



RF Power LDMOS Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

These 32 W RF power LDMOS transistors are designed for cellular base station applications requiring very wide instantaneous bandwidth capability covering the frequency range of 2110 to 2170 MHz.

- Typical Single-Carrier W-CDMA Performance: $V_{DD} = 28$ Vdc, $I_{DQ} = 800$ mA, $P_{out} = 32$ W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

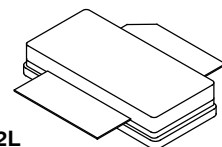
| Frequency | G_{ps} (dB) | η_D (%) | Output PAR (dB) | ACPR (dBc) | IRL (dB) |
|-----------|---------------|--------------|-----------------|------------|----------|
| 2110 MHz | 19.0 | 33.9 | 6.7 | -32.4 | -15 |
| 2140 MHz | 19.3 | 33.5 | 6.7 | -32.6 | -24 |
| 2170 MHz | 19.4 | 33.2 | 6.7 | -32.7 | -22 |

Features

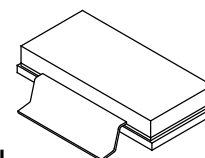
- Designed for Wide Instantaneous Bandwidth Applications
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Able to Withstand Extremely High Output VSWR and Broadband Operating Conditions
- Optimized for Doherty Applications
- In Tape and Reel. R3 Suffix = 250 Units, 56 mm Tape Width, 13-inch Reel.

AFT21S140W02SR3
AFT21S140W02GSR3

2110–2170 MHz, 32 W AVG., 28 V
AIRFAST RF POWER LDMOS
TRANSISTORS



NI-780S-2L
AFT21S140W02SR3



NI-780GS-2L
AFT21S140W02GSR3

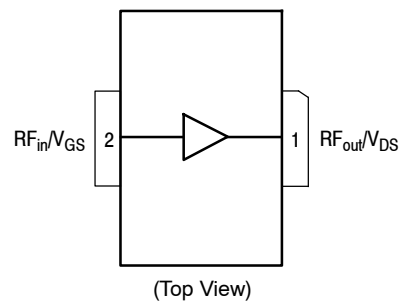


Figure 1. Pin Connections

Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|--|-----------|-------------|-----------|
| Drain-Source Voltage | V_{DSS} | -0.5, +65 | Vdc |
| Gate-Source Voltage | V_{GS} | -6.0, +10 | Vdc |
| Operating Voltage | V_{DD} | 32, +0 | Vdc |
| Storage Temperature Range | T_{stg} | -65 to +150 | °C |
| Case Operating Temperature Range | T_C | -40 to +125 | °C |
| Operating Junction Temperature Range (1,2) | T_J | -40 to +225 | °C |
| CW Operation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | CW | 124 0.70 | W W/°C |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (2,3) | Unit |
|--|-----------------|-------------|------|
| Thermal Resistance, Junction to Case Case Temperature 80°C , 32 W CW, 28 Vdc, $I_{DQ} = 800$ mA, 2140 MHz | $R_{\theta JC}$ | 0.59 | °C/W |

Table 3. ESD Protection Characteristics

| Test Methodology | Class |
|---------------------------------------|-------|
| Human Body Model (per JESD22-A114) | 2 |
| Machine Model (per EIA/JESD22-A115) | B |
| Charge Device Model (per JESD22-C101) | IV |

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

Off Characteristics

| | | | | | |
|---|-----------|---|---|----|-----------------|
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 65$ Vdc, $V_{GS} = 0$ Vdc) | I_{DSS} | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28$ Vdc, $V_{GS} = 0$ Vdc) | I_{DSS} | — | — | 5 | μAdc |
| Gate-Source Leakage Current ($V_{GS} = 5$ Vdc, $V_{DS} = 0$ Vdc) | I_{GSS} | — | — | 1 | μAdc |

On Characteristics

| | | | | | |
|---|--------------|-----|------|-----|-----|
| Gate Threshold Voltage ($V_{DS} = 10$ Vdc, $I_D = 146$ μAdc) | $V_{GS(th)}$ | 0.8 | 1.2 | 1.6 | Vdc |
| Gate Quiescent Voltage ($V_{DD} = 28$ Vdc, $I_D = 800$ mAdc, Measured in Functional Test) | $V_{GS(Q)}$ | 1.5 | 1.9 | 2.3 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10$ Vdc, $I_D = 1.4$ Adc) | $V_{DS(on)}$ | 0.1 | 0.15 | 0.3 | Vdc |

Functional Tests (4,5) (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28$ Vdc, $I_{DQ} = 800$ mA, $P_{out} = 32$ W Avg., $f = 2140$ 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.

| | | | | | |
|--|----------|------|-------|-------|-----|
| Power Gain | G_{ps} | 18.7 | 19.3 | 21.7 | dB |
| Drain Efficiency | η_D | 32.0 | 33.5 | — | % |
| Output Peak-to-Average Ratio @ 0.01% Probability on CCDF | PAR | 6.2 | 6.7 | — | dB |
| Adjacent Channel Power Ratio | ACPR | — | -32.6 | -30.5 | dBc |
| Input Return Loss | IRL | — | -24 | -9 | dB |

