HMMC-5040 (20-40 GHz) or the HMMC-5618 (5.9-20 GHz) MMIC amplifier for linear transmit applications. This device has input and output matching circuitry for use in 50 ohm environments.



Chip Size:	2.74 × 1.31 mm (108 × 51.6 mils)
Chip Size Tolerance:	±10 µm (±0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)

Absolute Maximum Ratings*

Symbol	Parameters/Conditions	Min.	Max.	Units
$V_{D1,2}$	Drain Supply Voltages		5.2	Volts
V_{G1},V_{GG}	Gate Supply Voltages	-3.0	0.5	Volts
Det.Bias	Applied Detector Bias (Optional)		5.2	Volts
I_{D1}	First Stage Drain Current		320	mA
I_{D2}	Second Stage Drain Current		640	mA
P_{in}	RF Input Power		23	dBm
T_{ch}	Channel Temperature**		170	°C
T_A	Backside Ambient Temperature	-55	+85	°C
T_{st}	Storage Temperature	-65	+170	°C
T_{max}	Max. Assembly Temperature		300	°C

*Absolute maximum ratings for continuous operation unless otherwise noted.

**Refer to *DC Specifications / Physical Properties* table for derating information.

DC Specifications/Physical Properties[*]

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
V_{D1}	Drain Supply Operating Voltage		3.5	5	Volts
V_{D2}	Drain Supply Operating Voltage		5	5	Volts
I_{D1}	First Stage Drain Supply Current (V_{D1} = 3.5 V, V_{G1} = Open, V_{GG} set for I_{D2} typical)		240	320	mA
I_{D2}	Second Stage Drain Supply Current (V_{D2} = 5 V, $V_{GG} \cong -0.8$ V)		460	640	mA
V_{G1},V_{GG}	Gate Supply Operating Voltages ($I_{D1} + I_{D2} \cong 700$ mA)		-0.8		Volts
V_P	Pinch-off Voltage [V_{DD} = 2.5 V, ($I_{D1} + I_{D2}$) ≤ 20 mA]	-2.5	-1.2	-0.8	Volts
Det.Bias	Detector Bias Voltage (Optional)		V_{D2}	5	Volts
$\theta_{1(ch\text{-}bs)}$	First Stage Thermal Resistance[†] (Channel-to-Backside at T_{ch} = 160°C)		67		°C/Watt
$\theta_{2(ch\text{-}bs)}$	Second Stage Thermal Resistance[†] (Channel-to-Backside at T_{ch} = 160°C)		37		°C/Watt
T_{ch}	Second Stage Channel Temperature[**] (T_A = 75°C, MTTF ≥ 10^6 hrs, V_{D2} = 5 V, I_{D2} = 460 mA)		160		°C

[*] Backside ambient operating temperature T_A = 25°C unless otherwise noted.
[†] Thermal resistance (°C/Watt) at a channel temperature T(°C) can be *estimated* using the equation:
$\theta(T) \cong \theta_{ch\text{-}bs} \times [T(°C)+273] / [160°C+273]$.
[**] Derate MTTF by a factor of two for every 8°C above T_{ch}.

RF Specifications

[T_A = 25°C, Z_0 = 50 Ω, V_{D1} = 3.5 V, V_{D2} = 5 V, I_{D2} = 460 mA ($I_{D1} \cong 240$ mA)]

Symbol	Parameters/Conditions	Lower Band Specifications			Mid Band Specifications			Upper Band Specifications			Units
		Min	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	
BW	Operating Bandwidth	17.7		21	21		26.5	25		31.5	GHz
Gain	Small Signal Gain	17	22		17	20		15	18		dB
P_{-1dB}	Output Power at 1dB Gain Compression	22	23		24	25		25	26		dBm
P_{SAT}	Saturated Output Power[*]		25			27			28		dBm
$(RL_{in})_{MIN}$	Min. Input Return Loss	8	10		9	12		10	12		dB
$(RL_{out})_{MIN}$	Min. Output Return Loss	15	20		15	20		15	20		dB
Isolation	Min. Reverse Isolation		50			50			50		dB

[*] Note: Devices operating continuously beyond 1 dB gain compression may experience power degradation.

Applications

The HMMC-5033 MMIC is a broadband power amplifier designed for use in transmitters that operate in various frequency bands between 17.7 GHz and 32 GHz. It can be attached to the output of the HMMC-5040 (20-40 GHz) or the HMMC-5618 (5.9-20 GHz) MMIC amplifier, increasing the power handling capability of transmitters requiring linear operation.

