Document Number: AFT18S230–12N
Rev. 0, 7/2015

RoHS

# RF Power LDMOS Transistor

## N–Channel Enhancement–Mode Lateral MOSFET

This 50 W RF power LDMOS transistor is designed for cellular base station applications covering the frequency range of 1805 to 1880 MHz.

**1800 MHz**

- Typical Single–Carrier W–CDMA Performance: $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1400 mA, $P_{out}$ = 50 W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

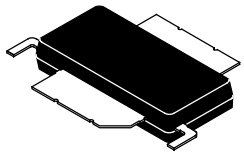
| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) | IRL (dB) |
|---|---|---|---|---|---|
| 1805 MHz | 17.1 | 33.3 | 7.1 | –33.6 | –14 |
| 1840 MHz | 17.5 | 33.3 | 7.1 | –33.6 | –16 |
| 1880 MHz | 17.6 | 33.8 | 6.9 | –33.7 | –11 |

**Features**

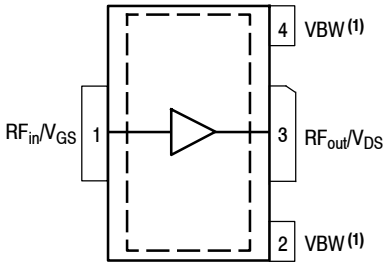
- High thermal conductivity packaging technology for reduced thermal resistance
- Greater negative gate–source voltage range for improved Class C operation
- Designed for digital predistortion error correction systems
- Optimized for Doherty applications

**AFT18S230–12NR3**

**1805–1880 MHz, 50 W AVG., 28 V AIRFAST RF POWER LDMOS TRANSISTOR**



**OM–780–2L2L PLASTIC**




(Top View)

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

**Figure 1. Pin Connections**

1. Device cannot operate with the $V_{DD}$ current supplied through pin 2 and pin 4.



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**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 +150 | °C |
| Operating Junction Temperature Range (1,2) | $T_J$ | –40 to +225 | °C |

**Table 2. Thermal Characteristics**

| Characteristic | Symbol | Value (2,3) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>Case Temperature 78°C, 50 W CW, 28 Vdc, $I_{DQ}$ = 1400 mA, 1842.5 MHz | $R_{\theta JC}$ | 0.27 | °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. 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°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics** | | | | | |
| Zero Gate Voltage Drain Leakage Current<br>($V_{DS}$ = 65 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current<br>($V_{DS}$ = 28 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 1 | μAdc |
| Gate–Source Leakage Current<br>($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 1 | μAdc |
| **On Characteristics** | | | | | |
| Gate Threshold Voltage<br>($V_{DS}$ = 10 Vdc, $I_D$ = 291 μAdc) | $V_{GS(th)}$ | 1.0 | 2.0 | 2.5 | Vdc |
| Gate Quiescent Voltage<br>($V_{DD}$ = 28 Vdc, $I_D$ = 1400 mAdc, Measured in Functional Test) | $V_{GS(Q)}$ | 2.3 | 2.8 | 3.3 | Vdc |
| Drain–Source On–Voltage<br>($V_{GS}$ = 10 Vdc, $I_D$ = 2.9 Adc) | $V_{DS(on)}$ | 0.1 | 0.24 | 0.3 | Vdc |

**Functional Tests** (4) (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1400 mA, $P_{out}$ = 50 W Avg., f = 1880 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 | $G_{ps}$ | 16.3 | 17.6 | 19.3 | dB |
| Drain Efficiency | $\eta_D$ | 29.0 | 33.8 | — | % |
| Output Peak–to–Average Ratio @ 0.01% Probability on CCDF | PAR | 6.0 | 6.9 | — | dB |
| Adjacent Channel Power Ratio | ACPR | — | –33.7 | –30.0 | dBc |
| Input Return Loss | IRL | — | –11 | –6 | dB |

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf/calculators.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf and search for AN1955.
4. Part internally matched both on input and output.

(continued)

**Table 5. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted) **(continued)**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Load Mismatch** (In Freescale Test Fixture, 50 ohm system) $I_{DQ}$ = 1400 mA, f = 1840 MHz | | | | | |
| VSWR 10:1 at 32 Vdc, 309 W CW Output Power<br>(3 dB Input Overdrive from 204 W CW Rated Power) | No Device Degradation | | | | |
| **Typical Performance** (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ}$ = 1400 mA, 1805–1880 MHz Bandwidth | | | | | |
| $P_{out}$ @ 1 dB Compression Point, CW | P1dB | — | 204 | — | W |
| AM/PM<br>(Maximum value measured at the P3dB compression point across the 1805–1880 MHz bandwidth) | Φ | — | –17 | — | ° |
| VBW Resonance Point<br>(IMD Third Order Intermodulation Inflection Point) | $VBW_{res}$ | — | 70 | — | MHz |
| Gain Flatness in 75 MHz Bandwidth @ $P_{out}$ = 50 W Avg. | $G_F$ | — | 0.4 | — | dB |
| Gain Variation over Temperature<br>(–30°C to +85°C) | ΔG | — | 0.009 | — | dB/°C |
| Output Power Variation over Temperature<br>(–30°C to +85°C) | ΔP1dB | — | 0.006 | — | dB/°C |

