

# RF LDMOS Wideband Integrated Power Amplifiers

The A2I25D025N wideband integrated circuit is designed with on-chip matching that makes it usable from 2100 to 2900 MHz. This multi-stage structure is rated for 26 to 32 V operation and covers all typical cellular base station modulation formats.

- Typical Single-Carrier W-CDMA Characterization Performance:  
 $V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ1(A+B)} = 56 \text{ mA}$ ,  $I_{DQ2(A+B)} = 136 \text{ mA}$ ,  $P_{out} = 3.2 \text{ W Avg.}$ ,  
Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF. <sup>(1)</sup>

| Frequency | $G_{ps}$<br>(dB) | PAE<br>(%) | ACPR<br>(dBc) |
|-----------|------------------|------------|---------------|
| 2300 MHz  | 32.0             | 19.0       | -46.7         |
| 2350 MHz  | 31.8             | 19.0       | -47.1         |
| 2400 MHz  | 31.7             | 19.1       | -47.5         |
| 2496 MHz  | 31.7             | 19.3       | -47.3         |
| 2600 MHz  | 32.0             | 19.5       | -47.1         |
| 2690 MHz  | 32.5             | 20.0       | -46.8         |

## Features

- On-Chip Matching (50 Ohm Input, DC Blocked)
- Integrated Quiescent Current Temperature Compensation with Enable/Disable Function <sup>(2)</sup>
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications

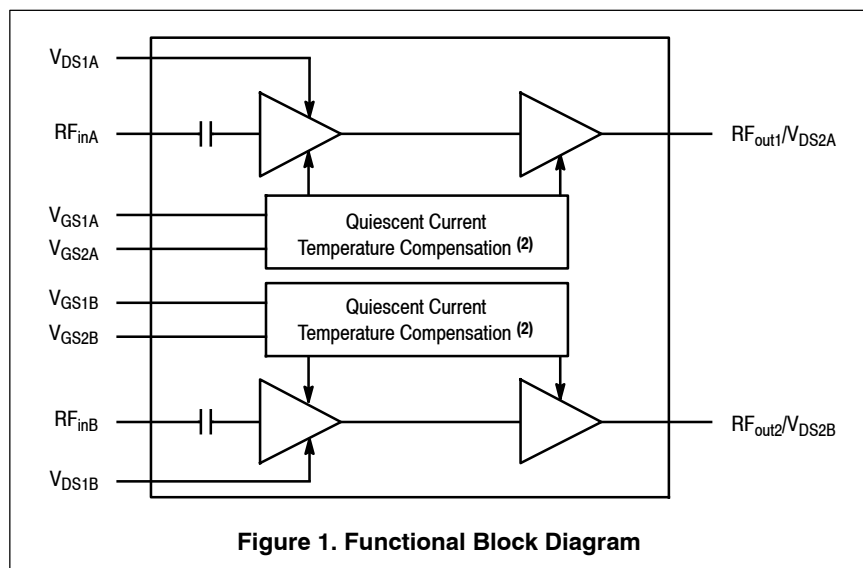
## A2I25D025NR1 A2I25D025GNR1

**2100–2900 MHz, 3.2 W AVG., 28 V  
AIRFAST RF LDMOS WIDEBAND  
INTEGRATED POWER AMPLIFIERS**

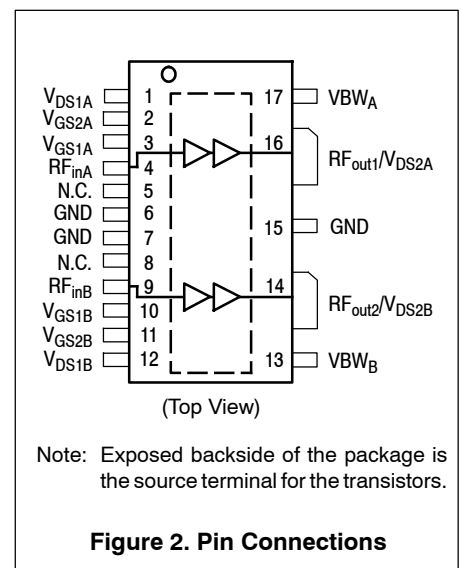
**TO-270WB-17  
PLASTIC  
A2I25D025NR1**



**TO-270WB-17  
PLASTIC  
A2I25D025GNR1**



**Figure 1. Functional Block Diagram**



Note: Exposed backside of the package is the source terminal for the transistors.

**Figure 2. Pin Connections**

- All data measured in fixture with device soldered to heatsink.
- Refer to AN1977, *Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family*, and to AN1987, *Quiescent Current Control for the RF Integrated Circuit Device Family*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes – AN1977 or AN1987.

**Table 1. Maximum Ratings**

| Rating                                     | Symbol    | Value       | Unit |
|--------------------------------------------|-----------|-------------|------|
| Drain–Source Voltage                       | $V_{DS}$  | –0.5, +65   | Vdc  |
| Gate–Source Voltage                        | $V_{GS}$  | –0.5, +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 +150 | °C   |
| Operating Junction Temperature Range (1,2) | $T_J$     | –40 to +225 | °C   |
| Input Power                                | $P_{in}$  | 20          | dBm  |

**Table 2. Thermal Characteristics**

| Characteristic                                                                                                                                                        | Symbol          | Value (2,3) | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|------|
| Thermal Resistance, Junction to Case<br>Case Temperature 74°C, 3.2 W, 2496 MHz<br>Stage 1, 28 Vdc, $I_{DQ1(A+B)} = 56$ mA<br>Stage 2, 28 Vdc, $I_{DQ2(A+B)} = 136$ mA | $R_{\theta JC}$ | 6.3<br>1.8  | °C/W |

**Table 3. ESD Protection Characteristics**

| Test Methodology                      | Class |
|---------------------------------------|-------|
| Human Body Model (per JESD22-A114)    | 1B    |
| Machine Model (per EIA/JESD22-A115)   | A     |
| Charge Device Model (per JESD22-C101) | II    |

**Table 4. Moisture Sensitivity Level**

| Test Methodology                     | Rating | Package Peak Temperature | Unit |
|--------------------------------------|--------|--------------------------|------|
| Per JESD22-A113, IPC/JEDEC J-STD-020 | 3      | 260                      | °C   |

**Table 5. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

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

**Stage 1 - Off Characteristics (4)**

|                                                                                   |           |   |   |    |                 |
|-----------------------------------------------------------------------------------|-----------|---|---|----|-----------------|
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 65$ Vdc, $V_{GS} = 0$ Vdc) | $I_{DSS}$ | — | — | 10 | $\mu\text{Adc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 32$ Vdc, $V_{GS} = 0$ Vdc) | $I_{DSS}$ | — | — | 1  | $\mu\text{Adc}$ |
| Gate–Source Leakage Current<br>( $V_{GS} = 1.0$ Vdc, $V_{DS} = 0$ Vdc)            | $I_{GSS}$ | — | — | 1  | $\mu\text{Adc}$ |

**Stage 1 - On Characteristics**

|                                                                                                               |              |     |     |     |     |
|---------------------------------------------------------------------------------------------------------------|--------------|-----|-----|-----|-----|
| Gate Threshold Voltage (4)<br>( $V_{DS} = 10$ Vdc, $I_D = 2.5$ $\mu\text{Adc}$ )                              | $V_{GS(th)}$ | 0.8 | 1.2 | 1.6 | Vdc |
| Gate Quiescent Voltage<br>( $V_{DS} = 28$ Vdc, $I_{DQ1(A+B)} = 59$ mAdc)                                      | $V_{GS(Q)}$  | —   | 2.0 | —   | Vdc |
| Fixture Gate Quiescent Voltage<br>( $V_{DD} = 28$ Vdc, $I_{DQ1(A+B)} = 59$ mAdc, Measured in Functional Test) | $V_{GG(Q)}$  | 4.6 | 5.3 | 6.1 | Vdc |

- Continuous use at maximum temperature will affect MTTF.
- MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes – AN1955.
- Each side of device measured separately.

