



# RF Power GaN Transistor

This 48 W RF power GaN transistor is designed for cellular base station applications covering the frequency range of 1805 to 2200 MHz.

This part is characterized and performance is guaranteed for applications operating in the 1805 to 2200 MHz band. There is no guarantee of performance when this part is used in applications designed outside of these frequencies.

## 2000 MHz

- Typical Single-Carrier W-CDMA Performance:  $V_{DD} = 48$  Vdc,  $I_{DQ} = 200$  mA,  $P_{out} = 48$  W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

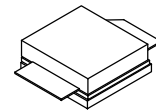
| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) | IRL (dB) |
|-----------|---------------|--------------|-----------------|------------|----------|
| 1805 MHz  | 17.4          | 33.5         | 7.0             | -34.7      | -14      |
| 1990 MHz  | 17.3          | 34.3         | 7.1             | -35.1      | -11      |
| 2170 MHz  | 17.7          | 37.5         | 6.8             | -33.2      | -12      |

## Features

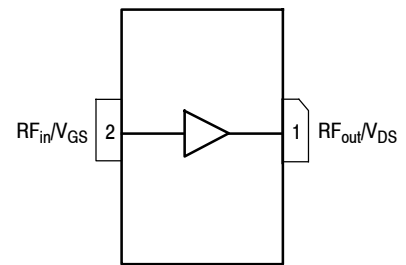
- High Terminal Impedances for Optimal Broadband Performance
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications

**A2G22S251-01SR3**

**1805–2200 MHz, 48 W AVG., 48 V  
 AIRFAST RF POWER GaN  
 TRANSISTOR**



**NI-400S-2S**



(Top View)

**Figure 1. Pin Connections**



**Table 1. Maximum Ratings**

| Rating  | Symbol     | Value       | Unit             |
|---|------------|-------------|------------------|
| Drain-Source Voltage                                    | $V_{DSS}$  | 125         | Vdc              |
| Gate-Source Voltage                                     | $V_{GS}$   | -8, 0       | Vdc              |
| Operating Voltage                                       | $V_{DD}$   | 0 to +55    | Vdc              |
| Maximum Forward Gate Current @ $T_C = 25^\circ\text{C}$ | $I_{GMAX}$ | 24          | mA               |
| Storage Temperature Range                               | $T_{stg}$  | -65 to +150 | $^\circ\text{C}$ |
| Case Operating Temperature Range                        | $T_C$      | -55 to +150 | $^\circ\text{C}$ |
| Operating Junction Temperature Range                    | $T_J$      | -55 to +225 | $^\circ\text{C}$ |
| Absolute Maximum Junction Temperature (1)               | $T_{MAX}$  | 275         | $^\circ\text{C}$ |

**Table 2. Thermal Characteristics**

| Characteristic  | Symbol                | Value    | Unit                      |
|---|-----------------------|----------|---------------------------|
| Thermal Resistance by Infrared Measurement, Active Die Surface-to-Case<br>Case Temperature $84^\circ\text{C}$ , $P_D = 88\text{ W}$ | $R_{\theta JC}$ (IR)  | 1.3 (2)  | $^\circ\text{C}/\text{W}$ |
| Thermal Resistance by Finite Element Analysis, Junction-to-Case<br>Case Temperature $85^\circ\text{C}$ , $P_D = 80\text{ W}$        | $R_{\theta JC}$ (FEA) | 1.75 (3) | $^\circ\text{C}/\text{W}$ |

**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) | II    |

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

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

**Off Characteristics**

|   |               |     |   |   |     |
|---|---------------|-----|---|---|-----|
| Drain-Source Breakdown Voltage<br>( $V_{GS} = -8\text{ Vdc}$ , $I_D = 20\text{ mAdc}$ ) | $V_{(BR)DSS}$ | 150 | — | — | Vdc |
|---|---------------|-----|---|---|-----|

**On Characteristics**

|   |              |      |      |      |      |
|---|--------------|------|------|------|------|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 20\text{ mAdc}$ )                               | $V_{GS(th)}$ | -3.8 | -3.0 | -2.3 | Vdc  |
| Gate Quiescent Voltage<br>( $V_{DD} = 48\text{ Vdc}$ , $I_D = 200\text{ mAdc}$ , Measured in Functional Test) | $V_{GS(Q)}$  | -3.6 | -3.1 | -2.3 | Vdc  |
| Gate-Source Leakage Current<br>( $V_{DS} = 0\text{ Vdc}$ , $V_{GS} = -5\text{ Vdc}$ )                         | $I_{GSS}$    | -7.5 | —    | —    | mAdc |

- Functional operation above  $225^\circ\text{C}$  has not been characterized and is not implied. Operation at  $T_{MAX}$  ( $275^\circ\text{C}$ ) reduces median time to failure by an order of magnitude; operation beyond  $T_{MAX}$  could cause permanent damage.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.nxp.com/RF> and search for AN1955.
- $R_{\theta JC}$  (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  $B = 8260$ .