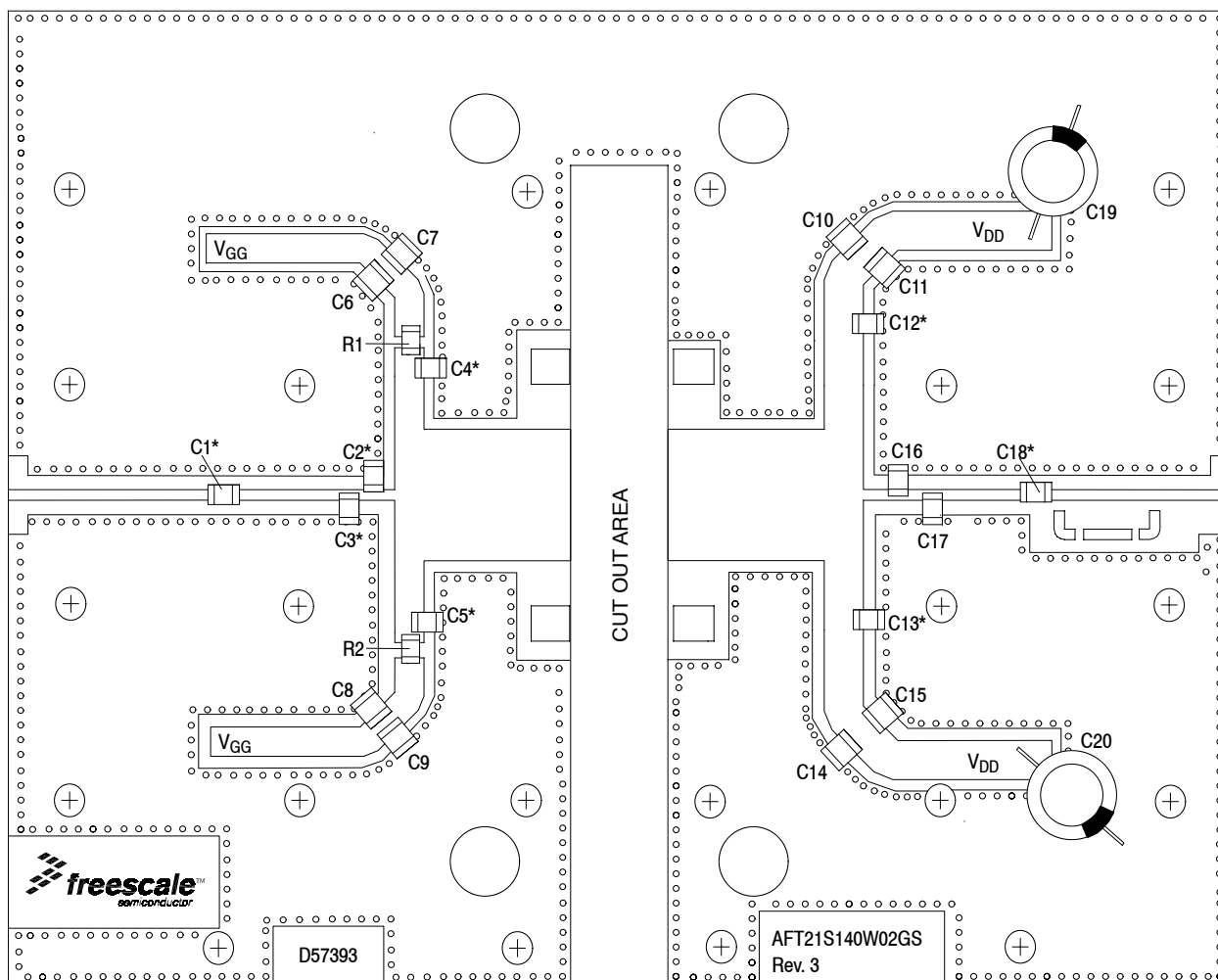
1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.
4. Part internally matched both on input and output.
5. Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GS) parts.

(continued)

Table 4. Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise noted) (continued)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|-----------------------|-----|------|-----|-------|
| Load Mismatch (In Freescale Test Fixture, 50 ohm system) $I_{DQ} = 800\text{ mA}$, $f = 2140\text{ MHz}$ | | | | | |
| VSWR 10:1 at 32 Vdc, 158 W CW ⁽¹⁾ Output Power (3 dB Input Overdrive from 112 W CW Rated Power) | No Device Degradation | | | | |
| Typical Performance (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 800\text{ mA}$, 2110–2170 MHz Bandwidth | | | | | |
| P_{out} @ 1 dB Compression Point, CW | P1dB | — | 112 | — | W |
| AM/PM (Maximum value measured at the P3dB compression point across the 2110–2170 MHz bandwidth) | Φ | — | -17 | — | ° |
| VBW Resonance Point (IMD Third Order Intermodulation Inflection Point) | VBW _{res} | — | 150 | — | MHz |
| Gain Flatness in 60 MHz Bandwidth @ $P_{out} = 32\text{ W Avg.}$ | G_F | — | 0.3 | — | dB |
| Gain Variation over Temperature (-30°C to +85°C) | ΔG | — | 0.03 | — | dB/°C |
| Output Power Variation over Temperature (-30°C to +85°C) ⁽¹⁾ | $\Delta P1dB$ | — | 0.01 | — | dB/°C |

1. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.



*C1, C2, C3, C4, C5, C12, C13 and C18 are mounted vertically.

