



## MMIC VCO w/ BUFFER AMPLIFIER, 3.9 - 4.45 GHz

### Typical Applications

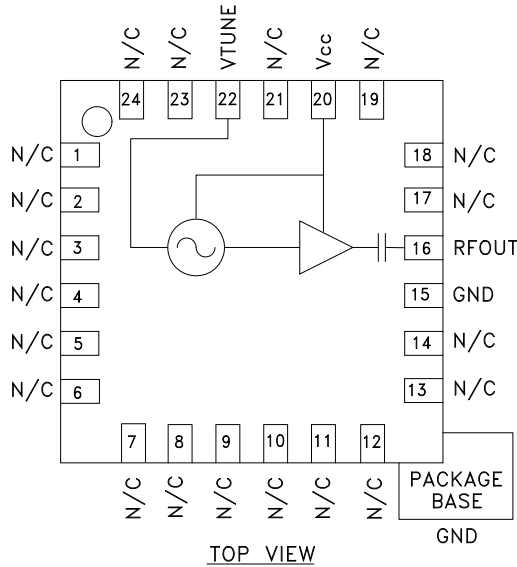
Low noise MMIC VCO w/Buffer Amplifier for:

- VSAT & Microwave Radio
- Radio Altimetry
- Test Equipment & Industrial Controls
- Military

### Features

- Pout: +5.0 dBm
- Phase Noise: -106 dBc/Hz @100 KHz
- No External Resonator Needed
- Single Supply: +3V @ 30 mA
- 24 Lead 4x4mm QFN Package: 9 mm<sup>2</sup>

### Functional Diagram



### General Description

The HMC391LP4 & HMC391LP4E are GaAs InGaP Heterojunction Bipolar Transistor (HBT) MMIC VCOs with integrated resonators, negative resistance devices, varactor diodes, and buffer amplifiers. Covering 3.9 to 4.45 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 5.0 dBm typical from a single supply of +3V @ 30 mA. The voltage controlled oscillator is packaged in a low cost leadless QFN 4 x 4 mm surface mount package.

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

| Parameter  | Min.       | Typ. | Max. | Units           |
|--|------------|------|------|-----------------|
| Frequency Range  | 3.9 - 4.45 |      |      | GHz             |
| Power Output   | 1.5        | 5.0  |      | dBm             |
| SSB Phase Noise @ 100 kHz Offset, $V_{tune} = +5V$ @ RF Output |            | -106 |      | dBc/Hz          |
| Tune Voltage ( $V_{tune}$ )                                    | 0          |      | 10   | V               |
| Supply Current ( $I_{cc}$ ) ( $V_{cc} = +3V$ )                 |            | 30   | 40   | mA              |
| Tune Port Leakage Current                                      |            |      | 10   | $\mu A$         |
| Output Return Loss   |            | 7    |      | dB              |
| Harmonics  |            |      |      |                 |
| 2nd  |            | -9   |      | dBc             |
| 3rd  |            | -23  |      | dBc             |
| Pulling (into a 2.0:1 VSWR)                                    |            | 8.0  |      | MHz pp          |
| Pushing @ $V_{tune} = +5V$                                     |            | 16   |      | MHz/V           |
| Frequency Drift Rate   |            | 0.5  |      | MHz/ $^\circ C$ |

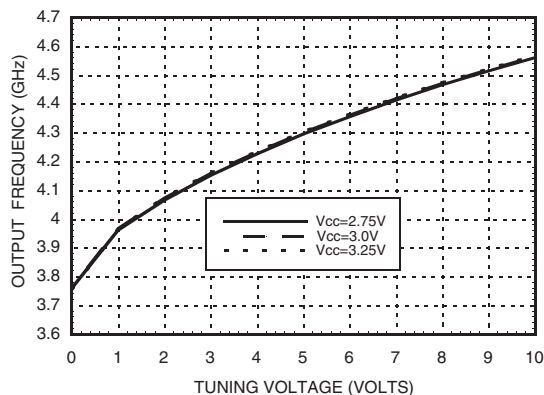
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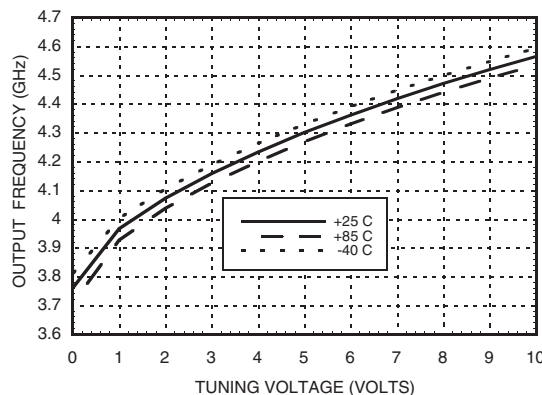
**MMIC VCO w/ BUFFER  
 AMPLIFIER, 3.9 - 4.45 GHz**