(continued)

**Table 5. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (continued)

| Characteristic                                                                                    | Symbol    | Min | Typ | Max | Unit            |
|---------------------------------------------------------------------------------------------------|-----------|-----|-----|-----|-----------------|
| <b>Stage 2 - Off Characteristics</b> <sup>(1)</sup>                                               |           |     |     |     |                 |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | —   | —   | 10  | $\mu\text{Adc}$ |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 32\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) | $I_{DSS}$ | —   | —   | 1   | $\mu\text{Adc}$ |
| Gate-Source Leakage Current<br>( $V_{GS} = 1.0\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )            | $I_{GSS}$ | —   | —   | 1   | $\mu\text{Adc}$ |

**Stage 2 - On Characteristics**

|                                                                                                                                |              |     |      |     |     |
|--------------------------------------------------------------------------------------------------------------------------------|--------------|-----|------|-----|-----|
| Gate Threshold Voltage <sup>(1)</sup><br>( $V_{DS} = 10\text{ Vdc}$ , $I_D = 16\text{ }\mu\text{Adc}$ )                        | $V_{GS(th)}$ | 0.8 | 1.2  | 1.6 | Vdc |
| Gate Quiescent Voltage<br>( $V_{DS} = 28\text{ Vdc}$ , $I_{DQ2(A+B)} = 157\text{ mAdc}$ )                                      | $V_{GS(Q)}$  | —   | 1.9  | —   | Vdc |
| Fixture Gate Quiescent Voltage<br>( $V_{DD} = 28\text{ Vdc}$ , $I_{DQ2(A+B)} = 157\text{ mAdc}$ , Measured in Functional Test) | $V_{GG(Q)}$  | 4.3 | 5.0  | 5.8 | Vdc |
| Drain-Source On-Voltage <sup>(1)</sup><br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 200\text{ mAdc}$ )                               | $V_{DS(on)}$ | 0.1 | 0.22 | 1.5 | Vdc |

**Functional Tests** <sup>(2,3)</sup> (In Freescale Production Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1(A+B)} = 59\text{ mA}$ ,  $I_{DQ2(A+B)} = 157\text{ mA}$ ,  $P_{out} = 3.2\text{ W Avg.}$ ,  $f = 2690\text{ MHz}$ , 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.

|                        |          |      |      |      |    |
|------------------------|----------|------|------|------|----|
| Power Gain             | $G_{ps}$ | 30.5 | 31.9 | 34.5 | dB |
| Power Added Efficiency | PAE      | 18.0 | 19.7 | —    | %  |

**Load Mismatch** (In Freescale Production Test Fixture, 50 ohm system)  $I_{DQ1(A+B)} = 59\text{ mA}$ ,  $I_{DQ2(A+B)} = 157\text{ mA}$ ,  $f = 2600\text{ MHz}$

|                                                                                                |                       |  |  |  |  |
|------------------------------------------------------------------------------------------------|-----------------------|--|--|--|--|
| VSWR 10:1 at 32 Vdc, 36.3 W CW Output Power<br>(3 dB Input Overdrive from 25 W CW Rated Power) | No Device Degradation |  |  |  |  |
|------------------------------------------------------------------------------------------------|-----------------------|--|--|--|--|

**Typical Performance** <sup>(4)</sup> (In Freescale Characterization Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1(A+B)} = 56\text{ mA}$ ,  $I_{DQ2(A+B)} = 136\text{ mA}$ , 2300–2690 MHz Bandwidth

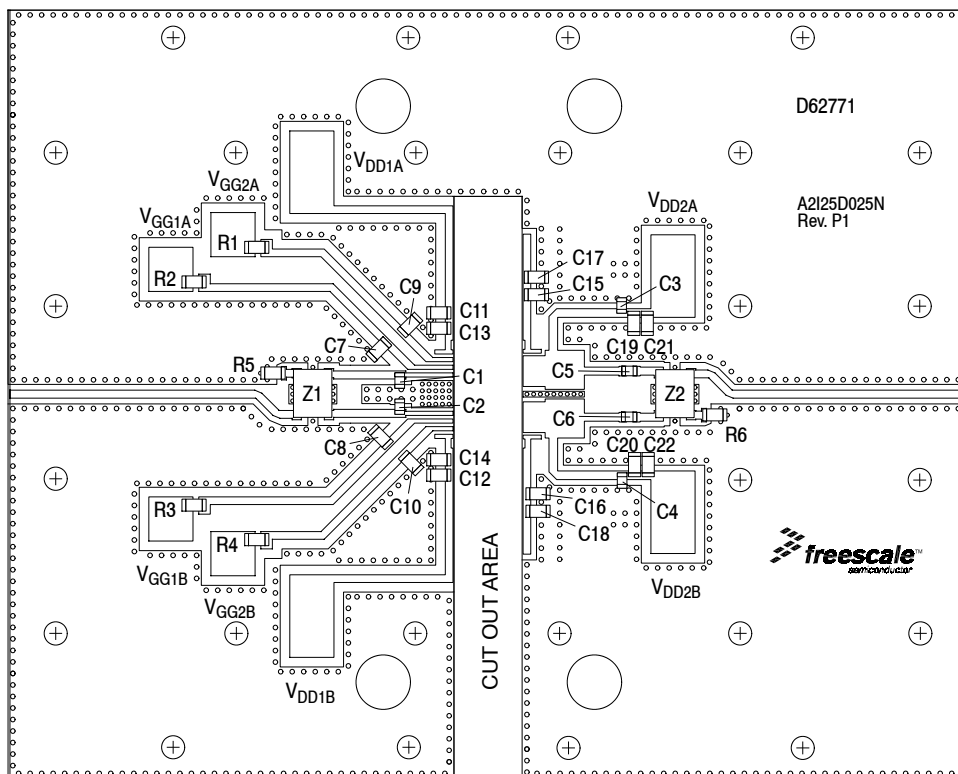
|                                                                                                                                                                                              |                  |        |              |        |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------|--------------|--------|-------|
| $P_{out}$ @ 1 dB Compression Point, CW                                                                                                                                                       | $P_{1dB}$        | —      | 24           | —      | W     |
| $P_{out}$ @ 3 dB Compression Point, CW <sup>(5)</sup>                                                                                                                                        | $P_{3dB}$        | —      | 35.5         | —      | W     |
| AM/PM<br>(Maximum value measured at the P3dB compression point across the 2300–2690 MHz frequency range.)                                                                                    | $\Phi$           | —      | –9.0         | —      | °     |
| VBW Resonance Point<br>(IMD Third Order Intermodulation Inflection Point)                                                                                                                    | $VBW_{res}$      | —      | 170          | —      | MHz   |
| Quiescent Current Accuracy over Temperature <sup>(6)</sup><br>with 4.7 k $\Omega$ Gate Feed Resistors (–30 to 85°C) Stage 1<br>with 4.7 k $\Omega$ Gate Feed Resistors (–30 to 85°C) Stage 2 | $\Delta I_{QT}$  | —<br>— | 2.43<br>1.13 | —<br>— | %     |
| Gain Flatness in 390 MHz Bandwidth @ $P_{out} = 3.2\text{ W Avg.}$                                                                                                                           | $G_F$            | —      | 0.8          | —      | dB    |
| Gain Variation over Temperature<br>(–30°C to +85°C)                                                                                                                                          | $\Delta G$       | —      | 0.036        | —      | dB/°C |
| Output Power Variation over Temperature<br>(–30°C to +85°C)                                                                                                                                  | $\Delta P_{1dB}$ | —      | 0.004        | —      | dB/°C |

**Table 6. Ordering Information**

| Device        | Tape and Reel Information                             | Package      |
|---------------|-------------------------------------------------------|--------------|
| A2I25D025NR1  | R1 Suffix = 500 Units, 44 mm Tape Width, 13-inch Reel | TO-270WB-17  |
| A2I25D025GNR1 |                                                       | TO-270WBG-17 |

- Each side of device measured separately.
- Part internally input and output matched.
- Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GN) parts.
- All data measured in fixture with device soldered to heatsink.
- $P_{3dB} = P_{avg} + 7.0\text{ dB}$  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.
- Refer to AN1977, *Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family*, and to AN1987, *Quiescent Current Control for the RF Integrated Circuit Device Family*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes – AN1977 or AN1987.

