

### Typical Applications

The HMC610LP4(E) is ideal for:

- Cellular / PCS / 3G
- WiMAX, WiBro, Fixed Wireless, & Military
- RF & Microwave Instrumentation
- Power Amplifier Linearization / Control Loops
- Transmitter Power Control
- Transmitter Signal Strength Indication

### Features

Accurate RMS-to-DC Conversion: DC to 3.9 GHz<sup>[1]</sup>

Input Dynamic Range of >70 dB:  
-60 to +10 dBm in 50 Ohms

Waveform & Modulation Independent:  
GSM / CDMA / TDMA

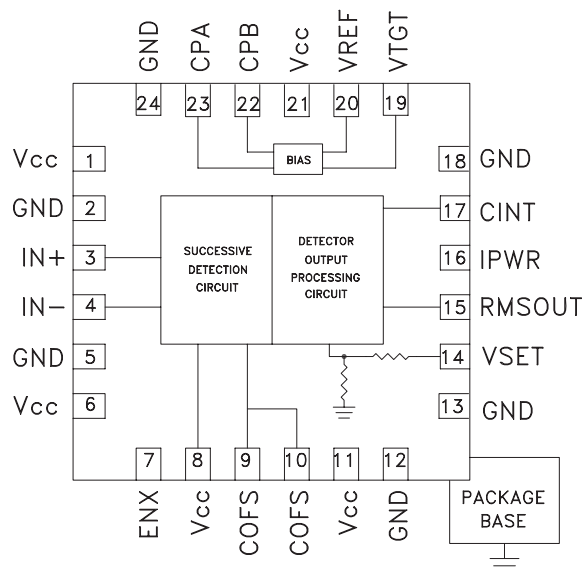
Linear-in-dB Output: Scaled 37 mV/dB

Operates from 4.5 to 5.5V from -40°C to +85°C

Power-Down Mode

Compact 4x4mm Leadless SMT Package

### Functional Diagram



### General Description

The HMC610LP4(E) is a true RMS power detector capable of providing a  $\pm 1$  dB measurement dynamic range of more than 70 dB. It converts any RF input signal at its differential input, regardless of modulation or waveform complexity, to an accurately scaled linear-in-dB output response that is equivalent to the Root-Mean-Square (RMS) of the input waveform.

For normal operation, the RMSOUT pin is shorted to the VSET input, and will provide a nominal logarithmic slope of 37 mV/dB and an intercept of -70 dBm for frequencies up to 2 GHz; other slopes are achieved with external resistors connected between RMSOUT and VSET pins. Temperature stability is excellent with  $\pm 0.5$  dB error from -40°C to 85°C maintained from 100 MHz to 3.9 GHz.

### Electrical Specifications, $T_A = +25^\circ\text{C}$ , $V_{CC} = 5\text{V}$ , $Z_0 = 50\Omega$ <sup>[2]</sup>

| Parameter                                                        | Typ. | Typ. | Typ. | Typ. | Typ. | Typ. | Typ. | Units |
|------------------------------------------------------------------|------|------|------|------|------|------|------|-------|
| Input Frequency                                                  | 900  | 1900 | 2200 | 2700 | 3000 | 3500 | 3900 | MHz   |
| <b>Dynamic Range</b>                                             |      |      |      |      |      |      |      |       |
| $\pm 1$ dB linearity, CW Input                                   | 73   | 72   | 71   | 68   | 65   | 56   | 42   | dB    |
| <b>Deviation vs. Temperature</b>                                 |      |      |      |      |      |      |      |       |
| Deviation from output @ 25°C, -45°C < $T_A$ < 85°C; Pin = -50dBm | -0.9 | -1.1 | -1.2 | -1.5 | -0.8 | -0.8 | -1.0 | dB    |
| Deviation from output @ 25°C, -45°C < $T_A$ < 85°C; Pin = -20dBm | 0.5  | 0.3  | 0.2  | 0.3  | 0.6  | 0.4  | 0.3  | dB    |
| Deviation from output @ 25°C, -45°C < $T_A$ < 85°C; Pin = 5dBm   | 0.8  | 0.5  | 0.4  | 0.8  | 1.2  | 1.3  | 1.3  | dB    |

[1] Low frequency operation determined by external components

[2] Differential Input Drive Via 1:1 Balun Transformer, VTGT Connected to VREF, RMSOUT Connected to VSET, Unless Otherwise Noted.



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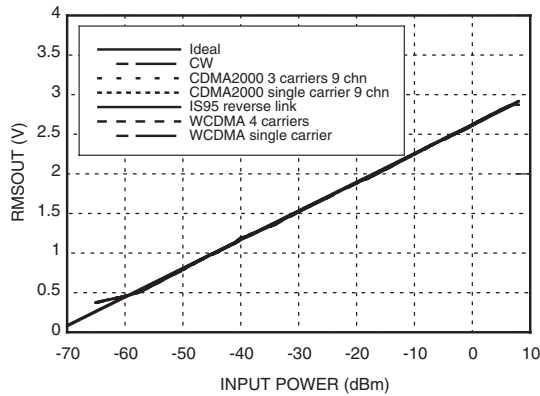
# HMC610LP4 / 610LP4E

