

# HMC388LP4 / 388LP4E

**MMIC VCO w/ BUFFER  
AMPLIFIER, 3.15 - 3.4 GHz**

## Typical Applications

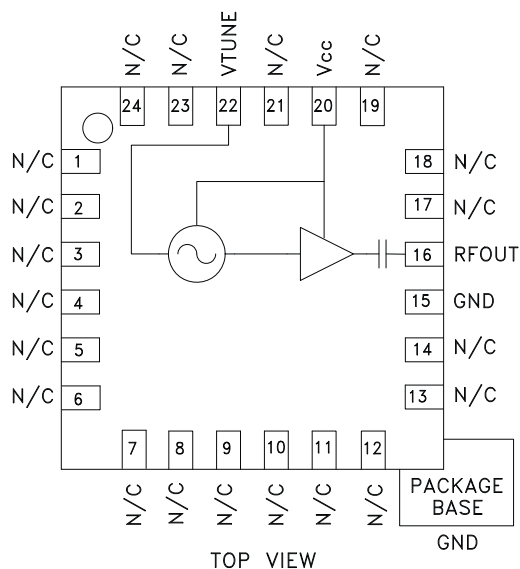
Low noise MMIC VCO w/Buffer Amplifier for:

- Wireless Local Loop (WLL)
- VSAT & Microwave Radio
- Test Equipment & Industrial Controls
- Military

## Features

Pout: +4.9 dBm  
Phase Noise: -113 dBc/Hz @100 KHz  
No External Resonator Needed  
Single Supply: 3V @ 39 mA  
QFN Leadless SMT Package, 16 mm<sup>2</sup>

## Functional Diagram



## General Description

The HMC388LP4 & HMC388LP4E are GaAs InGaP Heterojunction Bipolar Transistor (HBT) MMIC VCOs with integrated resonators, negative resistance devices, varactor diodes, and buffer amplifiers. Covering 3.15 to 3.4 GHz, the VCO's phase noise performance is excellent over temperature, shock, vibration and process due to the oscillator's monolithic structure. Power output is 4.9 dBm typical from a single supply of 3V @ 39mA. The voltage controlled oscillator is packaged in a low cost leadless QFN 4x4 mm surface mount package.

## Electrical Specifications, $T_A = +25^\circ \text{C}$ , $V_{CC} = +3V$

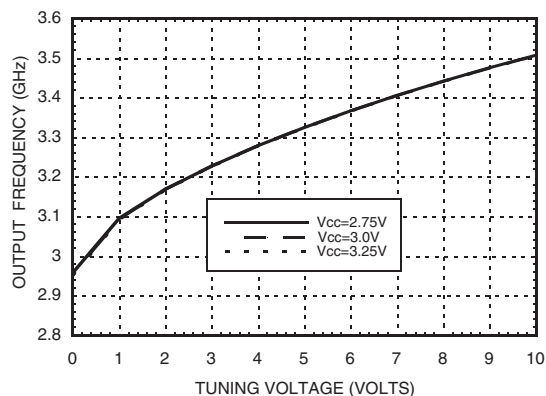
| Parameter                                                      | Min. | Typ.       | Max. | Units           |
|----------------------------------------------------------------|------|------------|------|-----------------|
| Frequency Range                                                |      | 3.15 - 3.4 |      | GHz             |
| Power Output                                                   | 1.5  | 4.9        |      | dBm             |
| SSB Phase Noise @ 100 kHz Offset, $V_{tune} = +5V$ @ RF Output |      | -113       |      | dBc/Hz          |
| Tune Voltage ( $V_{tune}$ )                                    | 0    |            | 10   | V               |
| Supply Current ( $I_{CC}$ ) ( $V_{CC} = +3.0V$ )               |      | 39         |      | mA              |
| Tune Port Leakage Current                                      |      |            | 10   | $\mu A$         |
| Output Return Loss                                             |      | 8          |      | dB              |
| Harmonics                                                      |      |            |      |                 |
| 2nd                                                            |      | -7         |      | dBc             |
| 3rd                                                            |      | -14        |      | dBc             |
| Pulling (into a 2.0:1 VSWR)                                    |      | 2.7        |      | MHz pp          |
| Pushing @ $V_{tune} = +5V$                                     |      | -2         |      | MHz/V           |
| Frequency Drift Rate                                           |      | 0.4        |      | MHz/ $^\circ C$ |