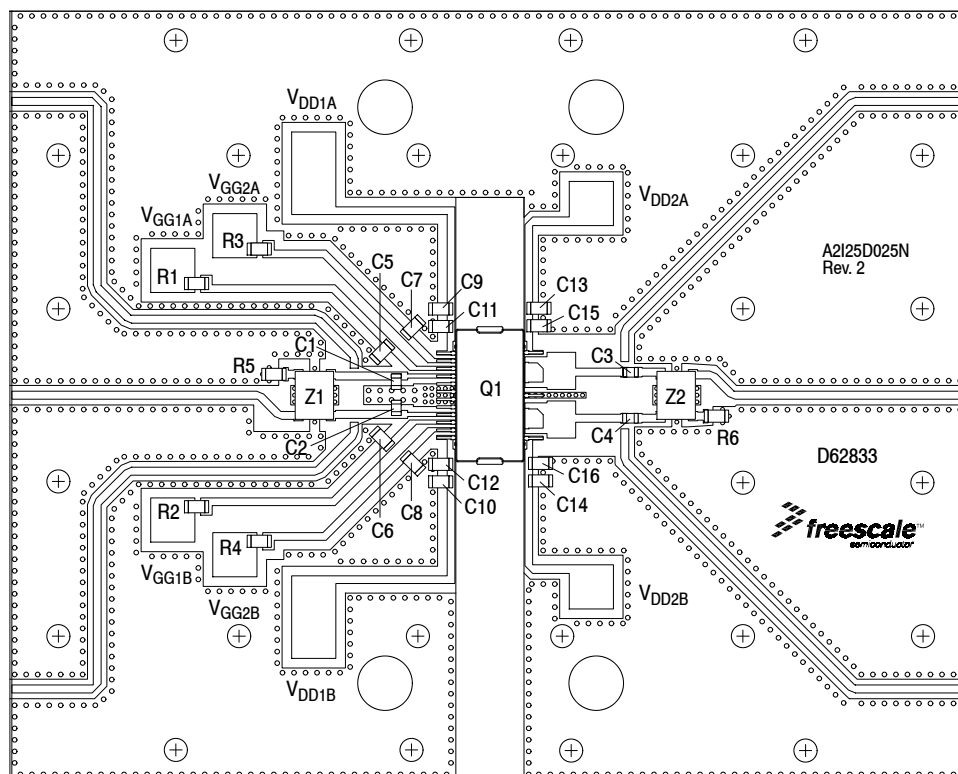
**A2I25D025NR1 A2I25D025GNR1**



**Figure 3. A2I25D025NR1 Production Test Circuit Component Layout**

**Table 7. A2I25D025NR1 Production Test Circuit Component Designations and Values**

| Part                                | Description                                 | Part Number        | Manufacturer |
|-------------------------------------|---------------------------------------------|--------------------|--------------|
| C1, C2                              | 0.9 pF Chip Capacitors                      | ATC600F0R9BT250XT  | ATC          |
| C3, C4                              | 15 pF Chip Capacitors                       | ATC600F150JT250XT  | ATC          |
| C5, C6                              | 30 pF Chip Capacitors                       | ATC600F300JT250XT  | ATC          |
| C7, C8, C9, C10, C15, C16, C19, C20 | 4.7 $\mu$ F Chip Capacitors                 | GRM31CR71H475KA12L | Murata       |
| C11, C12, C17, C18, C21, C22        | 10 $\mu$ F Chip Capacitors                  | GRM31CR61H106KA12L | Murata       |
| C13, C14                            | 1 $\mu$ F Chip Capacitors                   | GRM31MR71H105KA88L | Murata       |
| R1, R4                              | 4.7 K $\Omega$ Chip Resistors               | CRCW12064K70FKEA   | Vishay       |
| R2, R3                              | 2.2 k $\Omega$ , 1/4 W Chip Resistors       | CRCW12062K20FKEA   | Vishay       |
| R5, R6                              | 50 $\Omega$ , 10 W Chip Resistors           | 060120A15Z50-2     | Anaren       |
| Z1, Z2                              | 2300–2900 MHz Band, 3 dB Hybrid Couplers    | X3C26P1-03S        | Anaren       |
| PCB                                 | Rogers RO4350B, 0.020", $\epsilon_r = 3.66$ | D62771             | MTL          |



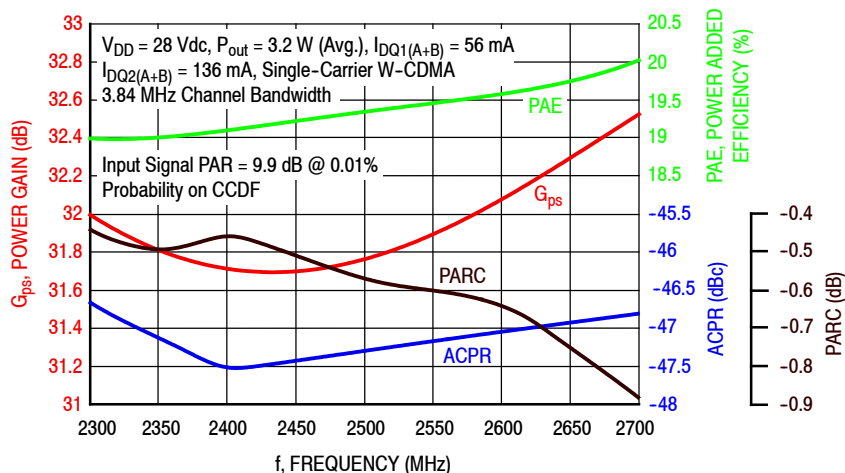
Note: All data measured in fixture with device soldered to heatsink.

**Figure 4. A2I25D025NR1 Characterization Test Circuit Component Layout**

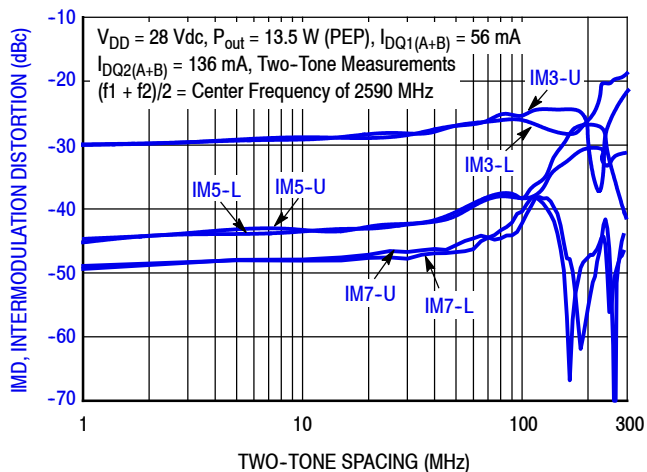
**Table 8. A2I25D025NR1 Characterization Test Circuit Component Designations and Values**

| Part                     | Description                                 | Part Number        | Manufacturer |
|--------------------------|---------------------------------------------|--------------------|--------------|
| C1, C2                   | 0.9 pF Chip Capacitors                      | ATC600F0R9BT250XT  | ATC          |
| C3, C4                   | 20 pF Chip Capacitors                       | ATC600F200JT250XT  | ATC          |
| C5, C6, C7, C8, C15, C16 | 4.7 $\mu$ F Chip Capacitors                 | GRM31CR71H475KA12L | Murata       |
| C9, C10, C13, C14        | 10 $\mu$ F Chip Capacitors                  | GRM31CR61H106KA12L | Murata       |
| C11, C12                 | 1.0 $\mu$ F Chip Capacitors                 | GRM31MR71H105KA88L | Murata       |
| Q1                       | RF LDMOS Power Amplifier                    | A2I25D025NR1       | Freescale    |
| R1, R2                   | 2.2 k $\Omega$ , 1/4 W Chip Resistors       | CRCW12062K20FKEA   | Vishay       |
| R3, R4                   | 4.7 k $\Omega$ , 1/4 W Chip Resistors       | CRCW12064K70FKEA   | Vishay       |
| R5, R6                   | 50 $\Omega$ , 8 W Chip Resistors            | C8A50Z4A           | Anaren       |
| Z1, Z2                   | 2300–2900 MHz Band, 3 dB Hybrid Couplers    | X3C26P1-03S        | Anaren       |
| PCB                      | Rogers RO4350B, 0.020", $\epsilon_r = 3.66$ | D62833             | MTL          |

