



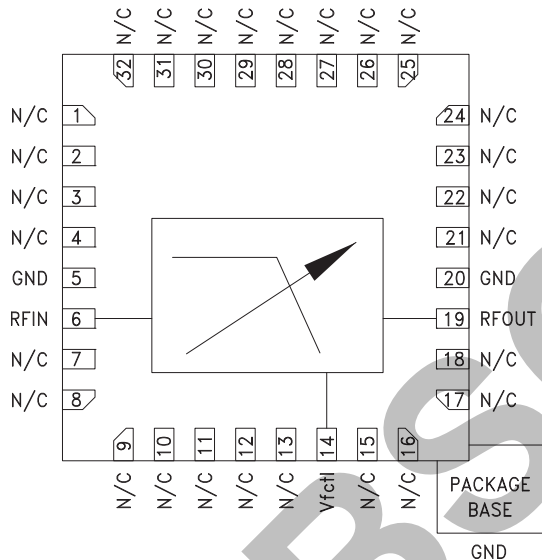
## FILTER - TUNABLE, LOW PASS SMT 2.2 - 4.0 GHz

### Typical Applications

The HMC881LP5E is ideal for:

- Test & Measurement Equipment
- Military RADAR & EW/ECM
- SATCOM & Space
- Industrial & Medical Equipment

### Functional Diagram



### Features

- Fast Tuning Response; 150 ns
- Excellent Wideband Rejection; 40 dB
- Single Positive Frequency Control: 0 to +14V
- Low Insertion Loss & User Selectable Cutoff Frequency
- Single Chip Replacement for Mechanically Tuned Designs
- 32 Lead 5x5 mm SMT Package

### General Description

The HMC881LP5E is a MMIC low pass filter which features a user selectable cutoff frequency. The cutoff frequency can be varied from 2.2 to 4.0 GHz by applying a single analog tuning voltage between 0 and 14V. This low pass filter provides a low 3.8 dB insertion loss, 10 dB return loss and 1.25 x  $f_{cutoff}$  stopband attenuation of >20 dB. This tunable filter can be used as a much smaller alternative to physically large switched filter banks and cavity tuned filters. The HMC881LP5E has excellent microphonics due to the monolithic design, and provides a dynamically adjustable solution in advanced communications applications. The low pass tunable filter is packaged in a RoHS compliant 5x5mm QFN leadless package.

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

| Parameter                                                                            | Min. | Typ.                | Max. | Units  |
|--------------------------------------------------------------------------------------|------|---------------------|------|--------|
| Passband                                                                             | 0    |                     | 4    | GHz    |
| $f_{cutoff}$ [1] Tuning Range                                                        | 2.2  |                     | 4    | GHz    |
| Stopband Frequency (Rejection >20 dB)                                                |      | 1.25 x $f_{cutoff}$ |      | GHz    |
| Re-entry Frequency (Rejection <30 dB)                                                |      | 30                  |      | GHz    |
| Insertion Loss                                                                       |      | 3.8                 |      | dB     |
| Return Loss                                                                          |      | 10                  |      | dB     |
| Maximum Input Power for Linear Operation                                             |      |                     | 10   | dBm    |
| Frequency Control Voltage (V <sub>fctl</sub> )                                       | 0    |                     | 14   | V      |
| Frequency Control Port Source/Sink Current ( $I_{fctl}$ )                            |      |                     | ±1   | mA     |
| Residual Phase Noise [2] (1 MHz offset)                                              |      | -165                |      | dBc/Hz |
| $f_{cutoff}$ Drift Rate (Fixed V <sub>fctl</sub> )                                   |      | -0.8                |      | MHz/°C |
| Tuning Characteristics [3]<br>t <sub>FULLBAND</sub> (0% V <sub>fctl</sub> to 90% RF) |      | 150                 |      | ns     |

[1]  $f_{cutoff}$  defined as the point at which the insertion loss is 3 dB below the minimum passband insertion loss.