(continued)

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

| Characteristic   | Symbol   | Min  | Typ   | Max  | Unit |
|--|----------|------|-------|------|------|
| <b>Functional Tests</b> <sup>(1)</sup> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 48\text{ Vdc}$ , $I_{DQ} = 200\text{ mA}$ , $P_{out} = 48\text{ W Avg.}$ , $f = 2170\text{ MHz}$ , 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 @ $\pm 5\text{ MHz}$ Offset. [See note on correct biasing sequence.] |          |      |       |      |      |
| Power Gain   | $G_{ps}$ | 16.2 | 17.7  | 19.2 | dB   |
| Drain Efficiency   | $\eta_D$ | 33.5 | 37.5  | —    | %    |
| Output Peak-to-Average Ratio @ 0.01% Probability on CCDF   | PAR      | 6.2  | 6.8   | —    | dB   |
| Adjacent Channel Power Ratio   | ACPR     | —    | -33.2 | -30  | dBc  |
| Input Return Loss  | IRL      | —    | -12   | -5   | dB   |

**Load Mismatch** (In Freescale Test Fixture, 50 ohm system)  $I_{DQ} = 200\text{ mA}$ ,  $f = 1990\text{ MHz}$ , 12  $\mu\text{sec}(\text{on})$ , 10% Duty Cycle

|  |                       |
|--|-----------------------|
| VSWR 10:1 at 55 Vdc, 250 W Pulsed CW Output Power<br>(3 dB Input Overdrive from 170 W Pulsed CW Rated Power) | No Device Degradation |
|--|-----------------------|

**Typical Performance** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 48\text{ Vdc}$ ,  $I_{DQ} = 200\text{ mA}$ , 1805–2170 MHz Bandwidth

|  |                    |   |       |   |       |
|--|--------------------|---|-------|---|-------|
| $P_{out}$ @ 1 dB Compression Point, CW   | P1dB               | — | 158   | — | W     |
| $P_{out}$ @ 3 dB Compression Point <sup>(2)</sup>  | P3dB               | — | 195   | — | W     |
| AM/PM<br>(Maximum value measured at the P3dB compression point across the 1805–2170 MHz bandwidth) | $\Phi$             | — | -16.9 | — | °     |
| VBW Resonance Point<br>(IMD Third Order Intermodulation Inflection Point)                          | VBW <sub>res</sub> | — | 140   | — | MHz   |
| Gain Flatness in 365 MHz Bandwidth @ $P_{out} = 48\text{ W Avg.}$                                  | $G_F$              | — | 0.36  | — | dB    |
| Gain Variation over Temperature<br>(-30°C to +85°C)  | $\Delta G$         | — | 0.014 | — | dB/°C |
| Output Power Variation over Temperature<br>(-30°C to +85°C)  | $\Delta P_{1dB}$   | — | 0.002 | — | dB/°C |

**Table 5. Ordering Information**

| Device          | Tape and Reel Information                             | Package    |
|-----------------|---|------------|
| A2G22S251-01SR3 | R3 Suffix = 250 Units, 32 mm Tape Width, 13-inch Reel | NI-400S-2S |

- Part internally input matched.
- P3dB =  $P_{avg} + 7.0\text{ dB}$  where  $P_{avg}$  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**

- Set  $V_{GS}$  to the pinch-off ( $V_P$ ) voltage, typically -5 V
- Turn on  $V_{DS}$  to nominal supply voltage (50 V)
- Increase  $V_{GS}$  until  $I_{DS}$  current is attained
- Apply RF input power to desired level

**Turning the device OFF**

- Turn RF power off
- Reduce  $V_{GS}$  down to  $V_P$ , typically -5 V
- Reduce  $V_{DS}$  down to 0 V (Adequate time must be allowed for  $V_{DS}$  to reduce to 0 V to prevent severe damage to device.)
- Turn off  $V_{GS}$