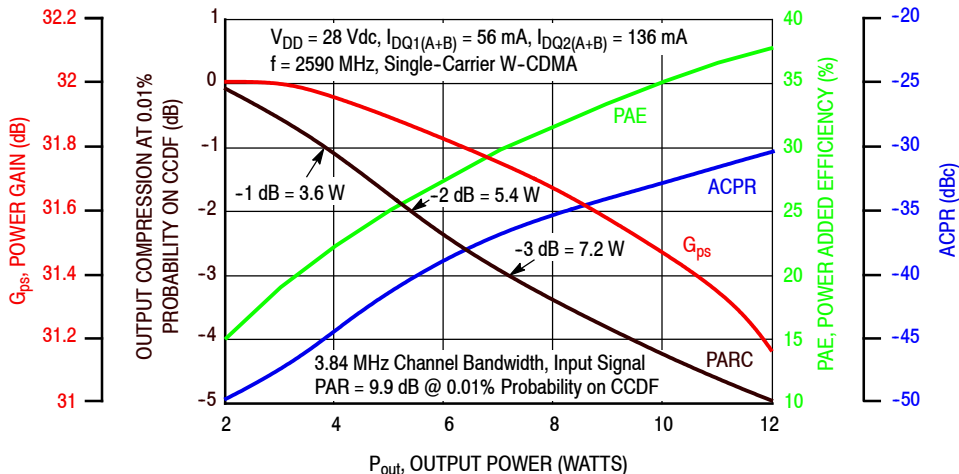
## TYPICAL CHARACTERISTICS



**Figure 5. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @  $P_{out} = 3.2$  Watts Avg.**

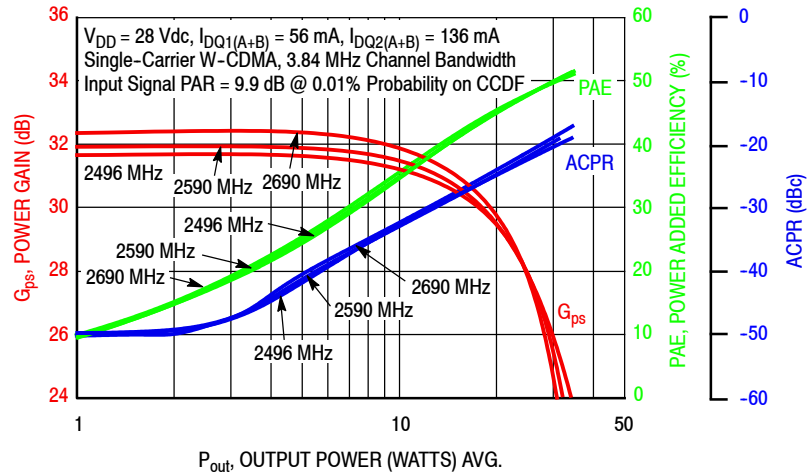


**Figure 6. Intermodulation Distortion Products versus Two-Tone Spacing**

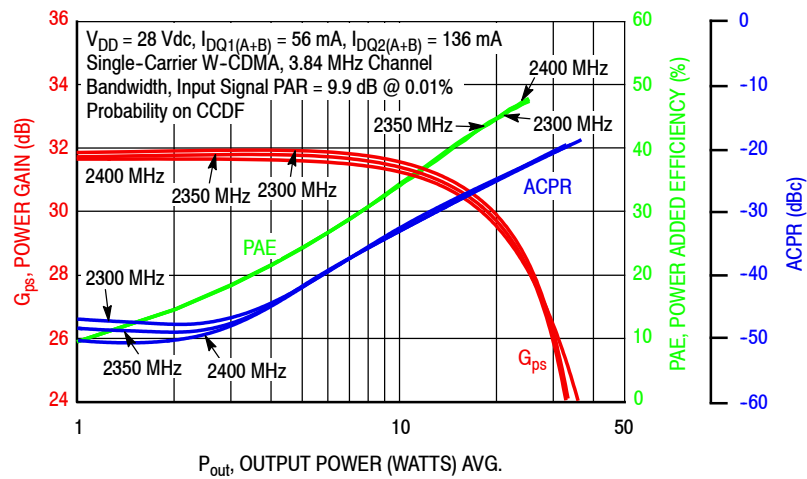


**Figure 7. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

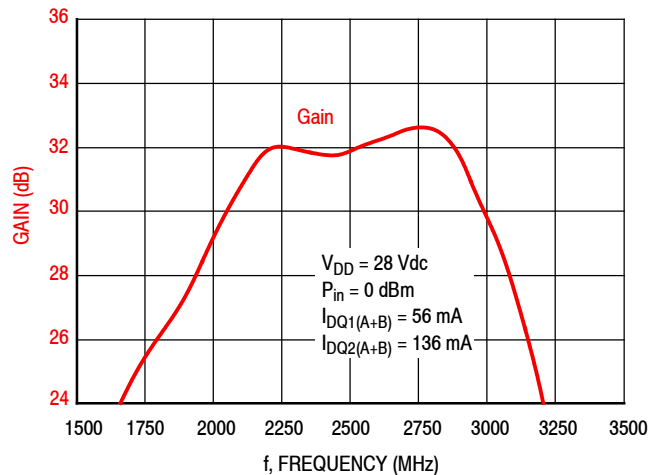
## TYPICAL CHARACTERISTICS



**Figure 8. Single-Carrier W-CDMA Power Gain, Power Added Efficiency and ACPR versus Output Power — 2496–2690 MHz**



**Figure 9. Single-Carrier W-CDMA Power Gain, Power Added Efficiency and ACPR versus Output Power — 2300–2400 MHz**



Note: Frequency response at band edges limited by hybrid couplers.

**Figure 10. Broadband Frequency Response**

**Table 9. Load Pull Performance — Maximum Power Tuning**
 $V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ1(A)} = 29 \text{ mA}$ ,  $I_{DQ2(A)} = 75 \text{ mA}$ , Pulsed CW, 10  $\mu\text{sec(ON)}$ , 10% Duty Cycle

| f<br>(MHz) | $Z_{\text{source}}$<br>( $\Omega$ ) | $Z_{\text{in}}$<br>( $\Omega$ ) | Max Output Power                        |           |       |     |         |           |
|------------|-------------------------------------|---------------------------------|-----------------------------------------|-----------|-------|-----|---------|-----------|
|            |                                     |                                 | P1dB                                    |           |       |     |         |           |
|            |                                     |                                 | $Z_{\text{load}}^{(1)}$<br>( $\Omega$ ) | Gain (dB) | (dBm) | (W) | PAE (%) | AM/PM (°) |
| 2300       | 35.0 + j9.89                        | 36.0 – j13.0                    | 10.4 – j9.63                            | 30.4      | 42.6  | 18  | 59.0    | –2        |
| 2350       | 43.2 + j11.9                        | 41.9 – j16.8                    | 10.8 – j11.0                            | 30.5      | 42.5  | 18  | 56.9    | –2        |
| 2400       | 45.8 + j23.1                        | 43.5 – j26.0                    | 10.6 – j8.31                            | 30.7      | 42.3  | 17  | 57.2    | –3        |
| 2496       | 43.9 + j37.9                        | 40.7 – j37.0                    | 10.1 – j8.37                            | 31.0      | 42.6  | 18  | 60.5    | –3        |
| 2590       | 33.1 + j43.7                        | 31.4 – j41.4                    | 9.32 – j9.38                            | 31.0      | 42.7  | 19  | 60.9    | –3        |
| 2690       | 29.5 + j41.2                        | 28.0 – j37.3                    | 7.84 – j9.97                            | 30.7      | 42.7  | 18  | 60.8    | –4        |

| f<br>(MHz) | $Z_{\text{source}}$<br>( $\Omega$ ) | $Z_{\text{in}}$<br>( $\Omega$ ) | Max Output Power                        |           |       |     |         |           |
|------------|-------------------------------------|---------------------------------|-----------------------------------------|-----------|-------|-----|---------|-----------|
|            |                                     |                                 | P3dB                                    |           |       |     |         |           |
|            |                                     |                                 | $Z_{\text{load}}^{(2)}$<br>( $\Omega$ ) | Gain (dB) | (dBm) | (W) | PAE (%) | AM/PM (°) |
| 2300       | 35.0 + j9.89                        | 37.3 – j16.5                    | 9.84 – j10.3                            | 28.2      | 43.3  | 21  | 59.2    | –6        |
| 2350       | 43.2 + j11.9                        | 41.5 – j20.9                    | 10.6 – j11.4                            | 28.5      | 43.2  | 21  | 58.3    | –7        |
| 2400       | 45.8 + j23.1                        | 41.0 – j29.4                    | 10.6 – j8.89                            | 28.6      | 43.1  | 21  | 58.9    | –8        |
| 2496       | 43.9 + j37.9                        | 37.0 – j37.7                    | 10.3 – j9.50                            | 28.8      | 43.4  | 22  | 61.4    | –8        |
| 2590       | 33.1 + j43.7                        | 28.2 – j40.5                    | 9.50 – j10.2                            | 28.9      | 43.5  | 23  | 61.3    | –8        |
| 2690       | 29.5 + j41.2                        | 25.3 – j35.2                    | 8.12 – j11.0                            | 28.5      | 43.4  | 22  | 61.6    | –11       |

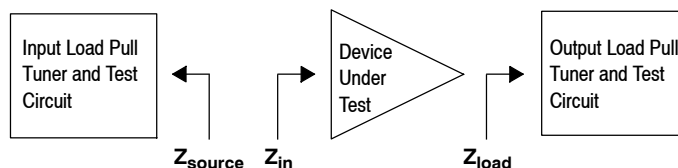
(1) Load impedance for optimum P1dB power.

(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.

