GNSS Front-End Module

**GENERAL DESCRIPTION**

The NJG1159PHH is a front-end module (FEM) designed for GNSS including GPS, GLONASS, BeiDou, and Galileo applications. This FEM offers low noise figure, high linearity, and high out-band rejection characteristics brought by included high performance pre-SAW filter and low noise amplifier (LNA). This FEM can operate from 1.5V to 3.3V single voltage in -40 to 105°C. This FEM has stand-by mode to save current consumption.

This FEM offers very small mounting area by included one SAW filter, only two external components, and very small package HFFP10-HH that is 1.5x1.1mm.

**FEATURES**

- Available for GNSS
- Low supply voltage 1.8/ 2.8V typ.
- Low current consumption 3.0/3.7mA typ. \( @V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V \)
- Low current consumption 0.1µA typ. \( @V_{DD}=1.8/ 2.8V, V_{CTL}=0V \) (Stand-by mode)
- High gain
  - 15.5/16.0dB typ. \( @V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1575MHz, 1559 to 1591MHz \)
  - 1.55/1.50dB typ. \( @V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1575MHz \)
  - 1.70/1.65dB typ. \( @V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1597 to 1606MHz \)
  - 1.75/1.70dB typ. \( @V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1595 to 1591MHz \)
- Low noise figure
  - 1.55dB typ. \( @f=704 to 915MHz \), relative to 1575MHz
  - 43dBc typ. \( @f=1710 to 1980MHz \), relative to 1575MHz
  - 51dBc typ. \( @f=2400 to 2500MHz \), relative to 1575MHz
- High out band rejection
- Small package size
- RoHS compliant and Halogen Free, MSL1

**PIN CONFIGURATION**

1 pin index (Top View)

```
1. VDD
2. VCTL
3. GND
4. PreIN
5. GND
6. PreOUT
7. LNAIN
8. LNAOUT
9. GND
10. GND
```

**TRUTH TABLE**

<table>
<thead>
<tr>
<th>VCTL</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Active mode</td>
</tr>
<tr>
<td>L</td>
<td>Stand-by mode</td>
</tr>
</tbody>
</table>

Note: Specifications and description listed in this datasheet are subject to change without notice.
### ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>RATINGS</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>$V_{DD}$</td>
<td>$V_{DD}=2.8V$, $f=1575$, 1597 to 1606, 1559 to 1591MHz</td>
<td>10</td>
<td>dBm</td>
</tr>
<tr>
<td>Control voltage</td>
<td>$V_{CTL}$</td>
<td>$V_{DD}=2.8V$, $f=1575$, 1597 to 1606, 1559 to 1591MHz</td>
<td>10</td>
<td>dBm</td>
</tr>
<tr>
<td>Input power</td>
<td>$P_n$ (inband)</td>
<td>$V_{DD}=2.8V$, $f=50$ to 1460, 1710 to 4000MHz</td>
<td>25</td>
<td>dBm</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_D$</td>
<td>4-layer FR4 PCB without through-hole (101.5x114.5mm), $T_j=110°C$</td>
<td>560</td>
<td>mW</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>$T_{opr}$</td>
<td></td>
<td>-40 to +105</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40 to +110</td>
<td>°C</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions: $T_a=+25°C$)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{DD}$</td>
<td></td>
<td>1.5</td>
<td>-</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>Control Voltage (High)</td>
<td>$V_{CTL(H)}$</td>
<td></td>
<td>1.5</td>
<td>1.8</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>Control Voltage (Low)</td>
<td>$V_{CTL(L)}$</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>Supply Current 1</td>
<td>$I_{DD1}$</td>
<td>RF OFF, $V_{DD}=2.8V$, $V_{CTL}=1.8V$</td>
<td>-</td>
<td>3.7</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Supply Current 2</td>
<td>$I_{DD2}$</td>
<td>RF OFF, $V_{DD}=1.8V$, $V_{CTL}=1.8V$</td>
<td>-</td>
<td>3.0</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Supply Current 3</td>
<td>$I_{DD3}$</td>
<td>RF OFF, $V_{DD}=2.8V$, $V_{CTL}=0V$</td>
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<td>0.1</td>
<td>5.0</td>
<td>µA</td>
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<tr>
<td>Supply Current 4</td>
<td>$I_{DD4}$</td>
<td>RF OFF, $V_{DD}=1.8V$, $V_{CTL}=0V$</td>
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<td>0.1</td>
<td>5.0</td>
<td>µA</td>
</tr>
<tr>
<td>Control Current</td>
<td>$I_{CTL}$</td>
<td>$V_{CTL}=1.8V$</td>
<td>-</td>
<td>5.0</td>
<td>15.0</td>
<td>µA</td>
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</table>
### ELECTRICAL CHARACTERISTICS 2 (RF)

