HMC896LP4E
FILTER - TUNABLE, BAND PASS SMT
10 - 18 GHz

Typical Applications
The HMC896LP4E is ideal for:
• Test & Measurement Equipment
• Military RADAR & EW/ECM
• SATCOM & Space
• Industrial & Medical Equipment

Functional Diagram

Features
Fast Tuning Response
Excellent Wideband Rejection
Tunable low side/high side rejection "notch"
Single Chip Replacement
for Mechanically Tuned Designs
24 Lead 4x4 mm SMT Package

General Description
The HMC896LP4E is a MMIC band pass filter which features a user selectable passband frequency. The 3 dB filter bandwidth is approximately 9%. The 20 dB filter bandwidth is approximately 22%. The center frequency can be varied between 10 and 18 GHz by applying an analog tune voltage between 0 and 14V. This tunable filter can be used as a much smaller alternative to physically large switched filter banks and cavity tuned filters. The HMC896LP4E has excellent microphonics due to the monolithic design, and provides a dynamically adjustable solution in advanced communications applications.

Electrical Specifications, \( T_A = +25 \, ^\circ \text{C} \), \( V_{\text{fctl}} = V_{\text{nctl}} \) Unless Otherwise Stated

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{\text{center}} ) Tuning Range</td>
<td>10</td>
<td>18</td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>3 dB Bandwidth</td>
<td>9</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Low Side Rejection Frequency (Rejection &gt;20 dB)</td>
<td>0.89 ( F_{\text{center}} )</td>
<td></td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>High Side Rejection Frequency (Rejection &gt;20 dB)</td>
<td>1.10 ( F_{\text{center}} )</td>
<td></td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>Low Side Sub-Harmonic Rejection (Rejection &gt;40 dB)</td>
<td>0.75 ( F_{\text{center}} )</td>
<td></td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>High Side Sub-Harmonic Rejection (Reception &gt;40 dB)</td>
<td>1.18 ( F_{\text{center}} )</td>
<td></td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>Re-entry Frequency (Rejection &lt;30 dB)</td>
<td>&gt;40</td>
<td></td>
<td>GHz</td>
<td></td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>9</td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Return Loss (2 dB bandwidth)</td>
<td>11</td>
<td></td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input IP3 (Pin = 0 to +15 dBm)</td>
<td>26</td>
<td></td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Input Power @ 5° Shift In Insertion Phase (V_{\text{fctl}} = 0V)</td>
<td>8</td>
<td></td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Input Power @ 5° Shift In Insertion Phase (V_{\text{fctl}} = 1V)</td>
<td>12</td>
<td></td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Frequency Control Voltage (V_{\text{fctl}})</td>
<td>0</td>
<td>14</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Source/Sink Current (I_{\text{fctl}})</td>
<td>±1</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Low Side/High Side Rejection Control Voltage (V_{\text{nctl}})</td>
<td>0</td>
<td>14</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Source/Sink current (I_{\text{nctl}})</td>
<td>±1</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Residual Phase Noise [1] (100 kHz Offset)</td>
<td>-158</td>
<td></td>
<td>dBc/Hz</td>
<td></td>
</tr>
<tr>
<td>( F_{\text{center}} ) Drift Rate</td>
<td>-1.5</td>
<td></td>
<td>MHz/°C</td>
<td></td>
</tr>
<tr>
<td>Tuning Speed, Phase Settling to within 10° [2]</td>
<td>&lt; 200</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

[2] Tuning speed includes 40 ns tuning voltage ramp from driver.