**70 dB RMS POWER  
DETECTOR, DC - 3.9 GHz**

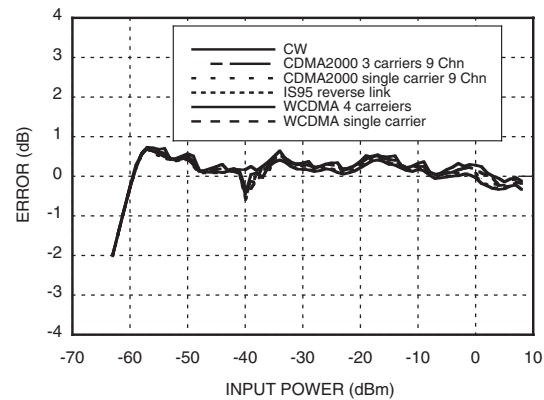
## Electrical Specifications, (continued)

| Parameter                             | Typ.                                          | Typ.  | Typ. | Typ. | Typ.  | Typ. | Typ.  | Units  |
|---------------------------------------|-----------------------------------------------|-------|------|------|-------|------|-------|--------|
| Input Frequency                       | 900                                           | 1900  | 2200 | 2700 | 3000  | 3500 | 3900  | MHz    |
| Modulation Deviation from CW Response |                                               |       |      |      |       |      |       |        |
| CDMA2000 3 Carriers, 9 Channels       | 0.15                                          | 0.12  | 0.15 | 0.18 | 0.25  | 0.3  | 0.35  | dB     |
| CDMA2000 1 Carrier, 9 Channels        | 0.1                                           | 0.08  | 0.1  | 0.14 | 0.2   | 0.25 | 0.3   | dB     |
| IS95 Reverse Link                     | 0.05                                          | 0.05  | 0.1  | 0.1  | 0.1   | 0.15 | 0.2   | dB     |
| WCDMA 1 Carrier                       | 0.1                                           | 0.14  | 0.12 | 0.18 | 0.2   | 0.3  | 0.3   | dB     |
| WCDMA 4 Carrier                       | 0.2                                           | 0.22  | 0.24 | 0.24 | 0.3   | 0.4  | 0.4   | dB     |
| Logarithmic Slope and Intercept       |                                               |       |      |      |       |      |       |        |
| Logarithmic Slope                     | 36.5                                          | 37.3  | 37.8 | 39.3 | 40.5  | 43.5 | 47.5  | mV/dBm |
| Logarithmic Intercept                 | -71.5                                         | -70.3 | -69  | -65  | -62   | -57  | -53   | dBm    |
| Parameter                             | Conditions                                    |       |      | Min. | Typ.  | Max. | Units |        |
| RMS Conformance Error                 | f ≤2.7 GHz                                    |       |      |      | ±0.6  |      | dB    |        |
| RF Input (INP, INN) Interface         |                                               |       |      |      |       |      |       |        |
| Input Resistance                      | Pins INN, INP, AC coupled, Differential drive |       |      |      | 200   |      | Ω     |        |
| Logout Interface (RMSOUT)             |                                               |       |      |      |       |      |       |        |
| Available Output Range                | RLOAD ≥ 200 Ω to ground                       |       |      | 0.4  |       | 3.2  | V     |        |
| Absolute Voltage Low End of Range     | Detection mode, f=900 MHz,Pin= -58 dBm        |       |      |      | 0.5   |      | V     |        |
| Absolute Voltage High End of Range    | Detection mode, f=900 MHz,Pin= +15 dBm        |       |      |      | 3.12  |      | V     |        |
| Source/Sink Current                   | RMSOUT held at Vs/2, to 1% change             |       |      |      | 8/0.4 |      | mA    |        |
| Rise Time, 10% to 90%                 | 0.2V to 1.9V, CINT=0                          |       |      |      | 10    |      | ns    |        |
| Fall Time, 90% to 10%                 | 1.9V to 0.2V. CINT=0                          |       |      |      | 500   |      | ns    |        |
| VSET Interface (VSET)                 |                                               |       |      |      |       |      |       |        |
| Nominal Input Voltage Range           | To ±1 dB error                                |       |      | 0.4  |       | 3.2  | V     |        |
| Input Resistance                      |                                               |       |      |      | 54    |      | kΩ    |        |
| Voltage Reference (VREF)              |                                               |       |      |      |       |      |       |        |
| Output Voltage                        | TA = 25°C                                     |       |      |      | 2     |      | V     |        |
| Temperature Sensitivity               | -40°C ≤ TA ≤ +85°C                            |       |      |      |       |      | mV/°C |        |
| Output Resistance                     | Small Signal at 100 kHz                       |       |      |      | 8     |      | Ω     |        |
| RMS Target Interface (VTGT)           |                                               |       |      |      | 2     |      | V     |        |
| Nominal Input Voltage Range           |                                               |       |      | 0.3  |       | 4.2  | V     |        |
| Power Supply Interface (Vdd)          |                                               |       |      |      |       |      |       |        |
| Supply Voltage                        |                                               |       |      | 4.5  |       | 5.5  | V     |        |
| Quiescent Current                     | Pin= -70 dBm                                  |       |      |      | 65    |      | mA    |        |
|                                       | Pin= +15 dBm                                  |       |      |      | 85    |      | mA    |        |

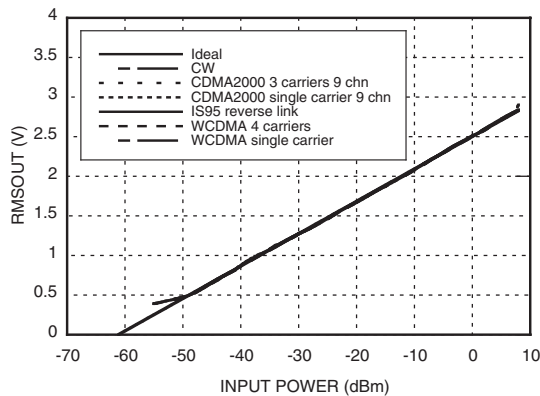
**RMSOUT vs. Pin with  
Different Modulations @ 900 MHz**



