Amplifiers
Amplifiers

• Overview
• Performance Parameters: Low Noise & High Power
• Design and Technology Issues
• Design Approach – Low Noise Amplifiers
• Conclusions - Impact on System Design
Performance Parameters

Low Noise Amplifier

ZEL-1724LN

50Ω  1700 to 2400 MHz

Features
• very low noise, 1.5 dB max.
• wideband, 1700 to 2400 MHz
• rugged shielded case

Applications
• PCS/DCS
• UMTS
• communication systems

Low Noise Amplifier Electrical Specifications

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>FREQUENCY (MHz)</th>
<th>NOISE FIGURE (dB)</th>
<th>GAIN (dB)</th>
<th>MAXIMUM POWER (dBm)</th>
<th>INTERCEPT POINT (dBm)</th>
<th>VSWR (:1) Max.</th>
<th>DC POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZEL-1724LN</td>
<td>1700 2400</td>
<td>1.5</td>
<td>20 ±1.0</td>
<td>+8 +13</td>
<td>+22</td>
<td>2.5 2.5</td>
<td>15 70</td>
</tr>
</tbody>
</table>

Noise Figure specified at room temperature, increases to 2 dB typical at +85°C
Open load is not recommended, potentially can cause damage
With no load derate max input power by 20 dB

Maximum Ratings
Operating Temperature  -54°C to 85°C
Storage Temperature  -55°C to 100°C
DC Voltage  +17V Max.
Performance Parameters

Coaxial Amplifier

ZHL-10W-2G+
ZHL-10W-2G

50Ω High Power 10W 800 to 2000 MHz

Features
- high power, 10 Watt
- low current consumption, 4A typ.
- usable over 700 to 2200 MHz
- internal power regulator (current remains constant over 22 to 28V)
- no damage with an open or short output load under full CW output power

Applications
- cellular, PCN, GSM, ISM
- lab test

Electrical Specifications

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>FREQ. (MHz)</th>
<th>GAIN (dB)</th>
<th>MAXIMUM POWER OUTPUT (dBm)</th>
<th>DYNAMIC RANGE</th>
<th>VSWR</th>
<th>DC POWER**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f1, f2</td>
<td>Min. Typ. Max.</td>
<td>(1 dB Compr.) Min. Typ.</td>
<td>NF (dB)</td>
<td>IP3 (dBm)</td>
<td>Typ.</td>
</tr>
<tr>
<td>ZHL-10W-2G(+)</td>
<td>800 2000 40 43 49</td>
<td>±2.0</td>
<td>+39 +40</td>
<td>+40 +41</td>
<td>7.0 +50</td>
<td>1.3 1.3</td>
</tr>
<tr>
<td>ZHL-10W-2GX+*</td>
<td>800 2000 40 43 40</td>
<td>±2.0</td>
<td>+39 +40</td>
<td>+40 +41</td>
<td>7.0 +50</td>
<td>1.3 1.3</td>
</tr>
</tbody>
</table>

*Heat sink and fan not included
**Power Supply should be capable of delivering 6A at start up

RoHS compliant in accordance with EU Directive (2002/95/EC)

To order without heat sink and fan, add suffix X to model number. Alternative heat sinking and heat removal must be provided by the user to limit maximum base-plate temperature to 75°C, in order to ensure proper performance. For reference, this requires thermal resistance of users external heat sink to be 0.008°C/W Max.
Performance Parameters

Functional Block Diagram

Features

- 4.9 to 5.9 GHz Frequency Coverage
- Low Noise Figure
- High Gain
- Low Current: 8mA Typical @ 3V
- 50-ohm Input and Output Match
- GaAs pHEMT Technology
- Leadless 1.3 x 2.0 x 0.4 mm Lead-Free SMT Package

Selected Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>min</th>
<th>typ</th>
<th>Max</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>4900</td>
<td>-</td>
<td>5900</td>
<td>MHz</td>
</tr>
<tr>
<td>Noise Figure (with onchip match)</td>
<td>1.3</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Small Signal Gain</td>
<td>16.5</td>
<td>18</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Input Power (IP1dB)</td>
<td>-13</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input IP3</td>
<td>-3</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
</tbody>
</table>

Applications

- 802.11a WLAN
- PCs and Mobile Devices
- WLAN Access Points
- WLAN Repeaters
Performance Parameters