Biasing and Operation

The recommended DC bias condition for optimum efficiency, performance, and reliability is V_{D1} = 3.5 volts and V_{D2} = 5 volts with V_{GG} set for $\mathrm{I_{D1}} + \mathrm{I_{D2}}$ = 700 mA (no connection to V_{G1}). This bias arrangement results in default drain currents $\mathrm{I_{D1}}$ = 240 mA and $\mathrm{I_{D2}}$ = 460 mA.

A single DC gate supply connected to V_{GG} will bias all gain stages.

If operation with both V_{D1} and V_{D2} at 5 volts is desired, an additional wire bond connection from the V_{G1} pad to the V_{GG} external bypass chip-capacitor (shorting V_{G1} to V_{GG}) will balance the currents in each gain stage. V_{GG} (= V_{G1}) can be adjusted for $\mathrm{I_{D1}} + \mathrm{I_{D2}}$ = 700 mA.

Muting can be accomplished by setting V_{G1} and/or V_{GG} to the pinchoff voltage $\mathrm{V_P}$.

An optional output power detector network is also provided. Detector sensitivity can be adjusted by biasing the diodes with typically 1 to 5 volts applied to the *Det-Bias* terminal. Simply connecting *Det-Bias* to the V_{D2} supply is a convenient method of biasing this detector network. The differential voltage between the *Det-Ref* and *Det-Out* pads can be correlated with the RF power emerging from the *RF Output* port.

The RF ports are AC-coupled at the RF input to the first stage and the RF output of the second stage. If the output detector is biased using the on-chip optional *Det-Bias* network, an external AC-blocking capacitor may be required at the *RF Output* port.

No ground wires are needed since 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.

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.