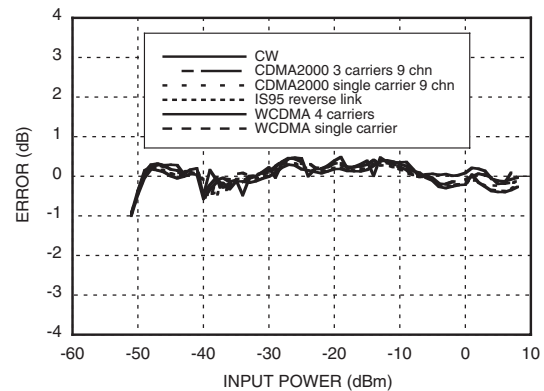
**RMSOUT Error vs. Pin with  
Different Modulations @ 900 MHz**



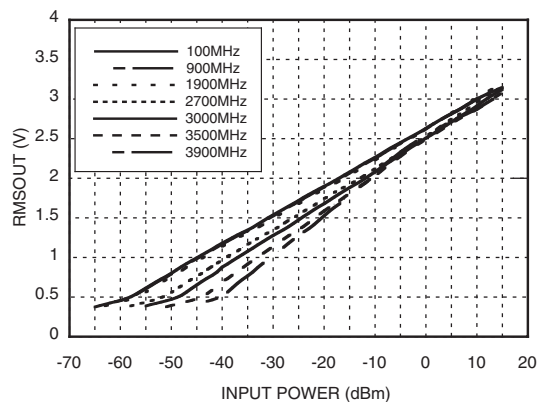
**RMSOUT vs. Pin with  
Different Modulations @ 3000 MHz**



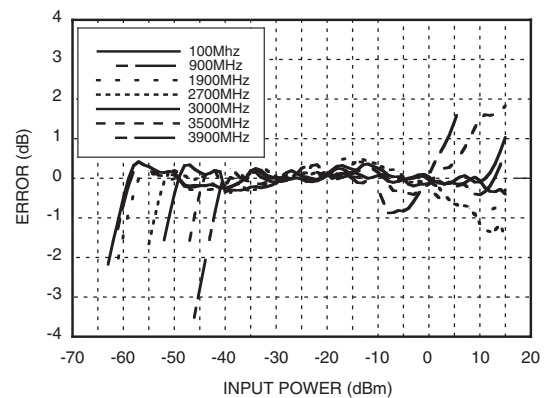
**RMSOUT Error vs. Pin with  
Different Modulations @ 3000 MHz**



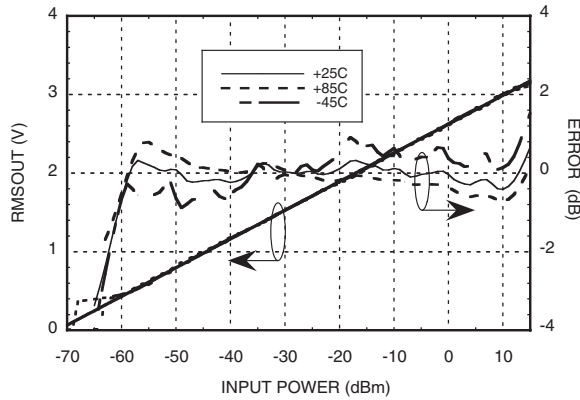
**RMSOUT vs. Pin & Frequency**



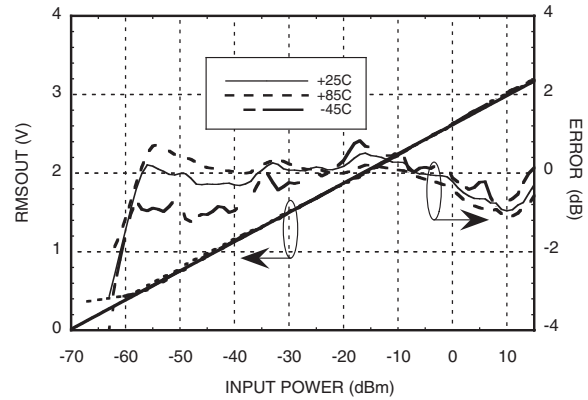
**RMSOUT Error vs. Pin & Frequency**



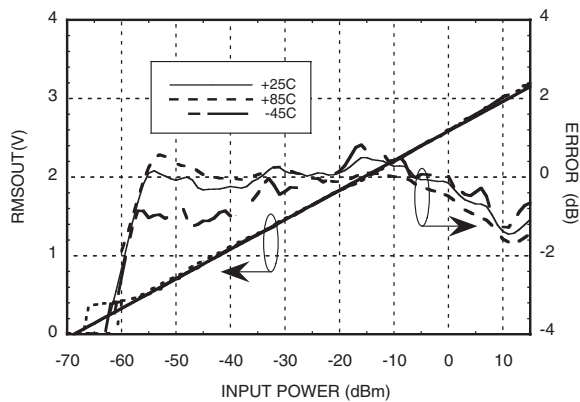
**RMSOUT & Error vs. Pin @ 900 MHz<sup>[1]</sup>**