**Table 6. Ordering Information**

| Device | Tape and Reel Information | Package |
|---|---|---|
| AFT18S230–12NR3 | R3 Suffix = 250 Units, 32 mm Tape Width, 13–inch Reel | OM–780–2L2L |

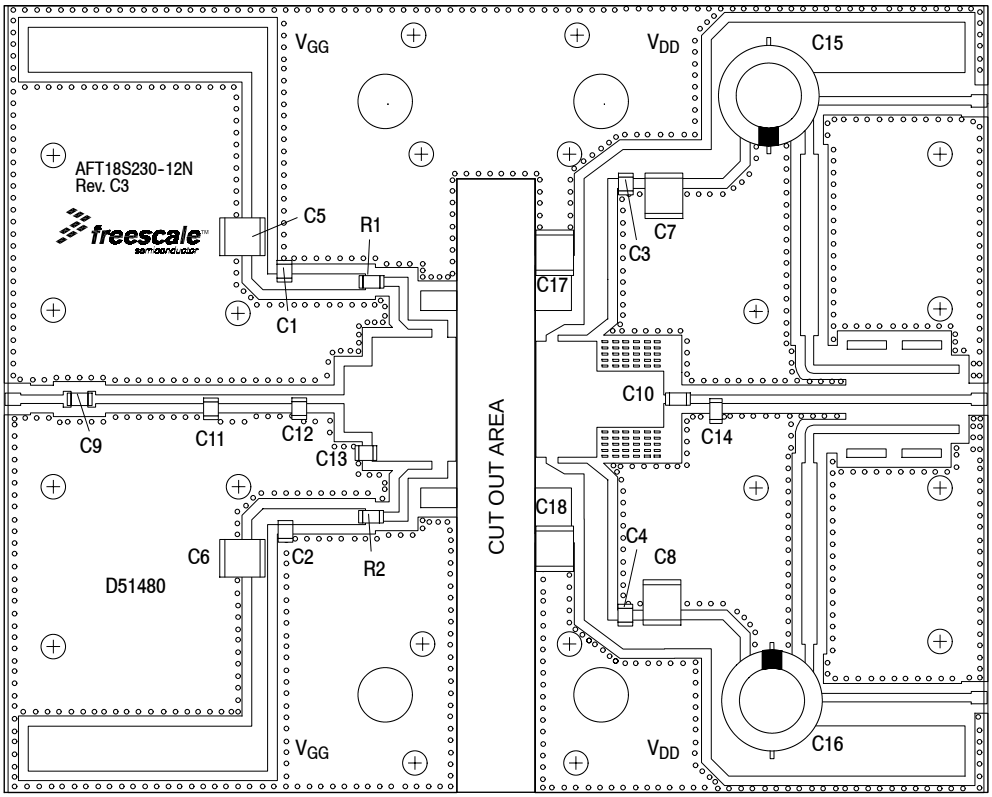



**Figure 2. AFT18S230-12NR3 Test Circuit Component Layout**

**Table 7. AFT18S230-12NR3 Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1, C2, C3, C4, C9 | 12 pF Chip Capacitors | ATC100B120FW1500XT | ATC |
| C5, C6, C7, C8, C17, C18 | 10 μF Chip Capacitors | C5750X7S2A106M230KB | TDK |
| C10 | 6.8 pF Chip Capacitor | ATC100B6R8BW1500XT | ATC |
| C11 | 1.1 pF Chip Capacitor | ATC100B1R1BW1500XT | ATC |
| C12 | 1.0 pF Chip Capacitor | ATC100B1R0BW1500XT | ATC |
| C13 | 0.4 pF Chip Capacitor | ATC100B0R4BW1500XT | ATC |
| C14 | 0.9 pF Chip Capacitor | ATC100B0R9BW1500XT | ATC |
| C15, C16 | 470 μF, 50 V Electrolytic Capacitors | 477CKS050M | Illinois Capacitor |
| R1, R2 | 4.02 Ω, 1/4 W Chip Resistors | CRCW12064R02FKEA | Vishay |
| PCB | Rogers RO4350B, 0.020″, $\varepsilon_r$ = 3.66 | D51480 | MTL |

