



# RF Power GaN Transistor

This 32 W RF power GaN transistor is designed for cellular base station applications 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 Single-Carrier W-CDMA Performance:  $V_{DD} = 48$  Vdc,  $I_{DQ} = 190$  mA,  $P_{out} = 32$  W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

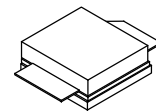
| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) | IRL (dB) |
|-----------|---------------|--------------|-----------------|------------|----------|
| 3400 MHz  | 15.6          | 37.2         | 7.0             | -33.6      | -16      |
| 3500 MHz  | 15.7          | 36.7         | 7.2             | -34.1      | -16      |
| 3600 MHz  | 15.9          | 38.9         | 7.2             | -33.2      | -13      |

### Features

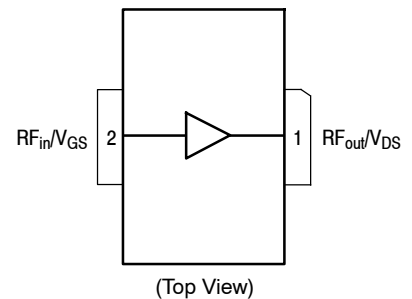
- High Terminal Impedances for Optimal Broadband Performance
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications

**A2G35S160-01SR3**

**3400–3600 MHz, 32 W AVG., 48 V  
 AIRFAST RF POWER GaN  
 TRANSISTOR**



**NI-400S-2S**



**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 @ $T_C = 25^\circ\text{C}$ | $I_{GMAX}$ | 19          | 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 $76^\circ\text{C}$ , $P_D = 66\text{ W}$ | $R_{\theta JC}$ (IR)  | 1.9 (2) | $^\circ\text{C}/\text{W}$ |
| Thermal Resistance by Finite Element Analysis, Junction-to-Case<br>Case Temperature $85^\circ\text{C}$ , $P_D = 65\text{ W}$        | $R_{\theta JC}$ (FEA) | 2.5 (3) | $^\circ\text{C}/\text{W}$ |

**Table 3. ESD Protection Characteristics**

| Test Methodology                      | Class |
|---------------------------------------|-------|
| Human Body Model (per JESD22-A114)    | 1A    |
| Machine Model (per EIA/JESD22-A115)   | A     |
| 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**

|   |               |     |   |   |     |
|---|---------------|-----|---|---|-----|
| Drain-Source Breakdown Voltage<br>( $V_{GS} = -8\text{ Vdc}$ , $I_D = 18.9\text{ mAdc}$ ) | $V_{(BR)DSS}$ | 150 | — | — | Vdc |
|---|---------------|-----|---|---|-----|

**On Characteristics**

|   |              |      |      |      |      |
|---|--------------|------|------|------|------|
| Gate Threshold Voltage<br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 18.9\text{ mAdc}$ )                             | $V_{GS(th)}$ | -3.8 | -3.1 | -2.3 | Vdc  |
| Gate Quiescent Voltage<br>( $V_{DD} = 48\text{ Vdc}$ , $I_D = 190\text{ mAdc}$ , Measured in Functional Test) | $V_{GS(Q)}$  | -3.6 | -2.6 | -2.3 | Vdc  |
| Gate-Source Leakage Current<br>( $V_{DS} = 0\text{ Vdc}$ , $V_{GS} = -5\text{ Vdc}$ )                         | $I_{GSS}$    | -5.9 | —    | —    | 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,  $A = -8.44$  and  $B = 7210$ .

(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) $V_{DD} = 48\text{ Vdc}$ , $I_{DQ} = 190\text{ mA}$ , $P_{out} = 32\text{ W Avg.}$ , $f = 3500\text{ MHz}$ , 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   | $G_{ps}$ | 13.5 | 15.7  | 18.0  | dB   |
| Drain Efficiency   | $\eta_D$ | 31.6 | 36.7  | —     | %    |
| Output Peak-to-Average Ratio @ 0.01% Probability on CCDF   | PAR      | 6.6  | 7.2   | —     | dB   |
| Adjacent Channel Power Ratio   | ACPR     | —    | -34.1 | -31.8 | dBc  |
| Input Return Loss  | IRL      | —    | -16   | -8    | dB   |