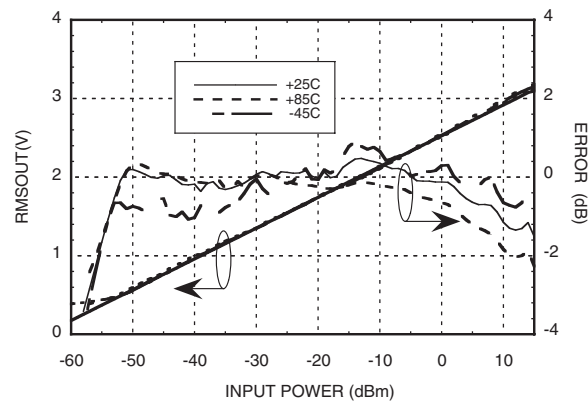
**RMSOUT & Error vs. Pin @ 1900 MHz<sup>[1]</sup>**



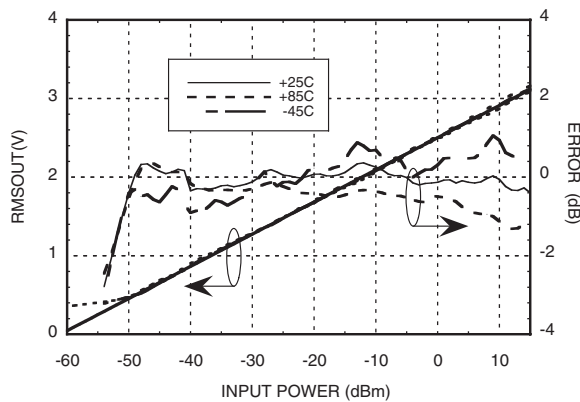
**RMSOUT & Error vs. Pin @ 2200 MHz<sup>[1]</sup>**



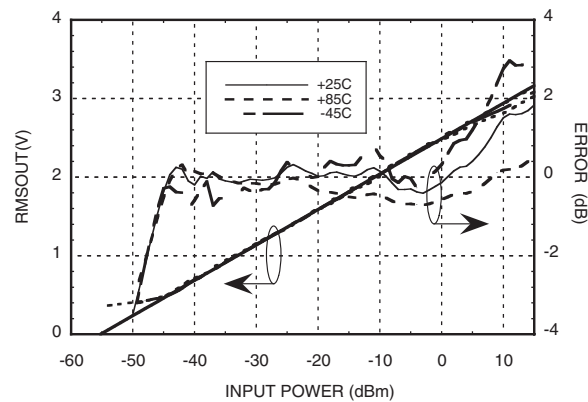
**RMSOUT & Error vs. Pin @ 2700 MHz<sup>[1]</sup>**



**RMSOUT & Error vs. Pin @ 3000 MHz<sup>[1]</sup>**

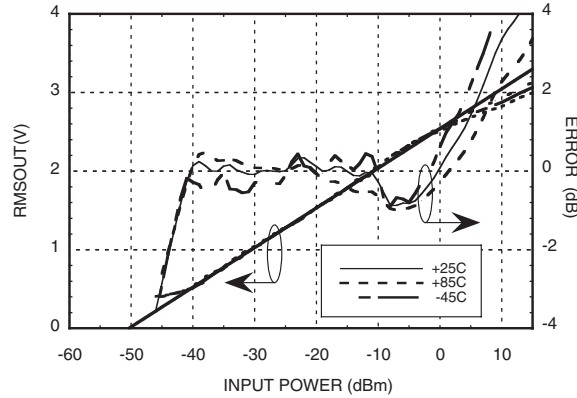


**RMSOUT & Error vs. Pin @ 3500 MHz<sup>[1]</sup>**

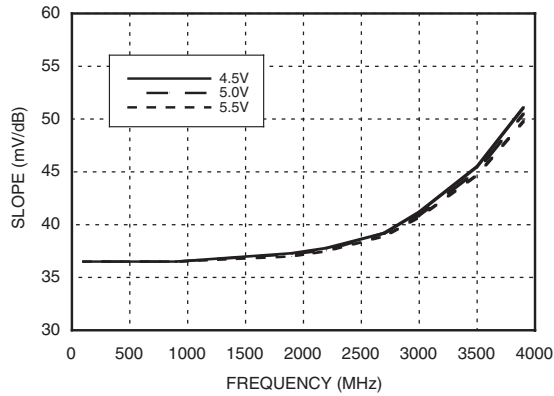


[1] CW input waveform.

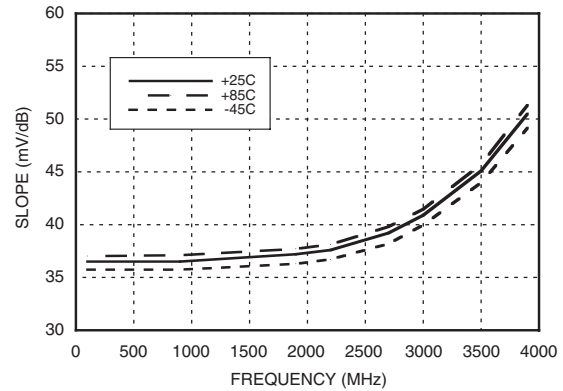
**RMSOUT & Error vs. Pin @ 3900 MHz [1]**



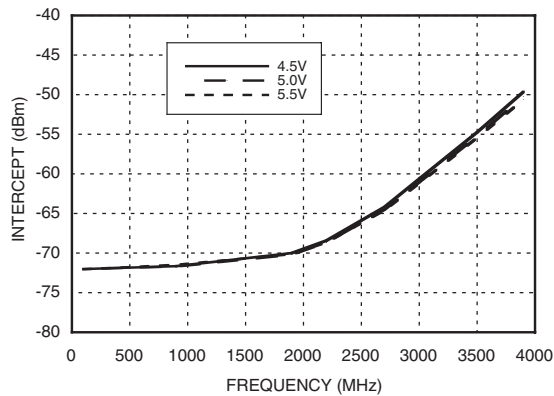
**Slope vs. Frequency & Supply Voltage**



