



# RF Power LDMOS Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

These 6.3 W RF power LDMOS transistors are designed for cellular base station applications covering the frequency range of 1805 to 2170 MHz.

### 2100 MHz

- Typical Single-Carrier W-CDMA Performance:  $V_{DD} = 28$  Vdc,  $I_{DQ} = 450$  mA,  $P_{out} = 6.3$  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)
2110 MHz	18.6	20.0	9.4	-43.0	-13
2140 MHz	18.8	20.0	9.2	-42.5	-14
2170 MHz	18.9	20.0	9.1	-42.5	-14

### 1800 MHz

- Typical Single-Carrier W-CDMA Performance:  $V_{DD} = 28$  Vdc,  $I_{DQ} = 450$  mA,  $P_{out} = 6.3$  W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

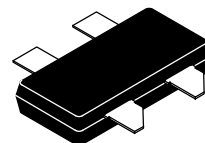
Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
1805 MHz	18.8	23.0	9.5	-43.0	-10
1840 MHz	19.1	23.8	9.4	-42.9	-15
1880 MHz	18.7	24.5	9.1	-42.9	-10

### Features

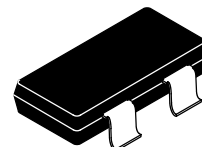
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications
- In Tape and Reel. R3 Suffix = 250 Units, 32 mm Tape Width, 13-inch Reel.

**AFT20P060-4NR3**  
**AFT20P060-4GNR3**

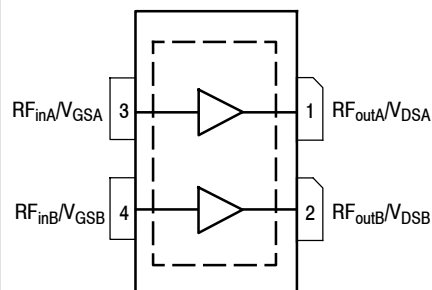
**1805–2170 MHz, 6.3 W AVG., 28 V**  
**AIRFAST RF POWER LDMOS**  
**TRANSISTORS**



**OM-780-4L**  
**PLASTIC**  
**AFT20P060-4NR3**



**OM-780G-4L**  
**PLASTIC**  
**AFT20P060-4GNR3**



(Top View)

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

**Figure 1. Pin Connections**

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +65	Vdc
Gate-Source Voltage	$V_{GS}$	-6.0, +10	Vdc
Operating Voltage	$V_{DD}$	32, +0	Vdc
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Case Operating Temperature Range	$T_C$	-40 to +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 Case Temperature 77°C, 6.3 W CW, 28 Vdc, $I_{DQ} = 450$ mA, 2140 MHz Case Temperature 80°C, 60 W CW, 28 Vdc, $I_{DQ} = 450$ mA, 2140 MHz	$R_{\theta JC}$	0.56 0.53	°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)	III

**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
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**Off Characteristics (4)**

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

**On Characteristics (4)**

Gate Threshold Voltage ( $V_{DS} = 10$ Vdc, $I_D = 36$ $\mu\text{Adc}$ )	$V_{GS(th)}$	1.5	2.0	2.5	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28$ Vdc, $I_D = 450$ mAdc)	$V_{GS(Q)}$	—	2.9	—	Vdc
Fixture Gate Quiescent Voltage (5) ( $V_{DD} = 28$ Vdc, $I_D = 450$ mAdc, Measured in Functional Test)	$V_{GG(Q)}$	5.3	5.8	6.3	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10$ Vdc, $I_D = 0.36$ Adc)	$V_{DS(on)}$	0.1	0.2	0.3	Vdc

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rtf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rtf>. Select Documentation/Application Notes - AN1955.
4. Each side of device measured separately.
5.  $V_{GG} = 2 \times V_{GS(Q)}$ . Parameter measured on Freescale Test Fixture, due to resistor divider network on the board. Refer to Test Fixture Layout.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Functional Tests</b> <sup>(1,2)</sup> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 450\text{ mA}$ , $P_{out} = 6.3\text{ W Avg.}$ , $f = 2170\text{ MHz}$ , 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.					
Power Gain	$G_{ps}$	17.5	18.9	20.5	dB
Drain Efficiency	$\eta_D$	18.7	20.0	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	8.7	9.1	—	dB
Adjacent Channel Power Ratio	ACPR	—	-42.5	-40.5	dBc
Input Return Loss	IRL	—	-14	-7	dB

**Load Mismatch** (In Freescale Test Fixture, 50 ohm system)  $I_{DQ} = 450\text{ mA}$ ,  $f = 2140\text{ MHz}$ 

VSWR 10:1 at 32 Vdc, 83 W CW Output Power (3 dB Input Overdrive from 60 W CW Rated Power)	No Device Degradation
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**Typical Performances** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 450\text{ mA}$ , 2110–2170 MHz Bandwidth

$P_{out}$ @ 1 dB Compression Point, CW	P1dB	—	60	—	W
AM/PM (Maximum value measured at the P3dB compression point across the 2110–2170 MHz frequency range. Measurement made on a single path of the device under Class AB conditions, $P_{out} = 47\text{ W}$ , $I_{DQ} = 177\text{ mA}$ .)	$\Phi$	—	-20	—	°
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW <sub>res</sub>	—	70	—	MHz
Gain Flatness in 60 MHz Bandwidth @ $P_{out} = 6.3\text{ W Avg.}$	$G_F$	—	0.33	—	dB
Gain Variation over Temperature (-30°C to +85°C)	$\Delta G$	—	0.012	—	dB/°C
Output Power Variation over Temperature (-30°C to +85°C)	$\Delta P1dB$	—	0.0002	—	dB/°C

- Part internally matched both on input and output.
- Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GN) parts.