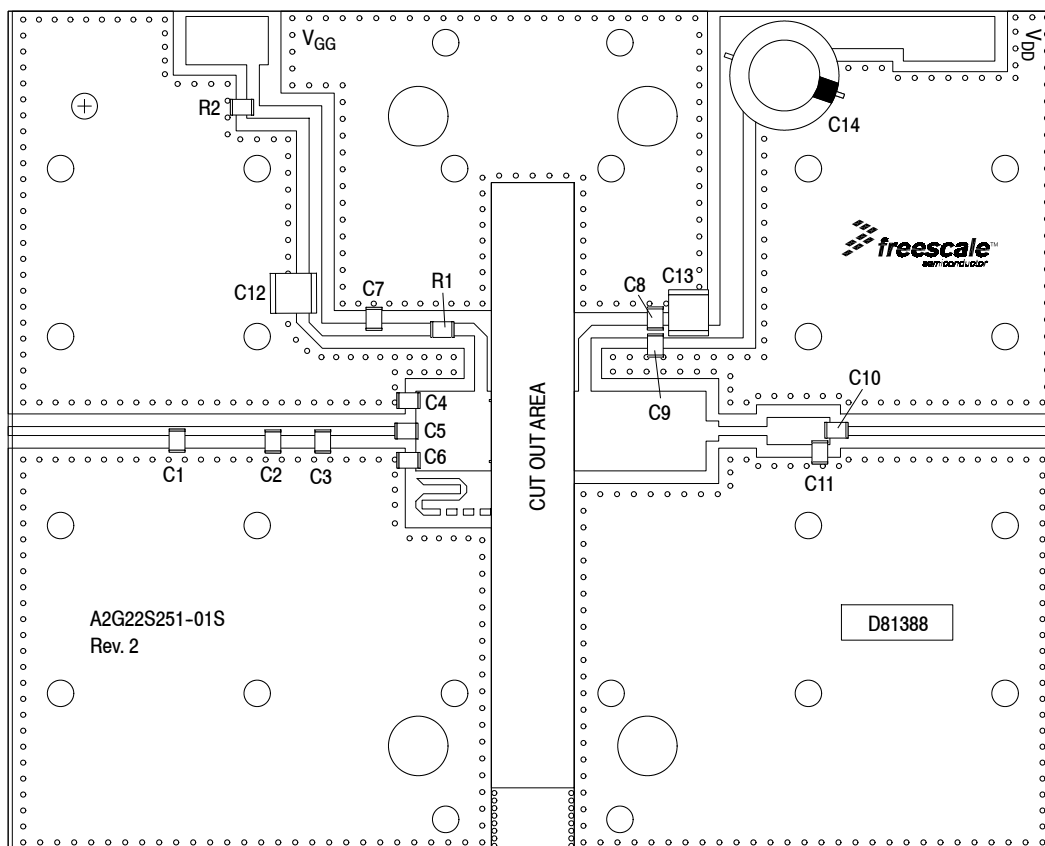


Figure 2. A2G22S251-01SR3 Test Circuit Component Layout

Table 6. A2G22S251-01SR3 Test Circuit Component Designations and Values

| Part        | Description                                 | Part Number           | Manufacturer |
|-------------|---|-----------------------|--------------|
| C1          | 1.8 pF Chip Capacitor                       | ATC600F1R8BT250XT     | ATC          |
| C2, C3      | 1.5 pF Chip Capacitors                      | ATC600F1R5BT250XT     | ATC          |
| C4, C11     | 0.3 pF Chip Capacitors                      | ATC600F0R3BT250XT     | ATC          |
| C5, C7      | 11 pF Chip Capacitors                       | ATC600F110JT250XT     | ATC          |
| C6          | 0.6 pF Chip Capacitor                       | ATC600F0R6BT250XT     | ATC          |
| C8, C9, C10 | 12 pF Chip Capacitors                       | ATC600F120JT250XT     | ATC          |
| C12, C13    | 10 $\mu$ F Chip Capacitors                  | C5750X7S2A106M230KB   | TDK          |
| C14         | 220 $\mu$ F, 100 V Electrolytic Capacitor   | MCGPR100V227M16X26-RH | Multicomp    |
| R1          | 3.9 $\Omega$ , 1/4 W Chip Resistor          | CRCW12063R90FKEA      | Vishay       |
| R2          | 1.5 k $\Omega$ , 1/4 W Chip Resistor        | CRCW12061K50FKEA      | Vishay       |
| PCB         | Rogers RO4350B, 0.020", $\epsilon_r = 3.66$ | D81388                | MTL          |

### TYPICAL CHARACTERISTICS — 1805–2170 MHz

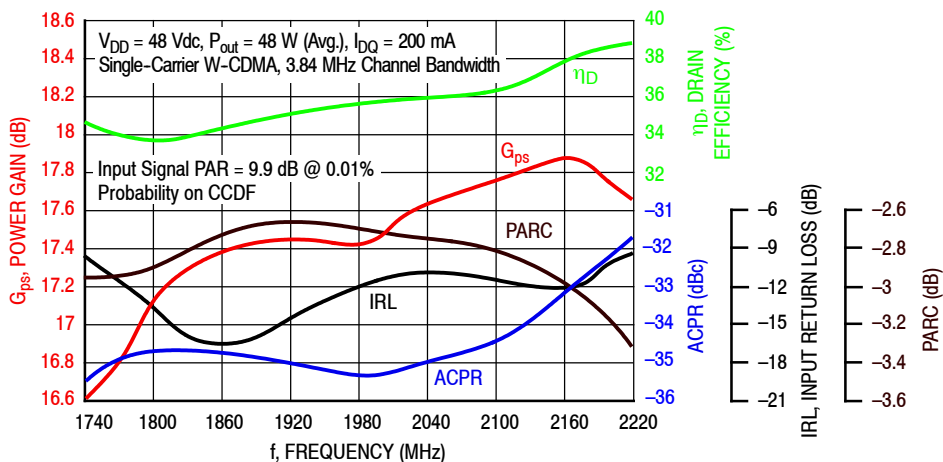


Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @  $P_{out} = 48$  Watts Avg.