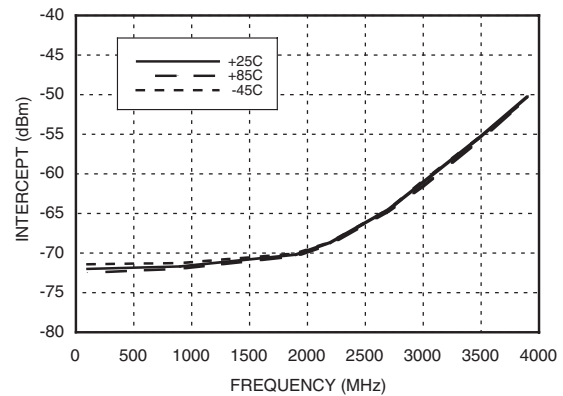
**Slope vs. Frequency**



**Intercept vs. Frequency & Supply Voltage**

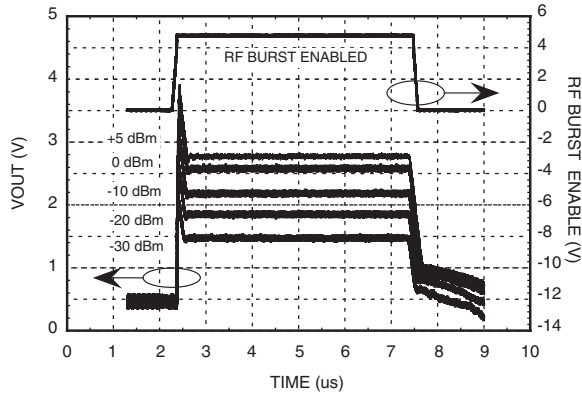


**Intercept vs. Frequency**

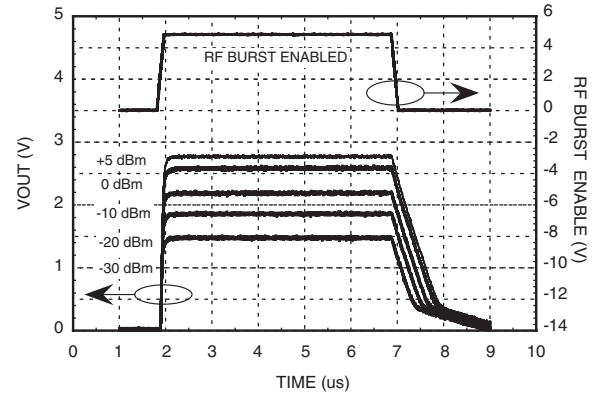


[1] CW input waveform.

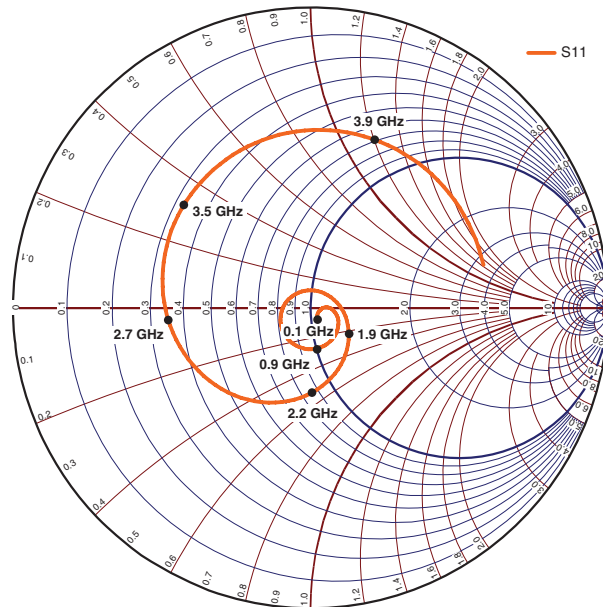
**Output Response to RF Burst**  
**Input @ 1900 MHz, CINT (C17) = Open**



**Output Response to RF Burst**  
**Input @ 1900 MHz, CINT (C17) = 0.1 μF**



**Input Impedance vs  
Frequency, 100 MHz - 3.9 GHz [1]**



[1] Reference plane at J1 connector on evaluation board.