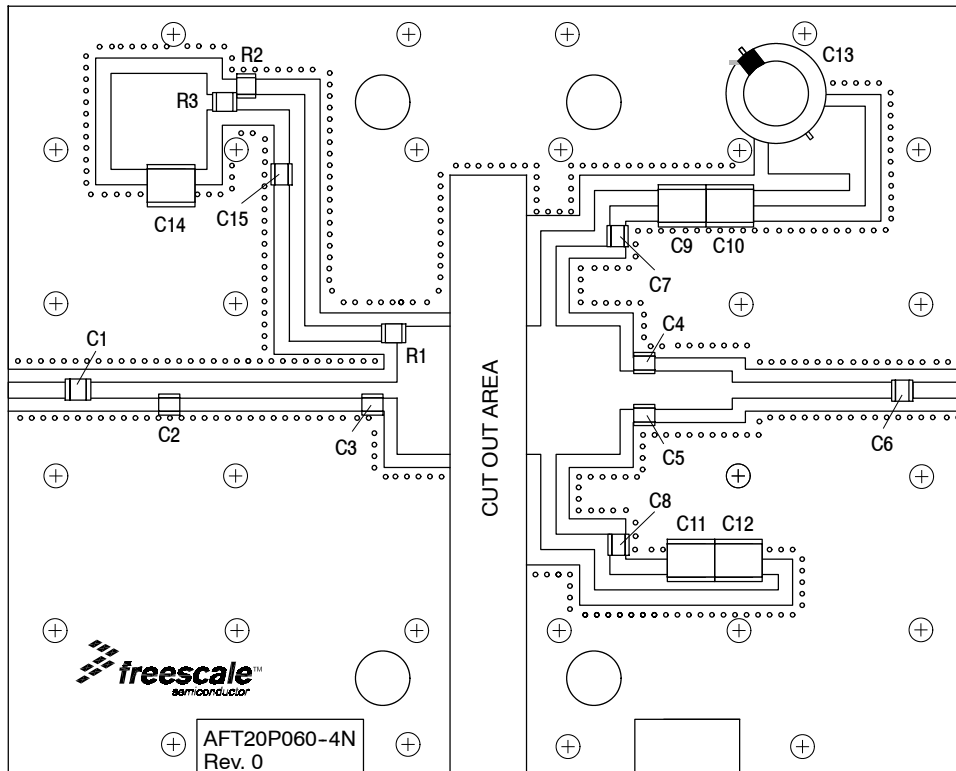
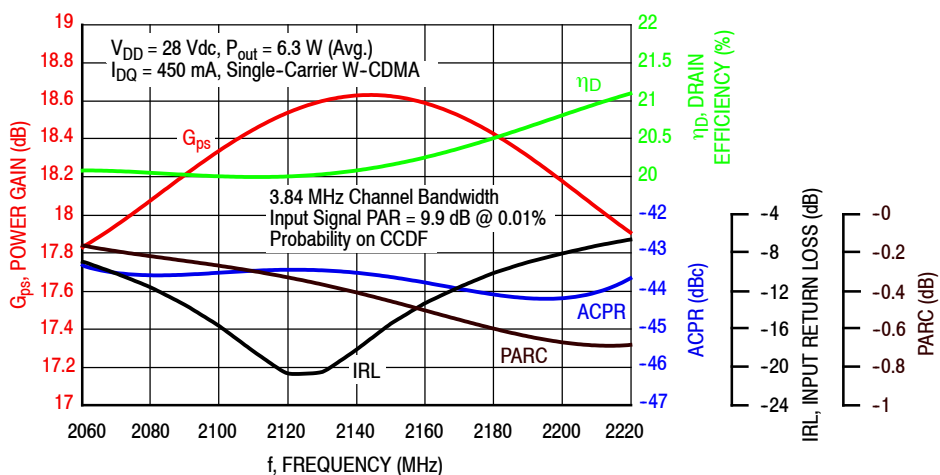


Figure 2. AFT20P060-4NR3 Test Circuit Component Layout — 2110–2170 MHz

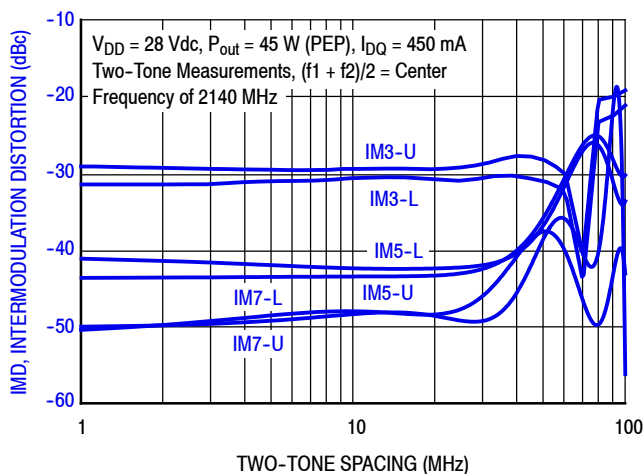
Table 6. AFT20P060-4NR3 Test Circuit Component Designations and Values — 2110–2170 MHz