[2] Optimum residual phase noise performance requires the use of a low noise driver circuit.

[3] Tuning speed is dependent on driver circuit. Data measured with a high speed op-amp driver and includes driver slew rate delay.

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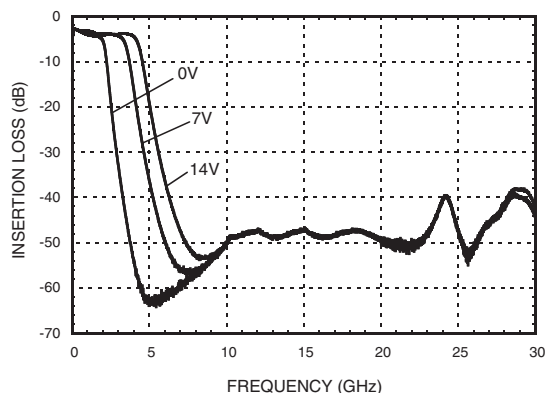


**FILTER - TUNABLE, LOW PASS SMT**  
**2.2 - 4.0 GHz**

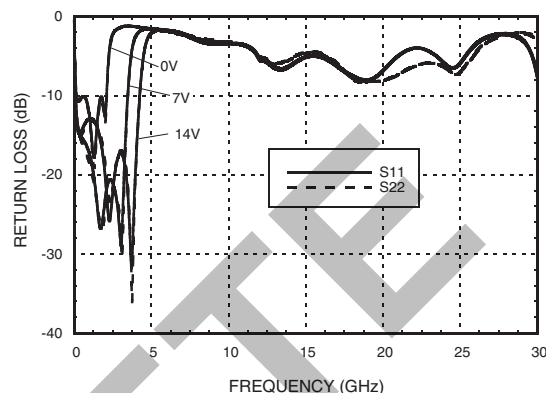
**3**

**FILTERS - TUNABLE - SMT**

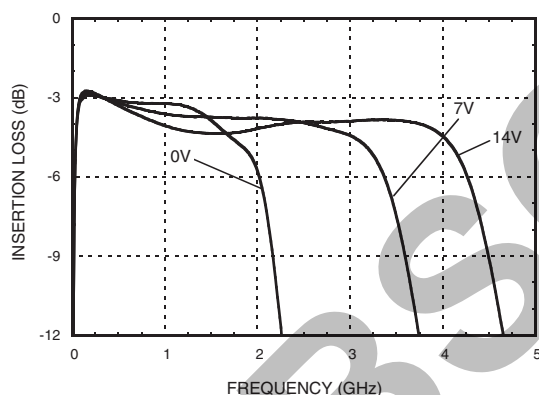
**Broadband Insertion Loss vs. Control Voltage**



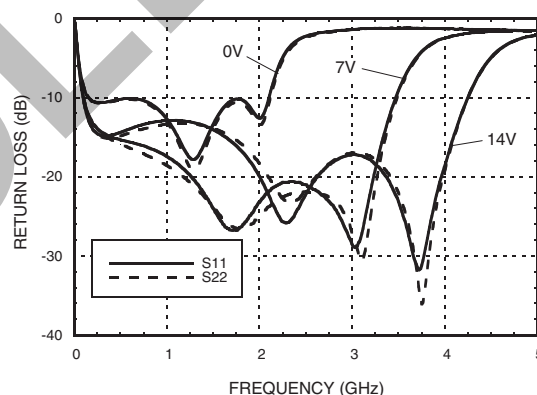
**Broadband Return Loss vs. Control Voltage**



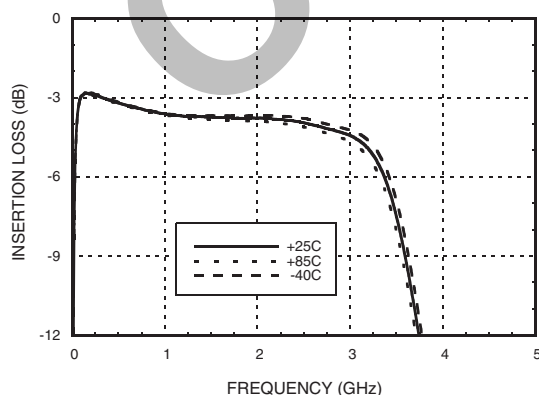
**Insertion Loss vs. Control Voltage <sup>[1]</sup>**