Advance Product Information
Preliminary: Subject to change without notice

3V HBT TDMA Power Amplifier IC TQ7625

Selected Electrical Characteristics

Test Conditions: \( V_{DD} = +3.5 \text{ V} \), \( T_{J}= 25 \text{°C} \), \( V_{BSAG}=2.75\text{V} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable Frequency Range</td>
<td>1850</td>
<td></td>
<td>1910</td>
<td>MHz</td>
</tr>
<tr>
<td>TDMA Output Power</td>
<td>28</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>TDMA Power Added Efficiency</td>
<td>40</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>ACP, Pout = +28 dBm</td>
<td>-30</td>
<td></td>
<td></td>
<td>dBc</td>
</tr>
<tr>
<td>ALT, Pout = +28 dBm</td>
<td>-53</td>
<td></td>
<td></td>
<td>dBc</td>
</tr>
<tr>
<td>Large Signal Gain</td>
<td>27.5</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Small Signal Gain (V(_{\text{mode}})=low)</td>
<td>26</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Receive Band Noise</td>
<td>-92</td>
<td></td>
<td></td>
<td>dBm/30KHz</td>
</tr>
<tr>
<td>Quiescent Current, Uses V(_{\text{mode}}), Switching</td>
<td>V(_{\text{mode}})= low</td>
<td>60</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>V(_{\text{mode}})= high</td>
<td>80</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>( V_{\text{RSS}} ), Externally Switched. P(_{\text{OUT}}) &lt;= +15dBm</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>( P_{\text{OUT}} ) = +28dBm</td>
<td>2.65</td>
<td>2.75</td>
<td>2.85</td>
<td>V</td>
</tr>
<tr>
<td>Second Harmonic, ( P_{\text{OUT}} ) = +28dBm</td>
<td>-45</td>
<td></td>
<td></td>
<td>dBc</td>
</tr>
<tr>
<td>Third Harmonic, ( P_{\text{OUT}} ) = +28dBm</td>
<td>-55</td>
<td></td>
<td></td>
<td>dBc</td>
</tr>
</tbody>
</table>

Primary Application(s)
- IS-136 Mobile Phones
- Dual Band Mobile phones

Key Features
- High Efficiency
- Low Quiescent Current, Mode Selectable
- Small size 3x3 mm leadless package
- Few external components
- Excellent ACP Performance
- Single +2.7V Supply

Package: 3x3 mm
Leadless 16 pin
Performance Parameters

Discrete MESFET

TGF1350-SCC

Key Features and Performance

- 0.5 um x 300 um FET
- 1.5 dB Noise Figure with 11 dB Associated Gain at 10 GHz
- 2.5 dB Noise Figure with 7 dB Associated Gain at 18 GHz
- All-Gold Metallization for High Reliability
- Recessed Gate Structure
- 0.620 x 0.514 x 0.102 mm (0.024 x 0.020 x 0.004 in.)
Performance Parameters

TGF4124-EPU  24 mm Discrete HFET

- 0.5 um gate finger length
- Nominal Pout of 12 Watts at 2.3 GHz
- Nominal PAE of 51.5% at 2.3 GHz
- Nominal Gain of 10.8 dB at 2.3 GHz
- Die size 36.0 x 81.0 x 4.0 mils
  (0.914 x 2.057 x 0.102 mm)

TGF4124-EPU RF Performance at F = 2.3 GHz
Vd = 8.0 V, Vg = -1.1 V, Iq = 2.17 A and T_A = 25°C
Design and Technology Issues

• Design Drivers:
  – Low noise: Noise Figure, Gain, Linearity
  – High power: Efficiency, Output Power, Bandwidth, Linearity

• Main Technologies:
  – Low Noise: CMOS (Silicon), Bi-CMOS (Silicon and Silicon-Germanium), GaAs
  – High Power: LDMOS (Silicon), MESFET (GaN and GaAs)

• (Other) Issues: Cost, Packaging (parasitics), Very Wideband Performance
Design and Technology Issues
Design Approach – Low Noise Amplifiers

• The basic steps:
  – Prepare to compromise
  – Select the transistor(s) and other components
  – Find the best CAD models available for the parts
  – Select the DC operating condition
  – Design input and output impedance matching networks
Design Approach – Low Noise Amplifiers
Design Approach – Low Noise Amplifiers

• Why compromise?
Design Approach – Low Noise Amplifiers

• Selecting the components
Design Approach – Low Noise Amplifiers

• Why are computer-aided-design (CAD) models so important?
Design Approach – Low Noise Amplifiers

- DC operating condition:

*Functional Block Diagram*
Design Approach – Low Noise Amplifiers

- Matching Networks

$$G_T = \frac{1 - |\Gamma_S|^2}{|1 - \Gamma_S \Gamma_{IN}|^2} \left| S_{21} \right|^2 \frac{1 - |\Gamma_L|^2}{|1 - S_{22} \Gamma_L|^2}$$
Amplifiers – Conclusions

• System-level specifications flow down to amplifier requirements → important for system designer to understand technology options and capabilities of each
• Impact on system design
  – Range – transmit power of PA and noise figure & gain of LNA
  – Battery life – PAs are one of the biggest consumers