HMC797APM5E

GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Typical Applications
The HMC797APM5E is ideal for:
• Test Instrumentation
• Military & Space
• Fiber Optics

Features
High P1dB Output Power: +29 dBm
High Psat Output Power: +31 dBm
High Gain: 15 dB
High Output IP3: +41 dBm
Supply Voltage: +10 V @ 400 mA
50 Ohm Matched Input/Output
32 Lead 5x5 mm SMT Package: 25 mm²

Functional Diagram

General Description
The HMC797APM5E is a GaAs MMIC pHEMT Distributed Power Amplifier which operates between DC and 22 GHz. The amplifier provides 15 dB of gain, +29 dBm of output power at 1 dB gain compression, +31 dBm of saturated output power, and 25% PAE while requiring 400 mA from a +10 V supply. With up to +41 dBm of output IP3, the HMC797APM5E is ideal for high linearity applications in military and space as well as test equipment where high order modulations are used. This versatile PA exhibits a positive gain slope from 2 to 20 GHz making it ideal for EW, ECM, Radar and test equipment applications. The HMC797APM5E amplifier I/Os are internally matched to 50 Ohms facilitating integration into multi-chip-modules (MCMs), is packaged in a leadless QFN 5x5 mm surface mount package, and requires no external matching components.

Electrical Specifications, $T_A = +25^\circ C$, Vdd = +10 V, Vgg2 = +3.5 V, Idd = 400 mA*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>DC - 12</td>
<td>12 - 18</td>
<td></td>
<td>18 - 22</td>
<td></td>
<td>GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>12.5</td>
<td>14.5</td>
<td>13</td>
<td>15</td>
<td>13</td>
<td>15.5</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain Flatness</td>
<td>±0.7</td>
<td>±0.5</td>
<td>±0.5</td>
<td></td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain Variation Over Temperature</td>
<td>0.014</td>
<td>0.018</td>
<td></td>
<td>0.02</td>
<td></td>
<td>dB/°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>15</td>
<td>15</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>13</td>
<td>15</td>
<td></td>
<td>13</td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power for 1 dB Compression (P1dB)</td>
<td>27</td>
<td>29</td>
<td>27</td>
<td>29</td>
<td>26</td>
<td>29</td>
<td>dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturated Output Power (Psat)</td>
<td>31</td>
<td>31</td>
<td></td>
<td>31</td>
<td></td>
<td></td>
<td>dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Third Order Intercept (IP3)</td>
<td>42</td>
<td>41</td>
<td></td>
<td>41</td>
<td></td>
<td></td>
<td>dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Measurement taken at Pout/Tone = +18 dBm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Figure</td>
<td>3.0</td>
<td>3.5</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current (Idd)</td>
<td>400</td>
<td>400</td>
<td></td>
<td>400</td>
<td></td>
<td></td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage (Vdd)</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Adjust Vgg1 between -2 to 0 V to achieve Idd = 400 mA typical, Vgg1 = -0.55V Typical to achieve Idd = 400 mA.

Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Specifications subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices. Trademarks and registered trademarks are the property of their respective owners.
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106
Phone: 781-329-4700 • Order online at www.analog.com
Application Support: Phone: 1-800-ANALOG-D
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Input Return Loss vs. Vdd

Input Return Loss vs. Idd

Output Return Loss vs. Temperature

Output Return Loss vs. Vdd

Output Return Loss vs. Idd

Reverse Isolation vs. Temperature

For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106
Phone: 781-329-4700 • Order online at www.analog.com
Application Support: Phone: 1-800-ANALOG-D
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Noise Figure vs. Temperature

Noise Figure vs. Idd

Low Frequency P1dB vs. Temperature

P1dB vs. Temperature

P1dB vs. Vdd

P1dB vs. Idd
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Low Frequency Psat vs. Temperature

Psat vs. Temperature

Psat vs. Vdd

Psat vs. Idd

Power Compression @ 2 GHz

Power Compression @ 6 GHz

For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106
Phone: 781-329-4700 • Order online at www.analog.com
Application Support: Phone: 1-800-ANALOG-D
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

