DC-22GHz, 16dB Gain Low-Noise Wideband Distributed Amplifier

Features
- Excellent combination of wide bandwidth, low noise and high associated gain
- 1.7dB NF with >15.5dB gain at 10GHz
- Output IP3 ~26-29dBm
- Input and output matched to 50Ω
- 100% DC and RF tested
- Chip size: 2.82mm x 1.50mm x 0.1mm

Applications
- Instrumentation
- Electronic warfare
- Microwave communications
- Radar

Features

Applications

Typical Performance (CW, Typical Device, RF Probe): $T_A = 25°C, V_{DD} = 8V, I_{DD} = 60mA$\(^1\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DC - 6GHz</th>
<th>6 - 18GHz</th>
<th>18 - 22GHz</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>3.0</td>
<td>2.0</td>
<td>3.2</td>
<td>dB</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>15</td>
<td>15</td>
<td>12</td>
<td>dB</td>
</tr>
<tr>
<td>Output Power, $P_{1db}$</td>
<td>16</td>
<td>15</td>
<td>13</td>
<td>dBm</td>
</tr>
<tr>
<td>Output Power $P_{3db}$</td>
<td>18</td>
<td>17</td>
<td>15</td>
<td>dBm</td>
</tr>
<tr>
<td>Output IP3</td>
<td>29</td>
<td>28</td>
<td>25</td>
<td>dBm</td>
</tr>
</tbody>
</table>

\(^1\) Adjust $V_{dd}$ to set $I_{dd} = 60mA$, typical value is -0.5V. Recommend $I_{dd} \sim 45mA$ for improved stability down to -55°C
Table 1: Absolute Maximum Ratings, Not Simultaneous

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain Voltage ($V_{DD}$)</td>
<td>+9</td>
<td>V</td>
</tr>
<tr>
<td>Gate Voltage ($V_{GG}$)</td>
<td>-2 to 0</td>
<td>V</td>
</tr>
<tr>
<td>Input Power ($P_{in}$)</td>
<td>20</td>
<td>dBm</td>
</tr>
<tr>
<td>Channel Temperature ($T_C$)</td>
<td>150°C</td>
<td></td>
</tr>
<tr>
<td>Operating Ambient Temperature ($T_A$)</td>
<td>-55 to +85°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 to +150°C</td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance, Channel to Die Backside ($R_{th}$)</td>
<td>40</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

2 MTTF > $10^8$ hours at $T_C = 150^\circ$C

Table 2: Specifications (CW, 100% Test): $T_A = 25^\circ$C, $V_{DD} = 8$V, $I_{DD} = 60$mA³

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain</td>
<td>20GHz</td>
<td>14.5</td>
<td>17</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Output Power, $P_{1dB}$</td>
<td>20GHz</td>
<td>12</td>
<td>14</td>
<td>-</td>
<td>dBm</td>
</tr>
</tbody>
</table>

³ Adjust $V_{GG}$ to get $I_{DD} = 60$mA, typical value is -0.5V

RF Probe Measurement Set-Up With Reference Planes⁴

External DC blocks maybe required, refer to Table 3 for more information.

⁴ Reference planes are the same for S-parameter files downloadable on www.microsemi.com/mmics
Typical Performance, RF Probe

\[ V_{DS} = 8V, \; I_{DQ} = 60mA, \; T_A = 25^\circ C \] unless otherwise noted

**S\textsubscript{11} Over Bias Current**

- 50mA
- 60mA
- 70mA

**S\textsubscript{11} Over Temperature**

- 25°C – 85°C
- \( I_{DQ} = 60mA \)

**S\textsubscript{22} Over Bias Current**

- 50mA
- 60mA
- 70mA

**S\textsubscript{22} Over Temperature**

- 25°C – 85°C
- \( I_{DQ} = 60mA \)

**S\textsubscript{21} Over Bias Current**

- 50mA
- 60mA
- 70mA

**S\textsubscript{21} Over Temperature**

- 25°C – 85°C
- \( I_{DQ} = 60mA \)
Typical Performance, RF Probe

V_{DS} = 8V, I_{DQ} = 60mA, T_A = 25°C unless otherwise noted

**Noise Figure Over Bias Current**

![Graph showing noise figure over bias current for different currents (50mA, 60mA, 70mA).](image)

**Noise Figure Over Temperature**

![Graph showing noise figure over temperature with I_{DD} = 60mA.](image)

**OIP3 Over Bias Current, 0dBm/tone**

![Graph showing OIP3 over bias current for different currents (50mA, 60mA, 70mA) at 0dBm/tone.](image)

**OIP3 Over Bias Current, 3dBm/tone**

![Graph showing OIP3 over bias current for different currents (50mA, 60mA, 70mA) at 3dBm/tone.](image)

**OIP3 Over Bias Current, 6dBm/tone**

![Graph showing OIP3 over bias current for different currents (50mA, 60mA, 70mA) at 6dBm/tone.](image)

**OIP3 Over Output Power Per Tone**

![Graph showing OIP3 over output power per tone.](image)
Typical Performance, RF Probe

$V_{DS} = 8\, \text{V}, \quad I_{DQ} = 60\, \text{mA}, \quad T_A = 25^\circ\text{C}$ unless otherwise noted

