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MICROWAVE CORPORATION v02.0314



# HMC789ST89E

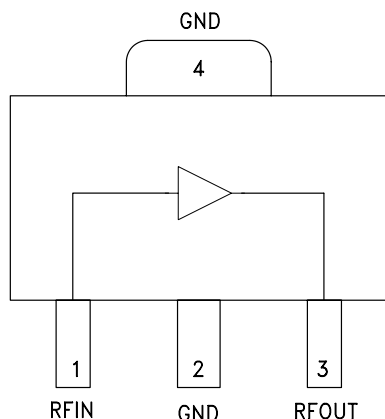
## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

### Typical Applications

The HMC789ST89E is ideal for:

- Cellular/4G
- Fixed Wireless & WLAN
- CATV, Cable Modem & DBS
- Microwave Radio & Test Equipment
- IF & RF Applications

### Functional Diagram



### Features

- High Output IP3: +42 dBm
- High Output P1dB: +25 dBm
- High Gain: 18 dB
- Single Supply: +5V
- 45% PAE @ +25 dBm Pout
- Industry Standard SOT89 Package

### General Description

The HMC789ST89E is a high linearity GaAs InGaP HBT gain block MMIC operating from 0.7 to 2.8 GHz and packaged in an industry standard SOT89 package. Utilizing a minimum number of external components and a single +5V supply, the amplifier output IP3 can be optimized to +45 dBm. The high output IP3 and high gain make the HMC789ST89E ideal for use in PA driver & pre-driver applications in Cellular/4G and Fixed Wireless.

### Electrical Specifications, $T_A = +25^\circ\text{C}$ , $V_S = +5\text{V}$ [1]

| Parameter                               | Min.      | Typ. | Max. | Min.        | Typ. | Max. | Min.        | Typ. | Max. | Units   |
|-----------------------------------------|-----------|------|------|-------------|------|------|-------------|------|------|---------|
| Frequency Range                         | 810 - 960 |      |      | 1710 - 1990 |      |      | 2420 - 2700 |      |      | MHz     |
| Gain                                    | 17        | 18   |      | 12          | 13.5 |      | 10          | 11   |      | dB      |
| Gain Variation Over Temperature         |           | 0.01 |      |             | 0.01 |      |             | 0.01 |      | dB / °C |
| Input Return Loss                       |           | 12   |      |             | 12   |      |             | 10   |      | dB      |
| Output Return Loss                      |           | 20   |      |             | 15   |      |             | 10   |      | dB      |
| Output Power for 1dB Compression (P1dB) | 21        | 23.5 |      | 23          | 25   |      | 22          | 24   |      | dBm     |
| Saturated Output Power (Psat)           |           | 25.5 |      |             | 27   |      |             | 26   |      | dBm     |
| Output Third Order Intercept (IP3) [2]  |           | 42   |      |             | 42   |      |             | 42   |      | dBm     |
| Noise Figure                            |           | 3.8  |      |             | 3.8  |      |             | 3.8  |      | dB      |
| Supply Current (Icq)                    |           | 125  | 150  |             | 125  | 150  |             | 125  | 150  | mA      |

[1] Specifications and data reflect HMC789ST89E measured using the respective application circuits for each designated frequency band found herein. Contact the HMC Applications Group for assistance in optimizing performance for your application.

[2] Two-tone output power of +10 dBm per tone, 1 MHz spacing.

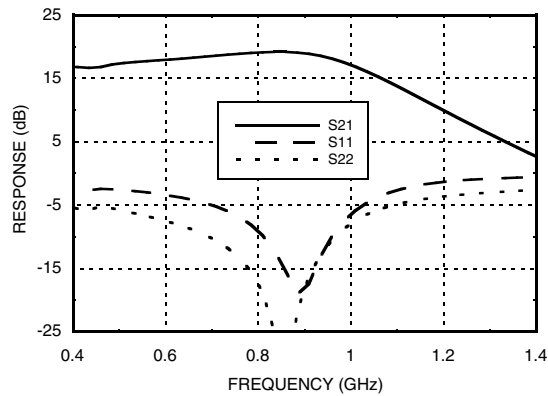
For price, delivery and to place orders: Hittite Microwave Corporation, 2 Elizabeth Drive, Chelmsford, MA 01824

Phone: 978-250-3343 Fax: 978-250-3373 Order On-line at [www.hittite.com](http://www.hittite.com)

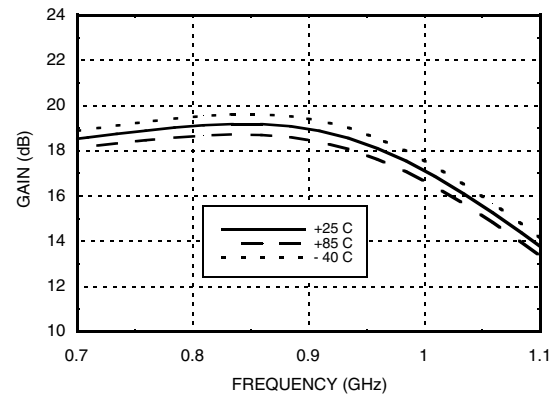
Application Support: Phone: 978-250-3343 or [apps@hittite.com](mailto:apps@hittite.com)

## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

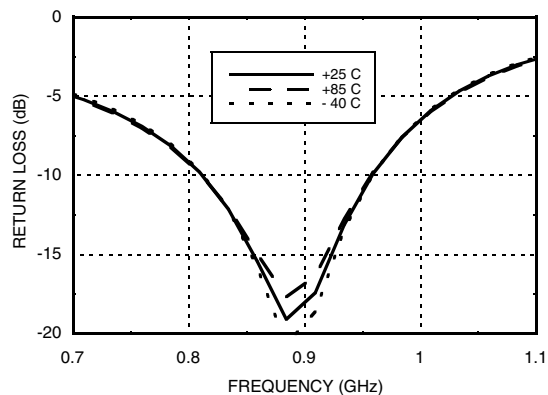
### Broadband Gain & Return Loss @ 900 MHz



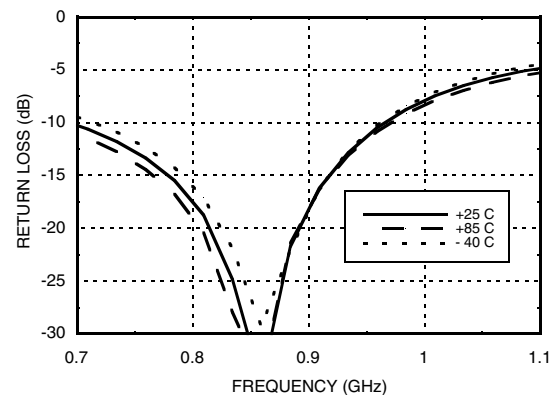
### Gain vs. Temperature @ 900 MHz



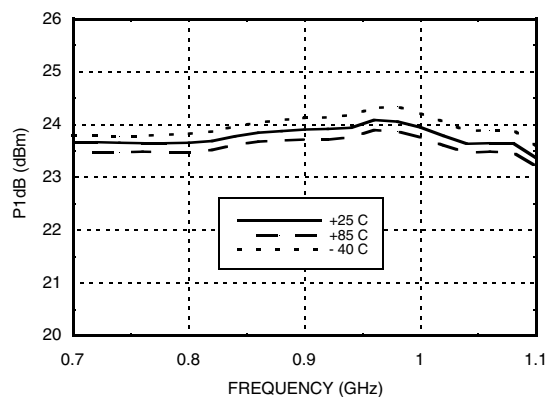
### Input Return Loss vs. Temperature @ 900 MHz



