RF Power GaN Transistor

This 14 W asymmetrical Doherty RF power GaN transistor is designed for cellular base station applications requiring very wide instantaneous bandwidth capability covering the frequency range of 3400 to 3600 MHz.

This part is characterized and performance is guaranteed for applications operating in the 3400 to 3600 MHz band. There is no guarantee of performance when this part is used in applications designed outside of these frequencies.

3500 MHz

- Typical Doherty Single-Carrier W-CDMA Performance: \(V_{DD} = 48\) Vdc, \(I_{DQA} = 80\) mA, \(V_{GSB} = -5.0\) Vdc, \(P_{out} = 14\) W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Gain (dB)</th>
<th>(\eta_{D}) (%)</th>
<th>Output PAR (dB)</th>
<th>ACPR (dbc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3400 MHz</td>
<td>14.0</td>
<td>43.8</td>
<td>9.6</td>
<td>-34.0</td>
</tr>
<tr>
<td>3500 MHz</td>
<td>14.0</td>
<td>41.4</td>
<td>9.7</td>
<td>-34.5</td>
</tr>
<tr>
<td>3600 MHz</td>
<td>14.0</td>
<td>42.5</td>
<td>9.6</td>
<td>-32.2</td>
</tr>
</tbody>
</table>

Features

- High terminal impedances for optimal broadband performance
- Advanced high performance in-package Doherty
- Able to withstand extremely high output VSWR and broadband operating conditions
### Table 1. Maximum Ratings

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Drain–Source Voltage</td>
<td>$V_{DSS}$</td>
<td>125</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate–Source Voltage</td>
<td>$V_{GS}$</td>
<td>$-8$, $0$</td>
<td>Vdc</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>$V_{DD}$</td>
<td>0 to $+55$</td>
<td>Vdc</td>
</tr>
<tr>
<td>Maximum Forward Gate Current @ $T_C = 25^\circ$C</td>
<td>$I_{GMAX}$</td>
<td>13.4</td>
<td>mA</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>$T_{stg}$</td>
<td>$-65$ to $+150$</td>
<td>°C</td>
</tr>
<tr>
<td>Case Operating Temperature Range</td>
<td>$T_C$</td>
<td>$-55$ to $+150$</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Junction Temperature Range</td>
<td>$T_J$</td>
<td>$-55$ to $+225$</td>
<td>°C</td>
</tr>
<tr>
<td>Absolute Maximum Junction Temperature (1)</td>
<td>$T_{MAX}$</td>
<td>275</td>
<td>°C</td>
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</table>

### Table 2. Thermal Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Thermal Resistance by Infrared Measurement, Active Die Surface-to-Case Case Temperature 71°C, $P_D = 24.3$ W</td>
<td>$R_{UJC}$ (IR)</td>
<td>2.3 (2)</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal Resistance by Finite Element Analysis, Junction-to-Case Case Temperature 90°C, $P_D = 24$ W</td>
<td>$R_{UJC}$ (FEA)</td>
<td>3.88 (3)</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

### Table 3. ESD Protection Characteristics

<table>
<thead>
<tr>
<th>Test Methodology</th>
<th>Class</th>
</tr>
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<tbody>
<tr>
<td>Human Body Model (per JS-001-2017)</td>
<td>1C</td>
</tr>
<tr>
<td>Charge Device Model (per JS-002-2014)</td>
<td>C2</td>
</tr>
</tbody>
</table>

### Table 4. Electrical Characteristics ($T_A = 25^\circ$C unless otherwise noted)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off Characteristics (4)</td>
<td>$V_{(BR)DSS}$</td>
<td>150</td>
<td>—</td>
<td>—</td>
<td>Vdc</td>
</tr>
<tr>
<td>On Characteristics - Side A, Carrier</td>
<td>$V_{GS(\text{th})}$</td>
<td>$-3.8$</td>
<td>$-3.1$</td>
<td>$-2.3$</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate Threshold Voltage</td>
<td>$V_{GS(\text{th})}$</td>
<td>$-3.6$</td>
<td>$-2.9$</td>
<td>$-2.6$</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate–Source Leakage Current (Carrier)</td>
<td>$I_{GS}$</td>
<td>$-1.7$</td>
<td>—</td>
<td>—</td>
<td>mAdc</td>
</tr>
<tr>
<td>On Characteristics - Side B, Peaking</td>
<td>$V_{GS(\text{th})}$</td>
<td>$-3.8$</td>
<td>$-3.2$</td>
<td>$-2.3$</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate Threshold Voltage</td>
<td>$V_{GS(\text{th})}$</td>
<td>$-3.8$</td>
<td>$-3.2$</td>
<td>$-2.3$</td>
<td>Vdc</td>
</tr>
<tr>
<td>Gate–Source Leakage Current (Peaking)</td>
<td>$I_{GS}$</td>
<td>$-2.5$</td>
<td>—</td>
<td>—</td>
<td>mAdc</td>
</tr>
</tbody>
</table>

