W-LAN/WiMAX Application

1. 2.4GHz BAND APPLICATION

1-1 SUMMARY

The characteristics of 2.4GHz band have evaluated as follows. The evaluation circuit structure and measured data are reviewed.

1-2-1 MEASURED DATA1 (DC)

General conditions: $V_{DD} = V_{INV} = 2.85 \text{V}$, $T_a = +25^\circ \text{C}$, $Z_s = Z_l = 50 \Omega$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Measurement data</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>$V_{DD}$</td>
<td>$2.85 \text{V}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverter Voltage</td>
<td>$V_{INV}$</td>
<td>$2.85 \text{V}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Voltage (High)</td>
<td>$V_{CTL}(H)$</td>
<td>$1.85 \text{V}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Voltage (Low)</td>
<td>$V_{CTL}(L)$</td>
<td>$0 \text{V}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating current</td>
<td>$I_{DD1}$</td>
<td>RF OFF, $V_{CTL} = 1.85 \text{V}$</td>
<td>$2.31$</td>
<td>mA</td>
</tr>
<tr>
<td>Operating current</td>
<td>$I_{DD2}$</td>
<td>RF OFF, $V_{CTL} = 0 \text{V}$</td>
<td>$0.04$</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>Inverter current</td>
<td>$I_{INV1}$</td>
<td>RF OFF, $V_{CTL} = 1.85 \text{V}$</td>
<td>$89.8$</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>Inverter current</td>
<td>$I_{INV2}$</td>
<td>RF OFF, $V_{CTL} = 0 \text{V}$</td>
<td>$16.1$</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>Control current</td>
<td>$I_{CTL}$</td>
<td>RF OFF, $V_{CTL} = 1.85 \text{V}$</td>
<td>$3.4$</td>
<td>$\mu$A</td>
</tr>
</tbody>
</table>
## 1-2-2 MEASURED DATA2 (LNA HIGH GAIN MODE)

General conditions: \( V_{DD}=V_{INV}=2.7\,V, \, V_{CTL}=1.85\,V, \, f_{RF}=2450\,MHz, \, T_a=+25^\circ C, \, Z_s=Z_l=50\,\Omega \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Measurement data</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating current</td>
<td>( I_{DD} )</td>
<td>RF OFF</td>
<td>2.21</td>
<td>mA</td>
</tr>
<tr>
<td>Small signal gain</td>
<td>Gain</td>
<td></td>
<td>15.5</td>
<td>dB</td>
</tr>
<tr>
<td>Isolation</td>
<td>ISO</td>
<td></td>
<td>-28.5</td>
<td>dB</td>
</tr>
<tr>
<td>Noise figure</td>
<td>NF</td>
<td>Exclude PCB/Connector losses (0.11dB)</td>
<td>1.39</td>
<td>dB</td>
</tr>
<tr>
<td>Pin at 1dB compression point</td>
<td>P-1dB(IN)</td>
<td></td>
<td>-8.5</td>
<td>dBm</td>
</tr>
<tr>
<td>Input 3rd order intercept point</td>
<td>IIP3</td>
<td>( f_1=f_{RF}, , f_2=f_{RF}+100,kHz, , Pin=-32,dBm )</td>
<td>+2.3</td>
<td>dBm</td>
</tr>
<tr>
<td>RF Input port VSWR</td>
<td>VSWRi</td>
<td></td>
<td>1.87</td>
<td></td>
</tr>
<tr>
<td>RF Output port VSWR</td>
<td>VSWRo</td>
<td></td>
<td>2.08</td>
<td></td>
</tr>
</tbody>
</table>

## 1-2-3 MEASURED DATA3 (LNA LOW GAIN MODE)

General conditions: \( V_{DD}=V_{INV}=2.7\,V, \, V_{CTL}=0\,V, \, f_{RF}=2450\,MHz, \, T_a=+25^\circ C, \, Z_s=Z_l=50\,\Omega \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Measurement data</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small signal gain</td>
<td>Gain</td>
<td></td>
<td>-6.9</td>
<td>dB</td>
</tr>
<tr>
<td>Isolation</td>
<td>ISO</td>
<td></td>
<td>-6.9</td>
<td>dB</td>
</tr>
<tr>
<td>Noise figure</td>
<td>NF</td>
<td>Exclude PCB/Connector losses (0.11dB)</td>
<td>6.7</td>
<td>dB</td>
</tr>
<tr>
<td>Pin at 1dB compression point</td>
<td>P-1dB(IN)</td>
<td></td>
<td>+10.2</td>
<td>dBm</td>
</tr>
<tr>
<td>Input 3rd order intercept point</td>
<td>IIP3</td>
<td>( f_1=f_{RF}, , f_2=f_{RF}+100,kHz, , Pin=-16,dBm )</td>
<td>+19.7</td>
<td>dBm</td>
</tr>
<tr>
<td>RF Input port VSWR</td>
<td>VSWRi</td>
<td></td>
<td>1.34</td>
<td></td>
</tr>
<tr>
<td>RF Output port VSWR</td>
<td>VSWRo</td>
<td></td>
<td>1.12</td>
<td></td>
</tr>
</tbody>
</table>
1-3 APPLICATION CIRCUIT

(Top View)

<table>
<thead>
<tr>
<th>Parts ID</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1~L3</td>
<td>TAIYO-YUDEN (HK1005 Series)</td>
</tr>
<tr>
<td>L4</td>
<td>MURATA (LQW15A Series)</td>
</tr>
<tr>
<td>C1~C3</td>
<td>MURATA (GRM15 Series)</td>
</tr>
</tbody>
</table>

1-4 PCB DESIGN

(Top View)