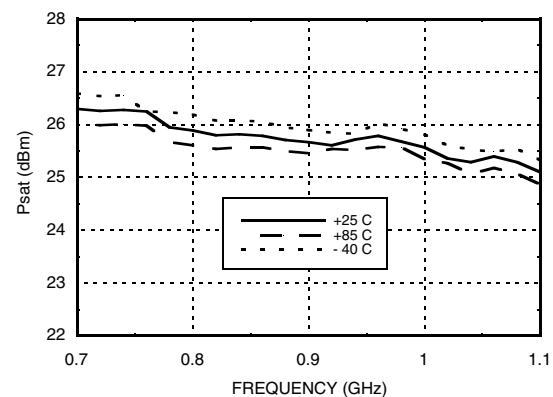
### Output Return Loss vs. Temperature @ 900 MHz



### P1dB vs. Temperature @ 900 MHz



### Psat vs. Temperature @ 900 MHz





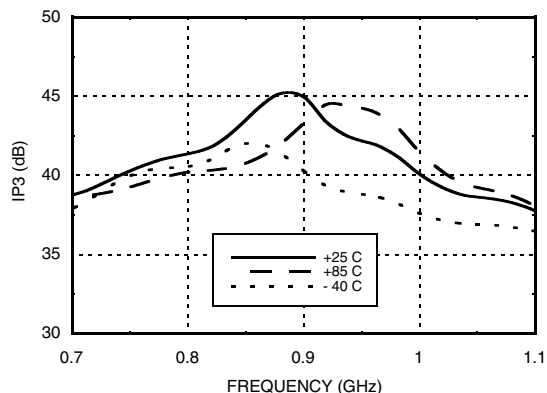
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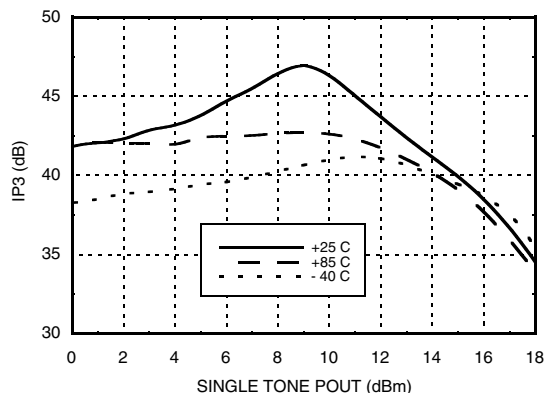
# HMC789ST89E

## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

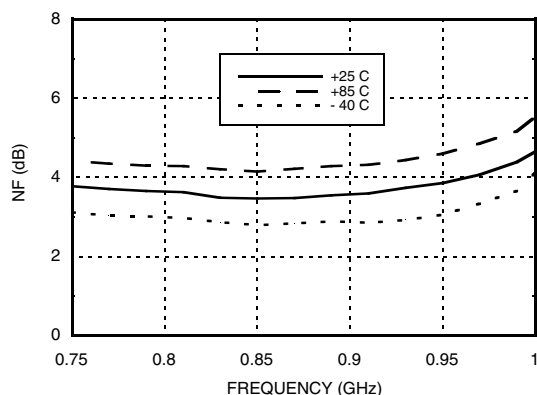
**Output IP3 vs. Temperature @ 900 MHz**  
**Pout = 10 dBm Each Tone**



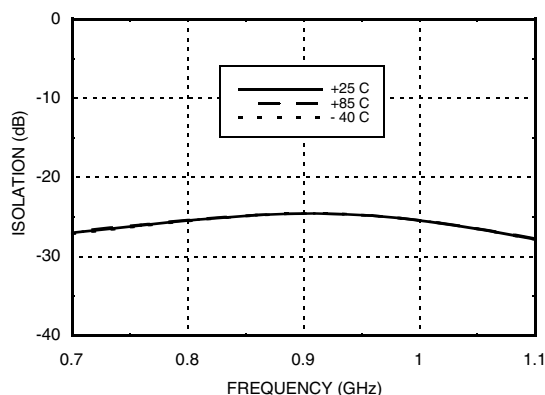
**Output IP3 vs.**  
**Output Power @ 900 MHz**



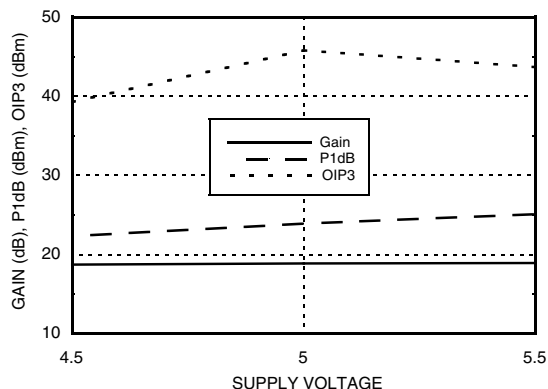
**Noise Figure vs. Temperature @ 900 MHz**



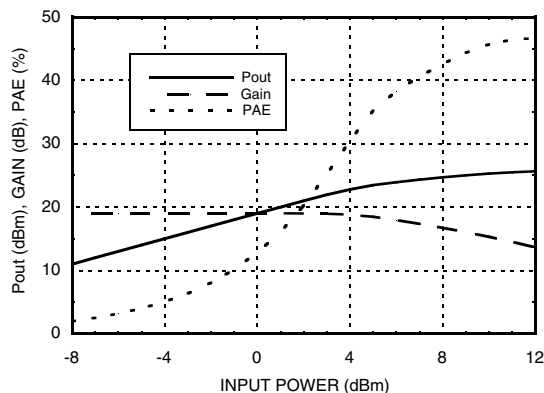
**Reverse Isolation vs.**  
**Temperature @ 900 MHz**