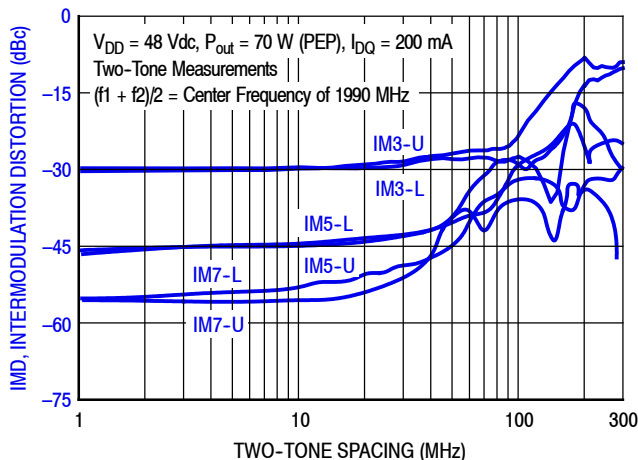


Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing

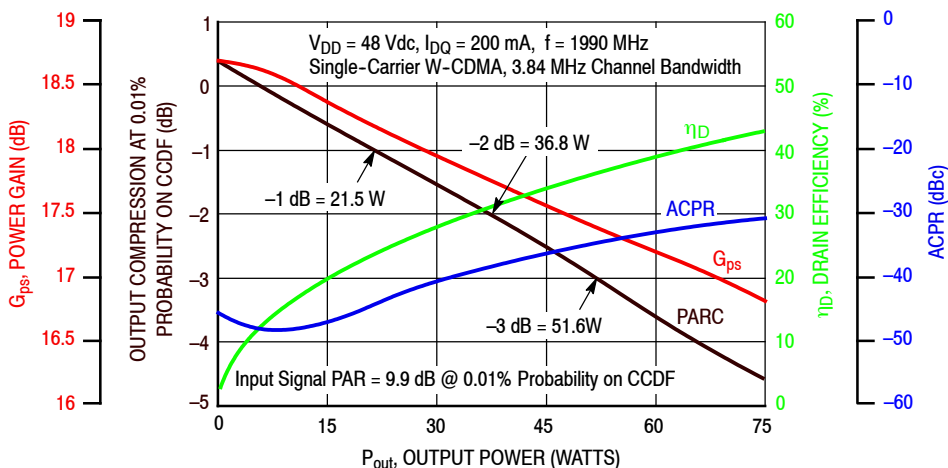


Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS — 1805–2170 MHz

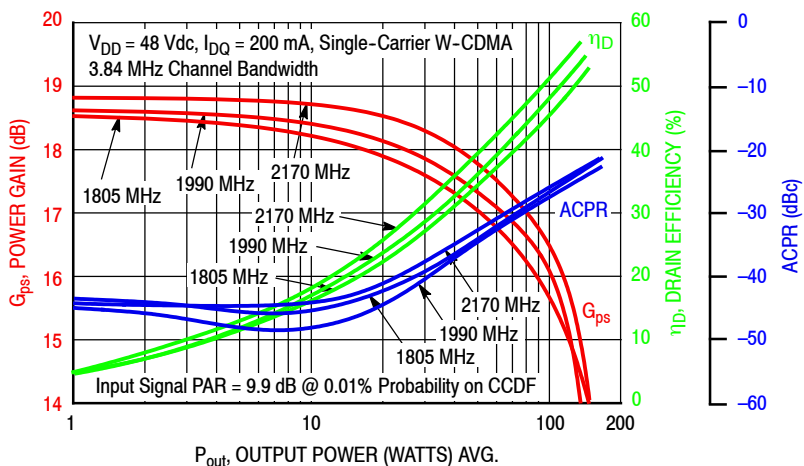


Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

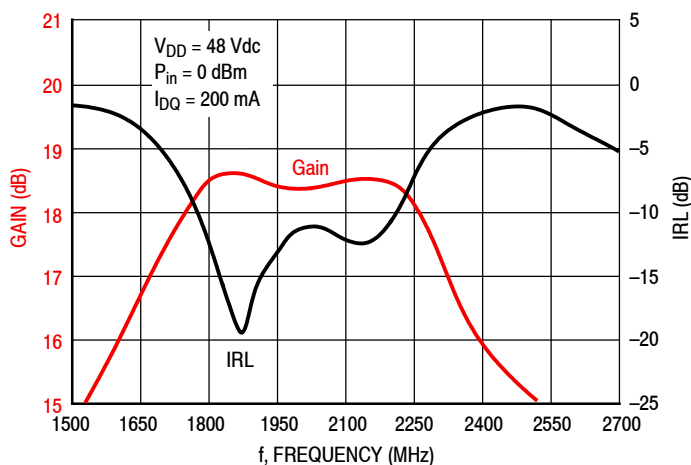


Figure 7. Broadband Frequency Response

**Table 7. Load Pull Performance — Maximum Power Tuning**

$V_{DD} = 48 \text{ Vdc}$ ,  $I_{DQ} = 222 \text{ mA}$ , 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) | $\eta_D$ (%) | AM/PM (°) |
| 1805    | $2.35 - j6.11$               | $2.60 + j6.52$           | $2.39 - j2.34$                   | 18.8      | 53.1  | 202 | 55.9         | -13       |
| 1990    | $4.56 - j7.73$               | $6.02 + j8.13$           | $2.38 - j3.05$                   | 18.4      | 52.7  | 185 | 54.2         | -13       |
| 2170    | $10.1 - j2.50$               | $9.62 + j1.70$           | $2.62 - j3.64$                   | 18.2      | 52.5  | 177 | 51.4         | -11       |

| f (MHz) | $Z_{\text{source}} (\Omega)$ | $Z_{\text{in}} (\Omega)$ | Max Output Power                 |           |       |     |              |           |
|---------|------------------------------|--------------------------|----------------------------------|-----------|-------|-----|--------------|-----------|
|         |                              |                          | P3dB                             |           |       |     |              |           |
|         |                              |                          | $Z_{\text{load}}^{(2)} (\Omega)$ | Gain (dB) | (dBm) | (W) | $\eta_D$ (%) | AM/PM (°) |
| 1805    | $2.35 - j6.11$               | $2.67 + j6.93$           | $3.62 - j3.15$                   | 17.1      | 54.4  | 277 | 63.8         | -15       |
| 1990    | $4.56 - j7.73$               | $6.90 + j8.73$           | $3.70 - j4.14$                   | 16.6      | 54.2  | 263 | 61.0         | -16       |
| 2170    | $10.1 - j2.50$               | $9.93 + j0.17$           | $3.70 - j4.12$                   | 16.6      | 54.0  | 254 | 60.5         | -16       |