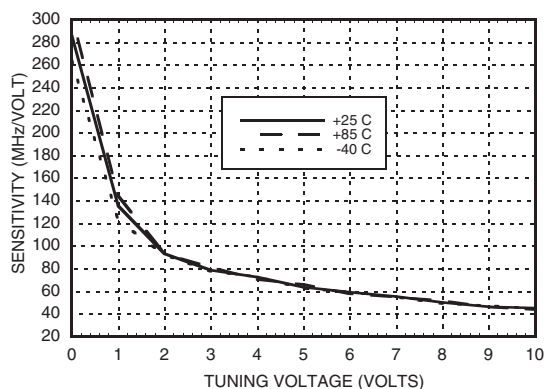
**Frequency vs. Tuning Voltage, T= 25°C**



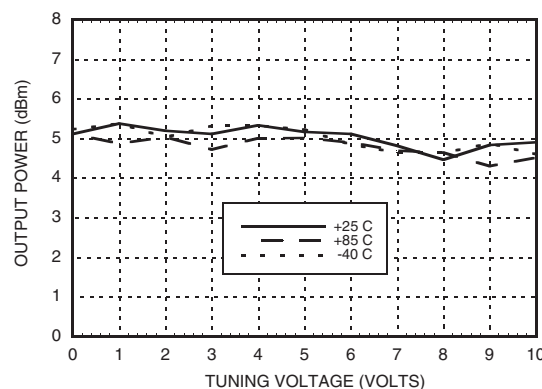
**Frequency vs. Tuning Voltage, Vcc= +3V**



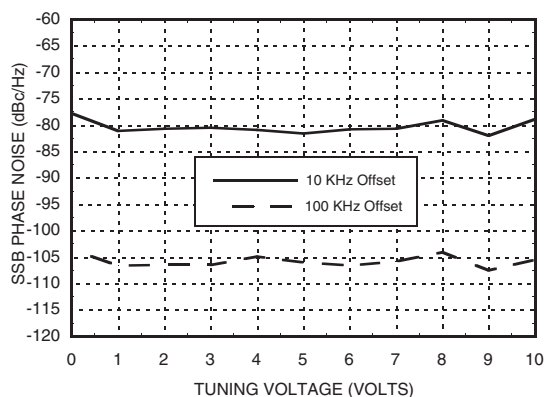
**Sensitivity vs. Tuning Voltage, Vcc= +3V**



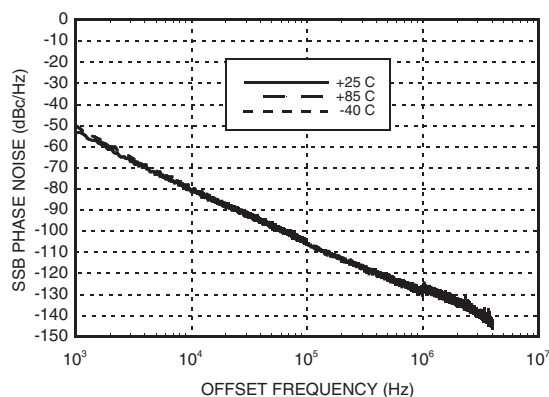
**Output Power vs.  
 Tuning Voltage, Vcc= +3V**



**Phase Noise vs. Tuning Voltage**



**Typical SSB Phase Noise @ Vtune= +5V**





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### Absolute Maximum Ratings

|  |                |
|--|----------------|
| Vcc  | +3.5 Vdc       |
| Vtune  | 0 to +11V      |
| Channel Temperature  | 135 °C         |
| Continuous Pdiss (T = 85°C)<br>(derate 3 mW/°C above 85°C) | 150 mW         |
| Thermal Resistance<br>(junction to ground paddle)          | 333 °C/W       |
| Storage Temperature  | -65 to +150 °C |
| Operating Temperature                                      | -40 to +85 °C  |