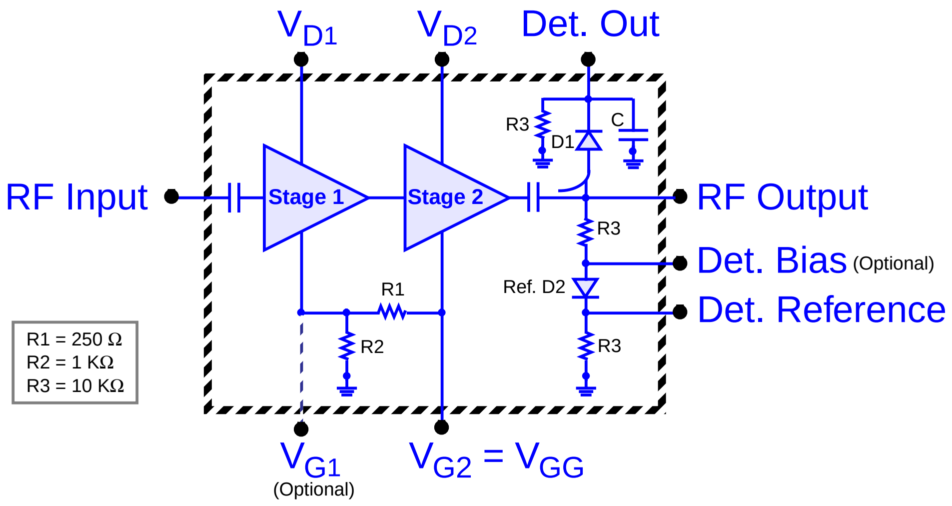


Figure 1.
HMMC-5033 Simplified Schematic Diagram

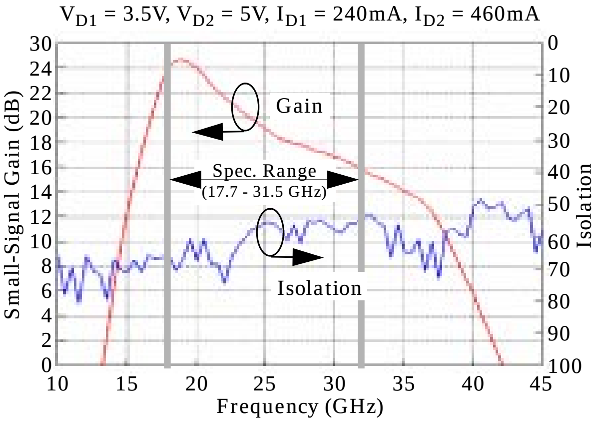


Figure 2.
Gain and Isolation versus Frequency

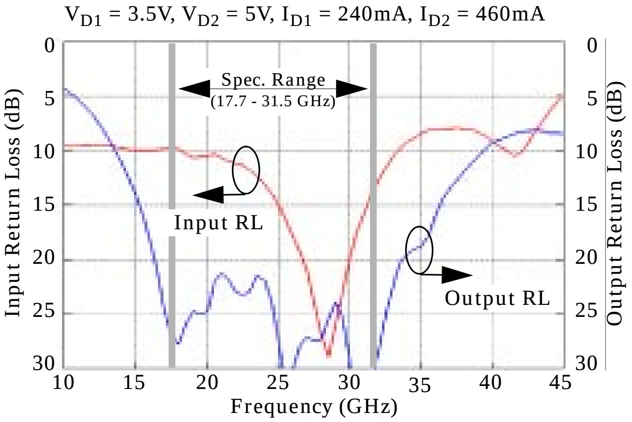


Figure 3.
Input and Output Return Loss versus Frequency

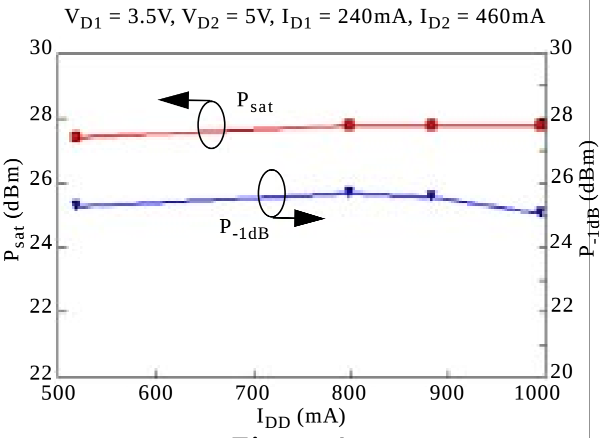


Figure 4.
Output Power versus Total Drain Current

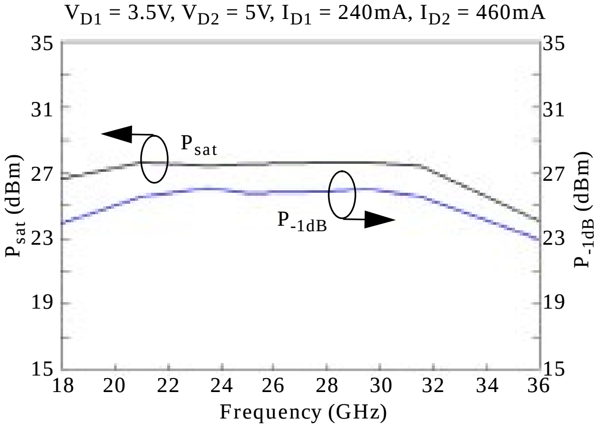


Figure 5.
Output Power versus Frequency

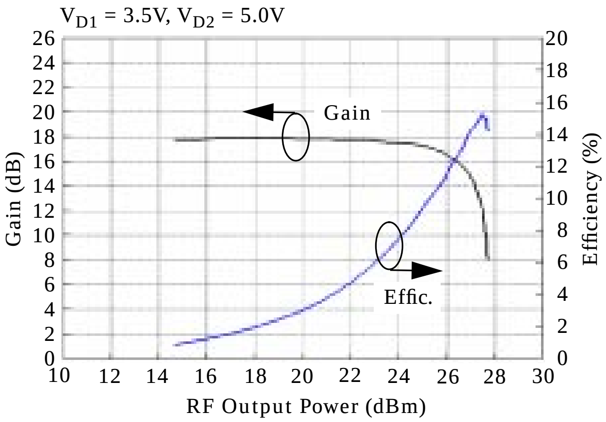


Figure 6.
Gain Compression and Efficiency at 28 GHz

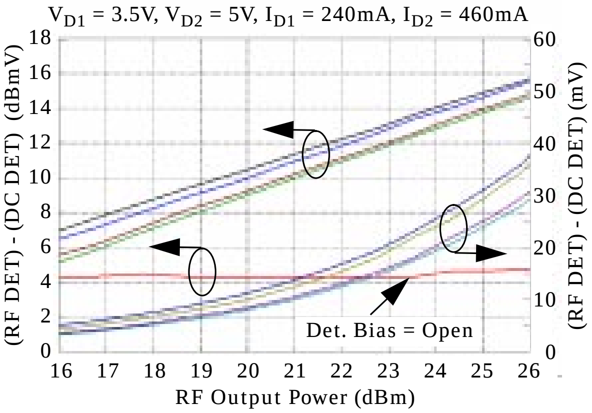


Figure 7.
Detector Voltages versus Output Power for Various Detector Bias Voltages