Figure 2. AFT21S140W02SR3 Test Circuit Component Layout

Table 5. AFT21S140W02SR3 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|------------------------------------|---|----------------------|--------------|
| C1, C4, C5, C18 | 6.2 pF Chip Capacitors | ATC100B6R2BT500XT | ATC |
| C2 | 0.5 pF Chip Capacitor | ATC100B0R5BT500XT | ATC |
| C3 | 1.1 pF Chip Capacitor | ATC100B1R1BT500XT | ATC |
| C6, C7, C8, C9, C10, C11, C14, C15 | 10 μ F, Chip Capacitors | GRM32ER61H106KA12L | Murata |
| C12, C13 | 8.2 pF Chip Capacitors | ATC100B8R2CT500XT | ATC |
| C16 | 2.2 pF Chip Capacitor | ATC100B2R2JT500XT | ATC |
| C17 | 0.9 pF Chip Capacitor | ATC100B0R9BT500XT | ATC |
| C19, C20 | 470 μ F, 63 V Electrolytic Capacitors | MCGPR63V477M13X26-RH | Multicomp |
| R1, R2 | 2.37 Ω , 1/4 W Chip Resistors | CRCW12062R37FNEA | Vishay |
| PCB | Rogers RO4350B, 0.020", $\epsilon_r = 3.66$ | D57393 | MTL |

TYPICAL CHARACTERISTICS

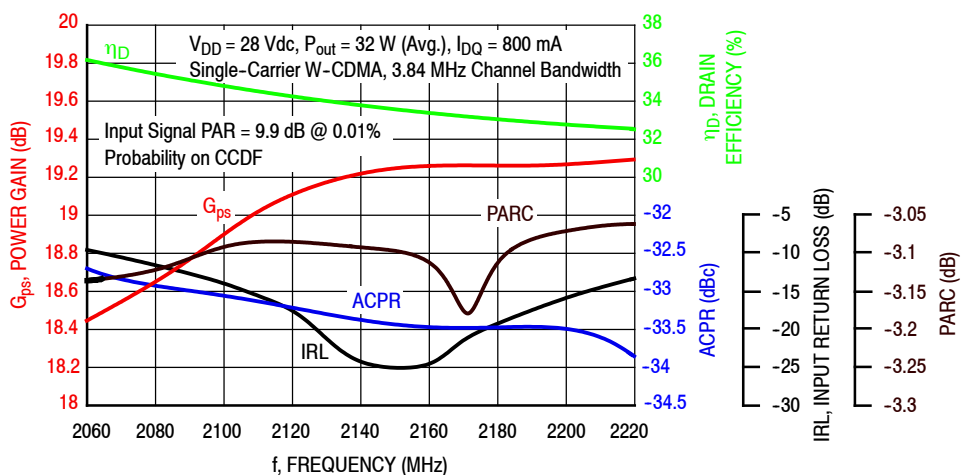


Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out} = 32$ Watts Avg.