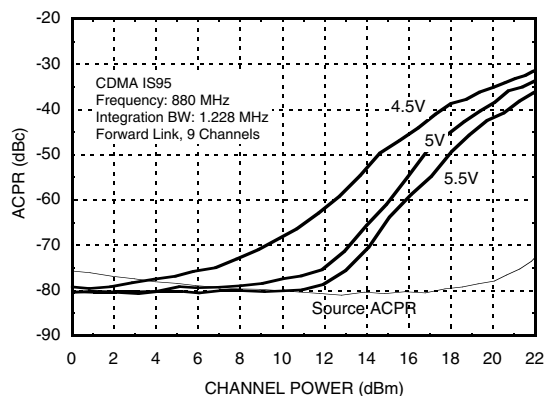
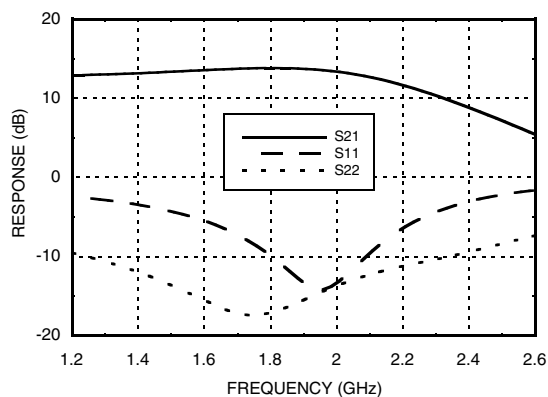
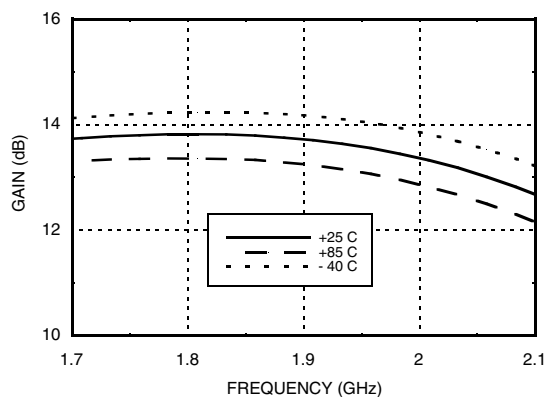
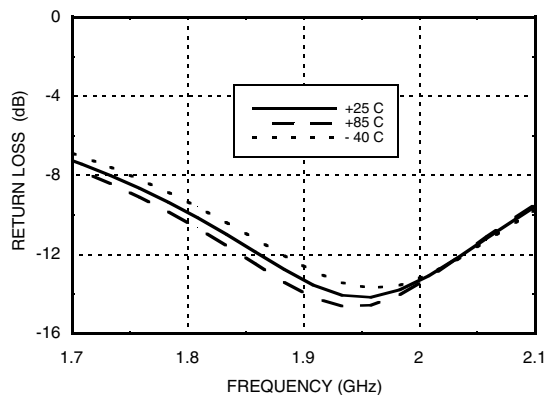
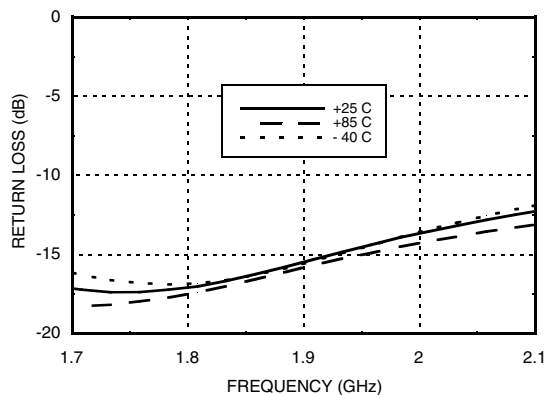


**Gain, Power & IP3 vs.**  
**Supply Voltage @ 900 MHz**



**Power Compression @ 900 MHz**



**InGaP HBT GAIN BLOCK MMIC  
 AMPLIFIER, 0.7 -2.8 GHz**
**ACPR vs. Supply Voltage @ 880 MHz  
 CDMA IS95, 9 Channels Forward**

**Broadband Gain &  
 Return Loss @ 1900 MHz**

**Gain vs. Temperature @ 1900 MHz**

**Input Return Loss vs.  
 Temperature @ 1900 MHz**

**Output Return Loss vs.  
 Temperature @ 1900 MHz**




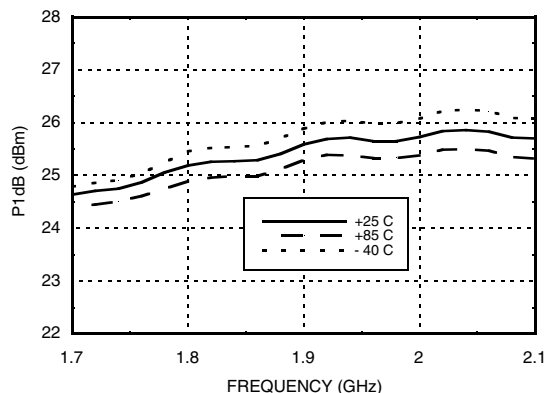
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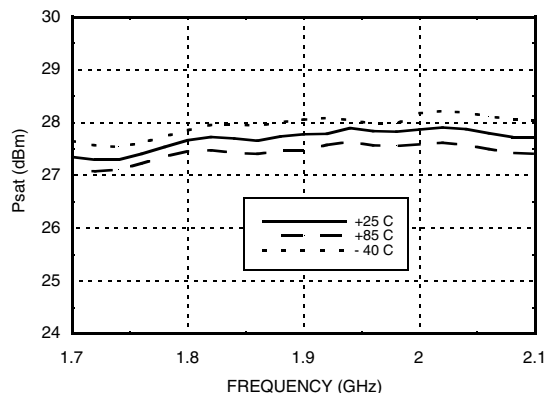
# HMC789ST89E

## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

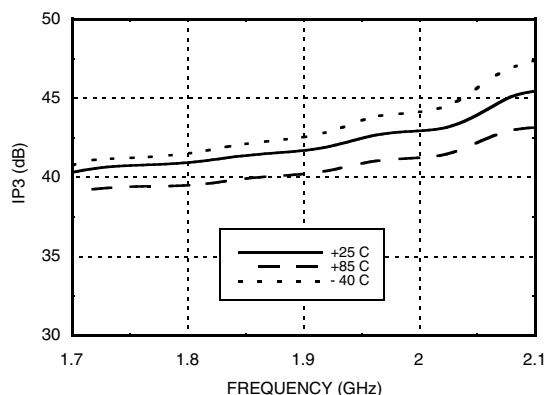
**P1dB vs. Temperature @ 1900 MHz**



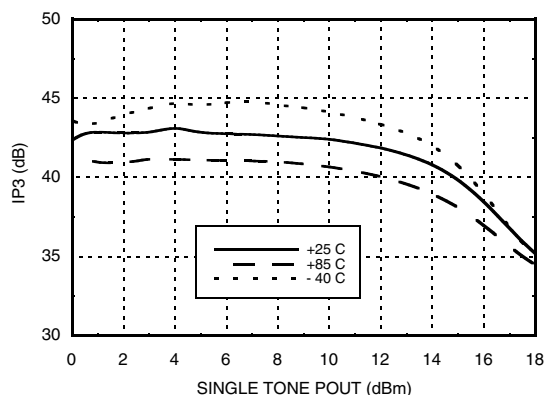
**Psat vs. Temperature @ 1900 MHz**



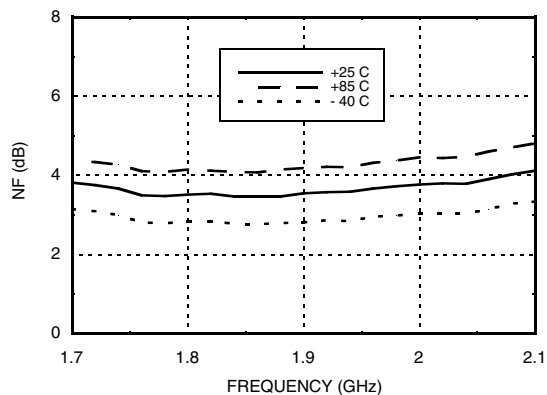
**Output IP3 vs. Temperature @ 1900 MHz**