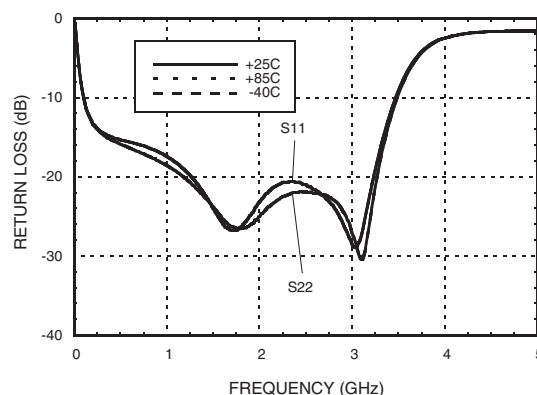
**Return Loss vs. Control Voltage <sup>[1]</sup>**



**Insertion Loss vs. Temperature, Vctl @ 7V <sup>[1]</sup>**



**Return Loss vs. Temperature, Vctl @ 7V <sup>[1]</sup>**



[1] Low frequency performance limited by external DC blocking capacitors at RF input and output.

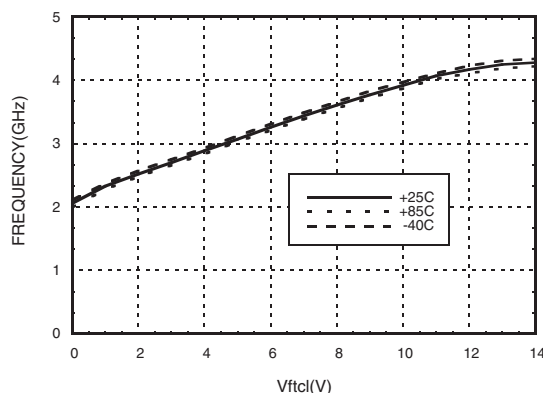


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**2.2 - 4.0 GHz**

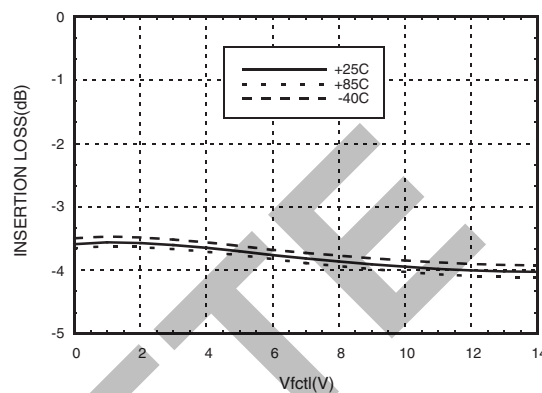
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FILTERS - TUNABLE - SMT