Part	Description	Part Number	Manufacturer
C1, C7, C8, C15	6.8 pF Chip Capacitors	ATC100B6R8CT500XT	ATC
C2	0.8 pF Chip Capacitor	ATC100B0R8BT500XT	ATC
C3	1.5 pF Chip Capacitor	ATC100B1R5BT500XT	ATC
C4, C5	0.2 pF Chip Capacitors	ATC100B0R2BT500XT	ATC
C6	5.6 pF Chip Capacitor	ATC100B5R6CT500XT	ATC
C9, C10, C11, C12, C14	10 $\mu$ F Chip Capacitors	C5750X7S2A106M	Kemet
C13	470 $\mu$ F, 63 V Electrolytic Capacitor	MCGPR63V477M13X26-RH	Multicomp
R1	5.9 $\Omega$ , 1/4 W Chip Resistor	CRCW12065R90FKEA	Vishay
R2, R3	2 K $\Omega$ , 1/4 W Chip Resistors	CRCW12062K00FKEA	Vishay
PCB	0.030", $\epsilon_r = 2.55$	AD255A	Arlon

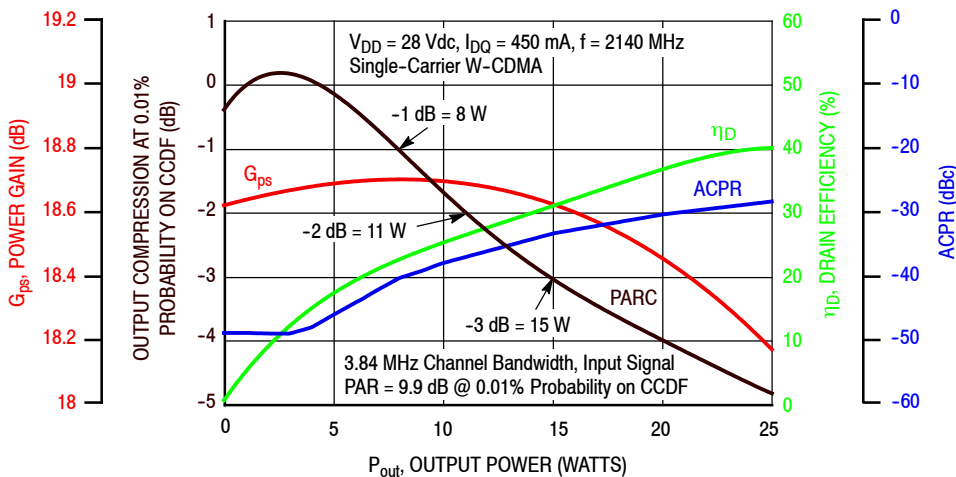