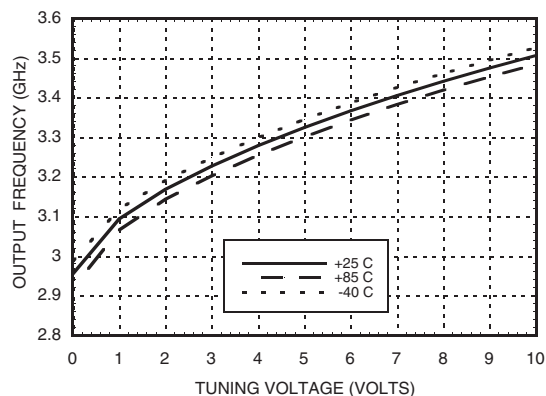
# HMC388LP4 / 388LP4E

## MMIC VCO w/ BUFFER AMPLIFIER, 3.15 - 3.4 GHz

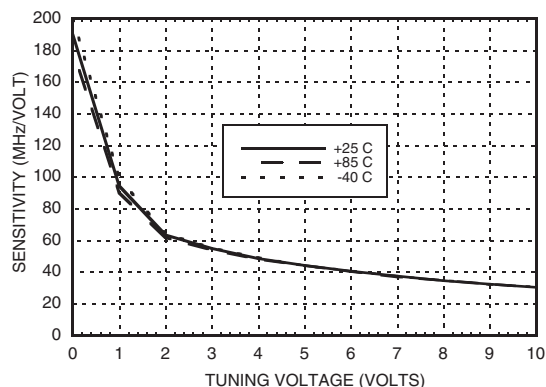
**Frequency vs. Tuning Voltage,  $T = 25^{\circ}\text{C}$**



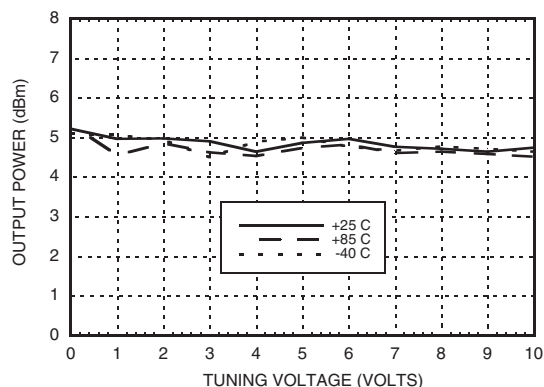
**Frequency vs. Tuning Voltage,  $V_{cc} = +3\text{V}$**



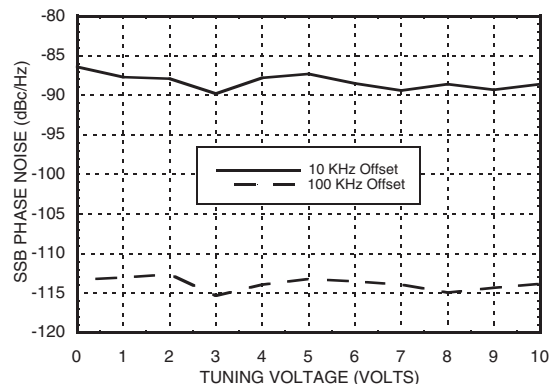
**Sensitivity vs. Tuning Voltage,  $V_{cc} = +3\text{V}$**



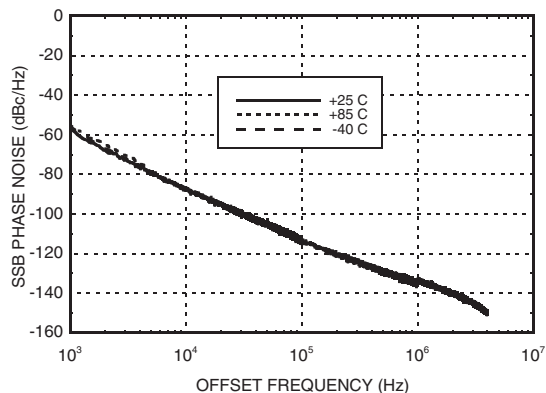
**Output Power vs.  
Tuning Voltage,  $V_{cc} = +3\text{V}$**