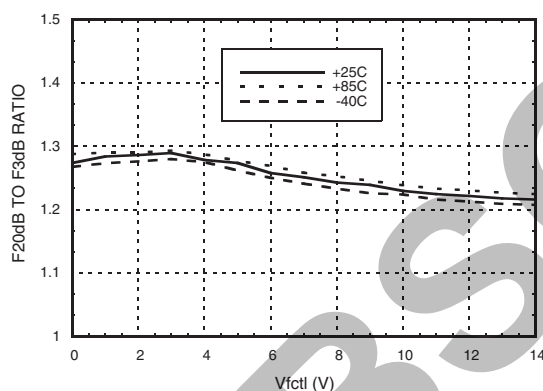
**Cutoff Frequency vs. Temperature**



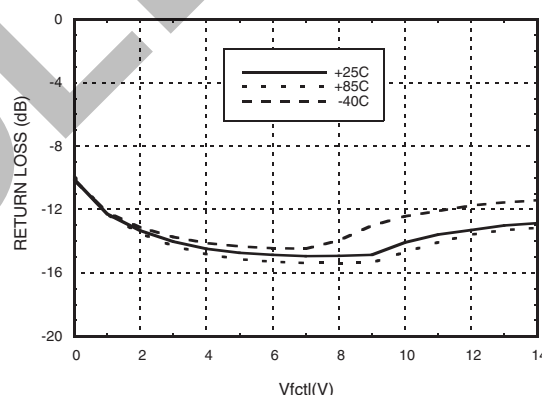
**Average Insertion Loss vs. Temperature in a 2 dB Bandwidth**



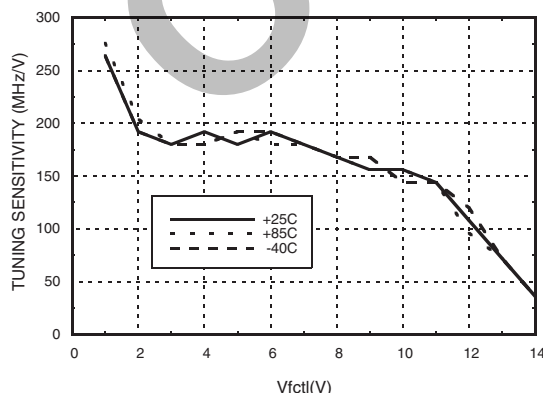
**Rejection Ratio vs. Temperature<sup>[1]</sup>**



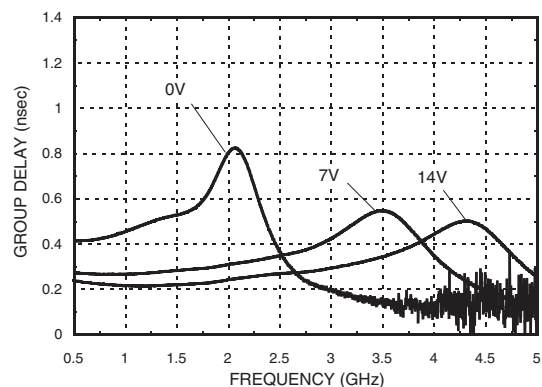
**Maximum Return Loss in a 2 dB Bandwidth vs. Temperature**



**Tuning Sensitivity vs. Temperature**



**Group Delay**



[1] Rejection ratio is defined as the ratio of the frequency at which the relative insertion loss is 20 dB, to  $f_{cutoff}$



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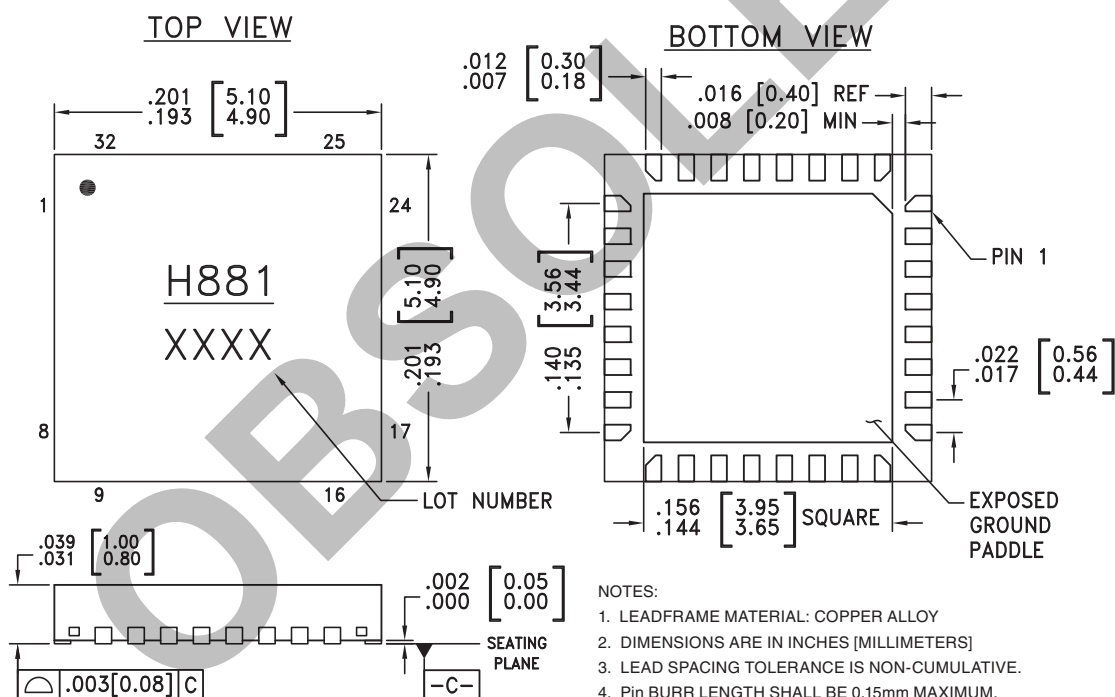