## TYPICAL CHARACTERISTICS

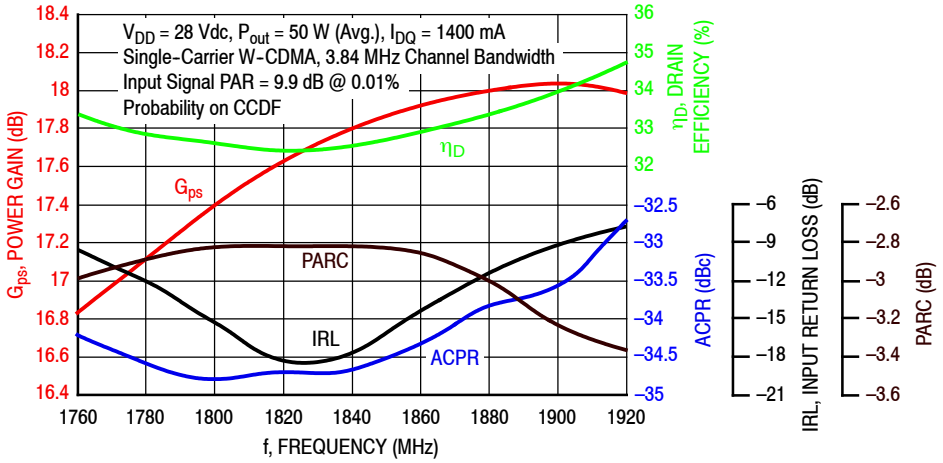



**Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ $P_{out}$ = 50 Watts Avg.**

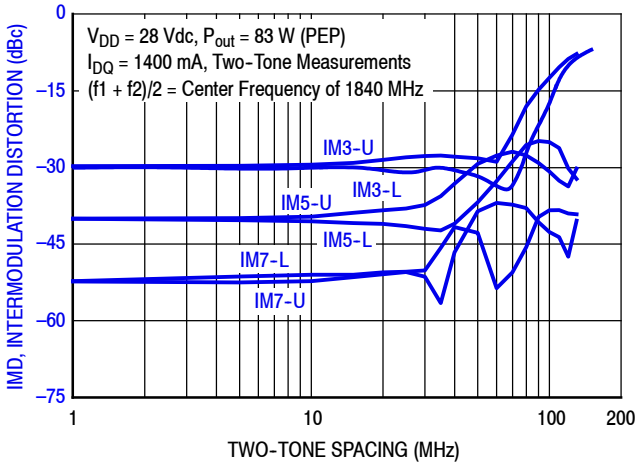



**Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing**

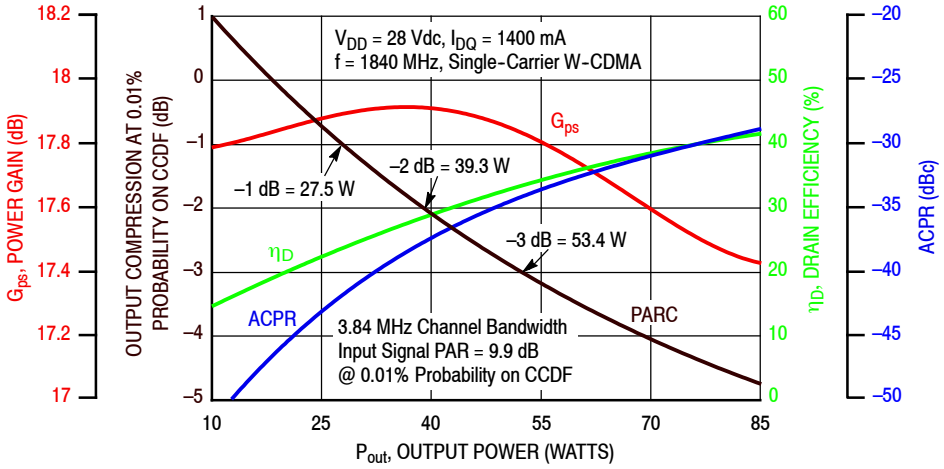



**Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

## TYPICAL CHARACTERISTICS

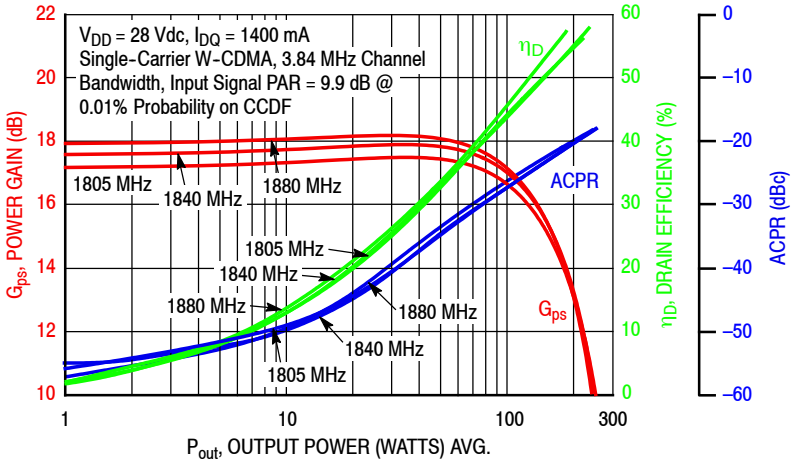



**Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**

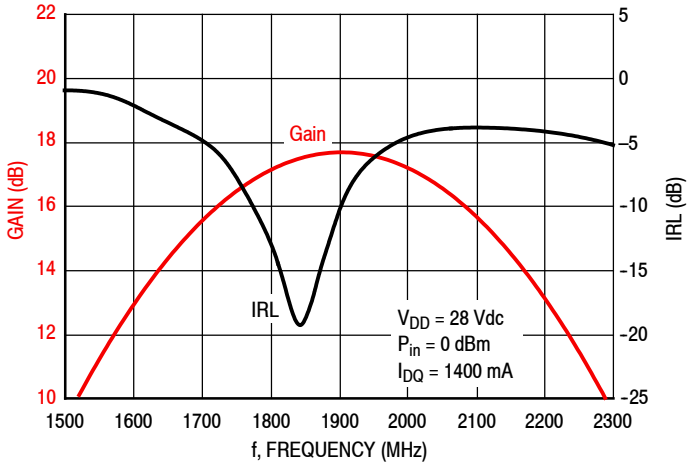



**Figure 7. Broadband Frequency Response**

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

$V_{DD}$ = 28 Vdc, $I_{DQA}$ = 1400 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

| f (MHz) | $Z_{source}$ (Ω) | $Z_{in}$ (Ω) | Max Output Power P1dB $Z_{load}$ (1) (Ω) | Gain (dB) | (dBm) | (W) | $\eta_D$ (%) | AM/PM (°) |
|---|---|---|---|---|---|---|---|---|
| 1805 | 1.17 – j4.25 | 1.10 + j3.92 | 1.10 – j3.55 | 16.8 | 54.0 | 250 | 53.4 | –12 |
| 1840 | 1.69 – j4.78 | 1.38 + j4.25 | 1.06 – j3.65 | 16.7 | 54.0 | 253 | 53.5 | –13 |
| 1880 | 3.16 – j5.35 | 2.16 + j4.57 | 1.09 – j3.92 | 16.5 | 54.0 | 250 | 52.4 | –13 |

| f (MHz) | $Z_{source}$ (Ω) | $Z_{in}$ (Ω) | Max Output Power P3dB $Z_{load}$ (2) (Ω) | Gain (dB) | (dBm) | (W) | $\eta_D$ (%) | AM/PM (°) |
|---|---|---|---|---|---|---|---|---|