### Typical Supply Current vs. Vcc

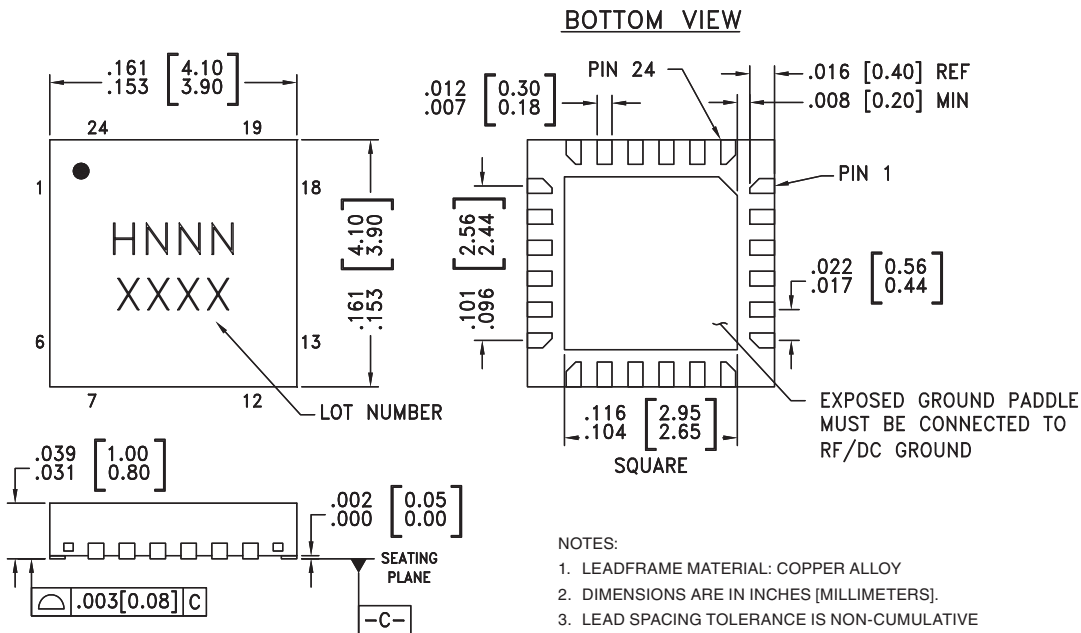
| Vcc (V) | Icc (mA) |
|---------|----------|
| 2.75    | 22       |
| 3.0     | 30       |
| 3.25    | 39       |

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



ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS

### Outline Drawing



#### NOTES:

- LEADFRAME MATERIAL: COPPER ALLOY
- DIMENSIONS ARE IN INCHES [MILLIMETERS].
- LEAD SPACING TOLERANCE IS NON-CUMULATIVE
- PAD BURR LENGTH SHALL BE 0.15mm MAXIMUM.  
PAD BURR HEIGHT SHALL BE 0.05mm MAXIMUM.
- PACKAGE WARP SHALL NOT EXCEED 0.05mm.
- ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
- REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED PCB LAND PATTERN

### Package Information

| Part Number | Package Body Material                              | Lead Finish   | MSL Rating          | Package Marking <sup>[3]</sup> |
|-------------|--|---------------|---------------------|--------------------------------|
| HMC391LP4   | Low Stress Injection Molded Plastic                | Sn/Pb Solder  | MSL1 <sup>[1]</sup> | H391<br>XXXX                   |
| HMC391LP4E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | H391<br>XXXX                   |

[1] Max peak reflow temperature of 235 °C

[2] Max peak reflow temperature of 260 °C

[3] 4-Digit lot number XXXX

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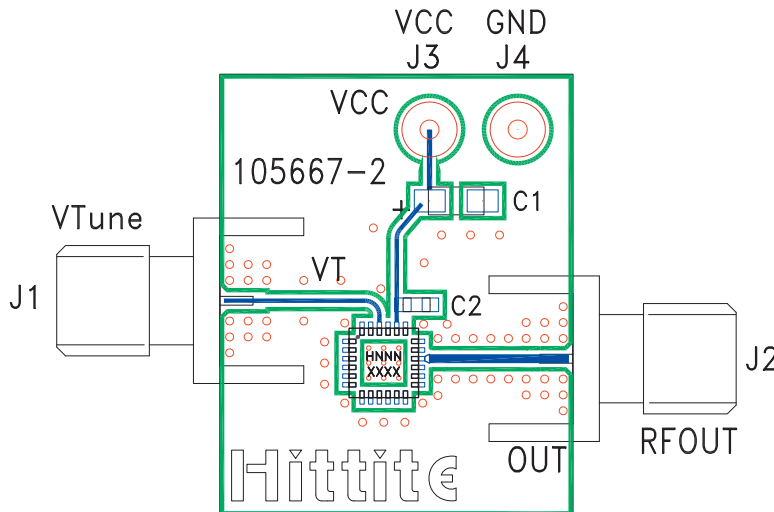
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**Pin Descriptions**

| Pin Number                 | Function | Description   | Interface Schematic |
|----------------------------|----------|---|---------------------|
| 1- 14, 17 - 19, 21, 23, 24 | N/C      | No Connection   |                     |
| 15                         | GND      | This pin must be connected to RF & DC ground. Package bottom has an exposed metal paddle that must be RF & DC grounded. |                     |
| 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.                                   |                     |

**Evaluation PCB**



**List of Materials for Evaluation PCB 105706 [1]**

| 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      | HMC391LP4 / HMC391LP4E VCO     |
| PCB [2] | 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.