### Reliability Information

|                                                             |               |
|-------------------------------------------------------------|---------------|
| Junction Temperature to Maintain<br>1 Million Hour MTTF     | 150 °C        |
| Nominal Junction Temperature<br>(T= 85 °C and Pin = 10 dBm) | 90 °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>[1]</sup> |
|-------------|----------------------------------------------------|---------------|---------------------|--------------------------------|
| HMC881LP5E  | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1 <sup>[2]</sup> | <u>H881</u><br>XXXX            |

[2] Max peak reflow temperature of 260 °C

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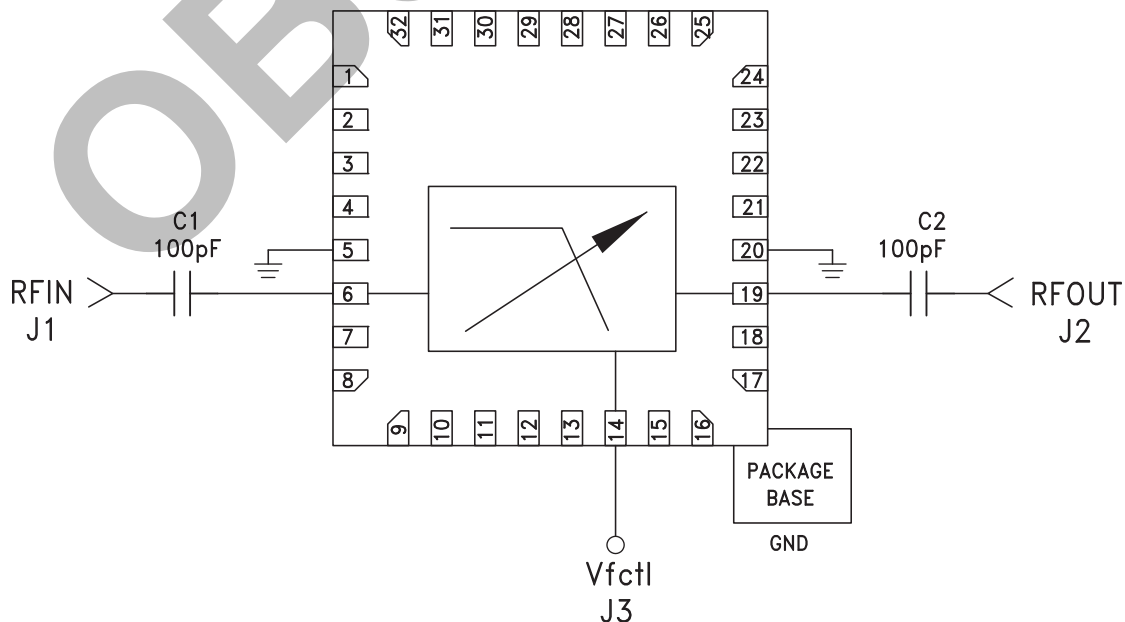
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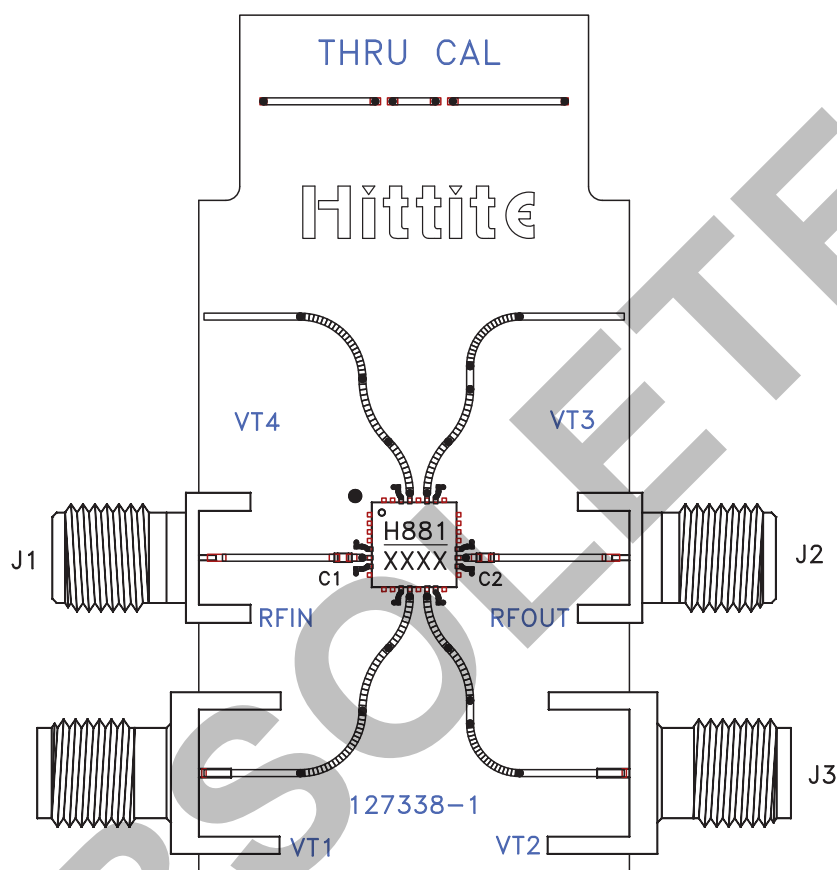
FILTERS - TUNABLE - SMT

**Pin Descriptions**

| Pin Number                         | Function | Description                                                                                                                              | Interface Schematic |
|------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1 - 4, 7 - 13,<br>15 - 18, 21 - 32 | N/C      | The pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally. |                     |
| 5, 20                              | GND      | These pins and exposed paddle must be connected to RF/DC ground.                                                                         |                     |
| 6                                  | RFIN     | This pin is DC coupled and matched to 50 Ohms. External voltage must not be applied to this pin.                                         |                     |
| 14                                 | Vfctl    | Cutoff frequency control voltage.                                                                                                        |                     |
| 19                                 | RFOUT    | This pin is DC coupled and matched to 50 Ohms. External voltage must not be applied to this pin.                                         |                     |

**Application Circuit**




**FILTER - TUNABLE, LOW PASS SMT**  
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**Evaluation PCB**

**List of Materials for Evaluation PCB 128531 [1]**

| Item    | Description                 |
|---------|-----------------------------|
| J1 - J3 | SMA - SRI                   |
| C1, C2  | 100 pF Capacitor, 0402 Pkg. |
| U1      | HMC881LP5E Filter           |
| PCB [2] | 127338 Evaluation PCB       |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Arlon 25FR or Rogers 25FR

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohms 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.