| 1805 | 1.17 – j4.25 | 1.07 + j4.03 | 1.10 – j3.61 | 14.7 | 54.7 | 298 | 55.8 | –18 |
| 1840 | 1.69 – j4.78 | 1.39 + j4.39 | 1.13 – j3.80 | 14.6 | 54.8 | 299 | 56.1 | –18 |
| 1880 | 3.16 – j5.35 | 2.25 + j4.78 | 1.16 – j4.07 | 14.3 | 54.7 | 296 | 54.3 | –18 |

(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.

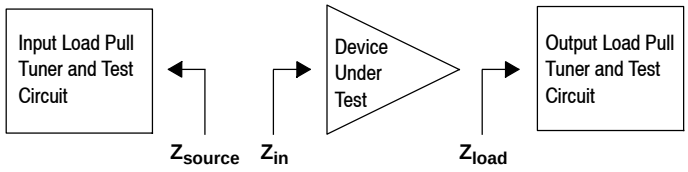
**Table 9. Load Pull Performance — Maximum Drain Efficiency Tuning**

$V_{DD}$ = 28 Vdc, $I_{DQA}$ = 1400 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

| f (MHz) | $Z_{source}$ (Ω) | $Z_{in}$ (Ω) | Max Drain Efficiency P1dB $Z_{load}$ (1) (Ω) | Gain (dB) | (dBm) | (W) | $\eta_D$ (%) | AM/PM (°) |
|---|---|---|---|---|---|---|---|---|
| 1805 | 1.17 – j4.25 | 1.12 + j4.11 | 1.95 – j2.42 | 19.5 | 52.3 | 171 | 64.8 | –19 |
| 1840 | 1.69 – j4.78 | 1.48 + j4.43 | 1.88 – j2.54 | 19.3 | 52.2 | 168 | 64.6 | –20 |
| 1880 | 3.16 – j5.35 | 2.41 + j4.75 | 1.77 – j2.67 | 19.1 | 52.2 | 164 | 64.1 | –20 |

| f (MHz) | $Z_{source}$ (Ω) | $Z_{in}$ (Ω) | Max Drain Efficiency P3dB $Z_{load}$ (2) (Ω) | Gain (dB) | (dBm) | (W) | $\eta_D$ (%) | AM/PM (°) |
|---|---|---|---|---|---|---|---|---|
| 1805 | 1.17 – j4.25 | 1.08 + j4.14 | 1.80 – j2.54 | 17.3 | 53.2 | 211 | 67.0 | –26 |
| 1840 | 1.69 – j4.78 | 1.42 + j4.52 | 1.69 – j2.54 | 17.3 | 52.9 | 197 | 66.5 | –28 |
| 1880 | 3.16 – j5.35 | 2.40 + j4.89 | 1.73 – j2.72 | 17.1 | 52.9 | 193 | 65.4 | –26 |