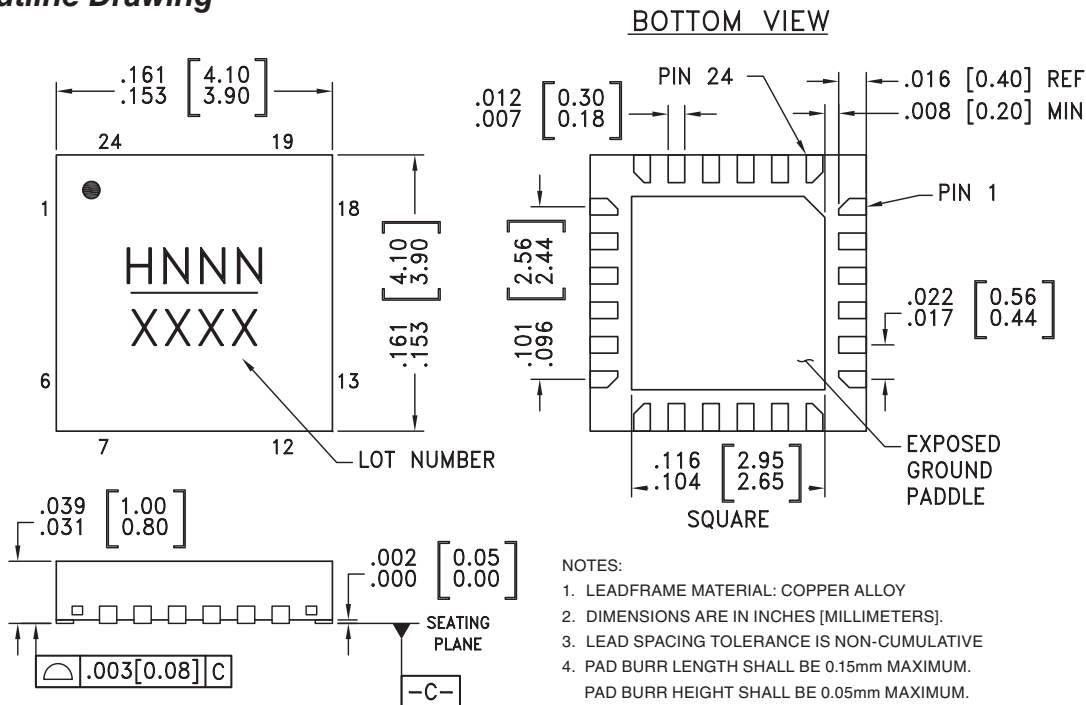
## Absolute Maximum Ratings

|                                                                            |                |
|----------------------------------------------------------------------------|----------------|
| Supply Voltage                                                             | 5.6V           |
| RF Input Power                                                             | 20 dBm         |
| Equivalent Voltage                                                         | 2.25 Vrms      |
| Channel / Junction Temperature                                             | 125 °C         |
| Continuous P <sub>diss</sub> (T = 85°C)<br>(Derate 22.72 mW/°C above 85°C) | 0.91 Watts     |
| Thermal Resistance (R <sub>thj</sub> )<br>(junction to ground paddle)      | 44.02 °C/W     |
| Storage Temperature                                                        | -65 to +150 °C |
| Operating Temperature                                                      | -40 to +85 °C  |



**ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS**

## Outline Drawing



## Package Information

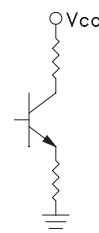
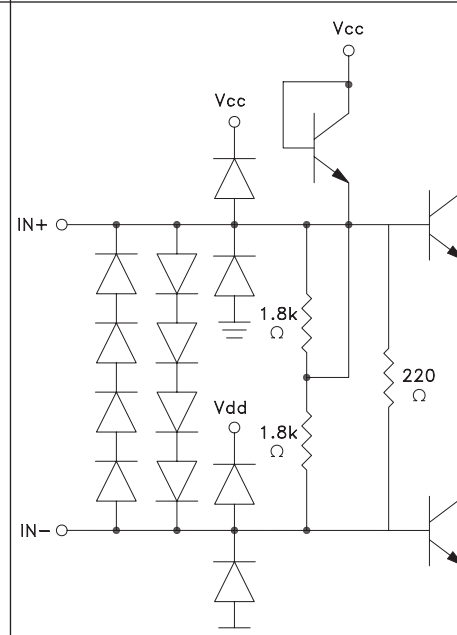
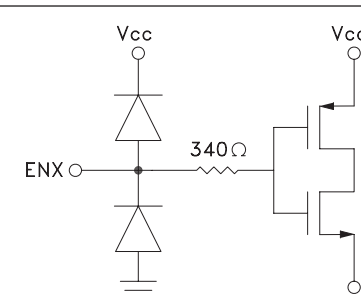
| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[3]</sup> |
|-------------|----------------------------------------------------|---------------|---------------------|--------------------------------|
| HMC610LP4   | Low Stress Injection Molded Plastic                | Sn/Pb Solder  | MSL1 <sup>[1]</sup> | H610<br>XXXX                   |
| HMC610LP4E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H610<br>XXXX                   |

[1] Max peak reflow temperature of 235 °C

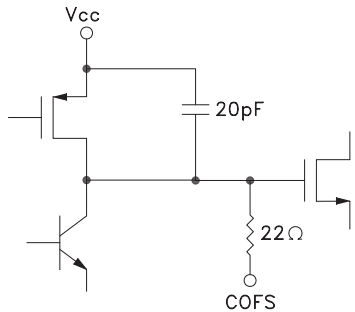
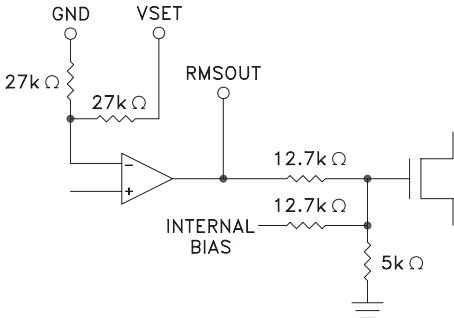
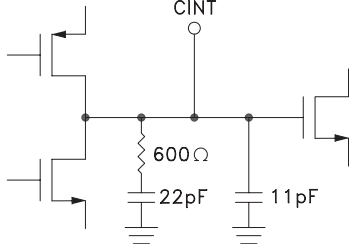
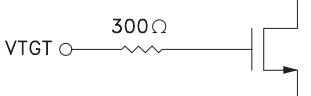
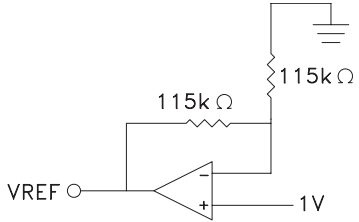
[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