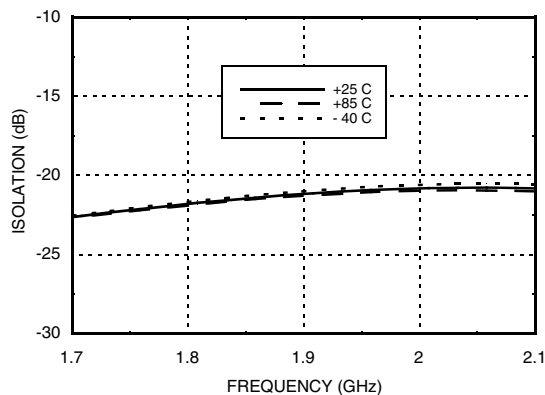
**Output IP3 vs. Output Power @ 1900 MHz**



**Noise Figure vs. Temperature @ 1900 MHz**

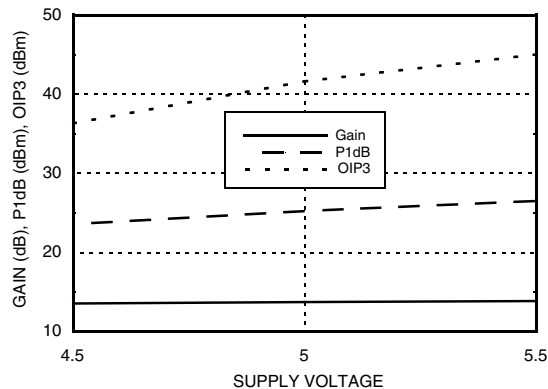


**Reverse Isolation vs. Temperature @ 1900 MHz**

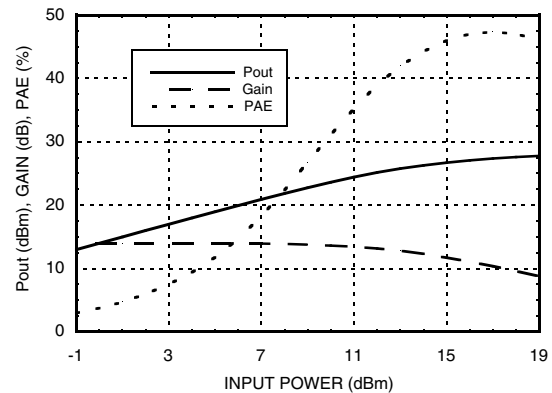


## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

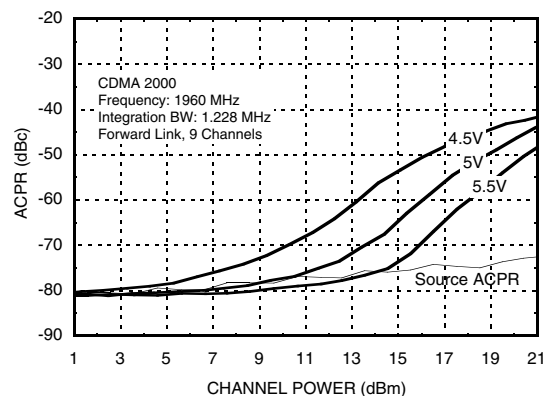
### Gain, Power & IP3 vs. Supply Voltage @ 1900 MHz



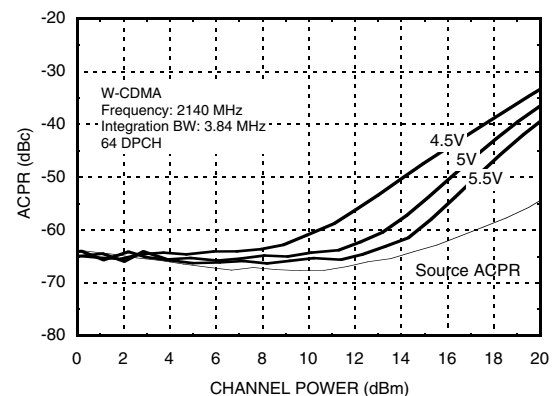
### Power Compression @ 1900 MHz



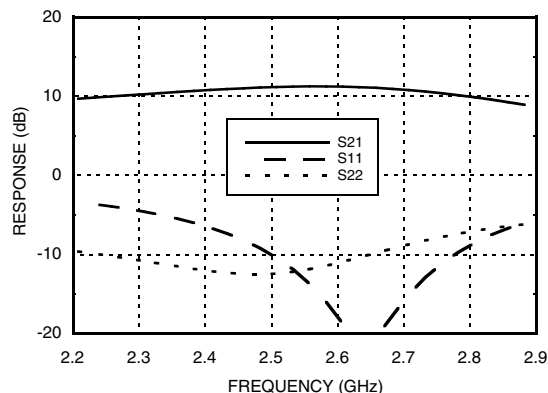
### ACPR vs. Supply Voltage @ 1960 MHz CDMA 2000, 9 Channels Forward



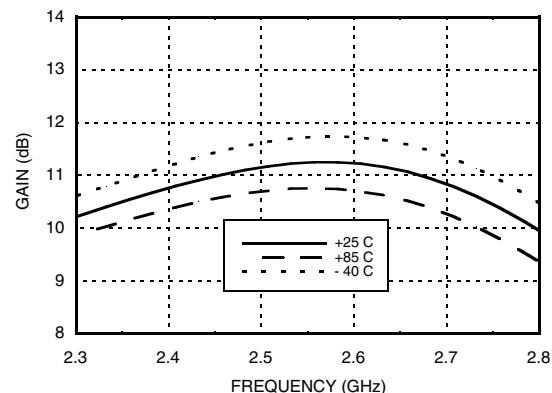
### ACPR vs. Supply Voltage @ 2140 MHz W-CDMA, 64 DPCH