General conditions: $V_{DD}=2.8V$, $V_{CTL}=1.8V$, $f_{RF}=1575MHz$, 1597 to 1606, 1559 to 1591MHz,
$T_a=+25^\circ C$, $Z_s=Z_l=50\Omega$, with application circuit

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain (GPS)</td>
<td>GainGPS1</td>
<td>$f=1575MHz$ (GPS) Exclude PCB, Connector Losses (0.17dB)</td>
<td>-</td>
<td>16.0</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Small Signal Gain (GLONASS)</td>
<td>GainGLN1</td>
<td>$f=1597$ to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.17dB)</td>
<td>-</td>
<td>16.5</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Small Signal Gain (BeiDou, Galileo)</td>
<td>GainBG1</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo) Exclude PCB, Connector Losses (0.17dB)</td>
<td>-</td>
<td>16.0</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure (GPS)</td>
<td>NFGPS1</td>
<td>$f=1575MHz$ (GPS) Exclude PCB, Connector Losses (0.09dB)</td>
<td>-</td>
<td>1.50</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure (GLONASS)</td>
<td>NFGLN1</td>
<td>$f=1597$ to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.09dB)</td>
<td>-</td>
<td>1.65</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure (BeiDou, Galileo)</td>
<td>NFBG1</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo) Exclude PCB, Connector Losses (0.09dB)</td>
<td>-</td>
<td>1.70</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Input Power at 1dB Gain Compression Point 1</td>
<td>P-1dB(IN)1</td>
<td>$f=1575$, 1597 to 1606, 1559 to 1591MHz</td>
<td>-</td>
<td>-10.0</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Input 3rd Order Intercept Point 1</td>
<td>IIP3_1</td>
<td>$f_1=1575,1597$ to 1606, 1559 to 1591MHz, $f_2=f_1+/−1MHz$, Pin=-30dBm</td>
<td>-</td>
<td>-2.0</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Out of Band Input 2nd Order Intercept Point 1</td>
<td>IIP2_OB1</td>
<td>$f_1=824.6MHz$ at $+15dBm$, $f_2=2400MHz$ at $+15dBm$, $f_{meas}=1575.4MHz$</td>
<td>-</td>
<td>+80</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Out of Band Input 3rd Order Intercept Point 1</td>
<td>IIP3_OB1</td>
<td>$f_1=1712.7MHz$ at $+15dBm$, $f_2=1850MHz$ at $+15dBm$, $f_{meas}=1575.4MHz$</td>
<td>-</td>
<td>+55</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>700MHz Harmonic1</td>
<td>2f01</td>
<td>Input jammer tone: 787.76MHz at $+15dBm$ Measure the harmonic tone at 1575.52MHz</td>
<td>-</td>
<td>-37</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Out-of-Band Input Power 1dB Compression 1</td>
<td>P-1dB(IN) _OB1-1</td>
<td>$f_{jam}=900MHz$, $f_{meas}=1575MHz$ at Pin=-40dBm</td>
<td>-</td>
<td>+24</td>
<td>-</td>
<td>dBm</td>
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<tr>
<td></td>
<td>P-1dB(IN) _OB1-2</td>
<td>$f_{jam}=1710MHz$, $f_{meas}=1575MHz$ at Pin=-40dBm</td>
<td>-</td>
<td>+24</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Low Band Rejection 1</td>
<td>BR_L1</td>
<td>$f=704$ to 915MHz, relative to 1575MHz</td>
<td>-</td>
<td>55</td>
<td>-</td>
<td>dBc</td>
</tr>
<tr>
<td>High Band Rejection 1</td>
<td>BR_H1</td>
<td>$f=1710$ to 1980MHz, relative to 1575MHz</td>
<td>-</td>
<td>43</td>
<td>-</td>
<td>dBc</td>
</tr>
<tr>
<td>WLAN Band Rejection 1</td>
<td>BR_W1</td>
<td>$f=2400$ to 2500MHz, relative to 1575MHz</td>
<td>-</td>
<td>51</td>
<td>-</td>
<td>dBc</td>
</tr>
<tr>
<td>RF IN Return Loss (GPS)</td>
<td>RLiGPS1</td>
<td>$f=1575MHz$ (GPS)</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF IN Return Loss (GLONASS)</td>
<td>RLiGLN1</td>
<td>$f=1597$ to 1606MHz (GLONASS)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF IN Return Loss (BeiDou, Galileo)</td>
<td>RLiBG1</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo)</td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF OUT Return Loss (GPS)</td>
<td>RLoGPS1</td>
<td>$f=1575MHz$ (GPS)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF OUT Return Loss (GLONASS)</td>
<td>RLoGLN1</td>
<td>$f=1597$ to 1606MHz (GLONASS)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF OUT Return Loss (BeiDou, Galileo)</td>
<td>RLoBG1</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Group Delay Time Deviation (GLONASS)</td>
<td>GDTDGLN1</td>
<td>$f=1597$ to 1606MHz (GLONASS)</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Group Delay Time Deviation (BeiDou)</td>
<td>GDTDAB1</td>
<td>$f=1559$ to 1563.2MHz (BeiDou)</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Group Delay Time Deviation (Galileo)</td>
<td>GDTDG1</td>
<td>$f=1559$ to 1591MHz (Galileo)</td>
<td>-</td>
<td>9</td>
<td>-</td>
<td>ns</td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS 3 (RF)