### TYPICAL CHARACTERISTICS



**Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @  $P_{out} = 6.3$  Watts Avg.**

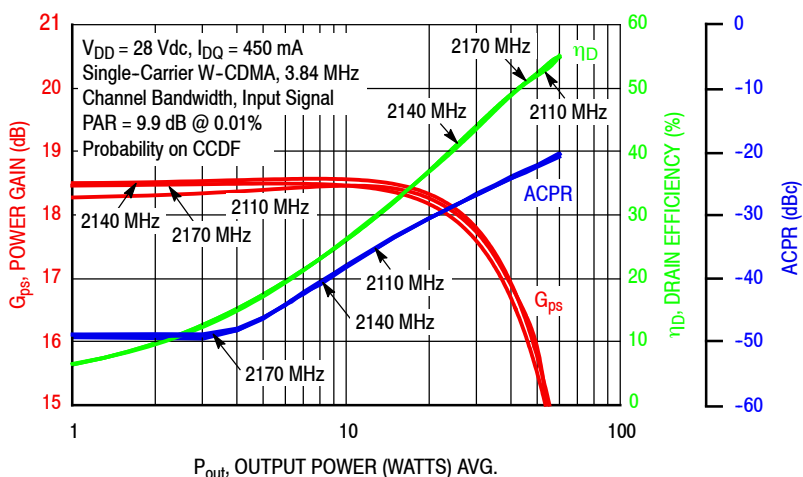


**Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing**

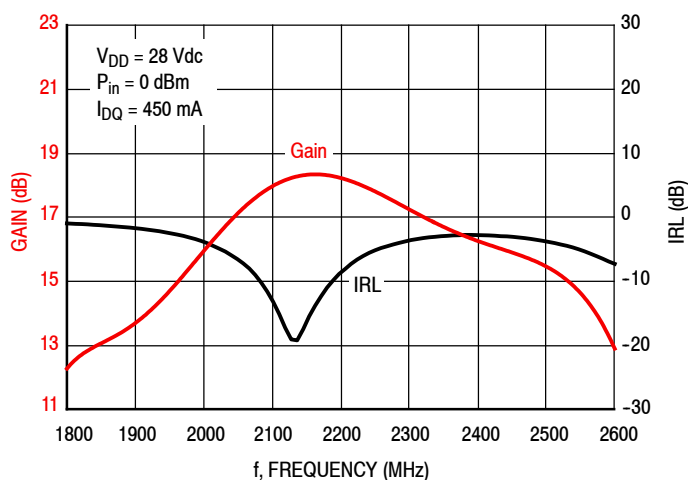


**Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

### TYPICAL CHARACTERISTICS

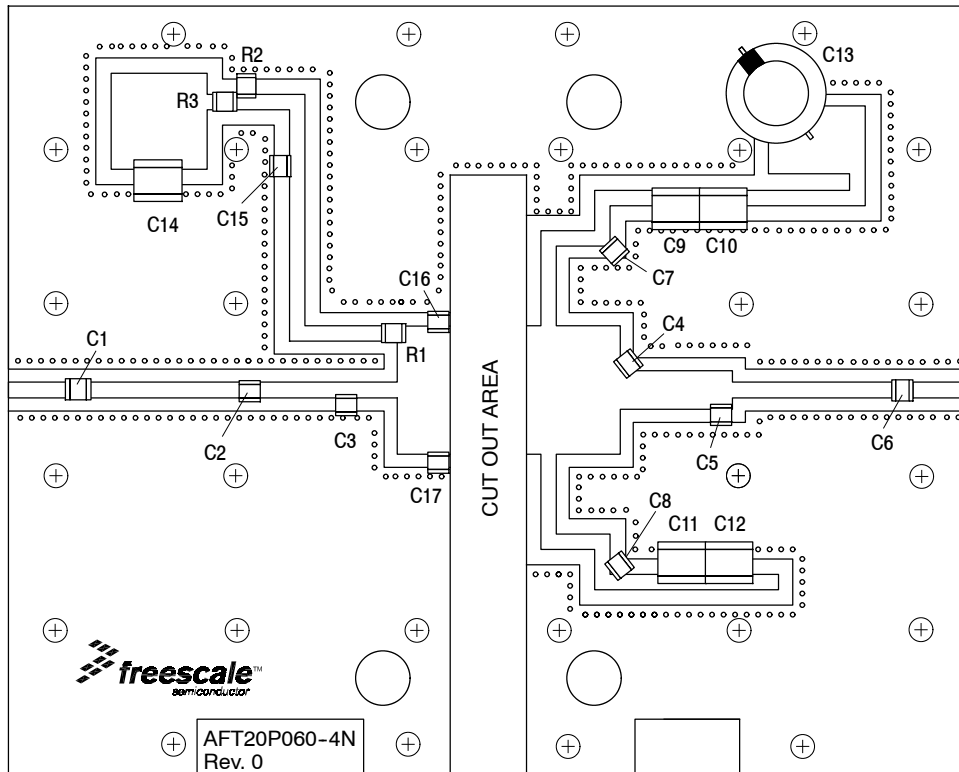


**Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**



**Figure 7. Broadband Frequency Response**

## ALTERNATE CHARACTERIZATION — 1805–1880 MHz

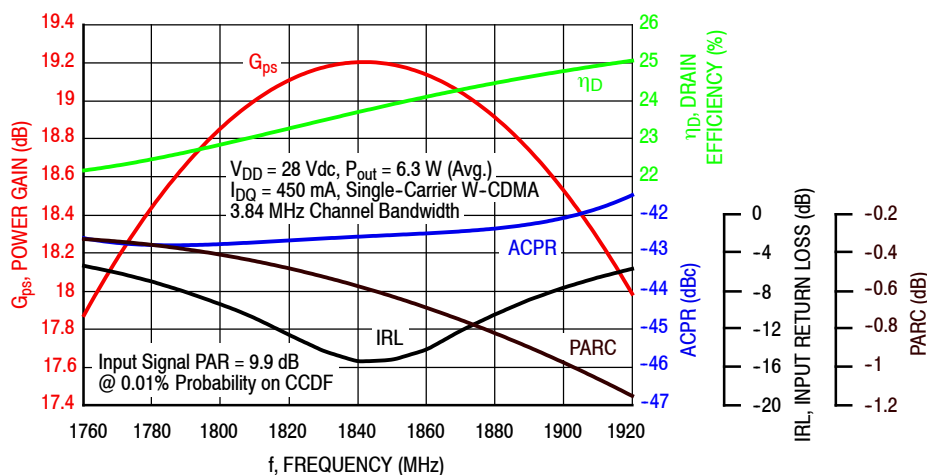


**Figure 8. AFT20P060-4NR3 Test Circuit Component Layout — 1805–1880 MHz**

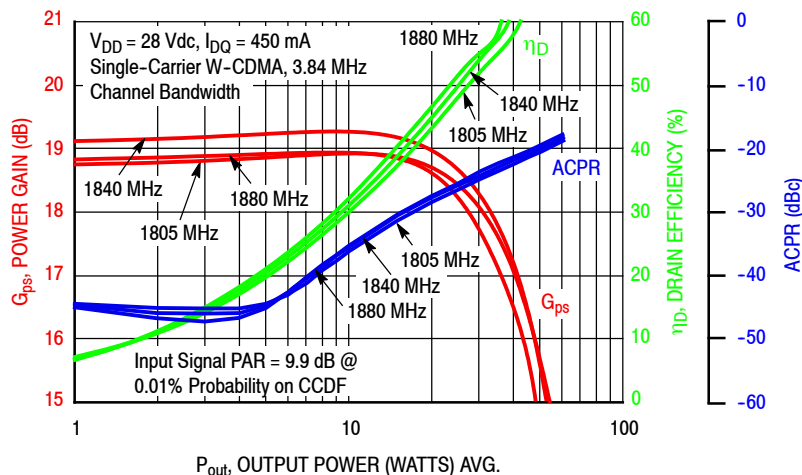
**Table 7. AFT20P060-4NR3 Test Circuit Component Designations and Values — 1805–1880 MHz**