### Broadband Gain & Return Loss @ 2600 MHz



### Gain vs. Temperature @ 2600 MHz







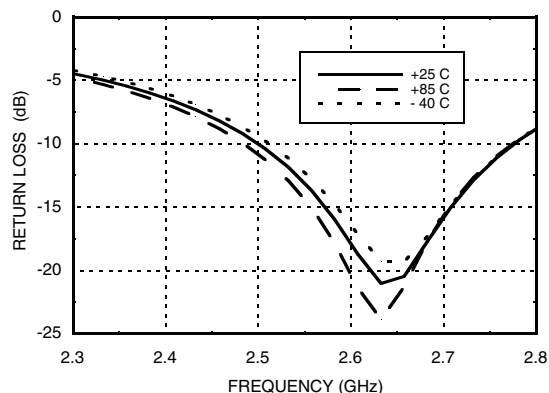
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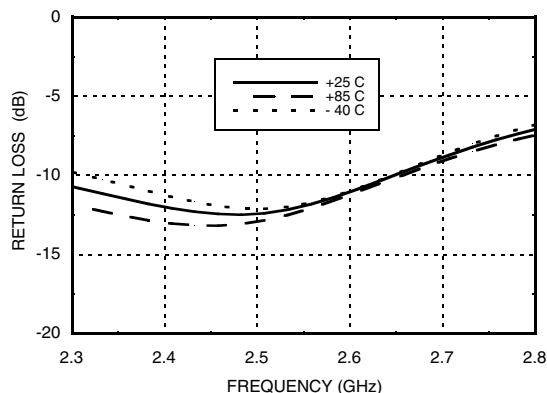
# HMC789ST89E

## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

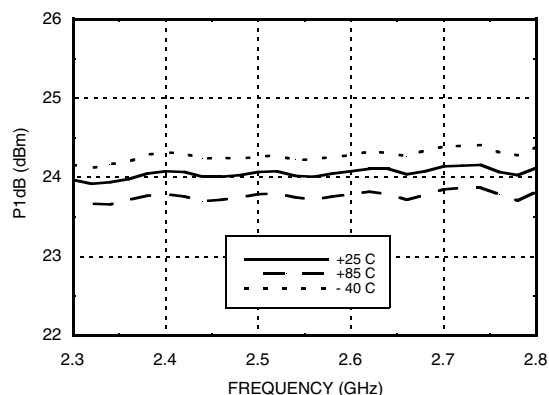
**Input Return Loss vs.  
Temperature @ 2600 MHz**



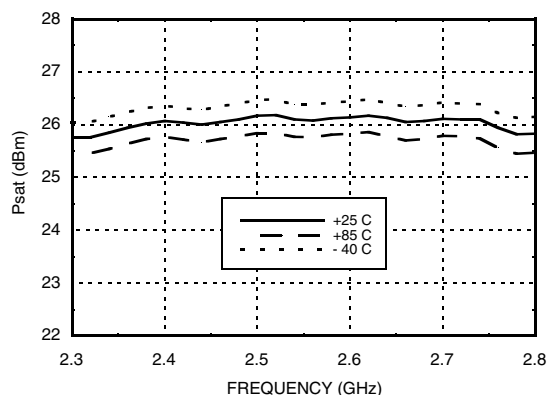
**Output Return Loss vs.  
Temperature @ 2600 MHz**



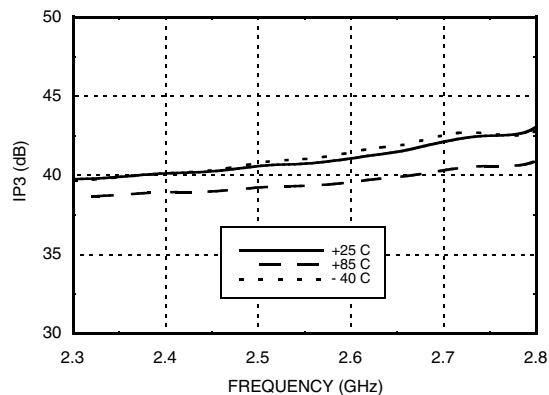
**P1dB vs. Temperature @ 2600 MHz**



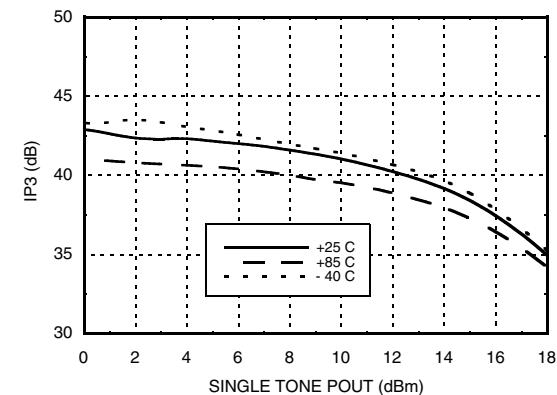
**Psat vs. Temperature @ 2600 MHz**



**Output IP3 vs. Temperature @ 2600 MHz**

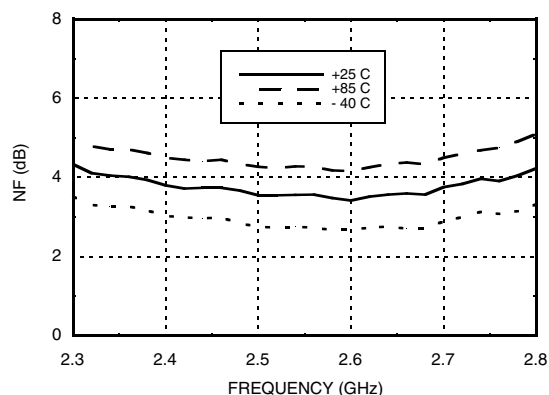


**Output IP3 vs. Output Power @ 2600 MHz**

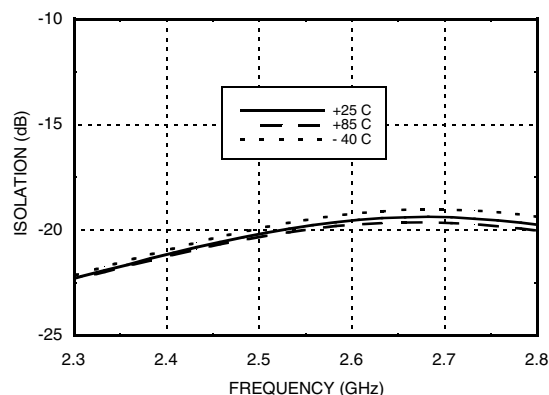


## InGaP HBT GAIN BLOCK MMIC AMPLIFIER, 0.7 -2.8 GHz

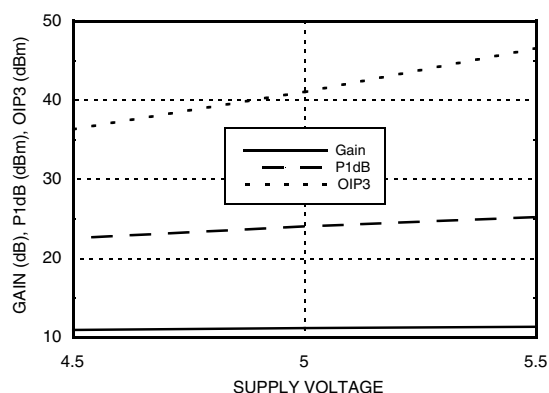
**Noise Figure vs. Temperature @ 2600 MHz**