(1) Load impedance for optimum P1dB power.

(2) Load impedance for optimum P3dB power.

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

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

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

**Table 8. Load Pull Performance — Maximum Efficiency Tuning**

$V_{DD} = 48 \text{ Vdc}$ ,  $I_{DQ} = 222 \text{ mA}$ , 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) | $\eta_D$ (%) | AM/PM (°) |
| 1805    | $2.35 - j6.11$               | $2.07 + j7.17$           | $2.18 - j0.08$                   | 20.5      | 50.9  | 124 | 68.5         | -29       |
| 1990    | $4.56 - j7.73$               | $5.77 + j9.93$           | $2.25 - j0.84$                   | 20.2      | 50.5  | 113 | 65.5         | -27       |
| 2170    | $10.1 - j2.50$               | $12.1 - j0.35$           | $2.03 - j1.14$                   | 20.2      | 50.2  | 104 | 63.8         | -27       |

| f (MHz) | $Z_{\text{source}} (\Omega)$ | $Z_{\text{in}} (\Omega)$ | Max Drain Efficiency             |           |       |     |              |           |
|---------|------------------------------|--------------------------|----------------------------------|-----------|-------|-----|--------------|-----------|
|         |                              |                          | P3dB                             |           |       |     |              |           |
|         |                              |                          | $Z_{\text{load}}^{(2)} (\Omega)$ | Gain (dB) | (dBm) | (W) | $\eta_D$ (%) | AM/PM (°) |
| 1805    | $2.35 - j6.11$               | $2.13 + j7.61$           | $2.56 - j0.03$                   | 18.7      | 52.1  | 161 | 75.8         | -37       |
| 1990    | $4.56 - j7.73$               | $7.18 + j10.9$           | $2.84 - j0.78$                   | 18.5      | 51.9  | 156 | 73.8         | -36       |
| 2170    | $10.1 - j2.50$               | $11.0 - j2.92$           | $2.30 - j1.05$                   | 18.4      | 51.5  | 140 | 72.1         | -39       |

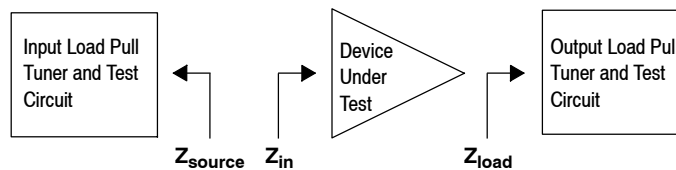
(1) Load impedance for optimum P1dB efficiency.

(2) Load impedance for optimum P3dB efficiency.