**Note: Measurement made on a per side basis.**


**Table 10. Load Pull Performance — Maximum Power Added Efficiency Tuning**
 $V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ1(A)} = 29 \text{ mA}$ ,  $I_{DQ2(A)} = 75 \text{ mA}$ , Pulsed CW, 10  $\mu\text{sec}(\text{on})$ , 10% Duty Cycle

| f<br>(MHz) | $Z_{\text{source}}$<br>( $\Omega$ ) | $Z_{\text{in}}$<br>( $\Omega$ ) | Max Power Added Efficiency              |           |       |     |         |           |
|------------|-------------------------------------|---------------------------------|-----------------------------------------|-----------|-------|-----|---------|-----------|
|            |                                     |                                 | P1dB                                    |           |       |     |         |           |
|            |                                     |                                 | $Z_{\text{load}}^{(1)}$<br>( $\Omega$ ) | Gain (dB) | (dBm) | (W) | PAE (%) | AM/PM (°) |
| 2300       | 35.0 + j9.89                        | 38.0 – j10.9                    | 18.2 – j1.09                            | 31.8      | 40.8  | 12  | 67.0    | –6        |
| 2350       | 43.2 + j11.9                        | 45.1 – j14.7                    | 16.1 – j0.71                            | 31.9      | 40.9  | 12  | 64.2    | –6        |
| 2400       | 45.8 + j23.1                        | 46.9 – j26.5                    | 14.9 – j0.56                            | 31.9      | 41.1  | 13  | 65.4    | –5        |
| 2496       | 43.9 + j37.9                        | 42.8 – j38.7                    | 12.1 – j2.47                            | 31.9      | 41.6  | 14  | 67.5    | –6        |
| 2590       | 33.1 + j43.7                        | 32.9 – j44.4                    | 9.72 – j2.39                            | 32.1      | 41.3  | 14  | 68.8    | –7        |
| 2690       | 29.5 + j41.2                        | 28.3 – j41.3                    | 7.82 – j4.78                            | 31.8      | 41.4  | 14  | 67.9    | –9        |

| f<br>(MHz) | $Z_{\text{source}}$<br>( $\Omega$ ) | $Z_{\text{in}}$<br>( $\Omega$ ) | Max Power Added Efficiency              |           |       |     |         |           |
|------------|-------------------------------------|---------------------------------|-----------------------------------------|-----------|-------|-----|---------|-----------|
|            |                                     |                                 | P3dB                                    |           |       |     |         |           |
|            |                                     |                                 | $Z_{\text{load}}^{(2)}$<br>( $\Omega$ ) | Gain (dB) | (dBm) | (W) | PAE (%) | AM/PM (°) |
| 2300       | 35.0 + j9.89                        | 38.7 – j13.1                    | 17.2 – j2.23                            | 29.7      | 41.7  | 15  | 66.7    | –11       |
| 2350       | 43.2 + j11.9                        | 44.6 – j17.7                    | 15.8 – j2.22                            | 29.8      | 41.9  | 15  | 64.7    | –9        |
| 2400       | 45.8 + j23.1                        | 45.2 – j28.8                    | 14.2 – j0.88                            | 29.9      | 41.9  | 15  | 65.7    | –10       |
| 2496       | 43.9 + j37.9                        | 40.4 – j39.4                    | 11.9 – j2.47                            | 29.9      | 42.3  | 17  | 67.9    | –11       |
| 2590       | 33.1 + j43.7                        | 30.3 – j43.9                    | 9.68 – j2.97                            | 30.0      | 42.1  | 16  | 68.5    | –12       |
| 2690       | 29.5 + j41.2                        | 25.7 – j39.0                    | 7.97 – j5.65                            | 29.7      | 42.4  | 17  | 67.4    | –15       |

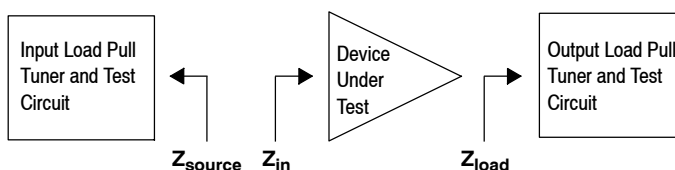
(1) Load impedance for optimum P1dB efficiency.

(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.

**Note: Measurement made on a per side basis.**


## P1dB - TYPICAL LOAD PULL CONTOURS — 2590 MHz

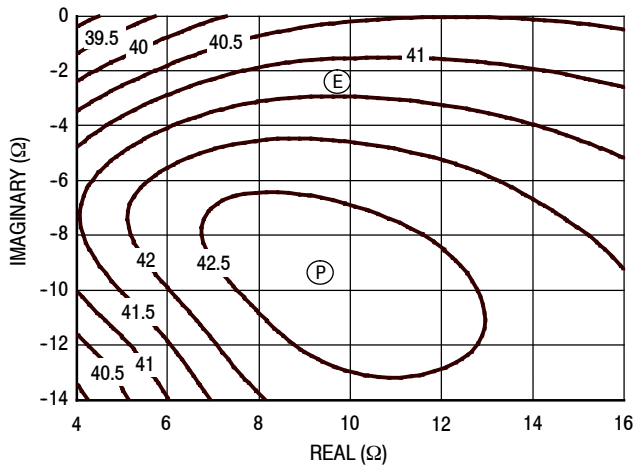


Figure 11. P1dB Load Pull Output Power Contours (dBm)

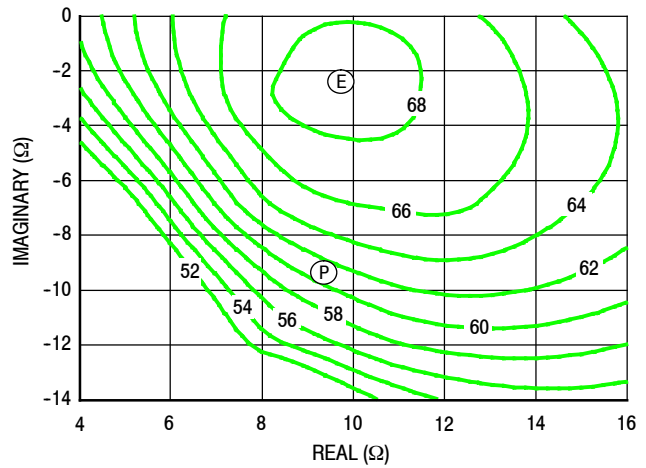


Figure 12. P1dB Load Pull Efficiency Contours (%)

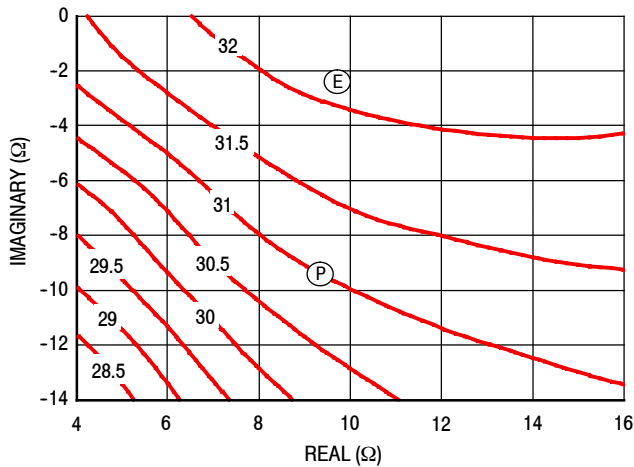


Figure 13. P1dB Load Pull Gain Contours (dB)

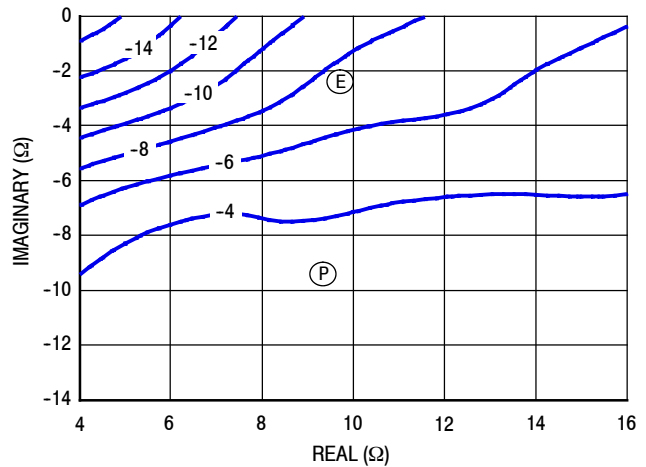


Figure 14. P1dB Load Pull AM/PM Contours (°)