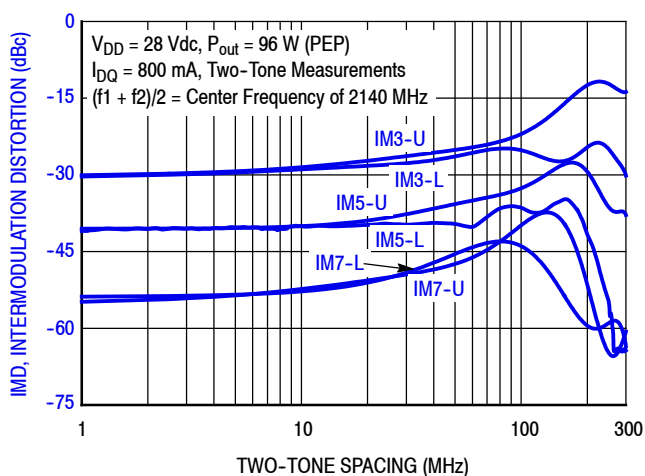


Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing

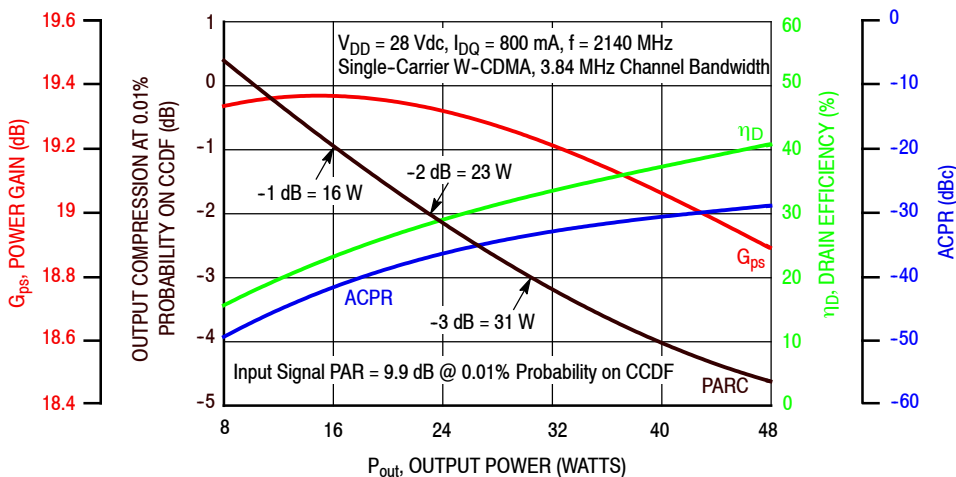


Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS

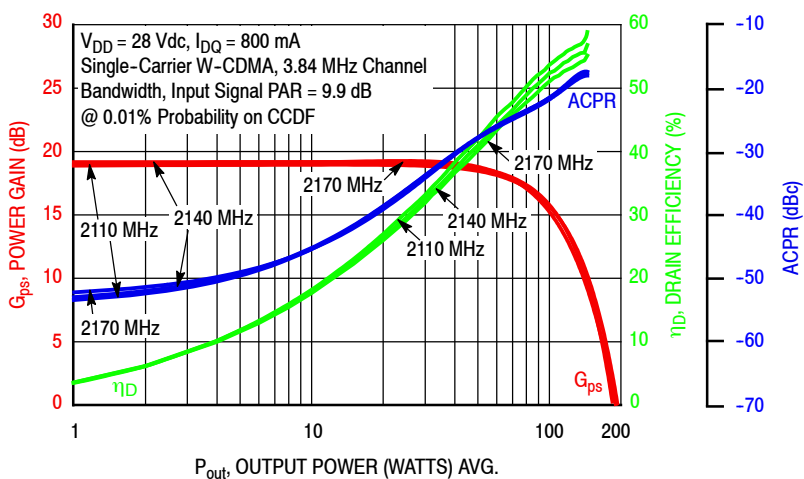


Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

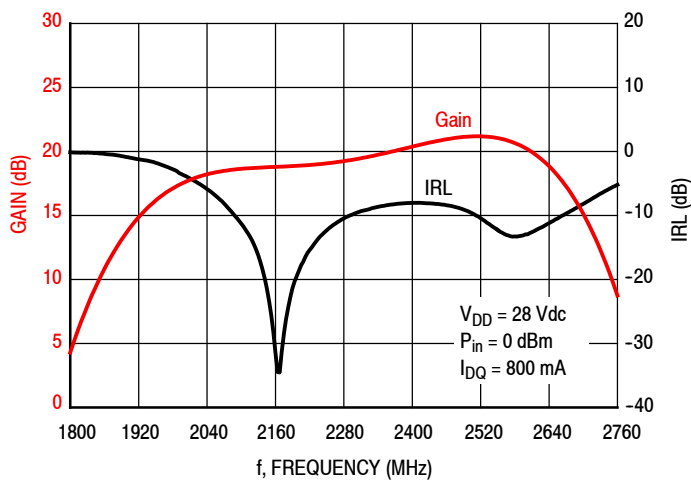


Figure 7. Broadband Frequency Response

Table 6. Load Pull Performance — Maximum Power Tuning
 $V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 770 \text{ mA}$, Pulsed CW, 10 $\mu\text{sec}(\text{on})$, 10% Duty Cycle

| f (MHz) | $Z_{\text{source}} (\Omega)$ | $Z_{\text{in}} (\Omega)$ | Max Output Power | | | | | |
|---------|------------------------------|--------------------------|----------------------------------|-----------|-------|-----|--------------|-----------|
| | | | P1dB | | | | | |
| | | | $Z_{\text{load}}^{(1)} (\Omega)$ | Gain (dB) | (dBm) | (W) | η_D (%) | AM/PM (°) |
| 2110 | 4.72 - j7.83 | 5.44 + j8.03 | 3.92 - j6.59 | 18.9 | 51.8 | 152 | 54.3 | -10 |
| 2140 | 6.03 - j8.06 | 6.63 + j8.08 | 3.84 - j6.22 | 19.0 | 51.9 | 156 | 55.5 | -11 |
| 2170 | 7.23 - j7.37 | 7.86 + j7.65 | 3.89 - j6.16 | 19.2 | 52.0 | 158 | 56.6 | -11 |

| f (MHz) | $Z_{\text{source}} (\Omega)$ | $Z_{\text{in}} (\Omega)$ | Max Output Power | | | | | |
|---------|------------------------------|--------------------------|----------------------------------|-----------|-------|-----|--------------|-----------|
| | | | P3dB | | | | | |
| | | | $Z_{\text{load}}^{(2)} (\Omega)$ | Gain (dB) | (dBm) | (W) | η_D (%) | AM/PM (°) |
| 2110 | 4.72 - j7.83 | 5.92 + j8.68 | 3.92 - j7.04 | 16.8 | 52.8 | 190 | 57.5 | -16 |
| 2140 | 6.03 - j8.06 | 7.42 + j8.66 | 3.99 - j6.82 | 16.9 | 52.8 | 193 | 58.4 | -17 |
| 2170 | 7.23 - j7.37 | 8.93 + j7.96 | 3.96 - j6.86 | 16.9 | 52.9 | 193 | 58.1 | -17 |

(1) Load impedance for optimum P1dB power.

(2) Load impedance for optimum P3dB power.

 Z_{source} = Measured impedance presented to the input of the device at the package reference plane.

 Z_{in} = Impedance as measured from gate contact to ground.

 Z_{load} = Measured impedance presented to the output of the device at the package reference plane.