**Phase Noise vs. Tuning Voltage**



**Typical SSB Phase Noise @  $V_{tune} = +5\text{V}$**





## MMIC VCO w/ BUFFER AMPLIFIER, 3.15 - 3.4 GHz

### Absolute Maximum Ratings

|                                                                           |                |
|---------------------------------------------------------------------------|----------------|
| Vcc                                                                       | +3.5 Vdc       |
| Vtune                                                                     | 0 to +11V      |
| Channel Temperature                                                       | 135 °C         |
| Continuous P <sub>diss</sub> (T = 85°C)<br>(derate 6.28 mW/°C above 85°C) | 565 W          |
| Storage Temperature                                                       | -65 to +150 °C |
| Operating Temperature                                                     | -40 to +85 °C  |
| ESD Sensitivity (HBM)                                                     | Class 1A       |

### Typical Supply Current vs. Vcc

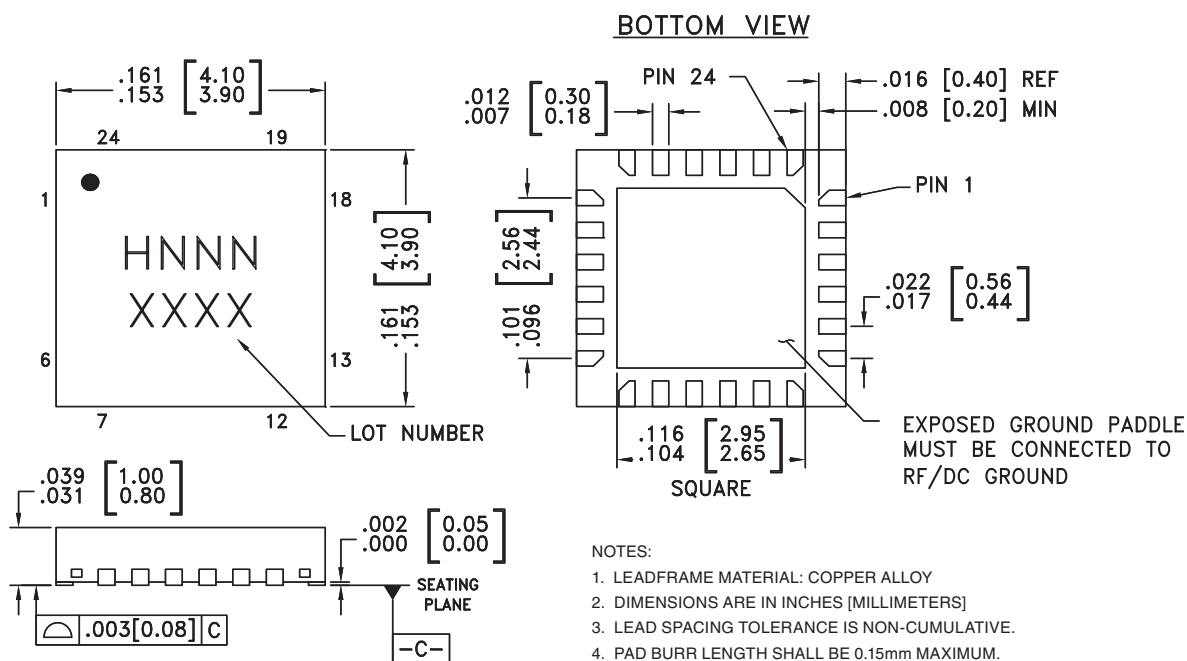
| Vcc (V) | Icc (mA) |
|---------|----------|
| 2.75    | 34       |
| 3.0     | 39       |
| 3.25    | 44       |

Note: VCO will operate over full voltage range shown above.



ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS

### Outline Drawing



### Package Information

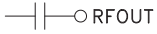
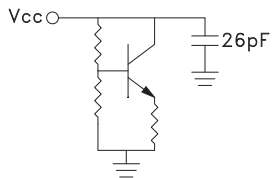
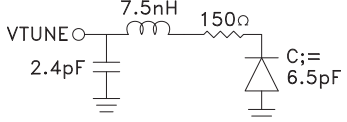
| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[3]</sup> |
|-------------|----------------------------------------------------|---------------|---------------------|--------------------------------|
| HMC388LP4   | Low Stress Injection Molded Plastic                | Sn/Pb Solder  | MSL1 <sup>[1]</sup> | H388<br>XXXX                   |
| HMC388LP4E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H388<br>XXXX                   |

[1] Max peak reflow temperature of 235 °C

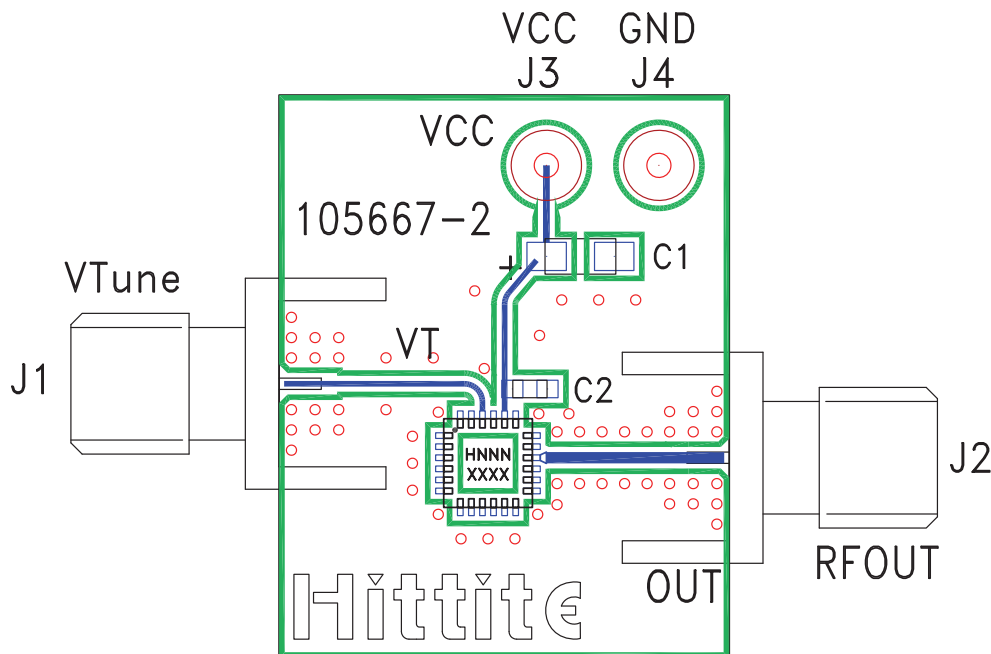
[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

### Pin Descriptions

| Pin Number                    | Function | Description                                                                           | Interface Schematic                                                                   |
|-------------------------------|----------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1- 14, 17 - 19,<br>21, 23, 24 | N/C      | No Connection                                                                         |                                                                                       |
| 15                            | GND      | This pin must be connected to RF & DC ground.                                         |    |
| 16                            | RFOUT    | RF output (AC coupled)                                                                |    |
| 20                            | Vcc      | Supply Voltage Vcc= 3V                                                                |    |
| 22                            | VTUNE    | Control Voltage Input. Modulation port bandwidth dependent on drive source impedance. |   |
|                               | GND      | Package bottom has an exposed metal paddle that must be RF & DC grounded.             |  |

**Evaluation PCB**



**List of Materials for Evaluation PCB 105706 <sup>[1]</sup>**

| Item               | Description                    |
|--------------------|--------------------------------|
| J1 - J2            | PCB Mount SMA RF Connector     |
| J3 - J4            | DC Pin                         |
| C1                 | 4.7 $\mu$ F Tantalum Capacitor |
| C2                 | 10,000 pF Capacitor, 0603 Pkg. |
| U1                 | HMC388LP4 / HMC388LP4E VCO     |
| PCB <sup>[2]</sup> | 105667 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.



**Notes:**

v02.0805

## HMC388LP4 / 388LP4E

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VCOs & PLOs - SMT

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