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

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

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



## P1dB - TYPICAL LOAD PULL CONTOURS — 1990 MHz

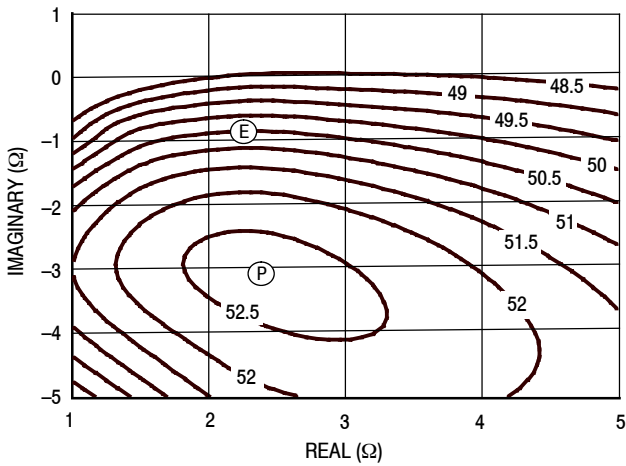


Figure 8. P1dB Load Pull Output Power Contours (dBm)

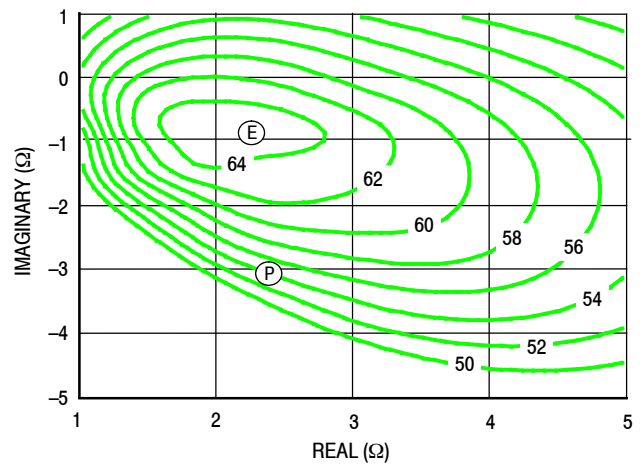


Figure 9. P1dB Load Pull Efficiency Contours (%)

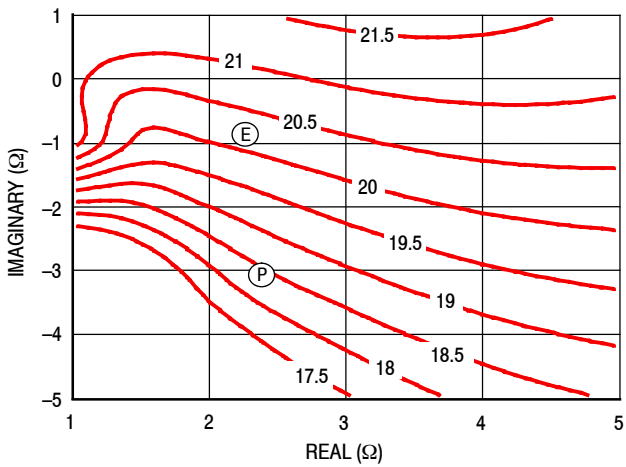


Figure 10. P1dB Load Pull Gain Contours (dB)

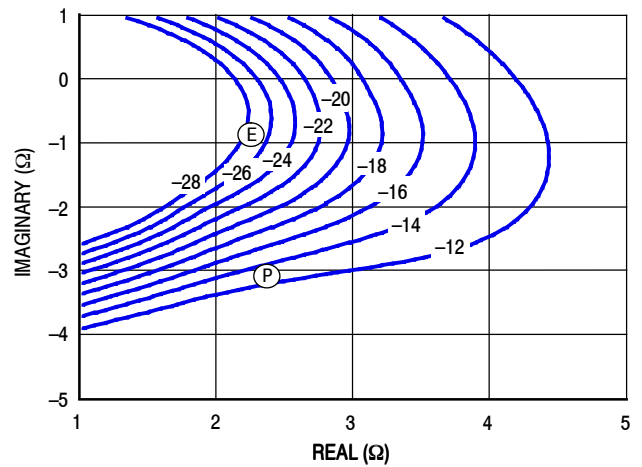


Figure 11. P1dB Load Pull AM/PM Contours (°)

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

- Gain
- Drain Efficiency
- Linearity
- Output Power



### P3dB - TYPICAL LOAD PULL CONTOURS — 1990 MHz

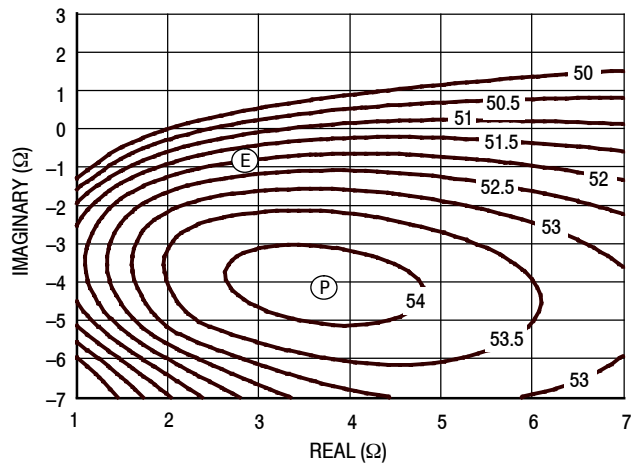


Figure 12. P3dB Load Pull Output Power Contours (dBm)