Table 7. Load Pull Performance — Maximum Drain Efficiency Tuning
 $V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 770 \text{ mA}$, Pulsed CW, 10 $\mu\text{sec}(\text{on})$, 10% Duty Cycle

| f (MHz) | $Z_{\text{source}} (\Omega)$ | $Z_{\text{in}} (\Omega)$ | Max Drain Efficiency | | | | | |
|---------|------------------------------|--------------------------|----------------------------------|-----------|-------|-----|--------------|-----------|
| | | | P1dB | | | | | |
| | | | $Z_{\text{load}}^{(1)} (\Omega)$ | Gain (dB) | (dBm) | (W) | η_D (%) | AM/PM (°) |
| 2110 | 4.72 - j7.83 | 5.45 + j8.49 | 8.22 - j1.63 | 21.7 | 49.5 | 89 | 64.0 | -18 |
| 2140 | 6.03 - j8.06 | 6.72 + j8.52 | 6.98 - j1.62 | 21.7 | 49.7 | 93 | 64.4 | -18 |
| 2170 | 7.23 - j7.37 | 8.07 + j8.09 | 5.87 - j1.79 | 21.7 | 50.0 | 99 | 65.8 | -19 |

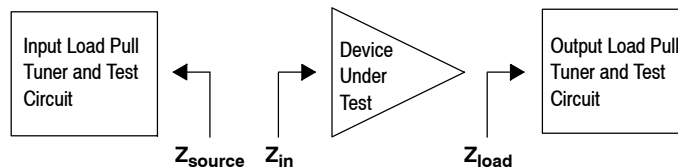
| f (MHz) | $Z_{\text{source}} (\Omega)$ | $Z_{\text{in}} (\Omega)$ | Max Drain Efficiency | | | | | |
|---------|------------------------------|--------------------------|----------------------------------|-----------|-------|-----|--------------|-----------|
| | | | P3dB | | | | | |
| | | | $Z_{\text{load}}^{(2)} (\Omega)$ | Gain (dB) | (dBm) | (W) | η_D (%) | AM/PM (°) |
| 2110 | 4.72 - j7.83 | 5.83 + j8.94 | 6.85 - j4.39 | 18.9 | 51.6 | 143 | 66.0 | -22 |
| 2140 | 6.03 - j8.06 | 7.35 + j8.95 | 6.31 - j4.25 | 18.8 | 51.7 | 148 | 66.5 | -23 |
| 2170 | 7.23 - j7.37 | 9.04 + j8.28 | 6.47 - j2.38 | 19.6 | 50.9 | 122 | 67.0 | -27 |

(1) Load impedance for optimum P1dB efficiency.

(2) Load impedance for optimum P3dB efficiency.

 Z_{source} = Measured impedance presented to the input of the device at the package reference plane.

 Z_{in} = Impedance as measured from gate contact to ground.

 Z_{load} = Measured impedance presented to the output of the device at the package reference plane.


P1dB - TYPICAL LOAD PULL CONTOURS — 2140 MHz

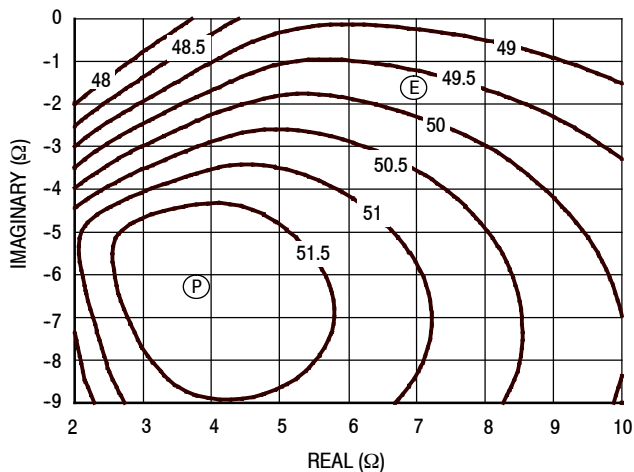


Figure 8. P1dB Load Pull Output Power Contours (dBm)

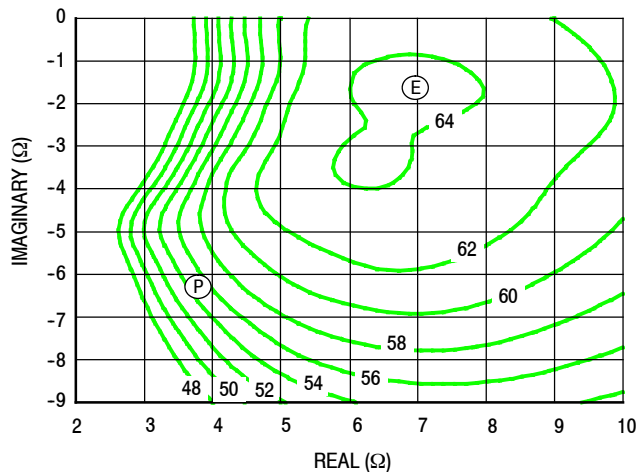


Figure 9. P1dB Load Pull Efficiency Contours (%)

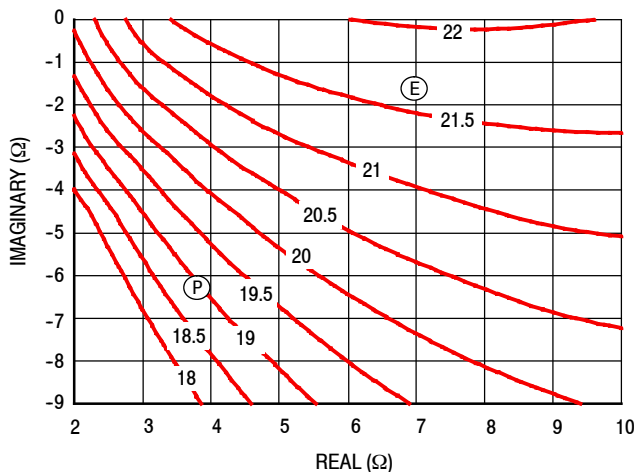


Figure 10. P1dB Load Pull Gain Contours (dB)