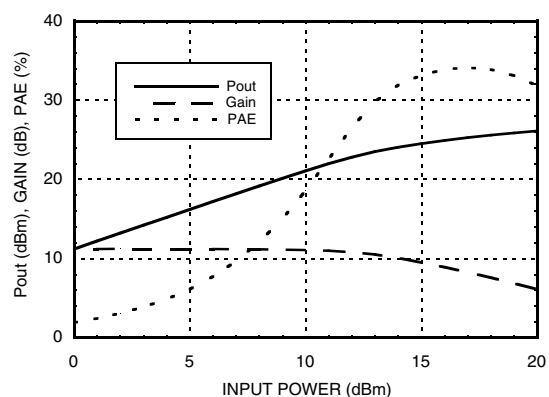
**Reverse Isolation vs. Temperature @ 2600 MHz**



**Gain, Power & IP3 vs. Supply Voltage @ 2600 MHz**



**Power Compression @ 2600 MHz**

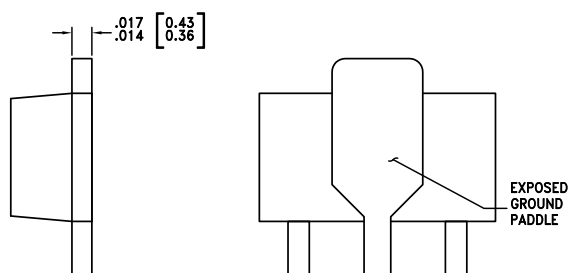
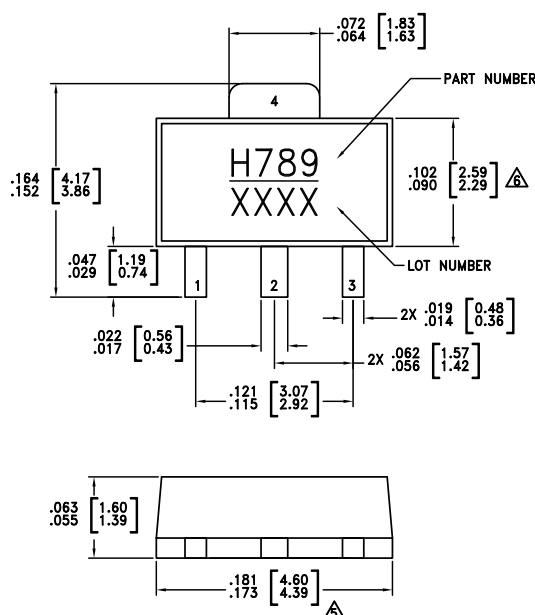




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**HMC789ST89E****InGaP HBT GAIN BLOCK MMIC  
AMPLIFIER, 0.7 -2.8 GHz****Absolute Maximum Ratings**

|                                                                 |                |
|-----------------------------------------------------------------|----------------|
| Collector Bias Voltage (Vcc)                                    | +6.0 V         |
| RF Input Power (RFIN)(Vs +5Vdc)                                 | +18 dBm        |
| Junction Temperature                                            | 150 °C         |
| Continuous Pdiss (T = 85 °C)<br>(derate 13.0 mW/°C above 85 °C) | 0.85 W         |
| Thermal Resistance<br>(junction to ground paddle)               | 77 °C/W        |
| Storage Temperature                                             | -65 to +150 °C |
| Operating Temperature                                           | -40 to +85 °C  |

ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**Outline Drawing**

## NOTES:

1. PACKAGE BODY MATERIAL:  
MOLDING COMPOUND MP-180S OR EQUIVALENT.
2. LEAD MATERIAL: Cu w/ Ag SPOT PLATING.
3. LEAD PLATING: 100% MATTE TIN.
4. DIMENSIONS ARE IN INCHES [MILLIMETERS]
5. DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.15mm PER SIDE.
6. DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.25mm PER SIDE.
7. ALL GROUND LEADS MUST BE SOLDERED TO PCB RF GROUND.

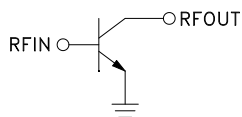
**Package Information**

| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[1]</sup> |
|-------------|----------------------------------------------------|---------------|---------------------|--------------------------------|
| HMC789ST89E | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H789<br>XXXX                   |

[1] 4-Digit lot number XXXX

[2] Max peak reflow temperature of 260 °C

### Pin Descriptions

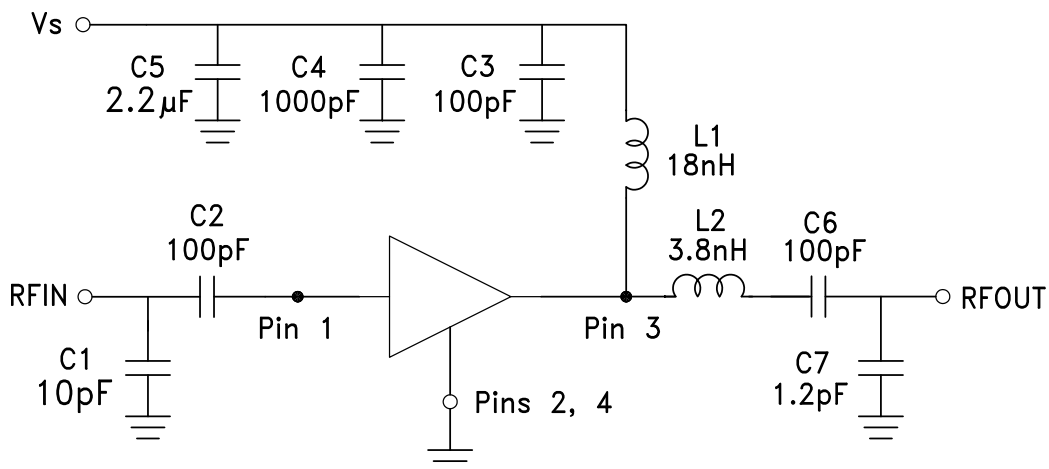
| Pin Number | Function | Description                                                                                                                     | Interface Schematic                                                                 |
|------------|----------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1          | RFIN     | This pin is DC coupled.<br>Off chip matching components are required.<br>See Application Circuit herein.                        |  |
| 3          | RFOUT    | RF output and DC Bias input for the amplifier.<br>Off chip matching components are required.<br>See Application Circuit herein. |                                                                                     |
| 2, 4       | GND      | These pins & package bottom must be connected to<br>RF/DC ground.                                                               |  |