Part	Description	Part Number	Manufacturer
C1	11 pF Chip Capacitor	ATC100B110JT500XT	ATC
C2, C5	1.1 pF Chip Capacitors	ATC100B1R1BT500XT	ATC
C3	1.8 pF Chip Capacitor	ATC100B1R8BT500XT	ATC
C4	0.5 pF Chip Capacitor	ATC100B0R5BT500XT	ATC
C6	15 pF Chip Capacitor	ATC100B150JT500XT	ATC
C7, C8, C15	12 pF Chip Capacitors	ATC100B120JT500XT	ATC
C9, C10, C11, C12, C14	10 $\mu$ F Chip Capacitors	C5750X7S2A106M	Kemet
C13	470 $\mu$ F, 63 V Electrolytic Capacitor	MCGPR63V477M13X26-RH	Multicomp
C16	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C17	3 pF Chip Capacitor	ATC100B3R0BT500XT	ATC
R1	5.9 $\Omega$ , 1/4 W Chip Resistor	CRCW12065R90FKEA	Vishay
R2, R3	2 K $\Omega$ , 1/4 W Chip Resistors	CRCW12062K00FKEA	Vishay
PCB	0.030", $\epsilon_r = 2.55$	AD255A	Arlon

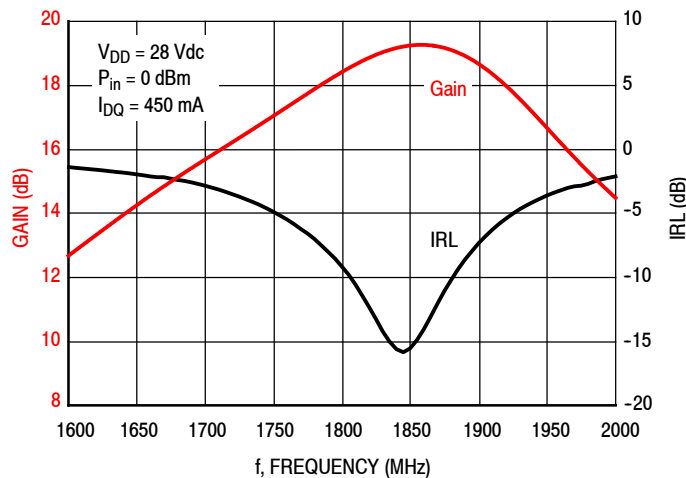
### TYPICAL CHARACTERISTICS — 1805–1880 MHz



**Figure 9. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @  $P_{out} = 6.3$  Watts Avg.**



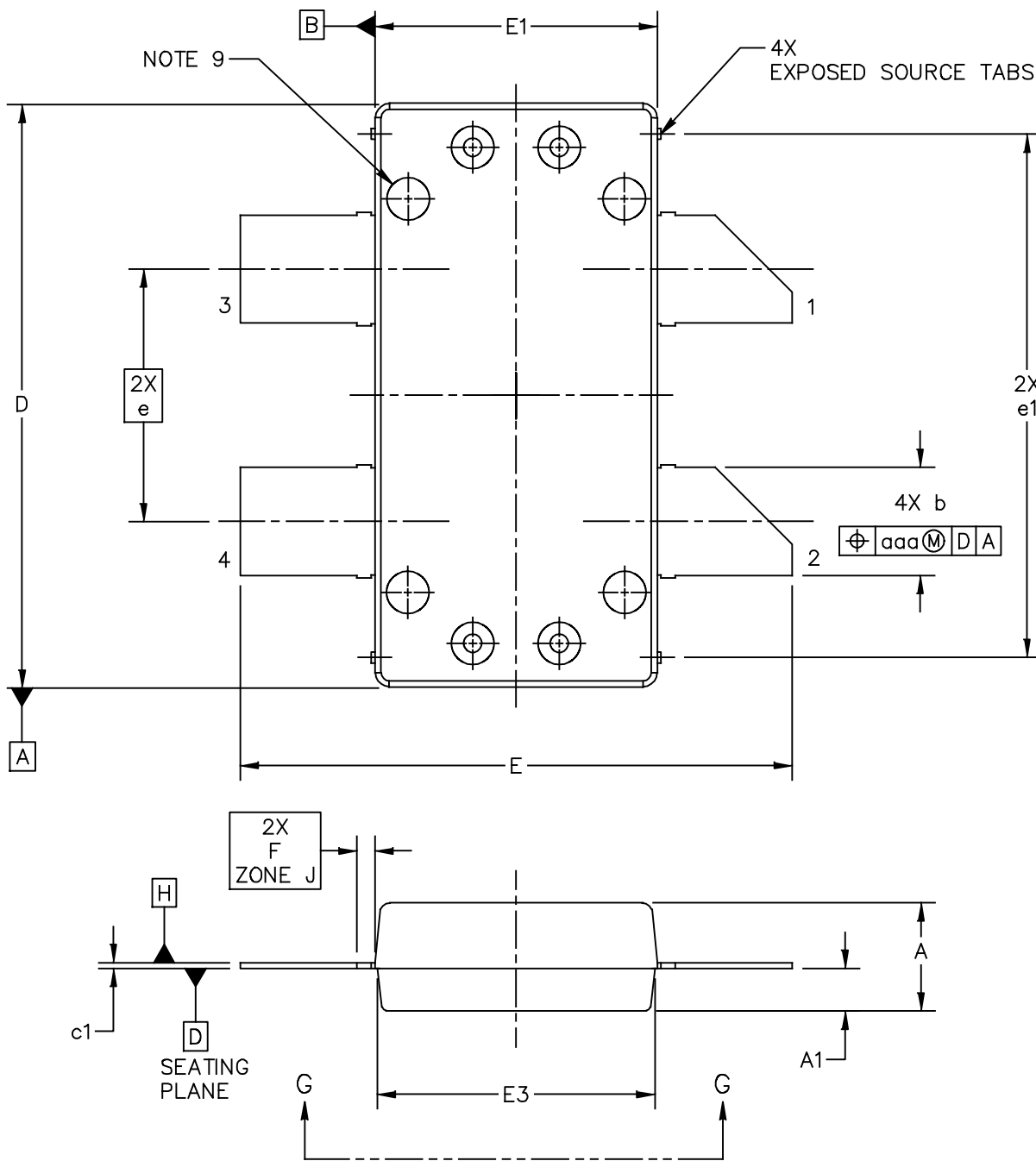
**Figure 10. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**