General conditions: $V_{DD}=1.8\text{V}$, $V_{CTL}=1.8\text{V}$, $f_{RF}=1575\text{MHz}$, 1597 to 1606, 1559 to 1591MHz, $T_a=+25^\circ\text{C}$, $Z_s=Z_L=50\Omega$, with application circuit

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain (GPS)2</td>
<td>GainGPS2</td>
<td>$f=1575\text{MHz (GPS)}$ Exclude PCB, Connector Losses (0.17dB)</td>
<td>-</td>
<td>15.5</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Small Signal Gain (GLONASS)2</td>
<td>GainGLN2</td>
<td>$f=1597$ to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.17dB)</td>
<td>-</td>
<td>16.0</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Small Signal Gain (BeiDou, Galileo)2</td>
<td>GainBG2</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo) Exclude PCB, Connector Losses (0.17dB)</td>
<td>-</td>
<td>15.5</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure (GPS)2</td>
<td>NFGPS2</td>
<td>$f=1575\text{MHz (GPS)}$ Exclude PCB, Connector Losses (0.09dB)</td>
<td>-</td>
<td>1.55</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure (GLONASS)2</td>
<td>NFGLN2</td>
<td>$f=1597$ to 1606MHz (GLONASS) Exclude PCB, Connector Losses (0.09dB)</td>
<td>-</td>
<td>1.70</td>
<td>-</td>
<td>dB</td>
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<td>Noise Figure (BeiDou, Galileo)2</td>
<td>NFBG2</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo) Exclude PCB, Connector Losses (0.09dB)</td>
<td>-</td>
<td>1.75</td>
<td>-</td>
<td>dB</td>
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<tr>
<td>Input Power at 1dB Gain Compression Point 2</td>
<td>$P_{-1dB(IN)}$2</td>
<td>$f=1575$, 1597 to 1606, 1559 to 1591MHz</td>
<td>-</td>
<td>-13.0</td>
<td>-</td>
<td>dBm</td>
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<tr>
<td>Input 3rd Order Intercept Point 2</td>
<td>IIP3_2</td>
<td>$f_1=1575$, 1597 to 1606, 1559 to 1591MHz, $f_2=f_1 +/\text{-1MHz}$, $P_{in}=-30\text{dBm}$</td>
<td>-</td>
<td>-5.0</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Out of Band Input 2nd Order Intercept Point 2</td>
<td>IIP2_OB2</td>
<td>$f_1=824.6\text{MHz at }+15\text{dBm}$, $f_2=2400\text{MHz at }+15\text{dBm}$, $f_{meas}=1575.4\text{MHz}$</td>
<td>-</td>
<td>+80</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Out of Band Input 3rd Order Intercept Point 2</td>
<td>IIP3_OB2</td>
<td>$f_1=1712.7\text{MHz at }+15\text{dBm}$, $f_2=1850\text{MHz at }+15\text{dBm}$, $f_{meas}=1575.4\text{MHz}$</td>
<td>-</td>