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Insertion Loss vs. Vnctl, Low Side
Vfctl = 7V

Insertion Loss vs. Vnctl, High Side
Vfctl = 7V

Center Frequency vs. Temperature,
Vfctl = Vnctl

Insertion Loss vs. Temperature,
Vfctl = Vnctl

3 dB Bandwidth vs. Temperature,
Vfctl = Vnctl

Input Return Loss in a 2 dB Bandwidth vs. Temperature, Vfctl = Vnctl

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Low Side Rejection Ratio vs. Temperature [1]

High Side Rejection Ratio vs. Temperature [1]

Tuning Sensitivity vs. Temperature

Group Delay vs. Frequency

Group Delay vs. Fcenter vs. Temperature

Input IP3 vs. Temperature

[1] Rejection ratio is defined as the ratio of the frequency at which the relative insertion loss is 20 dB to fcenter.

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Residual Phase Noise, $V_{fctl} = V_{nctl}$

Phase Sensitivity vs. $V_{fctl}$

Insertion Phase vs. Input Power
$V_{fctl} = V_{nctl}$

Fcenter vs. Input Power
$V_{fctl} = V_{nctl}$

**Absolute Maximum Ratings**

- Frequency Control Voltage ($V_{fctl}$): -0.5 to +15V
- Notch Control Voltage ($V_{nctl}$): -0.5 to +15V
- RF Power Input: 27 dBm
- Storage Temperature: -65 to +150 °C
- ESD Sensitivity (HBM): Class 1A

**Reliability Information**

- Junction Temperature to Maintain 1 Million Hour MTTF: 150 °C
- Nominal Junction Temperature (T= 85 °C and Pin = 27 dBm): 103 °C
- Operating Temperature: -40 to +85 °C

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Outline Drawing

Package Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package Body Material</th>
<th>Lead Finish</th>
<th>MSL Rating</th>
<th>Package Marking[^1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC896LP4E</td>
<td>RoHS-compliant Low Stress Injection Molded Plastic</td>
<td>100% matte Sn</td>
<td>MSL1[^2]</td>
<td>H896 XXXX</td>
</tr>
</tbody>
</table>

[^1]: 4-Digit lot number XXXX
[^2]: Max peak reflow temperature of 260 °C

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

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Function</th>
<th>Description</th>
<th>Interface Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 4 - 7, 12 - 15, 17 - 19, 24</td>
<td>GND</td>
<td>These pins and exposed paddle must be connected to RF/DC ground.</td>
<td>GND</td>
</tr>
<tr>
<td>11, 20 - 23</td>
<td>NC</td>
<td>The pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally</td>
<td>RFIN  2 pF</td>
</tr>
<tr>
<td>3</td>
<td>RFIN</td>
<td>This pin is AC coupled and matched to 50 Ohms.</td>
<td>Vnctl  1.5 kΩ  4 pF  1.2 pF</td>
</tr>
<tr>
<td>8</td>
<td>Vnctl</td>
<td>Low side/high side notch control voltage.</td>
<td>Vfctl  5 nH  125 Ω  10 pF  17 pF</td>
</tr>
<tr>
<td>9</td>
<td>Vfctl</td>
<td>Center frequency control voltage.</td>
<td>Vfctl  0.5 Ω  0.7 nH  170 Ω  4 pF  9 pF</td>
</tr>
<tr>
<td>10</td>
<td>Vfctl</td>
<td>Center frequency control voltage.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>RFOUT</td>
<td>This pin is AC coupled and matched to 50 Ohms.</td>
<td>RFOUT  2 pF</td>
</tr>
</tbody>
</table>

## Application Circuit

![Application Circuit Diagram](image-url)
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.

List of Materials for Evaluation PCB 131085

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1, J2</td>
<td>Connector, 2.9mm, Female</td>
</tr>
<tr>
<td>J5, J6, J7, J8</td>
<td>DC Pin</td>
</tr>
<tr>
<td>C1, C2, C3</td>
<td>100 pF Capacitor, 0402 Pkg.</td>
</tr>
<tr>
<td>U1</td>
<td>HMC896LP4E Filter - Tunable</td>
</tr>
<tr>
<td>PCB</td>
<td>130746 Evaluation PCB</td>
</tr>
</tbody>
</table>

[1] Reference this number when ordering complete evaluation PCB