**Load Mismatch** (In Freescale Test Fixture, 50 ohm system)  $I_{DQ} = 190\text{ mA}$ ,  $f = 3500\text{ MHz}$ , 12  $\mu\text{sec}(\text{on})$ , 10% Duty Cycle

|  |                       |
|--|-----------------------|
| VSWR 10:1 at 55 Vdc, 153 W Pulsed CW Output Power<br>(3 dB Input Overdrive from 126 W Pulsed CW Rated Power) | No Device Degradation |
|--|-----------------------|

**Typical Performance** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 48\text{ Vdc}$ ,  $I_{DQ} = 190\text{ mA}$ , 3400–3600 MHz Bandwidth

|  |                    |   |       |   |       |
|--|--------------------|---|-------|---|-------|
| $P_{out}$ @ 1 dB Compression Point, CW   | P1dB               | — | 126   | — | W     |
| $P_{out}$ @ 3 dB Compression Point <sup>(2)</sup>  | P3dB               | — | 162   | — | W     |
| AM/PM<br>(Maximum value measured at the P3dB compression point across the 3400–3600 MHz bandwidth) | $\Phi$             | — | -15.6 | — | °     |
| VBW Resonance Point<br>(IMD Third Order Intermodulation Inflection Point)                          | VBW <sub>res</sub> | — | 110   | — | MHz   |
| Gain Flatness in 200 MHz Bandwidth @ $P_{out} = 32\text{ W Avg.}$                                  | $G_F$              | — | 0.5   | — | dB    |
| Gain Variation over Temperature<br>(-30°C to +85°C)  | $\Delta G$         | — | 0.02  | — | dB/°C |
| Output Power Variation over Temperature<br>(-30°C to +85°C)  | $\Delta P_{1dB}$   | — | 0.01  | — | dB/°C |

**Table 5. Ordering Information**

| Device          | Tape and Reel Information                             | Package    |
|-----------------|---|------------|
| A2G35S160-01SR3 | R3 Suffix = 250 Units, 32 mm Tape Width, 13-inch Reel | NI-400S-2S |

1. Part internally input matched.

2. 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

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

### Turning the device OFF

1. Turn RF power off
2. Reduce  $V_{GS}$  down to  $V_P$ , typically -5 V
3. 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.)
4. Turn off  $V_{GS}$