<td>+55</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>700MHz Harmonic2</td>
<td>$2f_2$</td>
<td>Input jammer tone: 787.76MHz at $+15\text{dBm}$ Measure the harmonic tone at 1575.52MHz</td>
<td>-</td>
<td>-37</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Out-of-Band Input Power 1dB Compression 2</td>
<td>$P_{-1dB(IN)}$2</td>
<td>$f_{jam}=900\text{MHz}$, $f_{meas}=1575\text{MHz}$ at $P_{in}=-40\text{dBm}$</td>
<td>-</td>
<td>+24</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>$P_{-1dB(IN)}$2</td>
<td>$f_{jam}=1710\text{MHz}$, $f_{meas}=1575\text{MHz}$ at $P_{in}=-40\text{dBm}$</td>
<td>-</td>
<td>+24</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Low Band Rejection 2</td>
<td>$BR_L2$</td>
<td>$f=704$ to 915MHz, relative to 1575MHz</td>
<td>-</td>
<td>55</td>
<td>-</td>
<td>dBc</td>
</tr>
<tr>
<td>High Band Rejection 2</td>
<td>$BR_H2$</td>
<td>$f=1710$ to 1980MHz, relative to 1575MHz</td>
<td>-</td>
<td>43</td>
<td>-</td>
<td>dBc</td>
</tr>
<tr>
<td>WLAN Band Rejection 2</td>
<td>$BR_W2$</td>
<td>$f=2400$ to 2500MHz, relative to 1575MHz</td>
<td>-</td>
<td>51</td>
<td>-</td>
<td>dBc</td>
</tr>
<tr>
<td>RF IN Return Loss (GPS)2</td>
<td>RLGPS2</td>
<td>$f=1575\text{MHz (GPS)}$</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF IN Return Loss (GLONASS)2</td>
<td>RLGLN2</td>
<td>$f=1597$ to 1606MHz (GLONASS)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF IN Return Loss (BeiDou, Galileo)2</td>
<td>RLIBG2</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo)</td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF OUT Return Loss (GPS)2</td>
<td>RLoGPS2</td>
<td>$f=1575\text{MHz (GPS)}$</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF OUT Return Loss (GLONASS)2</td>
<td>RLoGLN2</td>
<td>$f=1597$ to 1606MHz (GLONASS)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>RF OUT Return Loss (BeiDou, Galileo)2</td>
<td>RLoBG2</td>
<td>$f=1559$ to 1591MHz (BeiDou, Galileo)</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Group Delay Time Deviation (GLONASS)2</td>
<td>GDTGLN2</td>
<td>$f=1597$ to 1606MHz (GLONASS)</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Group Delay Time Deviation (BeiDou)2</td>
<td>GDTDB2</td>
<td>$f=1559$ to 1563.2MHz (BeiDou)</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Group Delay Time Deviation (Galileo)2</td>
<td>GDTDG2</td>
<td>$f=1559$ to 1591MHz (Galileo)</td>
<td>-</td>
<td>9</td>
<td>-</td>
<td>ns</td>
</tr>
</tbody>
</table>
## TERMINAL INFORMATION