**NOTE:** (P) = Maximum Output Power

(E) = Maximum Power Added Efficiency

- Gain
- Power Added Efficiency
- Linearity
- Output Power

# P3dB - TYPICAL LOAD PULL CONTOURS — 2590 MHz

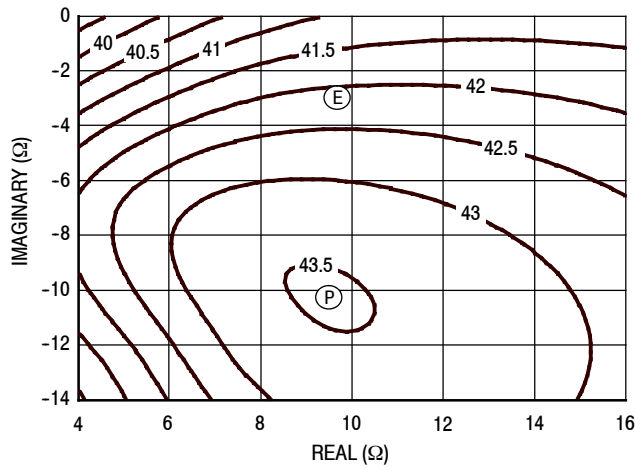


Figure 15. P3dB Load Pull Output Power Contours (dBm)

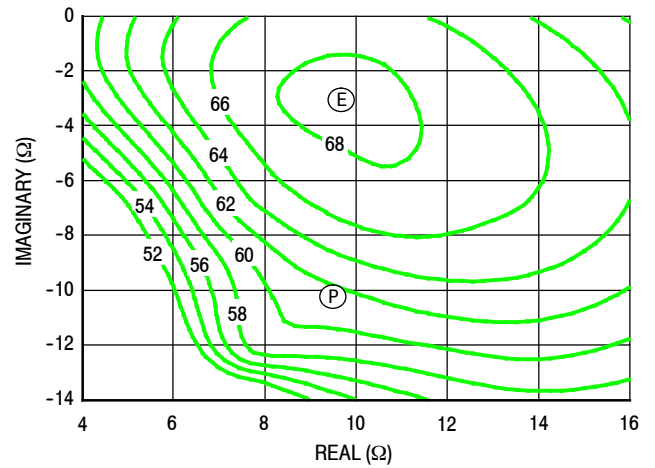


Figure 16. P3dB Load Pull Efficiency Contours (%)

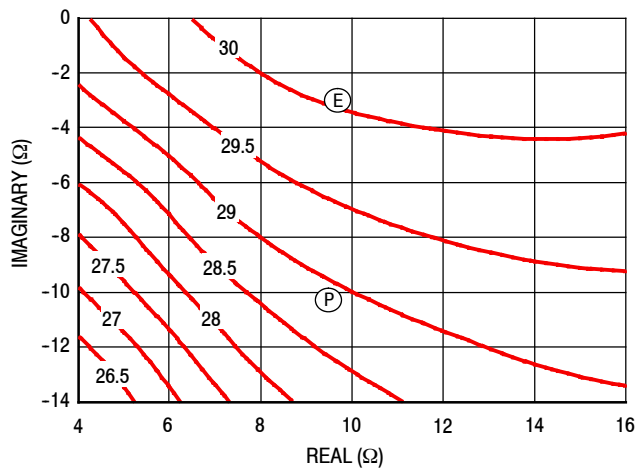


Figure 17. P3dB Load Pull Gain Contours (dB)

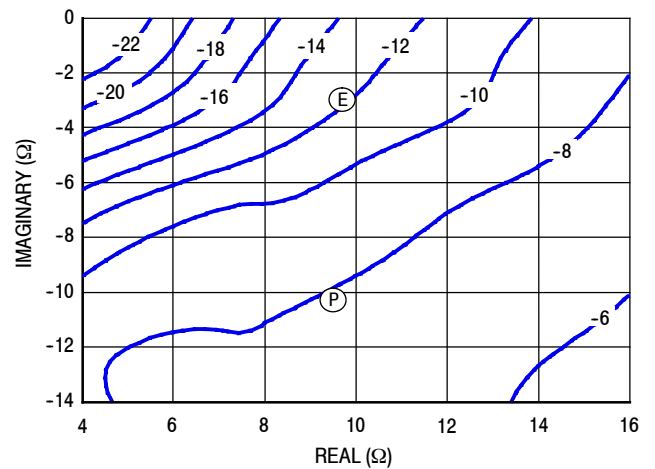


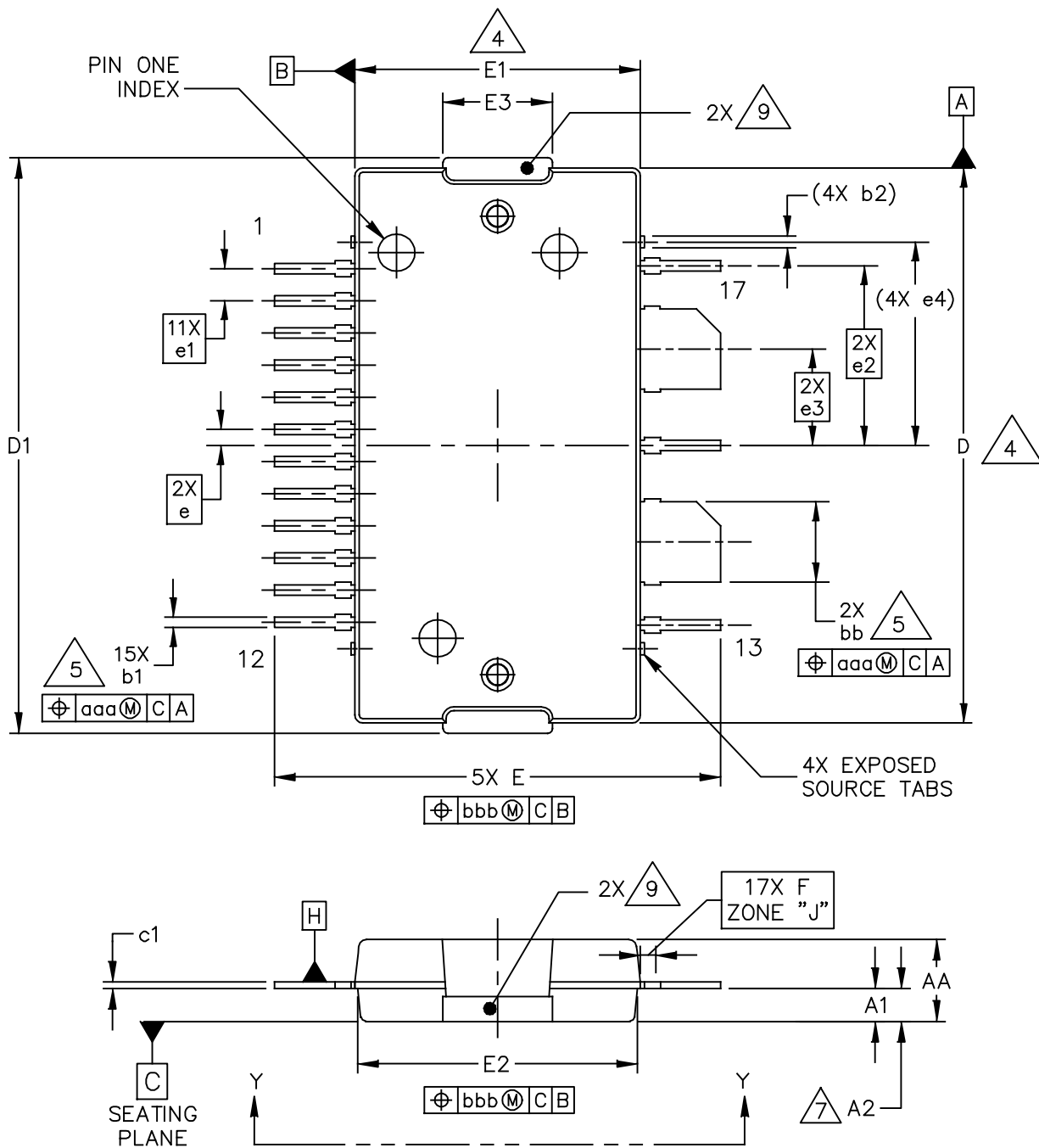
Figure 18. P3dB Load Pull AM/PM Contours (°)