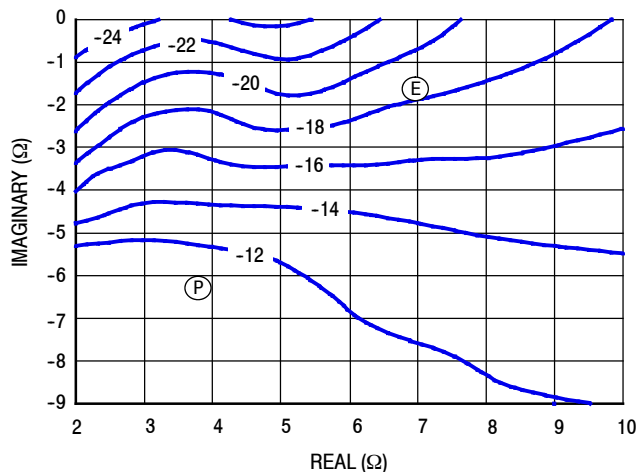


Figure 11. P1dB Load Pull AM/PM Contours (°)

NOTE: (P) = Maximum Output Power
 (E) = Maximum Drain Efficiency

- Gain
- Drain Efficiency
- Linearity
- Output Power

P3dB - TYPICAL LOAD PULL CONTOURS — 2140 MHz

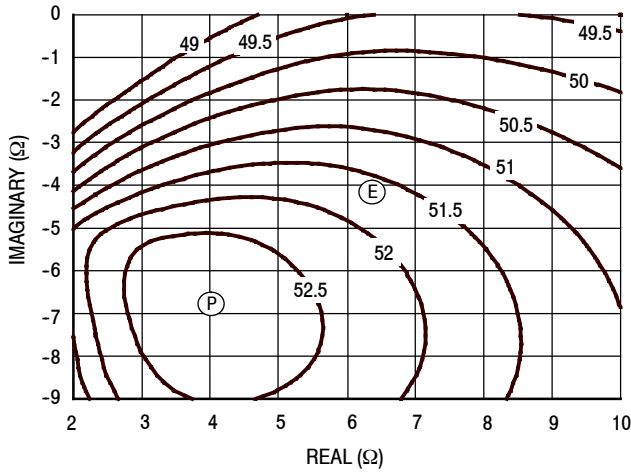


Figure 12. P3dB Load Pull Output Power Contours (dBm)

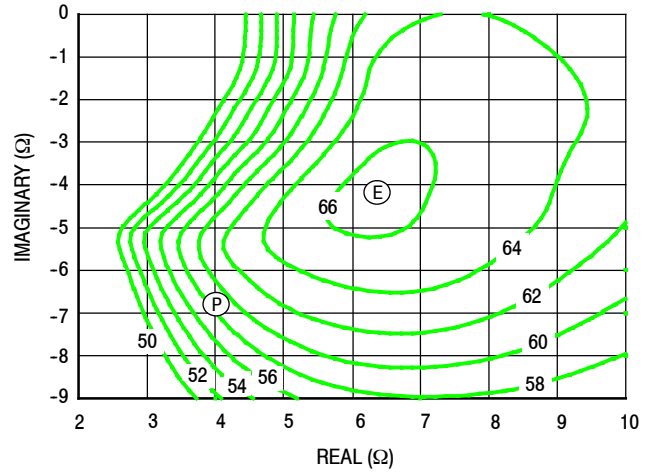


Figure 13. P3dB Load Pull Efficiency Contours (%)

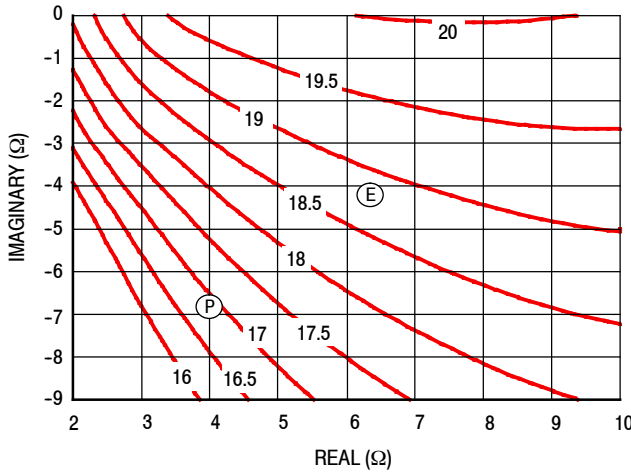


Figure 14. P3dB Load Pull Gain Contours (dB)