<table>
<thead>
<tr>
<th>No.</th>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VDD</td>
<td>Supply voltage terminal. Please connect bypass capacitor C1 with ground as close as possible.</td>
</tr>
<tr>
<td>2</td>
<td>VCTL</td>
<td>Control voltage terminal.</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.</td>
</tr>
<tr>
<td>4</td>
<td>PreIN</td>
<td>RF input terminal. This terminal connects to input of pre-SAW filter.</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.</td>
</tr>
<tr>
<td>6</td>
<td>PreOUT</td>
<td>Pre-SAW filter output terminal. This terminal connects to LNAIN with L1.</td>
</tr>
<tr>
<td>7</td>
<td>LNAIN</td>
<td>RF input terminal. This terminal requires only a matching inductor L1, and does not require DC blocking capacitor because of integrated capacitor.</td>
</tr>
<tr>
<td>8</td>
<td>LNAOUT</td>
<td>RF output terminal. This terminal requires no DC blocking capacitor since this terminal has integrated DC blocking capacitor.</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.</td>
</tr>
</tbody>
</table>
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD}=2.8\text{V}$, $V_{CTRL}=1.8\text{V}$, $Ta=25^\circ\text{C}$, $Z_s=Z_l=50\Omega$, with application circuit

S11, S22

S21, S12

VSWR

Zin, Zout
ELECTRICAL CHARACTERISTICS
Conditions: $V_{DD} = 2.8\,\text{V}$, $V_{CTL} = 1.8\,\text{V}$, $Ta = 25^\circ\text{C}$, $Z_s = Z_l = 50\,\Omega$, with application circuit

**NF, Gain vs. frequency**

$(V_{DD}=2.8\,\text{V}, V_{CTL}=1.8\,\text{V})$

Gain

NF

(NF, Gain: Exclude PCB, Connector Losses)

**S21 vs. frequency**

$(V_{DD}=2.8\,\text{V}, V_{CTL}=1.8\,\text{V})$

**Group Delay vs. frequency**

$(V_{DD}=2.8\,\text{V}, V_{CTL}=1.8\,\text{V})$

**Pout, I_{DD} vs. Pin**

$(V_{DD}=2.8\,\text{V}, V_{CTL}=1.8\,\text{V}, f_{RF}=1575\,\text{MHz})$

$I_{DD}$

Pout, IM3 vs. Pin

$(V_{DD}=2.8\,\text{V}, V_{CTL}=1.8\,\text{V}, f_1=1575\,\text{MHz}, f_2=1576\,\text{MHz})$

$I_{IP3}=-1.6\,\text{dBm}$

$O_{IP3}=+14.9\,\text{dBm}$
### ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD}=2.8\,V$, $V_{CTL}=1.8\,V$, $T_a=25^\circ C$, $Z_s=Z_l=50\,\Omega$, with application circuit

#### Out-of-band P-1dB ($f_{jam}=900\,MHz$)

$$
\begin{align*}
\text{Gain} & \quad \text{Pin at 900MHz (dBm)} \\
\text{P-1dB(IN)}_{OB} & > +26.0\,dBm \\
\text{(Gain: Exclude PCB, Connector Losses)}
\end{align*}
$$

#### Out-of-band P-1dB ($f_{jam}=1710\,MHz$)

$$
\begin{align*}
\text{Gain} & \quad \text{Pin at 1710MHz (dBm)} \\
\text{P-1dB(IN)}_{OB} & > +25.3\,dBm \\
\text{(Gain: Exclude PCB, Connector Losses)}
\end{align*}
$$

#### Out-of-band IIP2

$$
\begin{align*}
P_{out}, \text{IM2 (dBm)} & \quad \text{Pin (dBm)} \\
\text{IIP2}_{OB} & = +86.1\,dBm
\end{align*}
$$