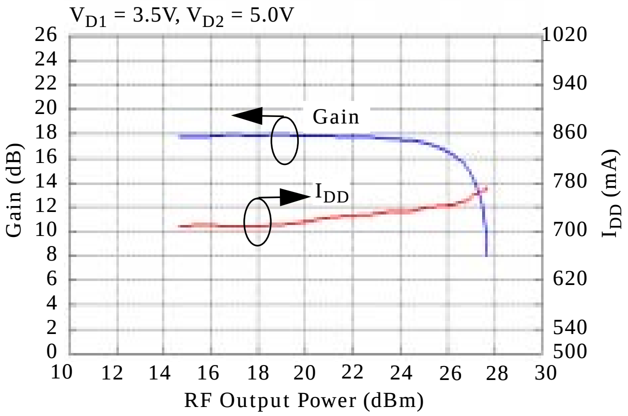


Figure 8.
Gain and Total Drain Current versus Output Power

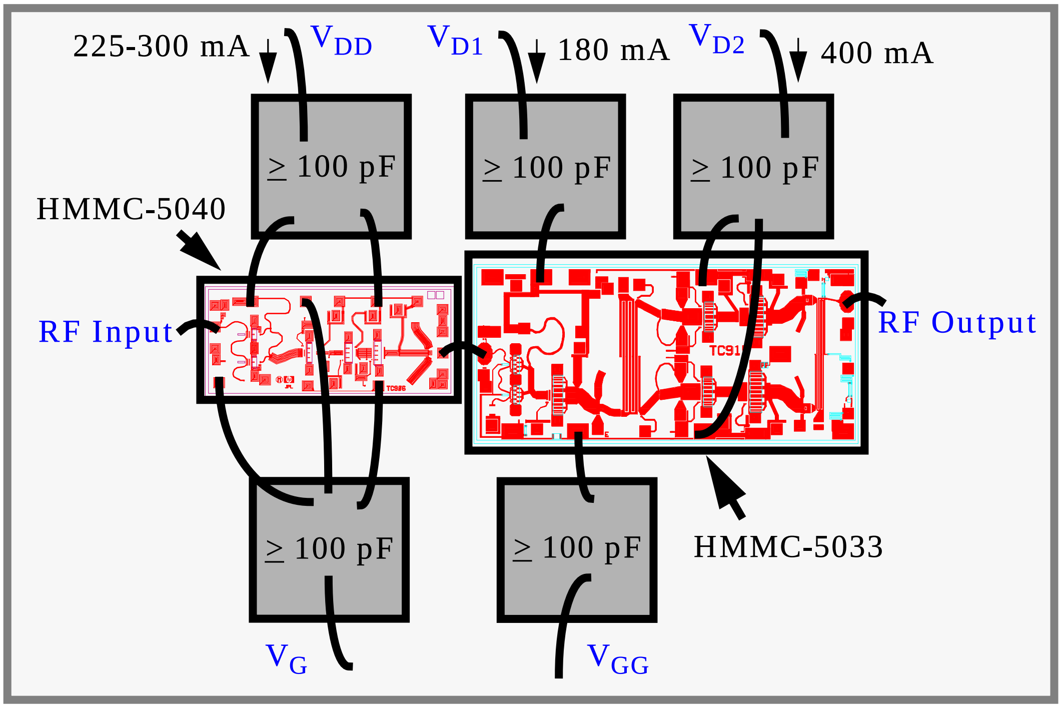


Figure 9.
Assembly diagram illustrating the HMMC-5033 cascaded with the HMMC-5040 for 20-32 GHz applications.