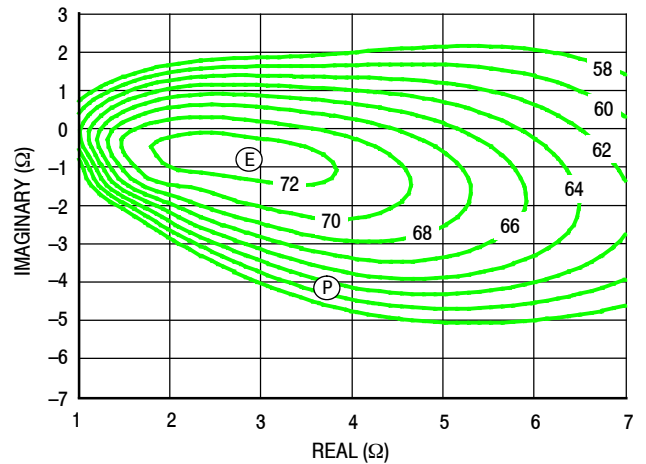


Figure 13. P3dB Load Pull Efficiency Contours (%)

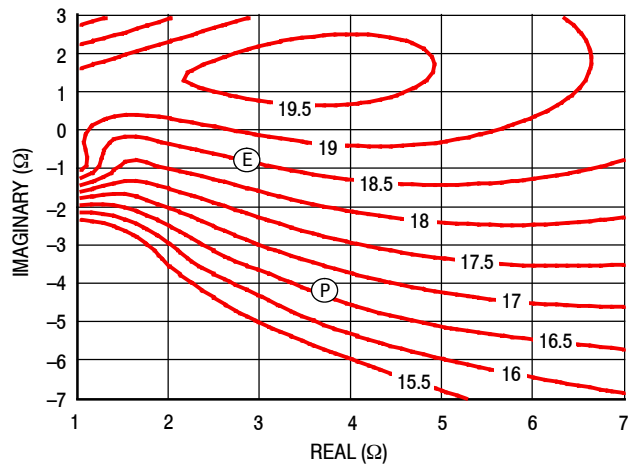


Figure 14. P3dB Load Pull Gain Contours (dB)

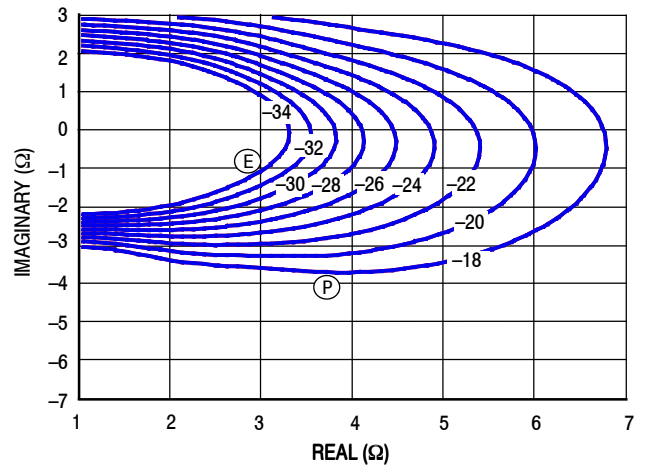
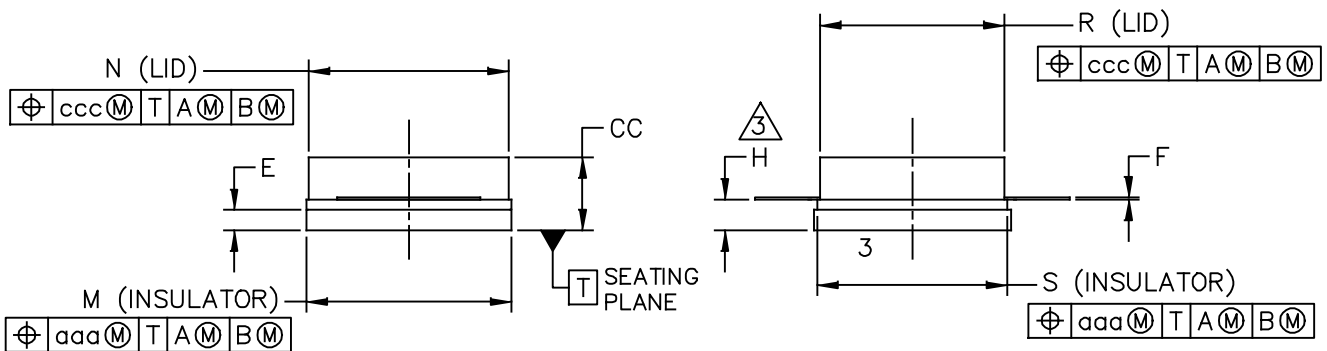
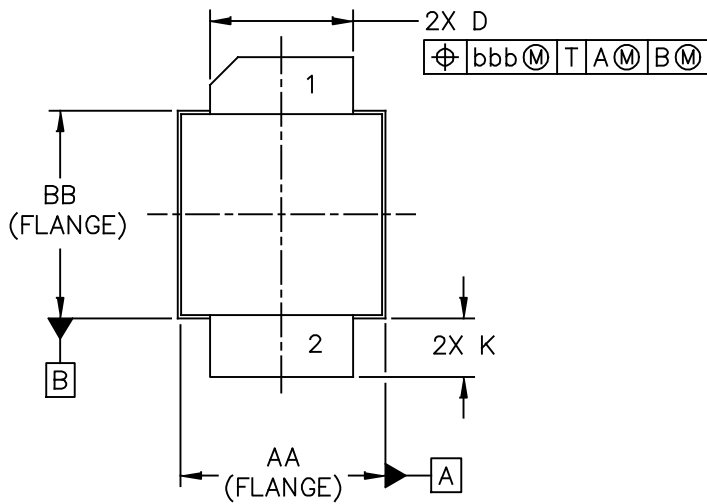