#### Out-of-band IIP3

$$
\begin{align*}
P_{out}, \text{IM3 (dBm)} & \quad \text{Pin (dBm)} \\
\text{IIP3}_{OB} & = +54.5\,dBm
\end{align*}
$$

#### 2nd Harmonics

$$
\begin{align*}
\text{2nd Harmonics (dBm)} & \quad \text{Pin (dBm)} \\
\text{2fo} & = -35.9\,dBm
\end{align*}
$$
ELECTRICAL CHARACTERISTICS
Conditions: $V_{DD} = 1.8V$, $V_{CTL} = 1.8V$, $T_a = 25^\circ C$, $Z_s = Z_l = 50\Omega$, with application circuit

S11, S22

S21, S12

VSWR

Zin, Zout
ELECTRICAL CHARACTERISTICS
Conditions: \( V_{DD} = 1.8V, V_{CTRL} = 1.8V, Ta = 25°C, Z_s = Z_l = 50\Omega \), with application circuit

**NF, Gain vs. frequency**
\( (V_{DD} = 1.8V, V_{CTRL} = 1.8V) \)

**S21 vs. frequency**
\( (V_{DD} = 1.8V, V_{CTRL} = 1.8V) \)

**Group Delay vs. frequency**
\( (V_{DD} = 1.8V, V_{CTRL} = 1.8V) \)

**Pout, I_{DD} vs. Pin**
\( (V_{DD} = 1.8V, V_{CTRL} = 1.8V, f_{RF} = 1575MHz) \)

**Pout, IM3 vs. Pin**
\( (V_{DD} = 1.8V, V_{CTRL} = 1.8V, f_1 = 1575MHz, f_2 = 1576MHz) \)
**ELECTRICAL CHARACTERISTICS**

Conditions: \( V_{DD} = 1.8V, V_{CTL} = 1.8V, T_a = 25°C, Z_s = Z_l = 50\Omega \), with application circuit

### Out-of-band P-1dB (\( f_{jam} = 900MHz \))

- \( V_{DD} = 1.8V, V_{CTL} = 1.8V, f_{meas} = 1575MHz \) at \( Pin = -40dBm \)

### Out-of-band P-1dB (\( f_{jam} = 1710MHz \))

- \( V_{DD} = 1.8V, V_{CTL} = 1.8V, f_{meas} = 1575MHz \) at \( Pin = -40dBm \)

### Out-of-band IIP2

- \( V_{DD} = 1.8V, V_{CTL} = 1.8V, f_{meas} = 1575.4MHz, f_1 = 824.6MHz, f_2 = 2400MHz \)

### Out-of-band IIP3

- \( V_{DD} = 1.8V, V_{CTL} = 1.8V, f_{meas} = 1575.4MHz, f_1 = 1712.7MHz, f_2 = 1850MHz \)

### 2nd Harmonics

- \( V_{DD} = 1.8V, V_{CTL} = 1.8V, f_{in} = 787.76MHz, f_{meas} = 1575.52MHz \)
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$, $Z_s=Z_l=50\,\Omega$, with application circuit

- **NF, Gain vs. Temperature**
  - Condition: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$, $f_{RF}=1575\,\text{MHz}$
  - Plot showing NF and Gain vs. temperature (°C)

- **Return Loss vs. Temperature**
  - Condition: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$, $f_{RF}=1575\,\text{MHz}$
  - Plot showing Return Loss vs. temperature (°C)

- **Band Rejection vs. Temperature**
  - Condition: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$
  - Plots showing Band Rejection vs. temperature (°C) for different frequencies

- **Group Delay Time Deviation vs. Temperature**
  - Conditions: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$, $f_{RF}=1597\sim1606, 1559\sim1563.2, 1559\sim1591\,\text{MHz}$
  - Plot showing Group Delay Time Deviation vs. temperature (°C)

- **I_{DD} vs. Temperature**
  - Condition: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$, $RF$ OFF
  - Plot showing $I_{DD}$ vs. temperature (°C) at Active and Standby modes