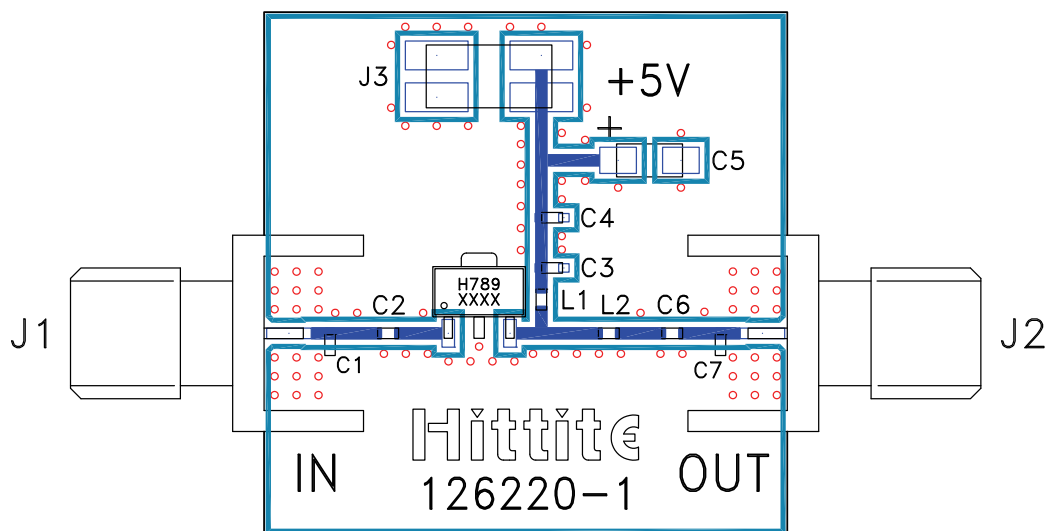
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**HMC789ST89E****InGaP HBT GAIN BLOCK MMIC  
AMPLIFIER, 0.7 -2.8 GHz****900 MHz Application Circuit**

This circuit was used to specify the performance for 810-960 MHz operation. Contact the HMC Applications Group for assistance in optimizing performance for your application.



| Recommended Component Values |             |
|------------------------------|-------------|
| C1                           | 10 pF       |
| C2                           | 100 pF      |
| C3                           | 100 pF      |
| C4                           | 1000 pF     |
| C5                           | 2.2 $\mu$ F |
| C6                           | 100 pF      |
| C7                           | 1.2 pF      |
| L1                           | 18 nH       |
| L2                           | 3.8 nH      |

**900 MHz Evaluation PCB**

**List of Materials for 900 MHz Evaluation PCB 126222 [1]**

| Item    | Description                     |
|---------|---------------------------------|
| J1 - J2 | PCB Mount SMA Connector         |
| J3      | 2 mm DC Header                  |
| C1      | 10 pF Capacitor, 0402 Pkg.      |
| C2      | 100 pF Capacitor, 0402 Pkg.     |
| C3      | 100 pF Capacitor, 0402 Pkg.     |
| C4      | 1000 pF Capacitor, 0402 Pkg.    |
| C5      | 2.2 $\mu$ F Capacitor, Tantalum |
| C6      | 100 pF Capacitor, 0402 Pkg.     |
| C7      | 1.2 pF Capacitor, 0402 Pkg.     |
| L1      | 18 nH Inductor, 0402 Pkg.       |
| L2      | 3.8 nH Inductor, 0402 Pkg.      |
| U1      | HMC789ST89E Linear Amplifier    |
| PCB [2] | 126220 Evaluation PCB           |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: FR4

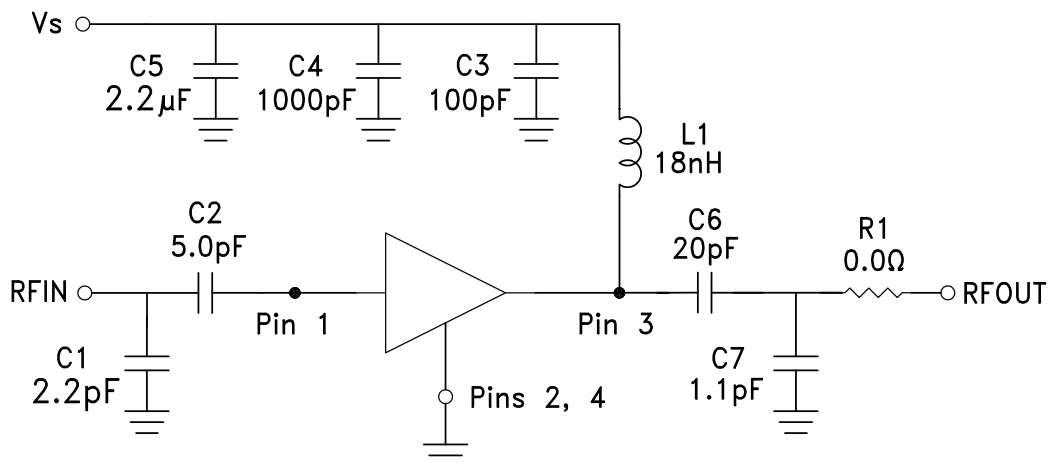
The circuit board used in this application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect 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 Hittite upon request.



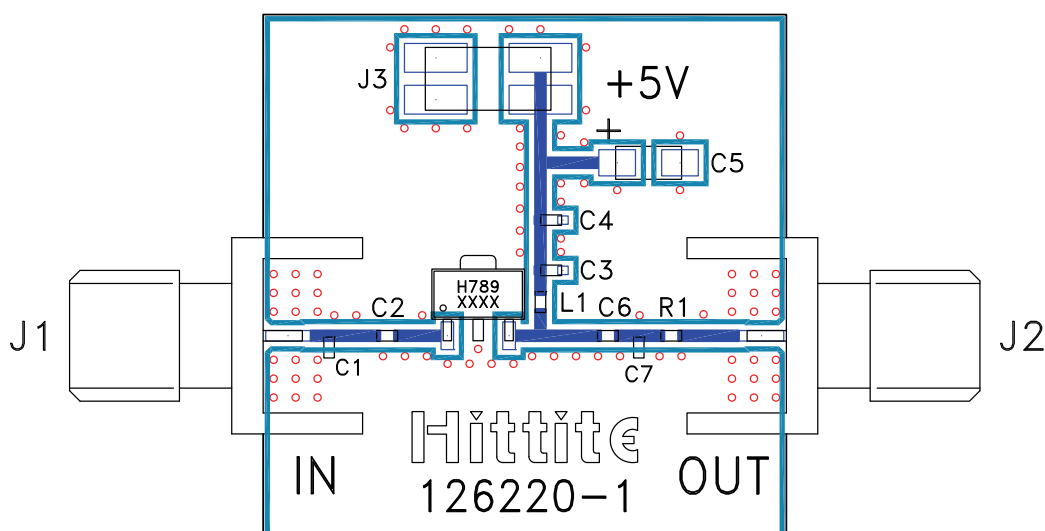
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**HMC789ST89E****InGaP HBT GAIN BLOCK MMIC  
AMPLIFIER, 0.7 -2.8 GHz****1900 MHz Application Circuit**

This circuit was used to specify the performance for 1710-1990 MHz operation. Contact the HMC Applications Group for assistance in optimizing performance for your application.