Figure 15. P3dB Load Pull AM/PM Contours (°)

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

- Gain
- Drain Efficiency
- Linearity
- Output Power

## PACKAGE DIMENSIONS



|  |                          |                            |
|--|--------------------------|----------------------------|
| © NXP SEMICONDUCTORS N.V.<br>ALL RIGHTS RESERVED | MECHANICAL OUTLINE       | PRINT VERSION NOT TO SCALE |
| TITLE:<br><br>NI-400S-2S                         | DOCUMENT NO: 98ASA10732D | REV: C                     |
|  | STANDARD: NON-JEDEC      |                            |
|  | SOT1828-1                | 13 JAN 2016                |

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DIMENSION H IS MEASURED .030 INCH (0.762 MM) AWAY FROM THE FLANGE TO CLEAR THE EPOXY FLOW OUT REGION PARALLEL TO DATUM B.
4. INPUT & OUTPUT LEADS (PIN 1 & 2) MAY HAVE SMALL FEATURES SUCH AS SQUARE HOLES OR NOTCHES FOR MANUFACTURING CONVENIENCE.

| DIM  | INCH  |       | MILLIMETER         |       | DIM                      | INCH                       |             | MILLIMETER |     |
|--|-------|-------|--------------------|-------|--------------------------|----------------------------|-------------|------------|-----|
|  | MIN   | MAX   | MIN                | MAX   |                          | MIN                        | MAX         | MIN        | MAX |
| AA   | .395  | .405  | 10.03              | 10.29 | aaa                      | .005                       |             | 0.13       |     |
| BB   | .382  | .388  | 9.70               | 9.86  | bbb                      | .010                       |             | 0.25       |     |
| CC   | .125  | .163  | 3.18               | 4.14  | ccc                      | .015                       |             | 0.38       |     |
| D  | .275  | .285  | 6.98               | 7.24  |                          |                            |             |            |     |
| E  | .035  | .045  | 0.89               | 1.14  |                          |                            |             |            |     |
| F  | .004  | .006  | 0.10               | 0.15  |                          |                            |             |            |     |
| H  | .057  | .067  | 1.45               | 1.70  |                          |                            |             |            |     |
| K  | .0995 | .1295 | 2.53               | 3.29  |                          |                            |             |            |     |
| M  | .395  | .405  | 10.03              | 10.29 |                          |                            |             |            |     |
| N  | .385  | .395  | 9.78               | 10.03 |                          |                            |             |            |     |
| R  | .355  | .365  | 9.02               | 9.27  |                          |                            |             |            |     |
| S  | .365  | .375  | 9.27               | 9.53  |                          |                            |             |            |     |
| © NXP SEMICONDUCTORS N.V.<br>ALL RIGHTS RESERVED |       |       | MECHANICAL OUTLINE |       |                          | PRINT VERSION NOT TO SCALE |             |            |     |
| TITLE:   |       |       |                    |       | DOCUMENT NO: 98ASA10732D |                            | REV: C      |            |     |
| NI-400S-2S                                       |       |       |                    |       | STANDARD: NON-JEDEC      |                            |             |            |     |
|  |       |       |                    |       | SOT1828-1                |                            | 13 JAN 2016 |            |     |

## PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources 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

- RF High Power Model
- .s2p File

### Development Tools

- Printed Circuit Boards

### To Download Resources Specific to a Given Part Number:

1. Go to <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.

| Revision | Date     | Description                     |
|----------|----------|---------------------------------|
| 0        | May 2016 | • Initial Release of Data Sheet |

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- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
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- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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ВЧ соединители, коаксиальные кабели,  
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(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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