PCB (FR-4):
- t=0.2mm
- MICROSTRIP LINE WIDTH =0.4mm (Z₀=50Ω)
- PCB SIZE=17.0mm x 17.0mm
### 1-5-1 TYPICAL CHARACTERISTICS (LNA HIGH GAIN MODE)

**NJG1126HB6 @High Gain**

**Pout vs. Pin**

![Pout vs. Pin](image)

- **Condition**: 
  - $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=1.85V$
  - $f_{RF}=2450MHz$, $T_a=+25^\circ C$,
  - $Z_s=Z_l=50\text{ohm}$

- **Pout, IM3 vs. Pin**

![Pout, IM3 vs. Pin](image)

- **Condition**: 
  - $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=1.85V$
  - $f_{RF}=2450MHz$, $T_a=+25^\circ C$,
  - $Z_s=Z_l=50\text{ohm}$

**Gain, $I_{DD}$ vs. Pin**

![Gain, $I_{DD}$ vs. Pin](image)

- **Condition**: 
  - $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=1.85V$
  - $f_{RF}=2450MHz$, $T_a=+25^\circ C$,
  - $Z_s=Z_l=50\text{ohm}$

**OIP3, IIP3 vs. frequency**

![OIP3, IIP3 vs. frequency](image)

- **Condition**: 
  - $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=1.85V$
  - $f_{RF}=2350-2600MHz$, Offset=+100kHz
  - $P_{in}=-32\text{dBm}$
  - $T_a=+25^\circ C$, $Z_s=Z_l=50\text{ohm}$

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1-5-2 TYPICAL CHARACTERISTICS (LNA HIGH GAIN MODE)

Condition
\( V_{DD} = V_{INV} = 2.7V, \quad V_{CTL} = 1.85V \)
\( f_{RF} = 2350 \sim 2600MHz, \quad Ta = +25^\circ C, \)
\( Z_s = Z_l = 50ohm \)
1-5-3 TYPICAL CHARACTERISTICS (LNA HIGH GAIN MODE)
Condition: $T_a=+25^\circ C$, $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=1.85V$, $Z_s=Z_l=50\Omega$

S11, S22
Zin, Zout

VSWRi, VSWRo
S21, S12
1-5-4 TYPICAL CHARACTERISTICS (LNA HIGH GAIN MODE)
Condition: \( T_a = +25^\circ C, \ V_{DD} = V_{\text{INV}} = 2.7V, \ V_{CTL} = 1.85V, \ Z_s = Z_l = 50\Omega \)

- **S11, S22** \( f = 50MHz \sim 20GHz \)
- **S21, S12** \( f = 50MHz \sim 20GHz \)

**NJG1126HB6 @High Gain**

\( k \) factor vs. frequency

Condition
\( V_{DD}=V_{\text{INV}}=2.7V, \ V_{CTL}=1.85V \)
\( f_{RF}=50MHz \sim 20GHz, \)
\( T_a=+25^\circ C, \ Z_s=Z_l=50\Omega \)
1-5-5 TYPICAL CHARACTERISTICS (LNA LOW GAIN MODE)

**NJG1126HB6 @Low Gain**

**Pout vs. Pin**

Condition:

\[ V_{DD} = V_{INV} = 2.7V, \, V_{CTL} = 0V \]
\[ f_{RF} = 2450MHz, \, T_a = +25^\circ C, \]
\[ Z_s = Z_l = 50ohm \]

**Gain, I\text{DD} vs. Pin**

Condition:

\[ V_{DD} = V_{INV} = 2.7V, \, V_{CTL} = 0V \]
\[ f_{RF} = 2450MHz, \, T_a = +25^\circ C, \]
\[ Z_s = Z_l = 50ohm \]

**Pout, IM3 vs. Pin**

Condition:

\[ V_{DD} = V_{INV} = 2.7V, \, V_{CTL} = 0V \]
\[ f_{RF} = 2450MHz + 2450.1MHz, \]
\[ T_a = +25^\circ C, \, Z_s = Z_l = 50ohm \]

**OIP3, IIP3 vs. Pin**

Condition:

\[ V_{DD} = V_{INV} = 2.7V, \, V_{CTL} = 0V \]
\[ f_{RF} = 2350~2600MHz, \, \text{Offset} = +100kHz \]
\[ P_{in} = -16dBm \]
\[ T_a = +25^\circ C, \, Z_s = Z_l = 50ohm \]
1-5-6 TYPICAL CHARACTERISTICS (LNA LOW GAIN MODE)

**Condition**
- $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=0V$
- $f_{RF}=2350$~$2600$MHz, $T_a=+25^\circ C$
- $Z_s=Z_I=50$ohm

***NJG1126HB6 @Low Gain***

**NF, Gain vs. frequency**

(Exclude PCB, Connector Losses)
1-5-7 TYPICAL CHARACTERISTICS (LNA LOW GAIN MODE)
Condition: Ta=+25°C, V_{DD}=V_{AV}=2.7V, V_{CTL}=0V, Z_s=Z_l=50Ω

S11, S22
Zin, Zout

VSWR_i, VSWR_o
S21, S12
1-5-8 TYPICAL CHARACTERISTICS (LNA LOW GAIN MODE)

Condition: $T_a=+25^\circ C$, $V_{DD}=V_{INV}=2.7V$, $V_{CTL}=0V$, $Z_s=Z_l=50\Omega$

S11, S22 ($f=50MHz$~$20GHz$)  
S21, S12 ($f=50MHz$~$20GHz$)

NJG1126HB6 @Low Gain  
k factor vs. frequency

Condition  
$V_{DD}=V_{INV}=2.7V$, $V_{CTL}=0V$  
$f_{RF}=50MHz$~$20GHz$,  
$T_a=+25^\circ C$, $Z_s=Z_l=50\Omega$