1. Functional operation above 225°C has not been characterized and is not implied. Operation at $T_{MAX}$ (275°C) reduces median time to failure by an order of magnitude; operation beyond $T_{MAX}$ could cause permanent damage.
3. $R_{UJC}$ (FEA) must be used for purposes related to reliability and limitations on maximum junction temperature. MTTF may be estimated by the expression $MTTF$ (hours) $= 10^{A + B/(T + 273)}$, where $T$ is the junction temperature in degrees Celsius, $A = -10.3$ and $B = 8260$.
4. Each side of device measured separately.

(continued)
Table 4. Electrical Characteristics (TA = 25°C unless otherwise noted) (continued)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Tests (1,2) (In NXP Doherty Test Fixture, 50 ohm system) VDD = 48 Vdc, IDQA = 80 mA, VGSB = –5.0 Vdc, Pout = 14 W Avg., f = 3600 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. [See note on correct biasing sequence.]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Power Gain</td>
<td>Gps</td>
<td>13.0</td>
<td>14.0</td>
<td>15.0</td>
<td>dB</td>
</tr>
<tr>
<td>Drain Efficiency</td>
<td>rID</td>
<td>37.7</td>
<td>42.5</td>
<td>—</td>
<td>%</td>
</tr>
<tr>
<td>Output Peak-to-Average Ratio @ 0.01% Probability on CCDF</td>
<td>PAR</td>
<td>8.8</td>
<td>9.6</td>
<td>—</td>
<td>dB</td>
</tr>
<tr>
<td>Adjacent Channel Power Ratio</td>
<td>ACPR</td>
<td>—</td>
<td>–32.2</td>
<td>–29.5</td>
<td>dBc</td>
</tr>
<tr>
<td>Load Mismatch (2) (In NXP Doherty Test Fixture, 50 ohm system) IDQA = 80 mA, VGSB = –5.1 Vdc, f = 3500 MHz, 12 μsec(on), 10% Duty Cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSWR 10:1 at 55 Vdc, 158 W Pulsed CW Output Power</td>
<td>—</td>
<td>No Device Degradation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3 dB Input Overdrive from 91 W Pulsed CW Rated Power)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical Performance (2) (In NXP Doherty Test Fixture, 50 ohm system) VDD = 48 Vdc, IDQA = 80 mA, VGSB = –5.1 Vdc, 3400–3600 MHz Bandwidth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pout @ 3 dB Compression Point (3)</td>
<td>P3dB</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>W</td>
</tr>
<tr>
<td>AM/PM (Maximum value measured at the P3dB compression point across the 3400–3600 MHz bandwidth)</td>
<td>Φ</td>
<td>—</td>
<td>–32</td>
<td>—</td>
<td>°</td>
</tr>
<tr>
<td>VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)</td>
<td>VBWres</td>
<td>—</td>
<td>260</td>
<td>—</td>
<td>MHz</td>
</tr>
<tr>
<td>Gain Flatness in 200 MHz Bandwidth @ Pout = 14 W Avg.</td>
<td>GF</td>
<td>—</td>
<td>0.31</td>
<td>—</td>
<td>dB</td>
</tr>
<tr>
<td>Gain Variation over Temperature (–30°C to +85°C)</td>
<td>ΔG</td>
<td>—</td>
<td>0.011</td>
<td>—</td>
<td>dB/°C</td>
</tr>
<tr>
<td>Output Power Variation over Temperature (–30°C to +85°C)</td>
<td>ΔP1dB</td>
<td>—</td>
<td>0.006</td>
<td>—</td>
<td>dB/°C</td>
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Table 5. Ordering Information

<table>
<thead>
<tr>
<th>Device</th>
<th>Tape and Reel Information</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3G35H100-04SR3</td>
<td>R3 Suffix = 250 Units, 32 mm Tape Width, 13-inch Reel</td>
<td>NI-780S-4L</td>
</tr>
</tbody>
</table>

1. Part internally input matched.
2. Measurements made with device in an asymmetrical Doherty configuration.
3. P3dB = Pavg + 7.0 dB where Pavg is the average output power measured using an unclipped W-CDMA single-carrier input signal where output PAR is compressed to 7.0 dB @ 0.01% probability on CCDF.