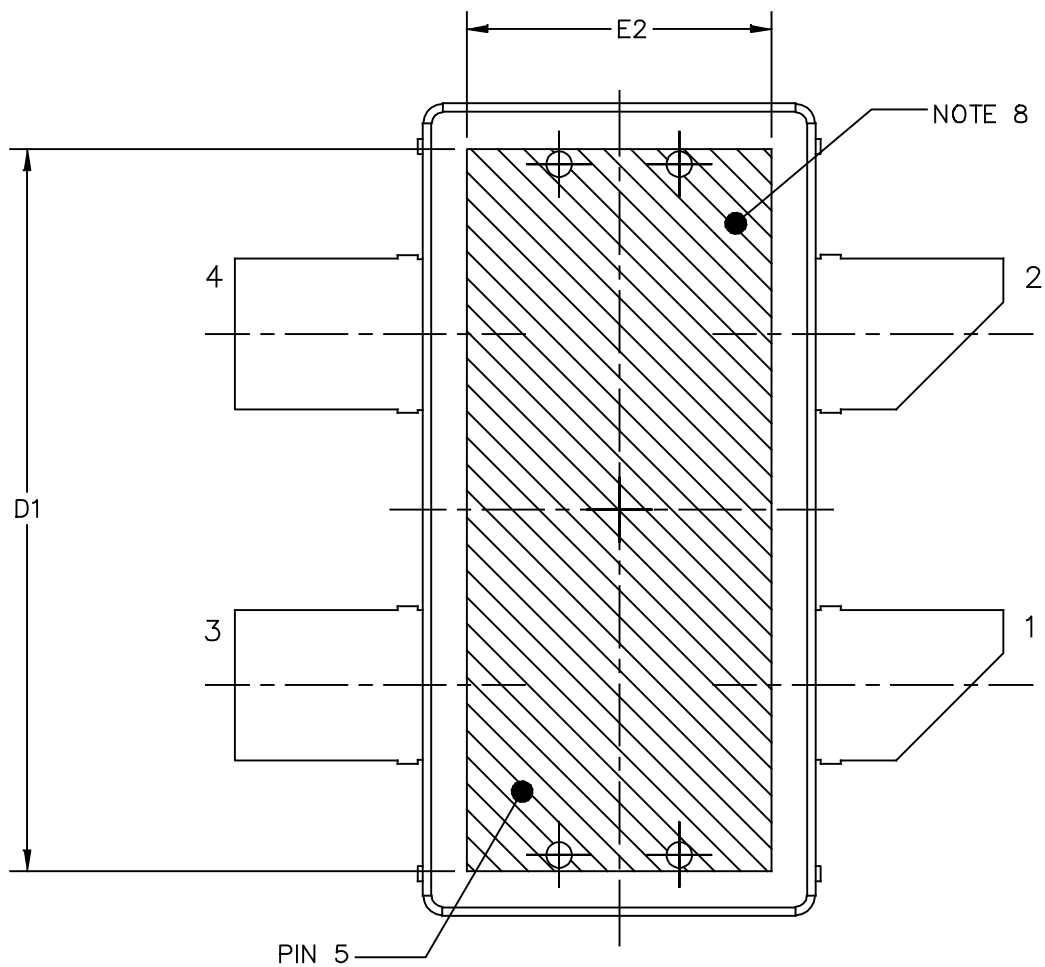
**Figure 11. Broadband Frequency Response**



### PACKAGE DIMENSIONS



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		CASE NUMBER: 2023-02		10 FEB 2010	
		STANDARD: NON-JEDEC			