(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 — 1840 MHz

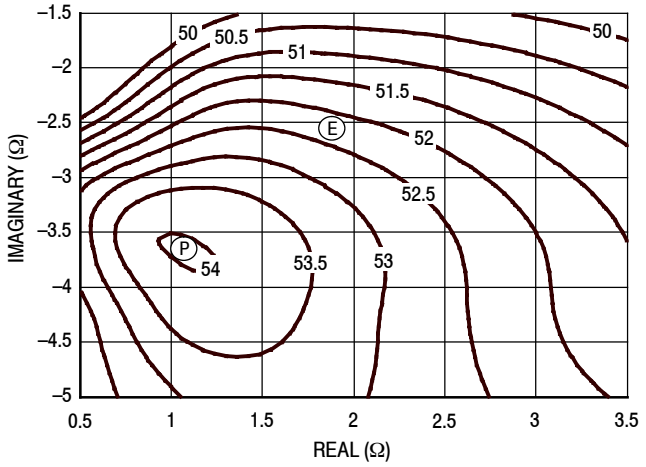



**Figure 8. P1dB Load Pull Output Power Contours (dBm)**

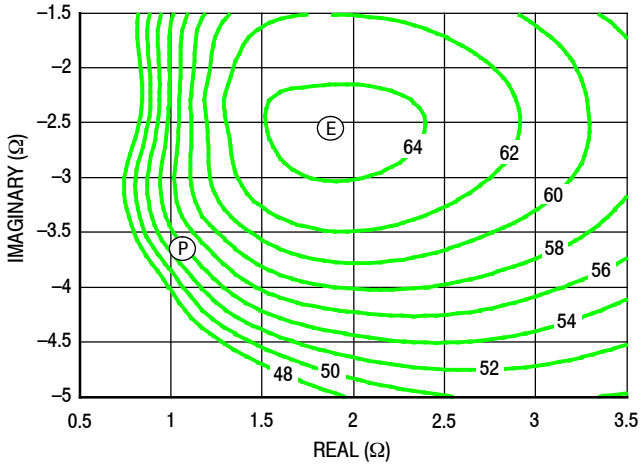



**Figure 9. P1dB Load Pull Efficiency Contours (%)**

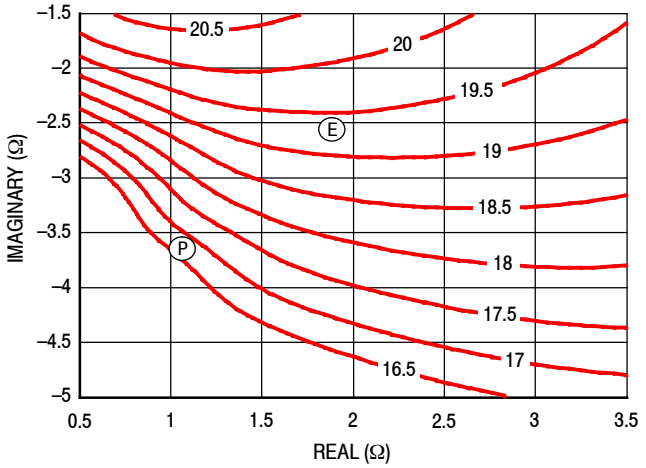



**Figure 10. P1dB Load Pull Gain Contours (dB)**

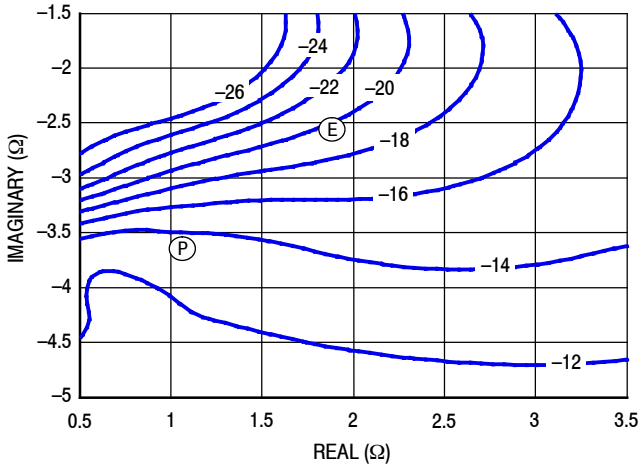



**Figure 11. P1dB Load Pull AM/PM Contours (°)**

**NOTE:** Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

Gain

Drain Efficiency

Linearity

Output Power

## P3dB – TYPICAL LOAD PULL CONTOURS — 1840 MHz

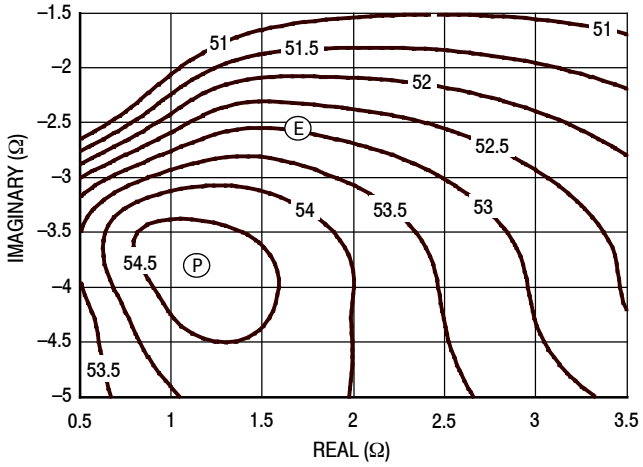



**Figure 12. P3dB Load Pull Output Power Contours (dBm)**

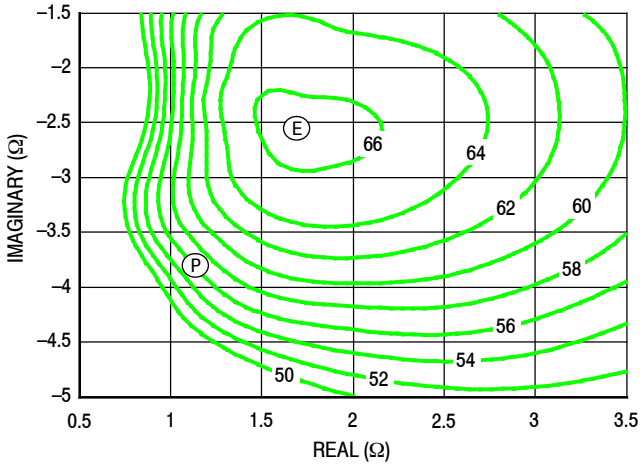



**Figure 13. P3dB Load Pull Efficiency Contours (%)**

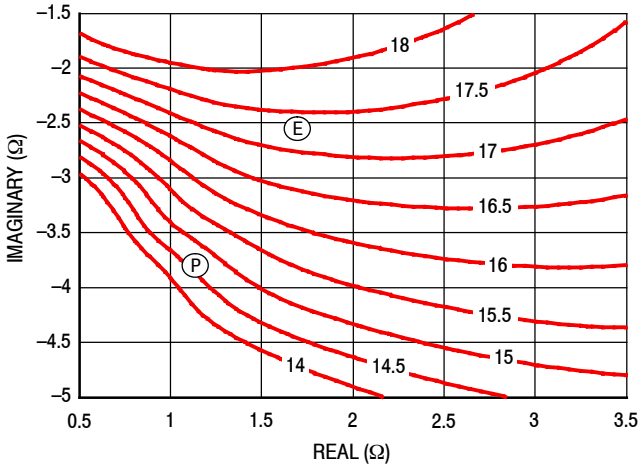



**Figure 14. P3dB Load Pull Gain Contours (dB)**

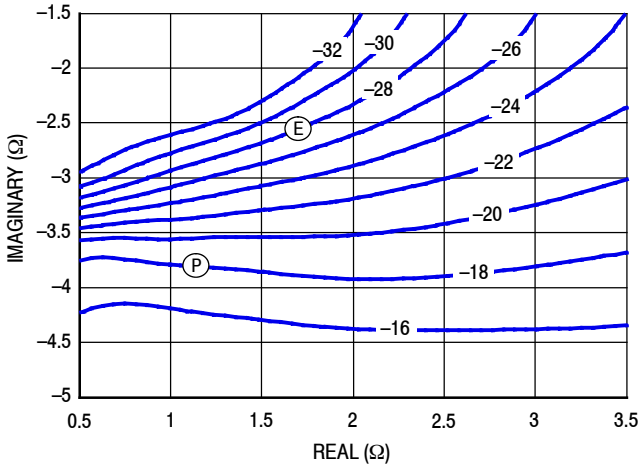