NOTE: Correct Biasing Sequence for GaN Depletion Mode Transistors

**Turning the device ON**
1. Set VGS to –5 V
2. Turn on VDS to nominal supply voltage (48 V)
3. Increase VGS until IDS current is attained
4. Apply RF input power to desired level

**Turning the device OFF**
1. Turn RF power off
2. Reduce VGS down to –5 V
3. Reduce VDS down to 0 V (Adequate time must be allowed for VDS to reduce to 0 V to prevent severe damage to device.)
4. Turn off VGS
Table 6. A3G35H100-04SR3 Test Circuit Component Designations and Values

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Part Number</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C6</td>
<td>0.1 pF Chip Capacitor</td>
<td>ATC600F0R1BT250XT</td>
<td>ATC</td>
</tr>
<tr>
<td>C2, C8, C10, C14</td>
<td>10 µF Chip Capacitor</td>
<td>C5750X7S2A106M230KB</td>
<td>TDK</td>
</tr>
<tr>
<td>C3, C4, C5, C7, C9, C11, C13</td>
<td>5.1 pF Chip Capacitor</td>
<td>ATC600F5R1BT250XT</td>
<td>ATC</td>
</tr>
<tr>
<td>C12</td>
<td>4.3 pF Chip Capacitor</td>
<td>ATC600F4R3BT250XT</td>
<td>ATC</td>
</tr>
<tr>
<td>C15, C16</td>
<td>220 µF, 100 V Electrolytic Capacitor</td>
<td>MCGPR100V227M16X26</td>
<td>Multicomp</td>
</tr>
<tr>
<td>R1</td>
<td>50 Ω, 10 W Chip Resistor</td>
<td>C10A50Z4</td>
<td>Anaren</td>
</tr>
<tr>
<td>R2, R7</td>
<td>51 kΩ, 1/4 W Chip Resistor</td>
<td>CRCW120651K0FKEA</td>
<td>Vishay</td>
</tr>
<tr>
<td>R3, R6</td>
<td>3 Ω, 1/4 W Chip Resistor</td>
<td>CRCW12063R00JNEA</td>
<td>Vishay</td>
</tr>
<tr>
<td>R4</td>
<td>1.5 Ω, 1/4 W Chip Resistor</td>
<td>RC1206FR−071R5L</td>
<td>Yageo</td>
</tr>
<tr>
<td>R5</td>
<td>1 Ω, 1/4 W Chip Resistor</td>
<td>CRCW12061R00FKEA</td>
<td>Vishay</td>
</tr>
<tr>
<td>Z1</td>
<td>3300−3800 MHz Band, 90°, 2 dB Hybrid Coupler</td>
<td>X3C35F1-02S</td>
<td>Anaren</td>
</tr>
<tr>
<td>PCB</td>
<td>Rogers RO4350B, 0.020″, εr = 3.66</td>
<td>D109679</td>
<td>MTL</td>
</tr>
</tbody>
</table>
TYPICAL CHARACTERISTICS — 3400–3600 MHz

Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 14 Watts Avg.

Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing

Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power
TYPICAL CHARACTERISTICS — 3400–3600 MHz

Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

Figure 7. Broadband Frequency Response
PACKAGE DIMENSIONS

N (LID)  M (INSULATOR)  R (LID)  S (INSULATOR)

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MECHANICAL OUTLINE

TITLE: NI-780S-4L

DOCUMENT NO: 98ASA10718D REV: C
STANDARD: NON-JEDEC
SOT1826-1 01 AUG 2016
NOTES:


2. CONTROLLING DIMENSION: INCH.

3. DELETED

4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM FLANGE TO CLEAR EPOXY FLOW OUT PARALLEL TO DATUM B.

<table>
<thead>
<tr>
<th>DIM</th>
<th>INCH</th>
<th>MILLIMETER</th>
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<th>DIM</th>
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<th>MILLIMETER</th>
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<tr>
<td></td>
<td>MIN</td>
<td>MAX</td>
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<td></td>
<td>MIN</td>
<td>MAX</td>
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<tr>
<td>AA</td>
<td>.805</td>
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<td>Z</td>
<td>.030</td>
<td>0.76</td>
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MECHANICAL OUTLINE

TITLE: NI-780S-4L

DOCUMENT NO: 98ASA10718D REV: C

STANDARD: NON-JEDEC

SOT1826-1 01 AUG 2016
PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

**Application Notes**
- AN1908: Solder Reflow Attach Method for High Power RF Devices in Air Cavity Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

**Software**
- .s2p File

**Development Tools**
- Printed Circuit Boards

**To Download Resources Specific to a Given Part Number:**
1. Go to [http://www.nxp.com/RF](http://www.nxp.com/RF)
2. Search by part number
3. Click part number link
4. Choose the desired resource from the drop down menu

**REVISION HISTORY**

The following table summarizes revisions to this document.

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>May 2018</td>
<td>Initial release of data sheet</td>
</tr>
</tbody>
</table>
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