---

Power Compression @ 10 GHz

Power Compression @ 14 GHz

Power Compression @ 18 GHz

Power Compression @ 22 GHz

PAE @ Psat vs. Frequency

Power Dissipation @ 85 C

---

For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106
Phone: 781-329-4700 • Order online at www.analog.com
Application Support: Phone: 1-800-ANALOG-D
HMC797APM5E

GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

**Gain & Power vs. Vdd @ 2 GHz**

![Graph showing Gain, P1dB, Psat vs. Vdd @ 2 GHz](image)

**Gain & Power vs. Vdd @ 10 GHz**

![Graph showing Gain, P1dB, Psat vs. Vdd @ 10 GHz](image)

**Gain & Power vs. Vdd @ 22 GHz**

![Graph showing Gain, P1dB, Psat vs. Vdd @ 22 GHz](image)

**Gain & Power vs. Idd @ 2 GHz**

![Graph showing Gain, P1dB, Psat vs. Idd @ 2 GHz](image)

**Gain & Power vs. Idd @ 10 GHz**

![Graph showing Gain, P1dB, Psat vs. Idd @ 10 GHz](image)

**Gain & Power vs. Idd @ 22 GHz**

![Graph showing Gain, P1dB, Psat vs. Idd @ 22 GHz](image)
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

OIP3 vs. Temperature
@ Pout / Tone = +18 dBm

Low Frequency OIP3 vs. Temperature
@ Pout / Tone = +18 dBm

OIP3 vs. Vdd
@ Pout / Tone = +18 dBm

OIP3 vs. Idd
@ Pout / Tone = +18 dBm

Output IM3 @ Vdd = +8 V

Output IM3 @ Vdd = +9 V
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Output IM3 @ Vdd = +10 V

Output IM3 @ Vdd = +11 V

OIP2 vs. Temperature
@ Pout / Tone = +18 dBm

OIP2 vs. Vdd
@ Pout / Tone = +18 dBm

OIP2 vs. Idd
@ Pout / Tone = +18 dBm

Second Harmonics vs. Temperature
@ Pout = +18 dBm

For price, delivery, and to place orders: Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106
Phone: 781-329-4700 • Order online at www.analog.com
Application Support: Phone: 1-800-ANALOG-D
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Second Harmonics vs. Vdd @ Pout = +18 dBm

Second Harmonics vs. Idd @ Pout = +18 dBm

Second Harmonics vs. Pout

Igg1 vs. Input Power

Igg2 vs. Input Power

Idd vs. Vgg1,
Representative of a Typical Device
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Drain Supply to GND</td>
<td>+12.0 V</td>
</tr>
<tr>
<td>Gate Bias Voltage (Vgg1)</td>
<td>-3.0 to 0 Vdc</td>
</tr>
<tr>
<td>Gate Bias Voltage (Vgg2)</td>
<td>+2.5 V to (Vdd - 5.5 V)</td>
</tr>
<tr>
<td>Continuous Pdiss (T= 85 °C)</td>
<td>5.37 W</td>
</tr>
<tr>
<td>(derate 60 mW/°C above 85 °C)</td>
<td></td>
</tr>
<tr>
<td>RF Input Power</td>
<td>+27 dBm</td>
</tr>
<tr>
<td>Output Load VSWR</td>
<td>7:1</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 to 150 °C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 to +85 °C</td>
</tr>
<tr>
<td>Max Peak Reflow Temperature</td>
<td>260 °C</td>
</tr>
<tr>
<td>ESD Sensitivity (HBM)</td>
<td>Class 1A - Passed 250V</td>
</tr>
</tbody>
</table>

Reliability Information

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction Temperature to Maintain 1 Million Hour MTTF</td>
<td>175 °C</td>
</tr>
<tr>
<td>Nominal Junction Temperature</td>
<td>152 °C</td>
</tr>
<tr>
<td>(T=85 °C, Vdd = 10 V)</td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance (channel to ground paddle)</td>
<td>16.75 °C/W</td>
</tr>
</tbody>
</table>

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only, functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

Outline Drawing

Package Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package Body Material</th>
<th>Lead Finish</th>
<th>MSL Rating</th>
<th>Package Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC797APM5E</td>
<td>RoHS-compliant Low Stress Pre-Molded Plastic</td>
<td>NiPdAu</td>
<td>MSL3 [1]</td>
<td>HMC797A</td>
</tr>
</tbody>
</table>