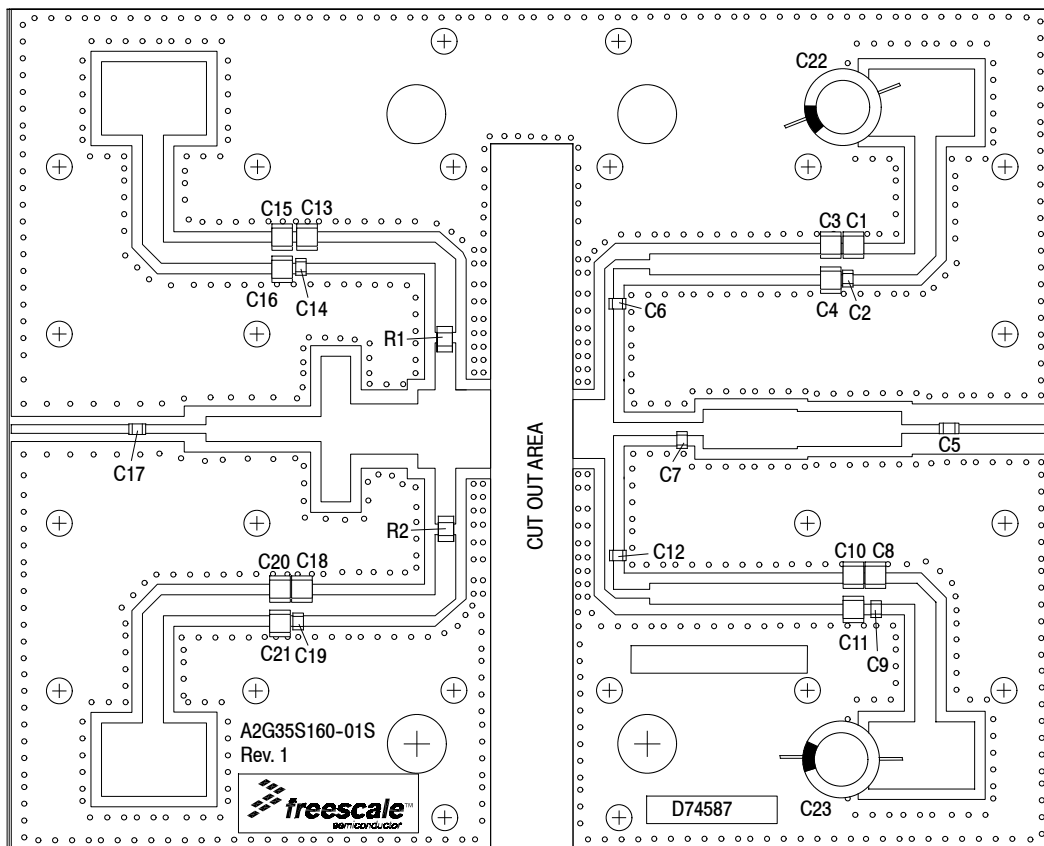
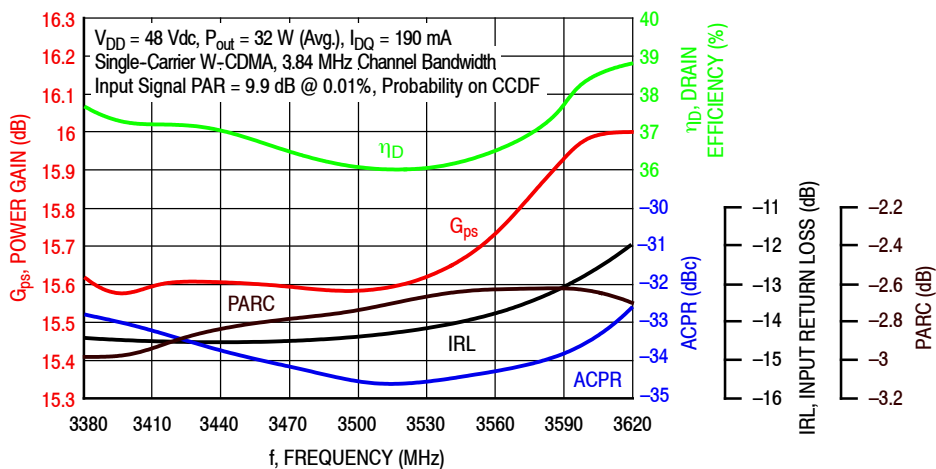


Figure 2. A2G35S160-01SR3 Test Circuit Component Layout

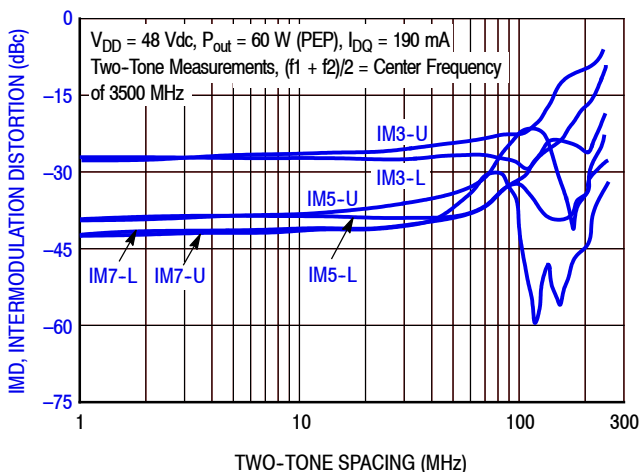
Table 6. A2G35S160-01SR3 Test Circuit Component Designations and Values