**Figure 15. P3dB Load Pull AM/PM Contours (°)**

**NOTE:** Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

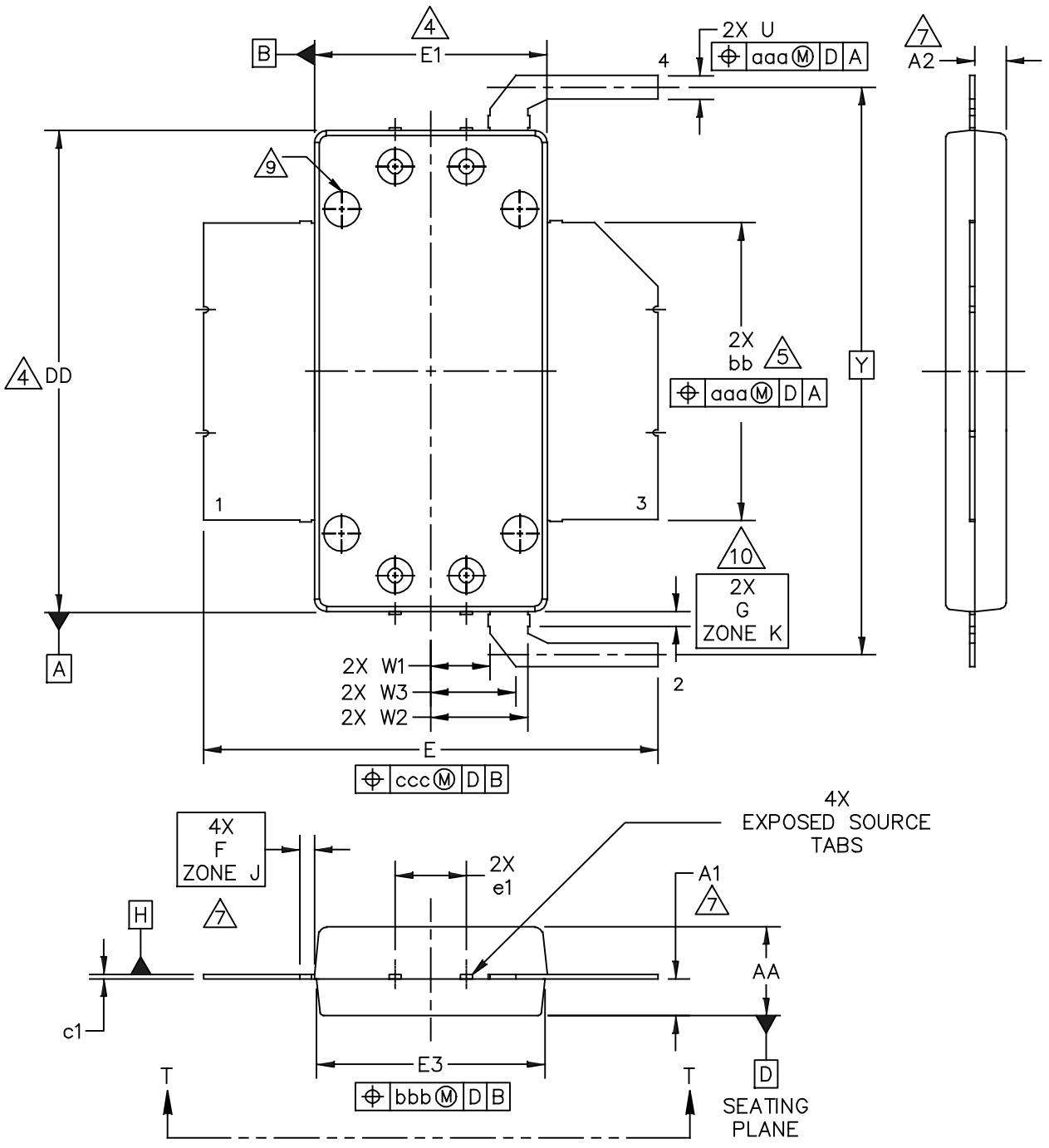
Gain

Drain Efficiency

Linearity

Output Power

## PACKAGE DIMENSIONS

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| | STANDARD: NON-JEDEC | |
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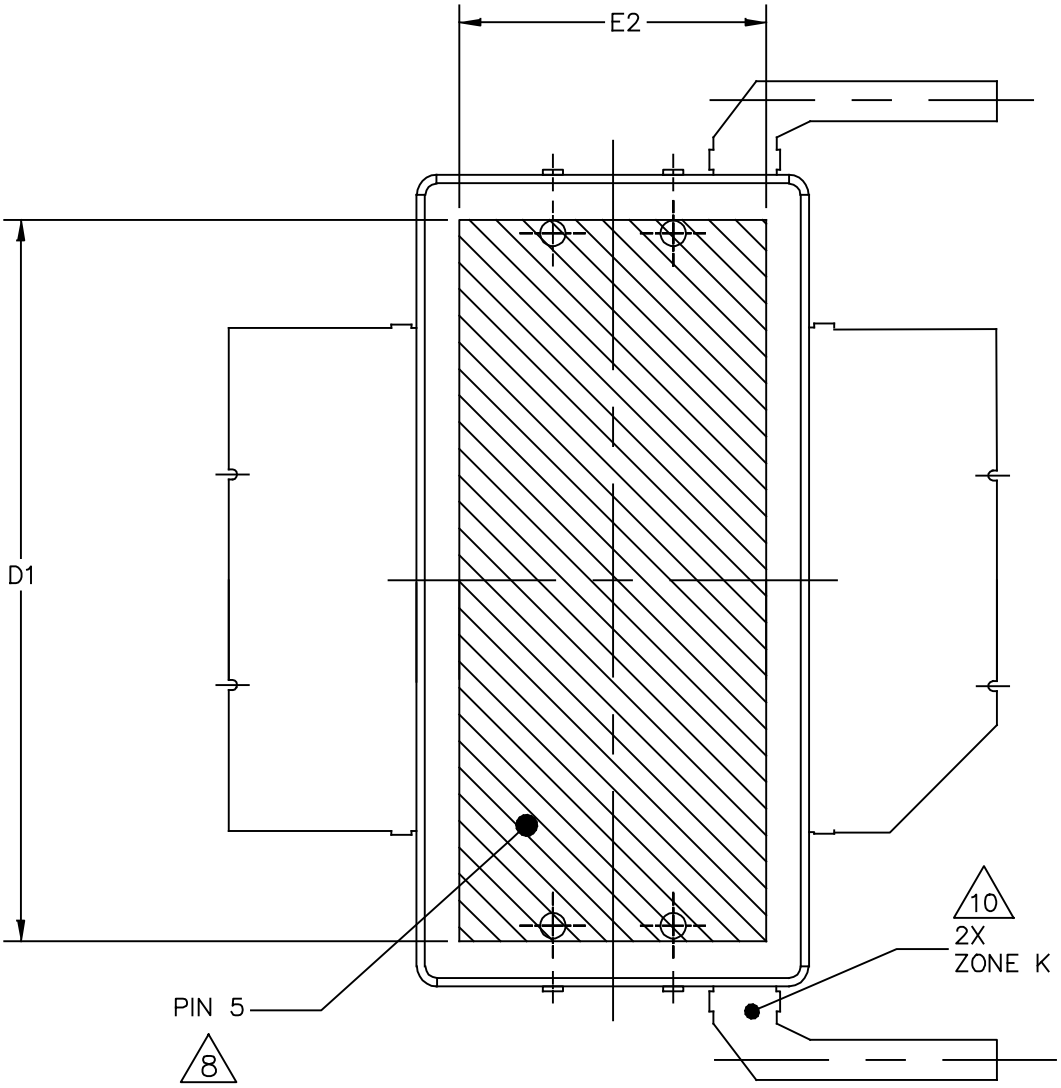


BOTTOM VIEW
VIEW T–T

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| | STANDARD: NON–JEDEC | |
| | 26 FEB 2014 | |

NOTES:
1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

3. DATUM PLANE H IS LOCATED AT 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 DD AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 INCH (0.15 MM) PER SIDE. DIMENSIONS DD AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.

5. DIMENSION bb DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 INCH (0.13 MM) TOTAL IN EXCESS OF THE bb DIMENSION AT MAXIMUM MATERIAL CONDITION.

6. DATUMS A AND B TO BE DETERMINED AT DATUM PLANE H.