[1] Max peak reflow temperature of 260 °C
### Pin Descriptions

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Function</th>
<th>Description</th>
<th>Interface Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 4, 6, 8, 9, 16, 17, 20, 22, 24, 25, 32 Package Bottom</td>
<td>GND</td>
<td>These pins &amp; exposed ground paddle must be connected to RF/DC ground.</td>
<td><img src="image1" alt="GND Interface Schematic" /></td>
</tr>
<tr>
<td>2</td>
<td>VGG2</td>
<td>Gate control 2 for amplifier. Attach bypass capacitor per application circuit herein. For nominal operation +3.5V should be applied to Vgg2.</td>
<td><img src="image2" alt="VGG2 Interface Schematic" /></td>
</tr>
<tr>
<td>3, 7, 10 - 12, 14, 18, 19, 23, 26 - 28, 31</td>
<td>N/C</td>
<td>No connection required. These pins may be connected to RF/DC ground without affecting performance.</td>
<td><img src="image3" alt="N/C Interface Schematic" /></td>
</tr>
<tr>
<td>5</td>
<td>RFIN</td>
<td>This pad is DC coupled and matched to 50 Ohms. Blocking capacitor is required.</td>
<td><img src="image4" alt="RFIN Interface Schematic" /></td>
</tr>
<tr>
<td>13</td>
<td>VGG1</td>
<td>Gate control 1 for amplifier. Attach bypass capacitor per application circuit herein. Please follow “MMIC Amplifier Biasing Procedure” application note.</td>
<td><img src="image5" alt="VGG1 Interface Schematic" /></td>
</tr>
<tr>
<td>15</td>
<td>ACG3</td>
<td>Low frequency termination. Attach bypass capacitor per application circuit herein.</td>
<td><img src="image6" alt="ACG3 Interface Schematic" /></td>
</tr>
<tr>
<td>21</td>
<td>RFOUT &amp; VDD</td>
<td>RF output for amplifier. Connect DC bias (Vdd) network to provide drain current (Idd). See application circuit herein.</td>
<td><img src="image7" alt="RFOUT &amp; VDD Interface Schematic" /></td>
</tr>
<tr>
<td>29</td>
<td>ACG2</td>
<td>Low frequency termination. Attach bypass capacitor per application circuit herein.</td>
<td><img src="image8" alt="ACG2 Interface Schematic" /></td>
</tr>
<tr>
<td>30</td>
<td>ACG1</td>
<td></td>
<td><img src="image9" alt="ACG1 Interface Schematic" /></td>
</tr>
</tbody>
</table>
HMC797APM5E

GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Evaluation PCB

Evaluation Order Information

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation PCB only</td>
<td>HMC797APM5E Evaluation PCB</td>
<td>EV1HMC797APM5</td>
</tr>
</tbody>
</table>

List of Materials for Evaluation Board

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1, J2</td>
<td>SMA Connectors</td>
</tr>
<tr>
<td>J3, J4</td>
<td>DC Pins</td>
</tr>
<tr>
<td>C1 - C4</td>
<td>100 pF Capacitor, 0402 Pkg.</td>
</tr>
<tr>
<td>C5, C8</td>
<td>10 kF Capacitor, 0402 Pkg.</td>
</tr>
<tr>
<td>C9 - C11</td>
<td>4.7 µF Capacitor, Tantalum</td>
</tr>
<tr>
<td>R1, R2</td>
<td>0 OHM Resistor, 0402 Pkg.</td>
</tr>
<tr>
<td>U1</td>
<td>HMC797APM5E Power Amplifier</td>
</tr>
<tr>
<td>PCB</td>
<td>600-01711-00 Evaluation PCB</td>
</tr>
</tbody>
</table>

[1] Circuit Board Material: Rogers 4350 or Arlon FR4

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation board should be mounted to an appropriate heat sink. The evaluation circuit board shown is available from Analog Devices, Inc.
HMC797APM5E
GaAs pHEMT MMIC
1 WATT POWER AMPLIFIER, DC - 22 GHz

Application Circuit

NOTE 1: Drain Bias (Vdd) must be applied through a broadband bias tee or external bias network.
NOTE 2: Optional Capacitors to be used if part is to be operated below 200MHz.