| Part              | Description                                 | Part Number         | Manufacturer |
|-------------------|---|---------------------|--------------|
| C1, C8, C13, C18  | 0.022 $\mu$ F Chip Capacitors               | GRM31MR72A223KA01L  | Murata       |
| C2, C9, C14, C19  | 1 nF Chip Capacitors                        | GRM1885C2A102JA01D  | Murata       |
| C3, C10, C15, C20 | 1 $\mu$ F Chip Capacitors                   | GRM31CR72A105KA01L  | Murata       |
| C4, C11, C16, C21 | 10 $\mu$ F Chip Capacitors                  | GRM32ER61H106KA12L  | Murata       |
| C5, C17           | 12 pF Chip Capacitors                       | GQM1875C2E120FB12D  | Murata       |
| C6, C12           | 15 pF Chip Capacitors                       | GQM1875C2E150JB12D  | Murata       |
| C7                | 0.6 pF Chip Capacitor                       | ATC600F0R6BW250XT   | ATC          |
| C22, C23          | 330 $\mu$ F, 63 V Electrolytic Capacitors   | MCRH63V337M13X21-RH | Multicomp    |
| R1, R2            | 5.60 $\Omega$ , 1/4 W Chip Resistors        | CRCW12065R60FKEA    | Vishay       |
| PCB               | Rogers RO4350B, 0.023", $\epsilon_r = 3.66$ | D74587              | MTL          |

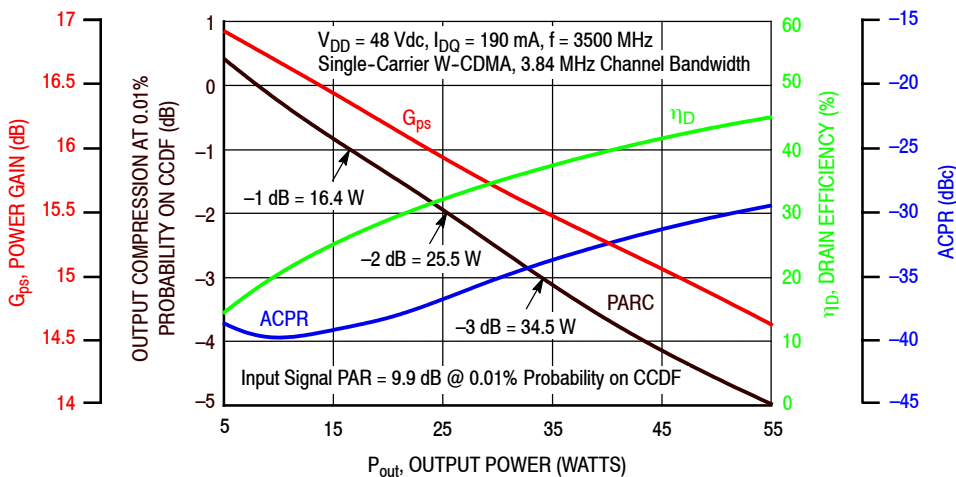
### TYPICAL CHARACTERISTICS — 3400–3600 MHz