| Recommended Component Values |         |
|------------------------------|---------|
| C1                           | 2.2 pF  |
| C2                           | 5.0 pF  |
| C3                           | 100 pF  |
| C4                           | 1000 pF |
| C5                           | 2.2 μF  |
| C6                           | 20 pF   |
| C7                           | 1.1 pF  |
| L1                           | 20 nH   |
| R1                           | 0.0 Ohm |

**1900 MHz Evaluation PCB**

**List of Materials for 1900 MHz Evaluation PCB 126223 <sup>[1]</sup>**

| Item               | Description                     |
|--------------------|---------------------------------|
| J1 - J2            | PCB Mount SMA Connector         |
| J3                 | 2 mm DC Header                  |
| C1                 | 2.2 pF Capacitor, 0402 Pkg.     |
| C2                 | 5.0 pF Capacitor, 0402 Pkg.     |
| C3                 | 100 pF Capacitor, 0402 Pkg.     |
| C4                 | 1000 pF Capacitor, 0402 Pkg.    |
| C5                 | 2.2 $\mu$ F Capacitor, Tantalum |
| C6                 | 20 pF Capacitor, 0402 Pkg.      |
| C7                 | 1.1 pF Capacitor, 0402 Pkg.     |
| L1                 | 18 nH Inductor, 0402 Pkg.       |
| R1                 | 0.0 Ohm Resistor, 0402 Pkg.     |
| U1                 | HMC789ST89E Linear Amplifier    |
| PCB <sup>[2]</sup> | 126220 Evaluation PCB           |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: FR4

The circuit board used in this 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 Hittite upon request.

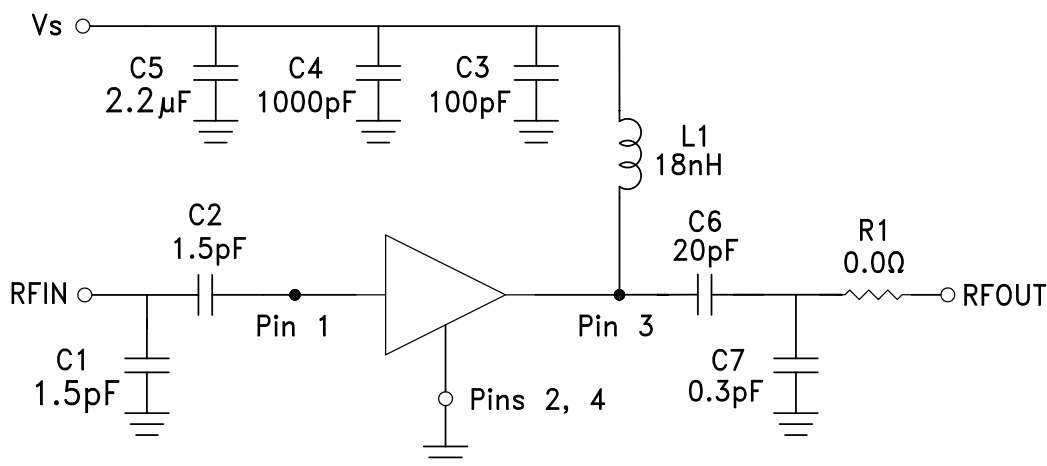




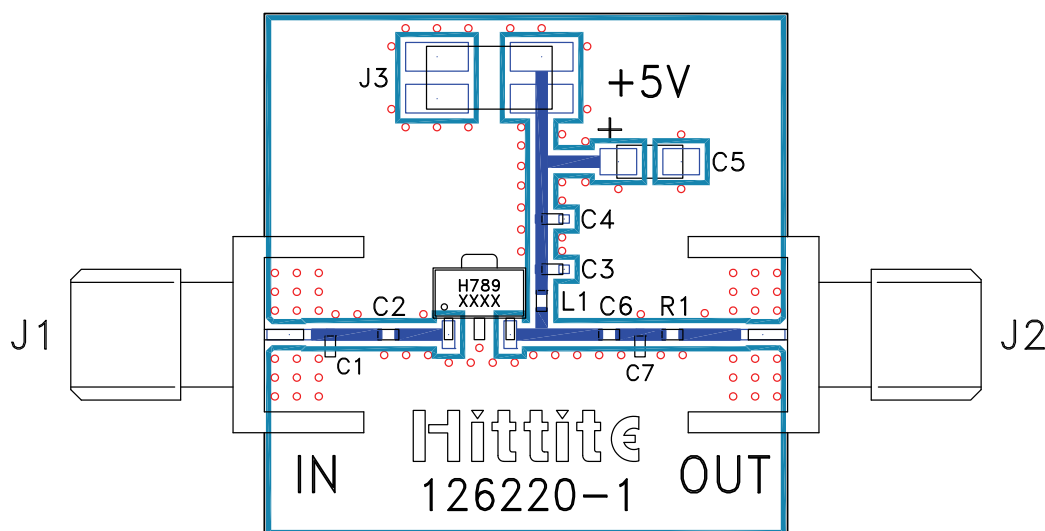
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**HMC789ST89E****InGaP HBT GAIN BLOCK MMIC  
AMPLIFIER, 0.7 -2.8 GHz****2600 MHz Application Circuit**

This circuit was used to specify the performance for 2420-2700 MHz operation. Contact the HMC Applications Group for assistance in optimizing performance for your application.



| Recommended Component Values |             |
|------------------------------|-------------|
| C1                           | 1.5 pF      |
| C2                           | 1.5 pF      |
| C3                           | 100 pF      |
| C4                           | 1000 pF     |
| C5                           | 2.2 $\mu$ F |
| C6                           | 20 pF       |
| C7                           | 0.3 pF      |
| L1                           | 18 nH       |
| L2                           | 12 nH       |
| R1                           | 0.0 Ohm     |

**2600 MHz Evaluation PCB**

**List of Materials for 2600 MHz Evaluation PCB 125682 <sup>[1]</sup>**

| Item               | Description                     |
|--------------------|---------------------------------|
| J1 - J2            | PCB Mount SMA Connector         |
| J3                 | 2 mm DC Header                  |
| C1                 | 1.5 pF Capacitor, 0402 Pkg.     |
| C2                 | 1.5 pF Capacitor, 0402 Pkg.     |
| C3                 | 100 pF Capacitor, 0402 Pkg.     |
| C4                 | 1000 pF Capacitor, 0402 Pkg.    |
| C5                 | 2.2 $\mu$ F Capacitor, Tantalum |
| C6                 | 20 pF Capacitor, 0402 Pkg.      |
| C7                 | 0.3 pF Capacitor, 0402 Pkg.     |
| L1                 | 18 nH Inductor, 0402 Pkg.       |
| R1                 | 0.0 Ohm Resistor, 0402 Pkg.     |
| U1                 | HMC789ST89E Linear Amplifier    |
| PCB <sup>[2]</sup> | 125220 Evaluation PCB           |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: FR4

The circuit board used in this 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 Hittite upon request.