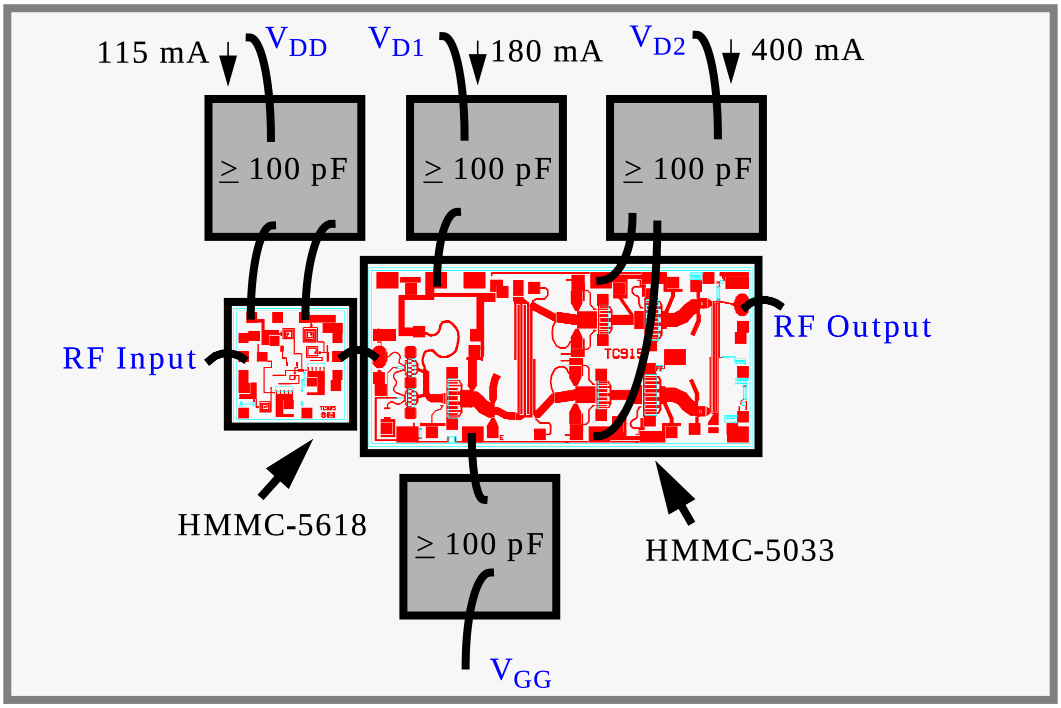


Figure 10.
Assembly diagram illustrating the HMMC-5033 cascaded with the HMMC-5618 for 17.7-20 GHz applications.

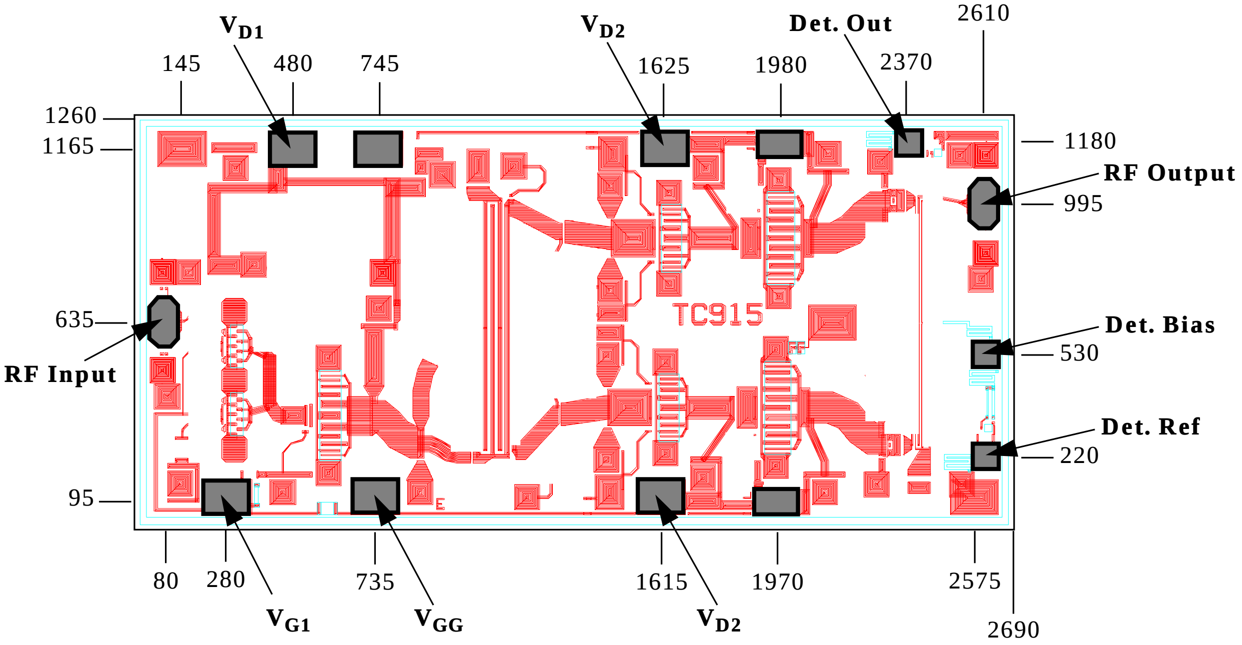


Figure 11.
HMMC-5033 Bonding Pad Locations

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.