**P$_{1\text{dB}}$ Over Bias Current**

![Graph showing P$_{1\text{dB}}$ over bias current](image1)

**P$_{3\text{dB}}$ Over Bias Current**

![Graph showing P$_{3\text{dB}}$ over bias current](image2)

**Power Sweep**

![Graph showing power sweep](image3)

**IMD3 Sweep**

![Graph showing IMD3 sweep](image4)
Connectorized Test Fixture
With SMK 2.92mm Connectors
Typical Performance, Connectorized Test Fixture

$V_{DS} = 8\, V$, $I_{DQ} = 60\, mA$, $T_A = 25\, ^\circ C$ unless otherwise noted

- **$S_{11}$ Over Temperature**
- **$S_{22}$ Over Temperature**
- **$S_{21}$ Over Temperature**
- **NF Over Temperature, $I_{DQ} = 50\, mA$**
- **NF Over Temperature, $I_{DQ} = 60\, mA$**
- **NF Over Temperature, $I_{DQ} = 70\, mA$**
Typical Performance, Connectorized Test Fixture

\[ V_{DS} = 8V, \ I_{DQ} = 60mA, \ T_A = 25^\circ C \] unless otherwise noted

**P_{1dB} Over Temperature**

-40°C

**P_{3dB} Over Temperature**

-40°C

**Power Sweep, -40°C**

-1GHz -3GHz -5GHz -7GHz

-9GHz -11GHz -13GHz -15GHz

-17GHz -19GHz -21GHz

**Power Sweep, +25°C**

-1GHz -3GHz -5GHz -7GHz

-9GHz -11GHz -13GHz -15GHz

-17GHz -19GHz -21GHz

**Power Sweep, +85°C**

-1GHz -3GHz -5GHz -7GHz

-9GHz -11GHz -13GHz -15GHz

-17GHz -19GHz -21GHz

**OIP3 Over Temperature, 0dBm/tone**

-40°C

+25°C

+85°C
Typical Performance, Connectorized Test Fixture

$V_{DS} = 8V$, $I_{DQ} = 60mA$, $T_A = 25^\circ C$ unless otherwise noted.

**OIP3 Over Temperature, 3dBm/tone**

-40°C
- +25°C
- +85°C

**OIP3 Over Temperature, 6dBm/tone**

-40°C
- +25°C
- +85°C

**IMD Sweep, -40°C**

$I_{DQ} = 60mA$, -40°C

1MHz Tone Spacing

-2GHz
-4GHz
-6GHz
-8GHz
-10GHz
-12GHz
-14GHz
-16GHz
-18GHz
-20GHz

**IMD Sweep, +25°C**

$I_{DQ} = 60mA$, +25°C

1MHz Tone Spacing

-2GHz
-4GHz
-6GHz
-8GHz
-10GHz
-12GHz
-14GHz
-16GHz
-18GHz
-20GHz

**IMD Sweep, +85°C**

$I_{DQ} = 60mA$, +85°C

1MHz Tone Spacing

-2GHz
-4GHz
-6GHz
-8GHz
-10GHz
-12GHz
-14GHz
-16GHz
-18GHz
-20GHz

**V_{GG} Over Temperature**

-50mA
- 60mA
- 70mA

**Temperature (°C)**

-0.60
-0.55
-0.50
-0.45
-0.40
Typical Performance, Connectorized Test Fixture

$V_{DS} = 8V$, $I_{DQ} = 60mA$, $T_A = 25°C$ unless otherwise noted

**Low-Frequency $S_{21}$**

![Graph of Low-Frequency $S_{21}$](image)

**Low-Frequency $S_{11}$, $S_{22}$**

![Graph of Low-Frequency $S_{11}$, $S_{22}$](image)
Chip layout showing pad locations.
All dimensions are in microns. Die thickness is 100 microns. Backside metal is gold, bond pad metal is gold. Refer to Die Handling Application Note MM-APP-0001 (visit www.microsemi.com/mmics).

Table 3: Pad Descriptions

<table>
<thead>
<tr>
<th>Pad #</th>
<th>Description</th>
<th>Pad Dimensions (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 3, 7, 9</td>
<td>Ground</td>
<td>100 x 100</td>
</tr>
<tr>
<td>2</td>
<td>RF&lt;sub&gt;IN&lt;/sub&gt;, Pad Is DC Coupled. Use External DC block</td>
<td>100 x 190</td>
</tr>
<tr>
<td>8</td>
<td>RF&lt;sub&gt;OUT&lt;/sub&gt;, Pad Is DC Coupled. Use External DC Block</td>
<td>100 x 190</td>
</tr>
<tr>
<td>4</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt;</td>
<td>100 x 100</td>
</tr>
<tr>
<td>12</td>
<td>V&lt;sub&gt;GG&lt;/sub&gt;</td>
<td>100 x 100</td>
</tr>
<tr>
<td>5, 6, 10, 11</td>
<td>Low Frequency Terminations</td>
<td>100 x 100</td>
</tr>
<tr>
<td>Die Backside</td>
<td>Must be connected to ground</td>
<td>-</td>
</tr>
</tbody>
</table>

Biasing
1. Set V<sub>GG</sub> = -2V
2. Set V<sub>DD</sub> = 8V
3. Adjust V<sub>GG</sub> to set I<sub>DD</sub>
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