**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 — 3400–3600 MHz

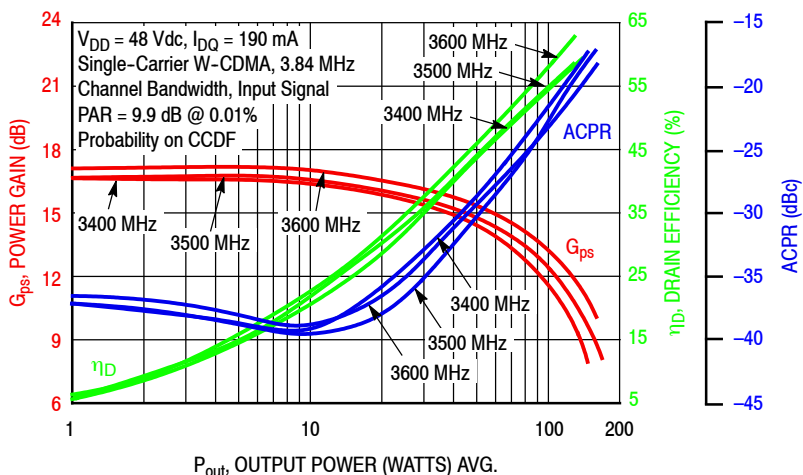


Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

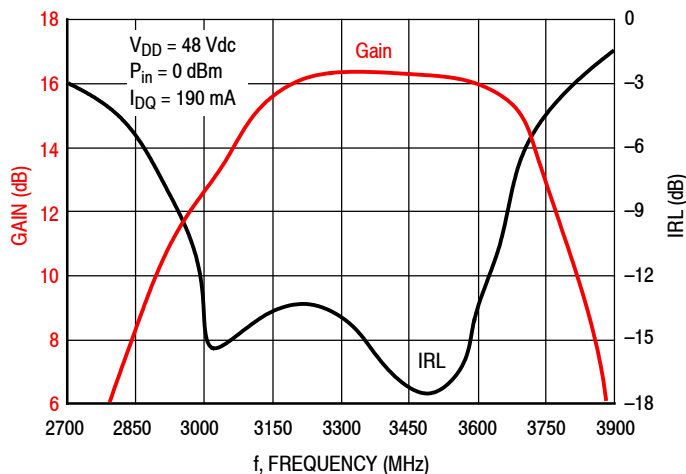
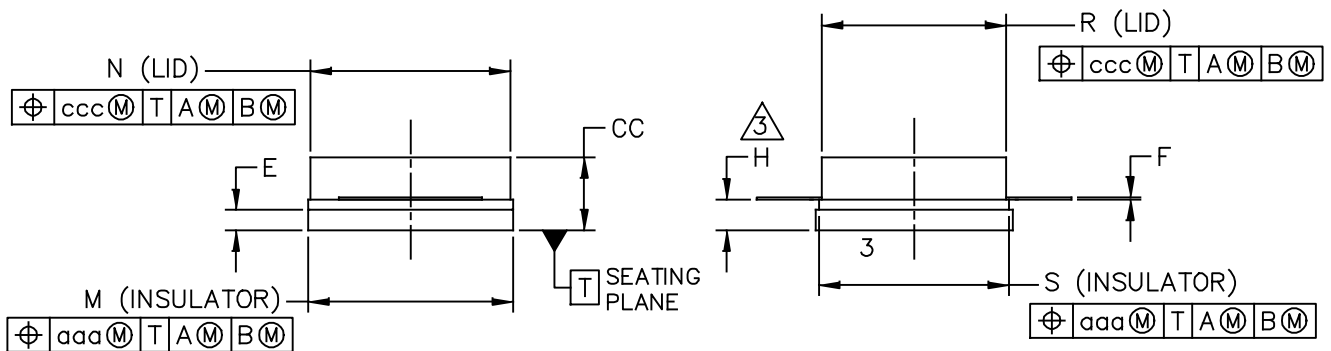
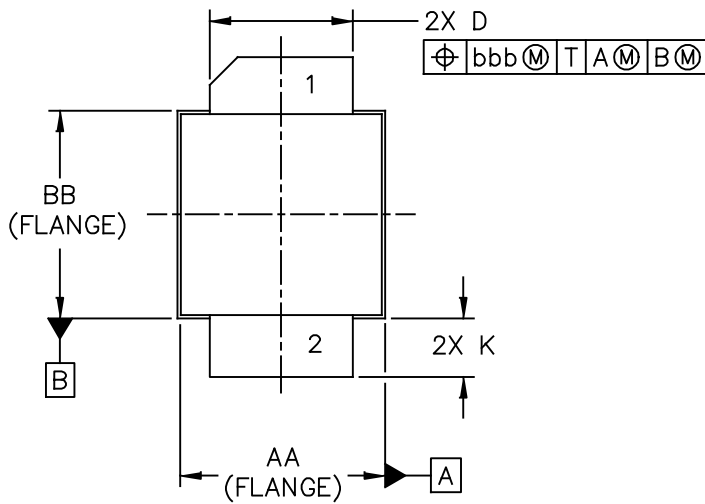


Figure 7. Broadband Frequency Response

## PACKAGE DIMENSIONS



|  |                          |                            |
|--|--------------------------|----------------------------|
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| 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  |                          |                            |             |            |     |
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|  |       |       |                    |       | 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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