- **k-factor vs. frequency**
  - Condition: $V_{DD}=2.8\,\text{V}$, $V_{CTL}=1.8\,\text{V}$
  - Plot showing k-factor vs. frequency (GHz) for different temperatures
ELECTRICAL CHARACTERISTICS

Conditions: $V_{DD}=2.8V$, $V_{CTL}=1.8V$, $Z_s=Z_l=50\Omega$, with application circuit

- **P-1dB(IN) vs. Temperature**
  (Vcc=2.8V, Vctl=1.8V, RF=1575MHz)

- **OIP3, IIP3 vs. Temperature**
  (Vcc=2.8V, Vctl=1.8V, f1=1575MHz, f2=1576MHz, Pin=-30dBm)

- **Out-of-band IIP2 vs. Temperature**
  (Vcc=2.8V, Vctl=1.8V, fmeas=1575.4MHz, f1=824.6MHz at Pin=-15dBm, f2=2400MHz at Pin=-15dBm)

- **Out-of-band IIP3 vs. Temperature**
  (Vcc=2.8V, Vctl=1.8V, fmeas=1575MHz, f1=1713MHz at Pin=-15dBm, f2=1851MHz at Pin=-15dBm)

- **2nd Harmonics vs. Temperature**
  (Vcc=2.8V, Vctl=1.8V, fmeas=1575.52MHz, f1n=787.76MHz at Pin=-15dBm)
ELECTRICAL CHARACTERISTICS

Conditions: $V_{\text{CTL}}=1.8\,\text{V}$, $T_a=25\,\text{°C}$, $Z_s=Z_l=50\,\Omega$, with application circuit

**NF, Gain vs. $V_{\text{DD}}$**

$V_{\text{CTL}}=1.8\,\text{V}$, $f_{\text{RF}}=1575\,\text{MHz}$

- Gain (dB)
- Noise Figure (dB)

**Return Loss vs. $V_{\text{DD}}$**

$V_{\text{CTL}}=1.8\,\text{V}$, $f_{\text{RF}}=1575\,\text{MHz}$

- Return Loss (dB)

**Band Rejection vs. $V_{\text{DD}}$**

$V_{\text{CTL}}=1.8\,\text{V}$

- Band Rejection (dB)

**Group Delay Time Deviation vs. $V_{\text{DD}}$**

$V_{\text{CTL}}=1.8\,\text{V}$, $f_{\text{RF}}=1597\sim1606$, $1559\sim1563.2$, $1559\sim1591\,\text{MHz}$

- Group Delay Time Deviation (ns)

**$I_{\text{DD}}$ vs. $V_{\text{DD}}$**

$V_{\text{CTL}}=1.8\,\text{V}/0\,\text{V}$, $\text{RF OFF}$

- $I_{\text{DD}}$ (mA) @Active Mode
- $I_{\text{DD}}$ (µA) @Standby Mode

*(NF, Gain: Exclude PCB, Connector Losses)*
**ELECTRICAL CHARACTERISTICS**

Conditions: $V_{\text{CTL}}=1.8\text{V}$, $T_a=25^\circ\text{C}$, $Z_s=Z_l=50\Omega$, with application circuit

---

**P-1dB(IN) vs. $V_{\text{DD}}$**

($V_{\text{CTL}}=1.8\text{V}$, $f_{\text{RF}}=1575\text{MHz}$)

**Out-of-band IIP2 vs. $V_{\text{DD}}$**

($V_{\text{CTL}}=1.8\text{V}$, $f_{\text{meas}}=1575.4\text{MHz}$,
$f_1=824.5\text{MHz}$ at $P_{\text{in}}=+15\text{dBm}$, $f_2=2400\text{MHz}$ at $P_{\text{in}}=+15\text{dBm}$)

**2nd Harmonics vs. $V_{\text{DD}}$**

($V_{\text{CTL}}=1.8\text{V}$, $f_{\text{meas}}=1575.52\text{MHz}$,
$f_{\text{in}}=787.76\text{MHz}$, $P_{\text{in}}=+15\text{dBm}$)