**NOTE:** (P) = Maximum Output Power

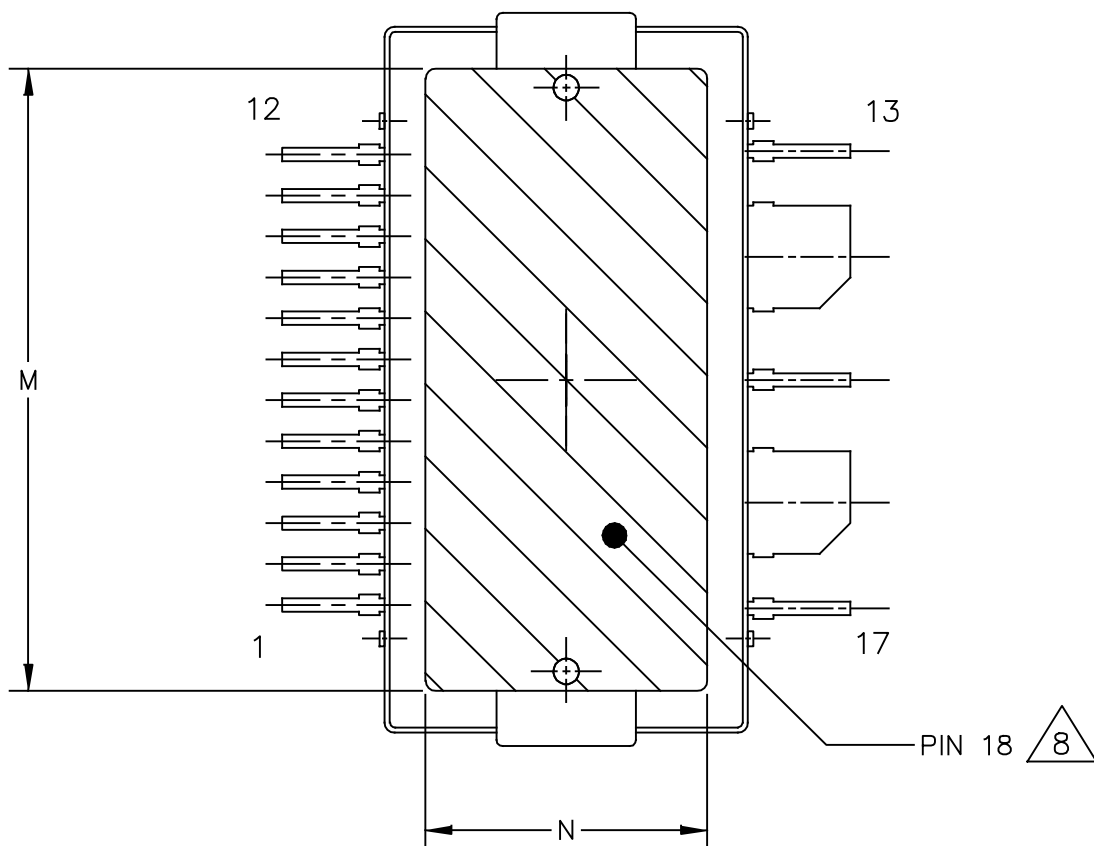
(E) = Maximum Power Added Efficiency

- Gain
- Power Added Efficiency
- Linearity
- Output Power

# PACKAGE DIMENSIONS



|                                                         |                                      |                            |
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|                                                         | STANDARD: NON-JEDEC                  |                            |
|                                                         | 02 SEP 2014                          |                            |



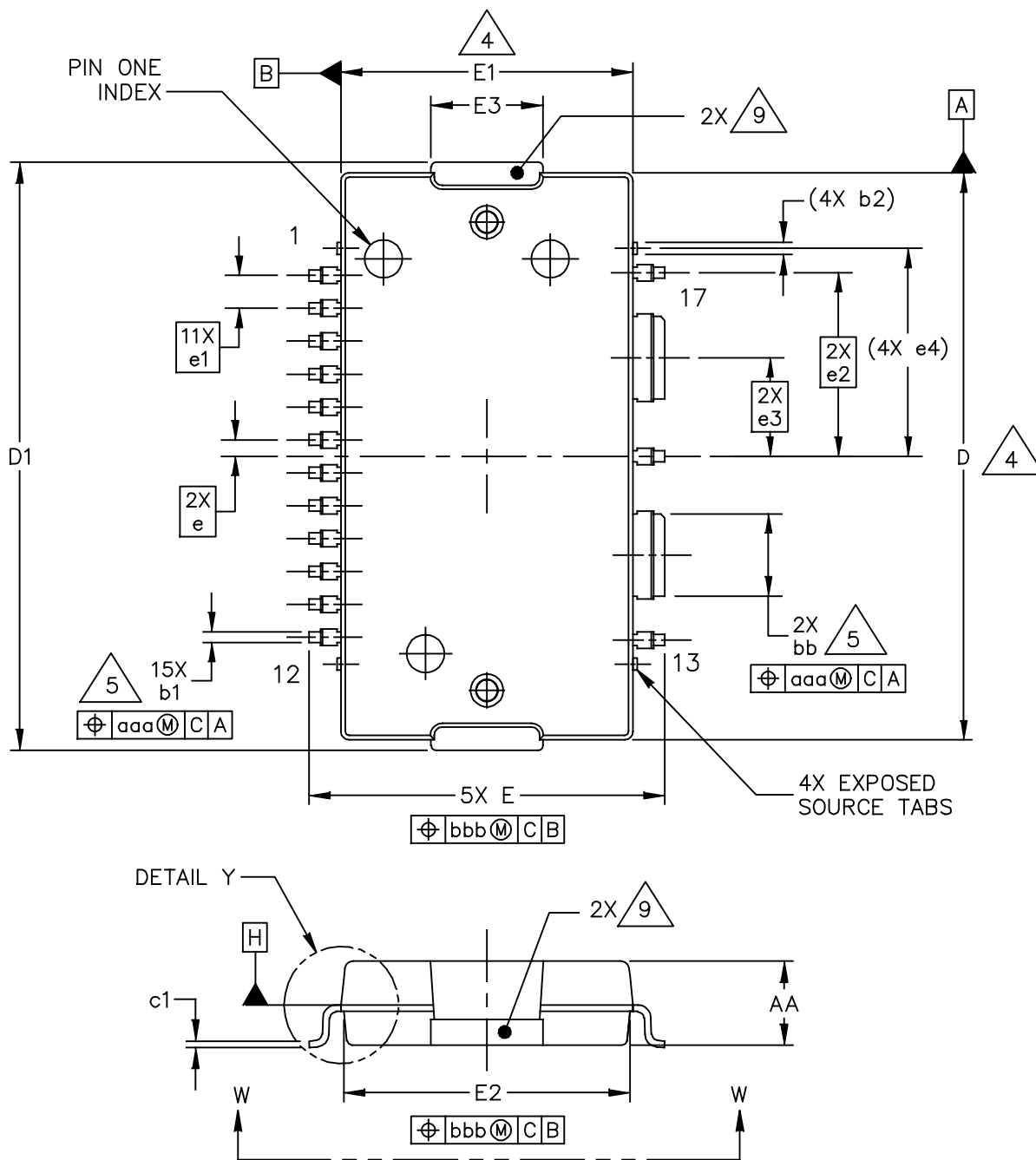
VIEW Y-Y

|                                                         |                          |                            |             |
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| TITLE:<br><br>TO-270WB-17                               | DOCUMENT NO: 98ASA00583D |                            | REV: A      |
|                                                         | STANDARD: NON-JEDEC      |                            |             |
|                                                         |                          |                            | 02 SEP 2014 |