7. DIMENSIONS A1 AND A2 APPLIES WITHIN ZONE J ONLY. A1 APPLIES TO PINS 1 AND 3. A2 APPLIES TO PINS 2 AND 4. TOLERANCES OF DIMENSIONS A1 AND A2 ARE TENTATIVE.

8. HATCHING REPRESENTS THE EXPOSED AREA OF THE HEAT SLUG. THE DIMENSIONS D1 AND E2 REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF EXPOSED AREA OF HEAT SLUG.

9. DIMPLED HOLE REPRESENTS INPUT SIDE.

10. ZONE K REPRESENTS NON–SOLDERABLE REGION WHERE MOLD FLASH AND RESIN BLEED ARE PERMITTED ON BOTH SIDES OF THE LEADS.

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| AA | .148 | .152 | 3.76 | 3.86 | W1 | .095 | .105 | 2.41 | 2.67 |
| A1 | .059 | .065 | 1.50 | 1.65 | W2 | .158 | .168 | 4.01 | 4.27 |
| A2 | .056 | .068 | 1.42 | 1.73 | W3 | .138 | .148 | 3.51 | 3.76 |
| DD | .808 | .812 | 20.52 | 20.62 | U | .037 | .043 | 0.94 | 1.09 |
| D1 | .720 | ---- | 18.29 | ---- | Y | .956 BSC | | 24.28 BSC | |
| E | .762 | .770 | 19.35 | 19.56 | bb | .497 | .503 | 12.62 | 12.78 |
| E1 | .390 | .394 | 9.91 | 10.01 | c1 | .007 | .011 | 0.18 | 0.28 |
| E2 | .306 | ---- | 7.77 | ---- | e1 | .116 | .124 | 2.95 | 3.15 |
| E3 | .383 | .387 | 9.73 | 9.83 | aaa | .004 | | 0.10 | |
| F | .025 BSC | | 0.64 BSC | | bbb | .006 | | 0.15 | |
| G | .030 BSC | | 0.76 BSC | | ccc | .010 | | 0.25 | |



MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

TITLE: OM–780–2L2L

DOCUMENT NO: 98ASA00574D REV: 0

STANDARD: NON–JEDEC

26 FEB 2014

## PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

**Application Notes**

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Over−Molded Plastic Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3789: Clamping of High Power RF Transistors and RFICs in Over−Molded Plastic Packages

**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

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

1. Go to http://www.freescale.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 | July 2015 | • Initial Release of Data Sheet |

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