---

**OIP3, IIP3 vs. $V_{\text{DD}}$**

($V_{\text{CTL}}=1.8\text{V}$, $f_1=1575\text{MHz}$, $f_2=1576\text{MHz}$, $P_{\text{in}}=-30\text{dBm}$)

**Out-of-band IIP3 vs. $V_{\text{DD}}$**

($V_{\text{CTL}}=1.8\text{V}$, $f_{\text{meas}}=1575\text{MHz}$,
$f_1=1713\text{MHz}$ at $P_{\text{in}}=+15\text{dBm}$, $f_2=1851\text{MHz}$ at $P_{\text{in}}=+15\text{dBm}$)

---

**OIP3 (dBm)**  | **IIP3 (dBm)**
---|---
$V_{\text{DD}}$ (V)

---

**P-1dB(IN) (dBm)**

---

**Out-of-band IIP2 (dBm)**

---

**IIP2_OB**

---

**IIP3_OB**

---

**2fo**

---

**2nd Harmonics (dBm)**

---

**Out-of-band IIP3 (dBm)**

---

**Out-of-band IIP3 (dBm)**

---

**New Japan Radio Co., Ltd.**

- 15 -
Application circuit

(Top View)

Parts list

<table>
<thead>
<tr>
<th>Parts ID</th>
<th>Manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>LQW15AN_00 Series (MURATA)</td>
</tr>
<tr>
<td>C1</td>
<td>GRM03 Series (MURATA)</td>
</tr>
</tbody>
</table>
**Evaluation board**

(Top View)

PCB
- Substrate: FR-4
- Thickness: 0.2mm
- Microstrip line width: 0.4mm ($Z_0=50\,\Omega$)
- Size: 14.0mm x 14.0mm

**PRECAUTIONS**
- Please layout ground pattern under this FEM in order not to couple with RFIN and RFOUT terminal.
- All external parts should be placed as close as possible to the FEM.
- For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the FEM.
RECOMMENDED FOOTPRINT PATTERN (HFFP10-HH Package) <Reference>

PKG : 1.5mm x 1.1mm
Pin pitch : 0.39mm

: Land
: Mask (Open area)  *Metal mask thickness : 100µm
: Resist(Open area)
NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

**Measuring instruments**
- NF Analyzer : Agilent N8973A
- Noise Source : Agilent 346A

**Setting the NF analyzer**

**Measurement mode form**
- Device under test : Amplifier
- System downconverter : off

**Mode setup form**
- Sideband : LSB
- Averages : 16
- Average mode : Point
- Bandwidth : 4MHz
- Loss comp : off
- Tcold : setting the temperature of noise source (303.15K)

**Calibration setup**

- Noise source, preamplifier and NF analyzer are connected directly.

**Measurement Setup**

- Noise source, DUT, preamplifier and NF analyzer are connected directly.
■ Package outline (HFFP10-HH)

1pin index

**TOP VIEW**

**SIDE VIEW**

**BOTTOM VIEW**

Electrode Dimensions clearance : ±0.05mm

- Unit : mm
- Substrate : Ceramic
- Terminal treat : Au
- Lid : SnAg/Kovar/Ni
- Weight (typ.) : 4.9mg

---

**Cautions on using this product**

This product contains Gallium-Arsenide (GaAs) which is a harmful material.

- Do NOT eat or put into mouth.
- Do NOT dispose in fire or break up this product.
- Do NOT chemically make gas or powder with this product.
- To waste this product, please obey the relating law of your country.

---

**[CAUTION]**

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.

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This product may be damaged with electric static discharge (ESD) or spike voltage. Please handle with care to avoid these damages.

---

This product is hollow seal package type, and it is with the structure susceptible to stress from the outside. Therefore, note the following in relation to the contents, after conducting an evaluation, please use.

1. After mounting this product, to implement the potting and transfer molding, please the confirmation of resistance to temperature changes and shrinkage stress involved in the molding.
2. When mounted on the product, collet diameter please use more than 1mmφ. In addition, the value of static load is recommended mounting less than 5N.
3. For dynamic load at the time of mounting, please use it after confirming in consideration of the contact area / speed / load.