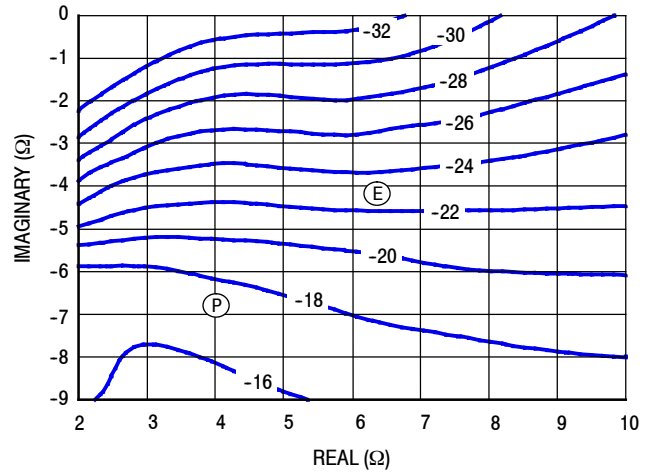
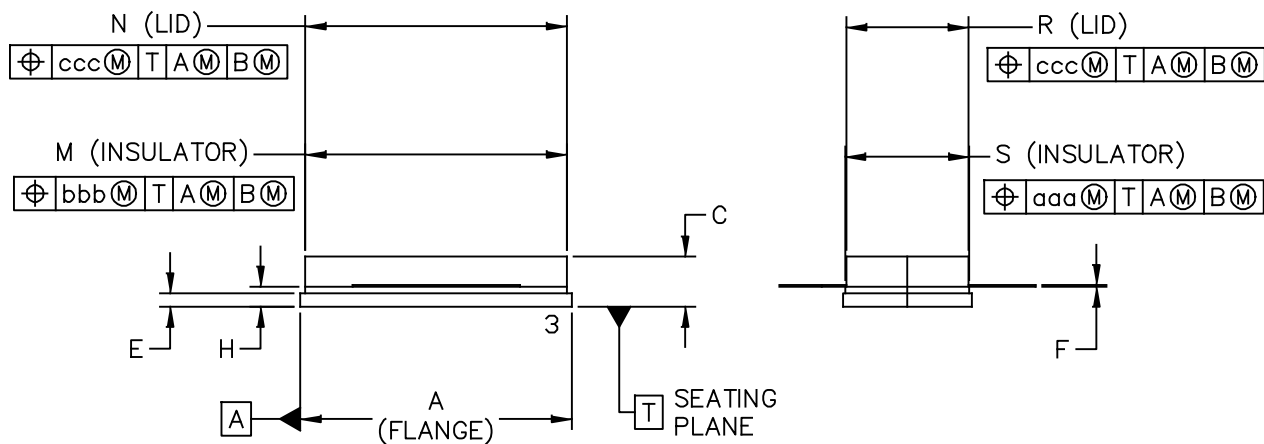
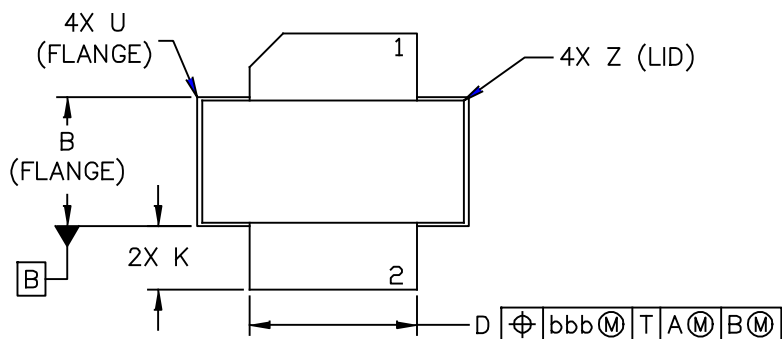


Figure 15. P3dB Load Pull AM/PM Contours (°)

NOTE: (P) = Maximum Output Power
 (E) = Maximum Drain Efficiency

- Gain
- Drain Efficiency
- Linearity
- Output Power

PACKAGE DIMENSIONS



| | | | |
|---|--------------------------|----------------------------|--|
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| TITLE: NI-780S | DOCUMENT NO: 98ASB16718C | REV: H | |
| | CASE NUMBER: 465A-06 | 31 MAR 2005 | |
| | STANDARD: NON-JEDEC | | |

NOTES:

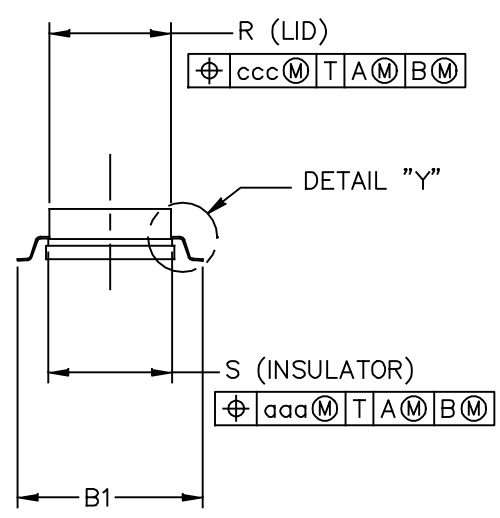
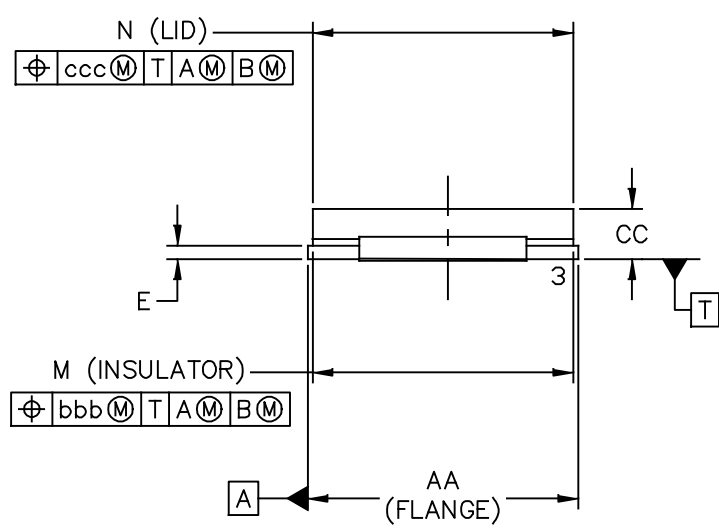
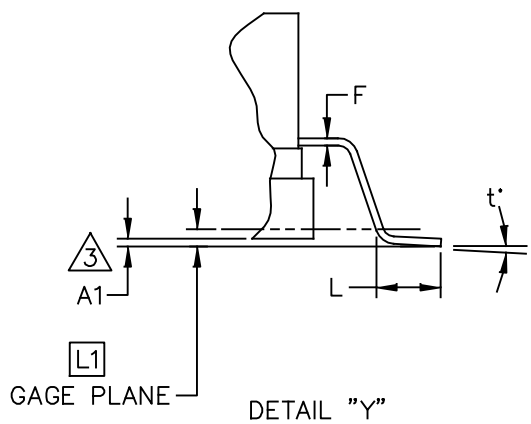
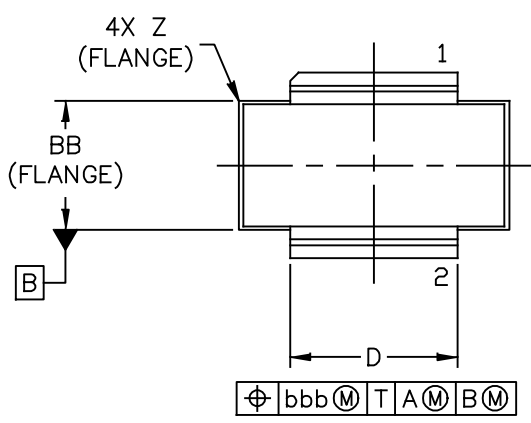
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