BOTTOM VIEW  
VIEW G-G

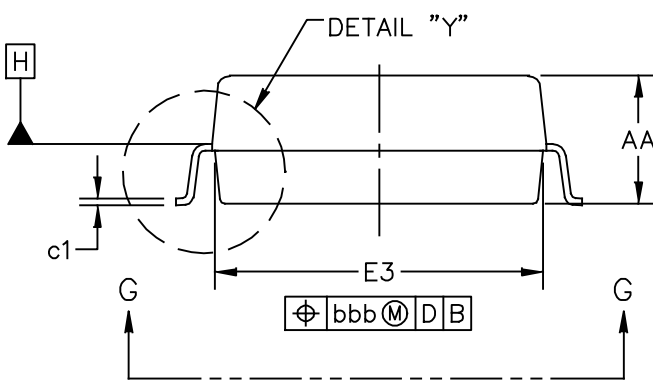
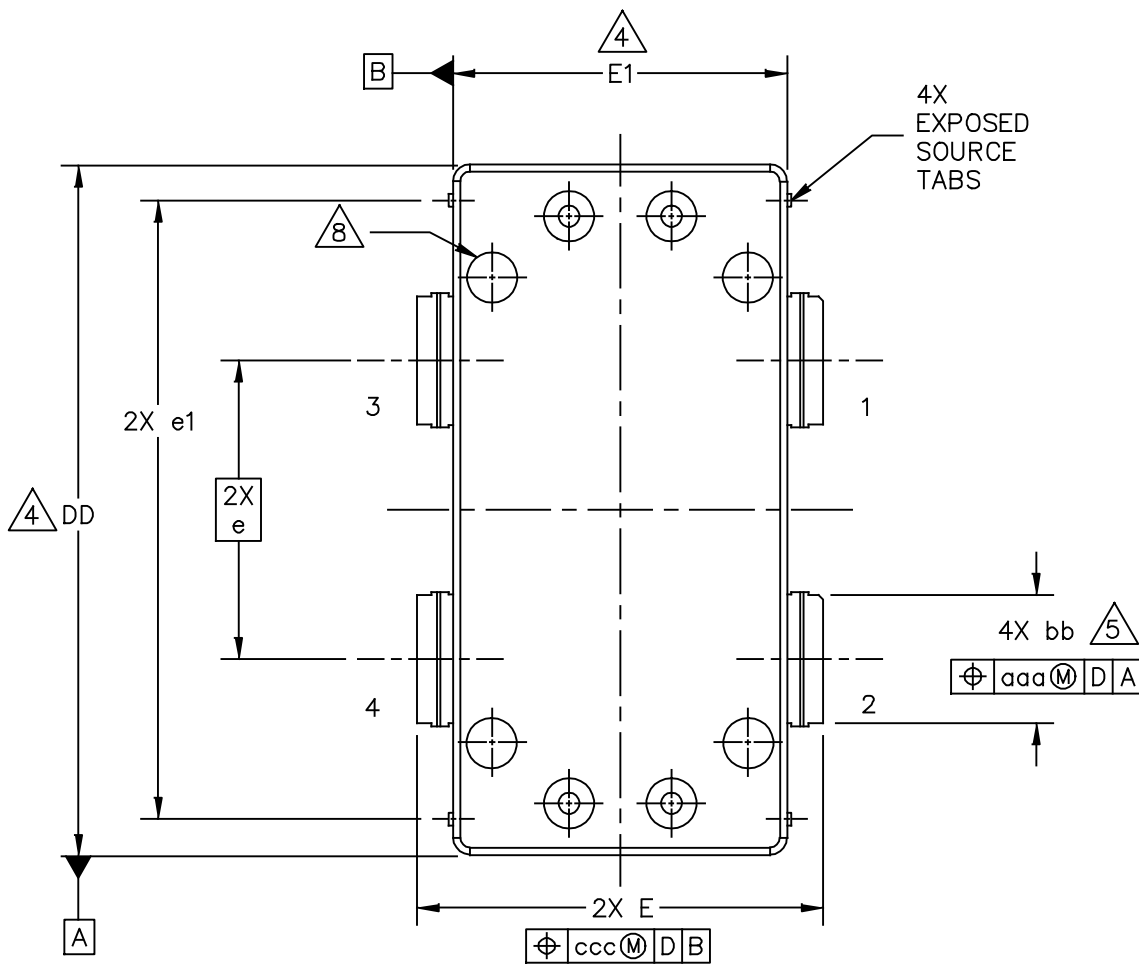
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	CASE NUMBER: 2023-02	10 FEB 2010	
	STANDARD: NON-JEDEC		

NOTES:

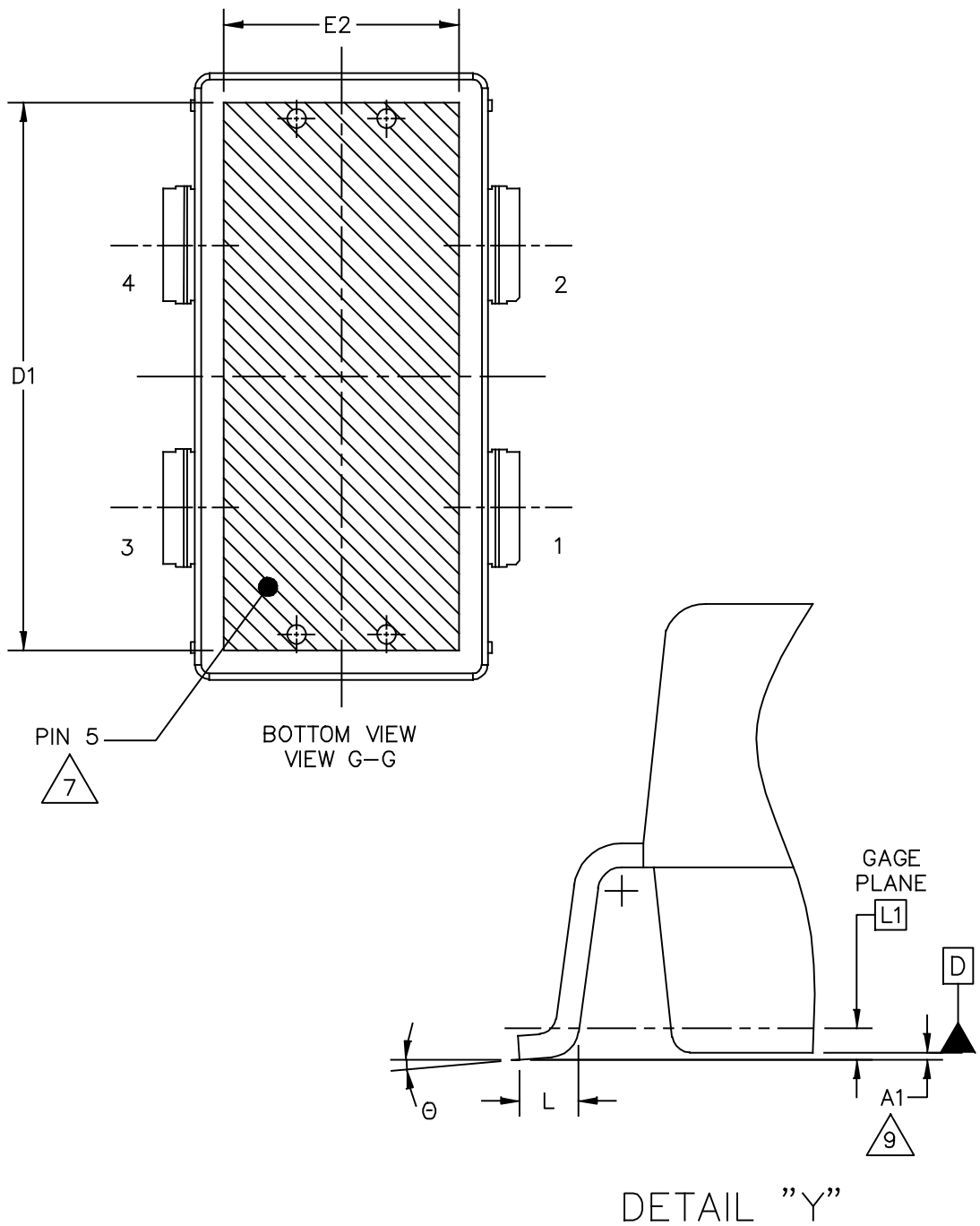
1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION A1 APPLIES WITHIN ZONE "J" ONLY.
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.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	0.148	.152	3.76	3.86	b	.147	.153	3.73	3.89
A1	.059	.065	1.50	1.65	c1	.007	.011	0.18	0.28
D	.808	.812	20.52	20.62	e	.350 BSC		8.89 BSC	
D1	.720	----	18.29	----	e1	.721	.729	18.31	18.52
E	.762	.770	19.36	19.56	aaa	.004		0.10	
E1	.390	.394	9.91	10.01					
E2	.306	----	7.77	----					
E3	.383	.387	9.72	9.83					
F	.025 BSC		0.635 BSC						

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	STANDARD: NON-JEDEC	
	14 NOV 2013	

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. 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.

8. DIMPLED HOLE REPRESENTS INPUT SIDE.

9. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM D. THE POSITIVE VALUE IMPLIES THAT THE BOTTOM OF PACKAGE IS HIGHER THAN THE BOTTOM OF THE LEAD.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
AA	.148	.152	3.76	3.86	bb	.147	.153	3.73	3.89
A1	-.002	.002	-0.05	0.05	c1	.007	.011	0.18	0.28
DD	.808	.812	20.52	20.62	e	0.350 BSC		8.89 BSC	
D1	.720	----	18.29	----	e1	.721	.729	18.31	18.52
E	.470	.482	11.94	12.24	θ	0°	8°	0°	8°
E1	.390	.394	9.91	10.01	aaa	.004		0.10	
E2	.306	----	7.77	----	bbb	.006		0.15	
E3	.383	.387	9.73	9.83	ccc	.010		0.25	
L	.018	.024	0.46	0.61					
L1	.010 BSC		0.25 BSC						

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		14 NOV 2013	

## PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

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

### Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

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

### Development Tools

- Printed Circuit Boards

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

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Jan. 2013	<ul style="list-style-type: none"> <li>• Initial Release of Data Sheet</li> </ul>
1	Dec. 2013	<ul style="list-style-type: none"> <li>• Added part number AFT20P060-4GNR3, p. 1</li> <li>• Added OM780G-4L isometric, p. 1, and Mechanical Outline, pp. 12-14</li> </ul>

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