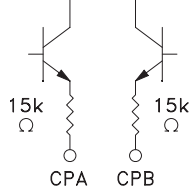
### Pin Descriptions

| Pin Number               | Function | Description                                                                                                   | Interface Schematic                                                                   |
|--------------------------|----------|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1, 6, 8, 11, 21          | Vcc      | Bias Supply. Connect supply voltage to these pins with appropriate filtering.                                 |    |
| 2, 5, 12, 13, 16, 18, 24 | GND      | Package bottom has an exposed metal paddle that must be connected to RF/DC ground.                            |    |
| 3, 4                     | IN+, IN- | RF Input pins. Connect RF to IN+ and IN- through a 1:1 balun.                                                 |    |
| 7                        | ENX      | Disable pin. Connect to GND for normal operation. Applying voltage V>0.8 Vdd will initiate power saving mode. |  |

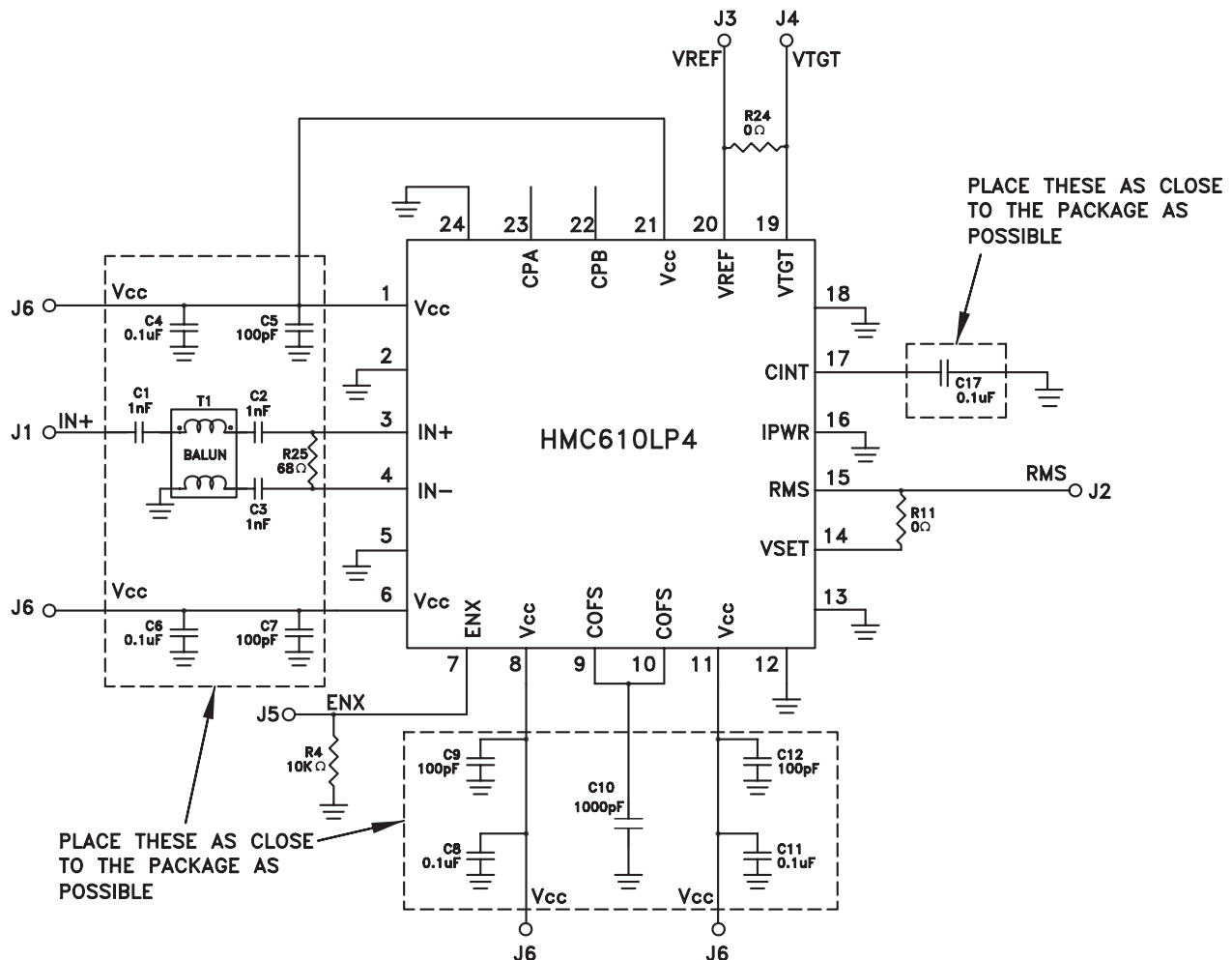
### Pin Descriptions (Continued)

| Pin Number | Function | Description                                                                                                                                                                     | Interface Schematic                                                                   |
|------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 9, 10      | COFS     | Input high pass filter capacitor. Connect to common via a capacitor to determine 3 dB point of input signal high-pass filter.                                                   |    |
| 14         | VSET     | VSET input. Short this pin to RMSOUT for normal operation. Use a resistor between RMSOUT and VSET to increase the logarithmic slope.                                            |    |
| 15         | RMSOUT   | Logarithmic output that converts the input power to a DC level. Short this pin to VSET for normal operation.                                                                    |                                                                                       |
| 16         | IPWR     | Ground for proper operation                                                                                                                                                     |                                                                                       |
| 17         | CINT     | Connection for ground referenced loop filter integration capacitor.                                                                                                             |  |
| 19         | VTGT     | This voltage input changes the logarithmic intercept point. Use of lower target voltage reduces error for complex signals with large crest factors. Normally connected to VREF. |  |
| 20         | VREF     | Reference voltage output.                                                                                                                                                       |  |