STYLE 1:

- PIN 1. DRAIN
2. GATE
3. SOURCE

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|-----|------|-------|------------|-------|-----|-------|-----|------------|-------|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| A | .805 | -.815 | 20.45 | 20.7 | U | -.040 | - | - | 1.02 |
| B | .380 | -.390 | 9.65 | 9.91 | Z | -.030 | - | - | 0.76 |
| C | .125 | -.170 | 3.18 | 4.32 | aaa | -.005 | - | - | 0.127 |
| D | .495 | -.505 | 12.57 | 12.83 | bbb | -.010 | - | - | 0.254 |
| E | .035 | -.045 | 0.89 | 1.14 | ccc | -.015 | - | - | 0.381 |
| F | .003 | -.006 | 0.08 | 0.15 | - | - | - | - | - |
| H | .057 | -.067 | 1.45 | 1.7 | - | - | - | - | - |
| K | .170 | -.210 | 4.32 | 5.33 | - | - | - | - | - |
| M | .774 | -.786 | 19.61 | 20.02 | - | - | - | - | - |
| N | .772 | -.788 | 19.61 | 20.02 | - | - | - | - | - |
| R | .365 | -.375 | 9.27 | 9.53 | - | - | - | - | - |
| S | .365 | -.375 | 9.27 | 9.52 | - | - | - | - | - |

| | | | | | |
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| TITLE: NI-780S | | DOCUMENT NO: 98ASB16718C | | REV: H | |
| | | CASE NUMBER: 465A-06 | | 31 MAR 2005 | |
| | | STANDARD: NON-JEDEC | | | |



| | | |
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| TITLE: NI-780GS-2L | DOCUMENT NO: 98ASA00193D | REV: B |
| | STANDARD: NON-JEDEC | |
| | 05 SEP 2013 | |

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.

2. CONTROLLING DIMENSION: INCH.

3. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM T. THE POSITIVE VALUE IMPLIES THAT THE PACKAGE BOTTOM IS HIGHER THAN THE LEAD BOTTOM.

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|---|----------|------|--------------------|-------|--------------------------|----------------------------|--------|------------|-------|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| AA | .805 | .815 | 20.45 | 20.70 | Z | R.000 | R.040 | R0.00 | R1.02 |
| A1 | .002 | .008 | 0.05 | 0.20 | t | 0 | 8 | 0 | 8 |
| BB | .380 | .390 | 9.65 | 9.91 | | | | | |
| B1 | .546 | .562 | 13.87 | 14.27 | | | | | |
| CC | .125 | .170 | 3.18 | 4.32 | aaa | .005 | | 0.13 | |
| D | .495 | .505 | 12.57 | 12.83 | bbb | .010 | | 0.25 | |
| E | .035 | .045 | 0.89 | 1.14 | ccc | .015 | | 0.38 | |
| F | .003 | .006 | 0.08 | 0.15 | | | | | |
| L | .038 | .046 | 0.97 | 1.17 | | | | | |
| L1 | .010 BSC | | 0.25 BSC | | | | | | |
| M | .774 | .786 | 19.66 | 19.96 | | | | | |
| N | .772 | .788 | 19.61 | 20.02 | | | | | |
| R | .365 | .375 | 9.27 | 9.53 | | | | | |
| S | .365 | .375 | 9.27 | 9.53 | | | | | |
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| TITLE: | | | | | DOCUMENT NO: 98ASA00193D | | REV: B | | |
| NI-780GS-2L | | | | | STANDARD: NON-JEDEC | | | | |
| | | | | | 05 SEP 2013 | | | | |

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following documents, software and tools to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

Development Tools

- Printed Circuit Boards

For Software and Tools, do a Part Number search at <http://www.freescale.com>, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|----------|-----------|---------------------------------|
| 0 | Feb. 2014 | • Initial Release of Data Sheet |

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Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

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