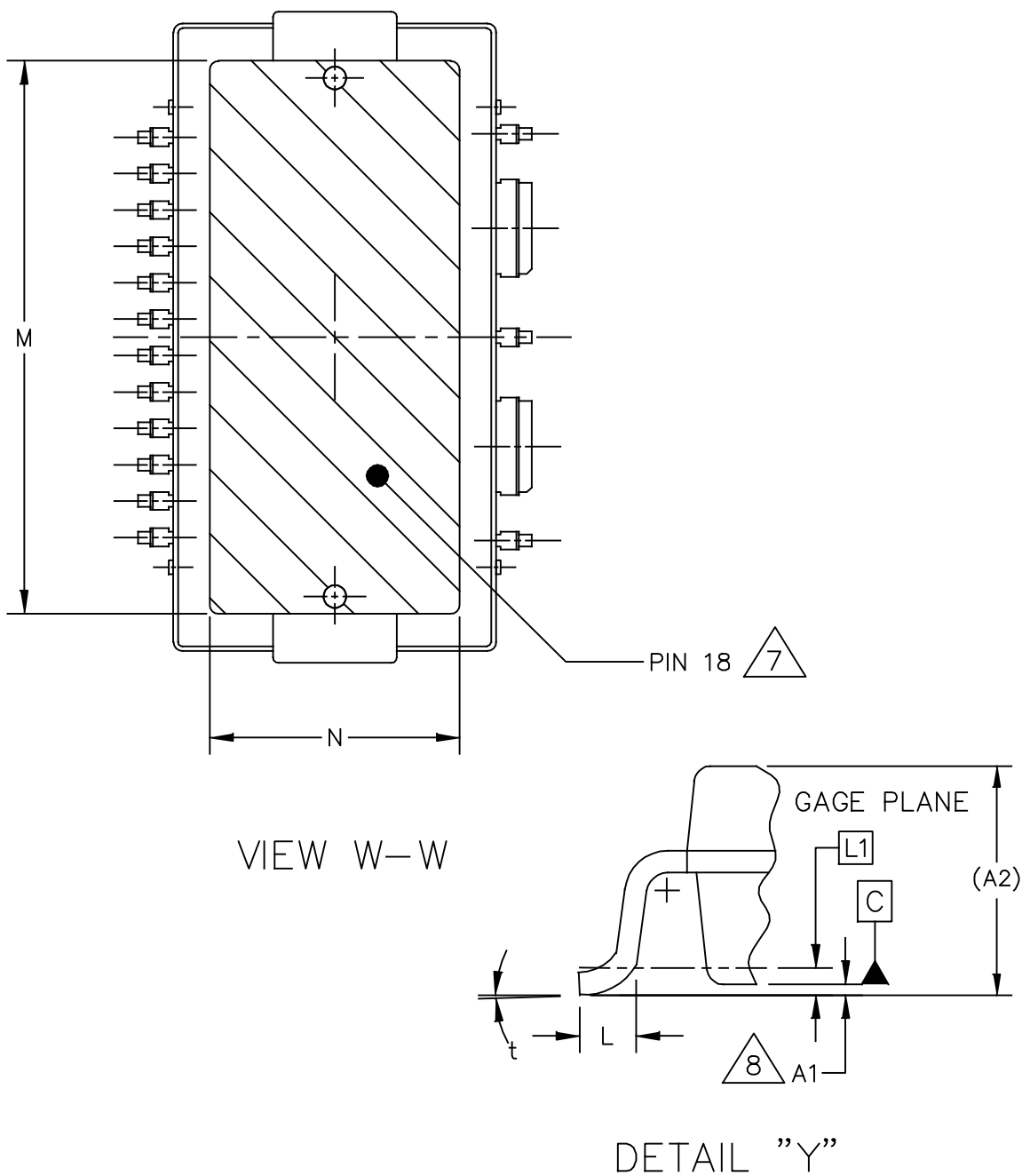
# NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
3. DATUM PLANE H IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 INCH (0.15 MM) PER SIDE. DIMENSIONS D AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
5. DIMENSIONS bb AND b1 DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 INCH (0.13 MM) TOTAL IN EXCESS OF THE bb AND b1 DIMENSIONS AT MAXIMUM MATERIAL CONDITION.
6. DATUMS A AND B TO BE DETERMINED AT DATUM PLANE H.
7. DIMENSION A2 APPLIES WITHIN ZONE J ONLY.
8. HATCHING REPRESENTS THE EXPOSED AND SOLDERABLE AREA OF THE HEAT SLUG. DIMENSIONS M AND N REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF EXPOSED AREA OF THE HEAT SLUG.
9. THESE SURFACES OF THE HEAT SLUG ARE NOT PART OF THE SOLDERABLE SURFACES AND MAY REMAIN UNPLATED.

| INCH                                                    |          |       | MILLIMETER |                    | INCH                                 |                |                            | MILLIMETER     |      |
|---------------------------------------------------------|----------|-------|------------|--------------------|--------------------------------------|----------------|----------------------------|----------------|------|
| DIM                                                     | MIN      | MAX   | MIN        | MAX                | DIM                                  | MIN            | MAX                        | MIN            | MAX  |
| AA                                                      | .099     | .105  | 2.51       | 2.67               | bb                                   | .097           | .103                       | 2.46           | 2.62 |
| A1                                                      | .039     | .043  | 0.99       | 1.09               | b1                                   | .010           | .016                       | 0.25           | 0.41 |
| A2                                                      | .040     | .042  | 1.02       | 1.07               | b2                                   | -----          | .019                       | -----          | 0.48 |
| D                                                       | .688     | .692  | 17.48      | 17.58              | c1                                   | .007           | .011                       | 0.18           | 0.28 |
| D1                                                      | .712     | .720  | 18.08      | 18.29              | e                                    | .020 BSC       |                            | 0.51 BSC       |      |
| E                                                       | .551     | .559  | 14.00      | 14.20              | e1                                   | .040 BSC       |                            | 1.02 BSC       |      |
| E1                                                      | .353     | .357  | 8.97       | 9.07               | e2                                   | .223 BSC       |                            | 5.66 BSC       |      |
| E2                                                      | .346     | .350  | 8.79       | 8.89               | e3                                   | .120 BSC       |                            | 3.05 BSC       |      |
| E3                                                      | .132     | .140  | 3.35       | 3.56               | e4                                   | .253 INFO ONLY |                            | 6.43 INFO ONLY |      |
| F                                                       | .025 BSC |       | 0.64 BSC   |                    | aaa                                  | .004           |                            | 0.10           |      |
| M                                                       | .600     | ----- | 15.24      | -----              | bbb                                  | .008           |                            | 0.20           |      |
| N                                                       | .270     | ----- | 6.86       | -----              |                                      |                |                            |                |      |
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|                                                         | 02 SEP 2014                          |                            |



|                                                         |                          |                            |
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|                                                         | STANDARD: NON-JEDEC      |                            |
|                                                         |                          | 02 SEP 2014                |

NOTES:

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8. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM C. THE POSITIVE VALUE IMPLIES THAT THE BOTTOM OF THE PACKAGE IS HIGHER THAN THE BOTTOM OF THE LEAD.
9. THESE SURFACES OF THE HEAT SLUG ARE NOT PART OF THE SOLDERABLE SURFACES AND MAY REMAIN UNPLATED.

| INCH                                                    |          |       | MILLIMETER |                    | DIM                                                  | INCH           |                            | MILLIMETER     |      |
|---------------------------------------------------------|----------|-------|------------|--------------------|------------------------------------------------------|----------------|----------------------------|----------------|------|
| DIM                                                     | MIN      | MAX   | MIN        | MAX                |                                                      | MIN            | MAX                        | MIN            | MAX  |
| AA                                                      | .099     | .105  | 2.51       | 2.67               | bb                                                   | .097           | .103                       | 2.46           | 2.62 |
| A1                                                      | .001     | .004  | 0.03       | 0.10               | b1                                                   | .010           | .016                       | 0.25           | 0.41 |
| A2                                                      | (.105)   |       | (2.67)     |                    | b2                                                   | -----          | .019                       | -----          | 0.48 |
| D                                                       | .688     | .692  | 17.48      | 17.58              | c1                                                   | .007           | .011                       | 0.18           | 0.28 |
| D1                                                      | .712     | .720  | 18.08      | 18.29              | e                                                    | .020 BSC       |                            | 0.51 BSC       |      |
| E                                                       | .429     | .437  | 10.90      | 11.10              | e1                                                   | .040 BSC       |                            | 1.02 BSC       |      |
| E1                                                      | .353     | .357  | 8.97       | 9.07               | e2                                                   | .223 BSC       |                            | 5.66 BSC       |      |
| E2                                                      | .346     | .350  | 8.79       | 8.89               | e3                                                   | .120 BSC       |                            | 3.05 BSC       |      |
| E3                                                      | .132     | .140  | 3.35       | 3.56               | e4                                                   | .253 INFO ONLY |                            | 6.43 INFO ONLY |      |
| L                                                       | .018     | .024  | 0.46       | 0.61               | t                                                    | 2'             | 8'                         | 2'             | 8'   |
| L1                                                      | .010 BSC |       | 0.25 BSC   |                    | aaa                                                  | .004           |                            | 0.10           |      |
| M                                                       | .600     | ----- | 15.24      | -----              | bbb                                                  | .008           |                            | 0.20           |      |
| N                                                       | .270     | ----- | 6.86       | -----              |                                                      |                |                            |                |      |
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|                                                         |          |       |            |                    | STANDARD: NON-JEDEC                                  |                |                            |                |      |
|                                                         |          |       |            |                    | 02 SEP 2014                                          |                |                            |                |      |

## 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
- AN1977: Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family
- AN1987: Quiescent Current Control for the RF Integrated Circuit Device Family

### 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 Software & Tools 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        | Mar. 2015 | <ul style="list-style-type: none"> <li>• Initial release of data sheet</li> </ul> |

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