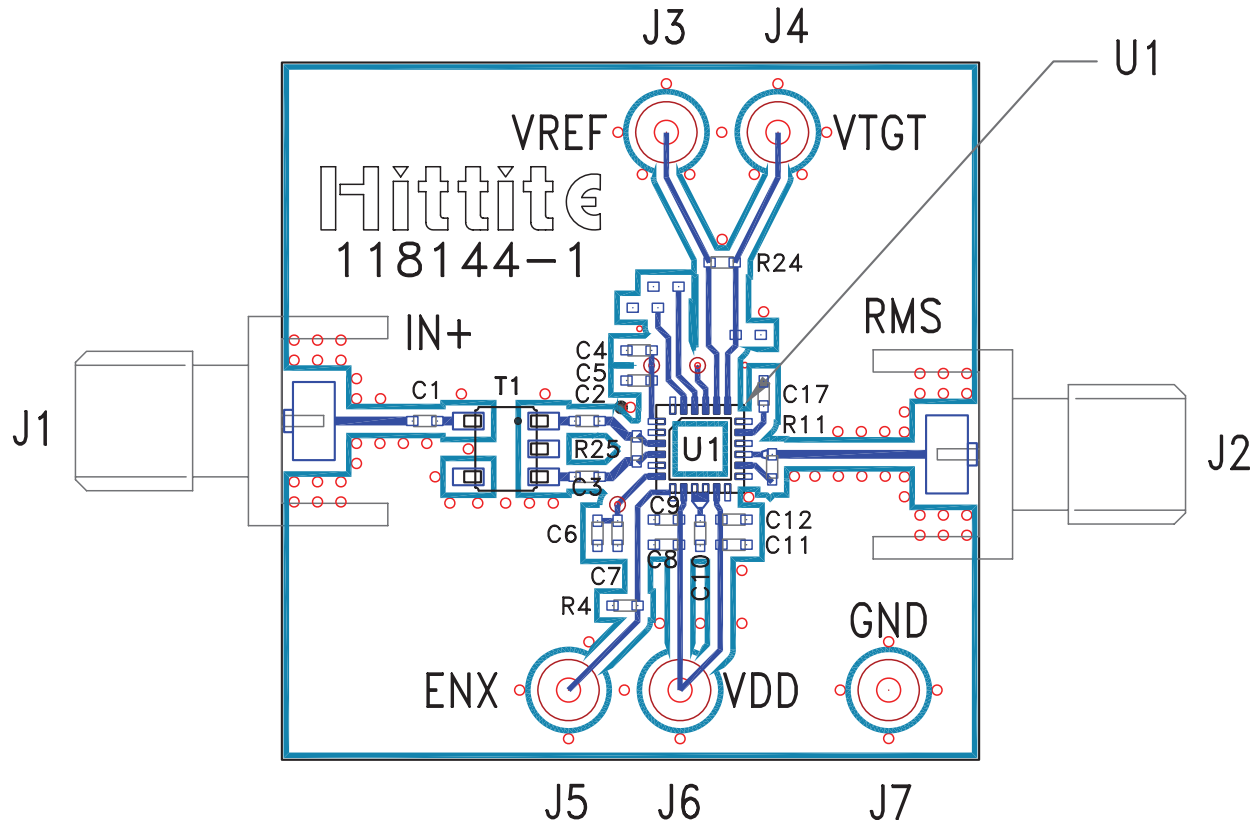
## Pin Descriptions (Continued)

| Pin Number | Function | Description                                                                   | Interface Schematic                                                                 |
|------------|----------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 22, 23     | CPB, CPA | Temperature compensation pins. Leave both pins floating for normal operation. |  |

## Application & Evaluation PCB Schematic



## Evaluation PCB



## List of Materials for Evaluation PCB 118147 [1]

| Item                 | Description                                                 |
|----------------------|-------------------------------------------------------------|
| J1 - J2              | PC Mount SMA connector                                      |
| J3 - J7              | DC Pins                                                     |
| C1 - C3              | 1 nF Capacitor, 0402 Pkg.                                   |
| C4, C6, C8, C11, C17 | 0.1 $\mu$ F Capacitor, 0402 Pkg.                            |
| C5, C7, C9, C12      | 100 PF Capacitor, 0402 Pkg.                                 |
| C10                  | 1000 PF Capacitor, 0402 Pkg.                                |
| R25                  | 68 $\Omega$ Resistor, 0402 Pkg.                             |
| R11, R24             | 0 $\Omega$ Resistor, 0402 Pkg.                              |
| R4                   | 10k $\Omega$ Resistor, 0402 Pkg.                            |
| T1                   | 1:1 Balun, M/A-COM ETC1-1-13                                |
| U1                   | HMC610LP4 / HMC610LP4E<br>Logarithmic Detector / Controller |
| PCB [2]              | 118144 Eval Board                                           |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350

The circuit board used in the final 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 circuit board shown is available from Hittite upon request.



MICROWAVE CORPORATION

v02.0607



## HMC610LP4 / 610LP4E

**70 dB RMS POWER  
DETECTOR, DC - 3.9 GHz**

### Notes