Freescale Semiconductor
Technical Data

Document Number: MRF6S21100N
Rev. 1, 5/2006

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRF6S21100NR1
MRF6S21100NBR1

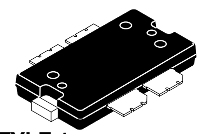
2110-2170 MHz, 23 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

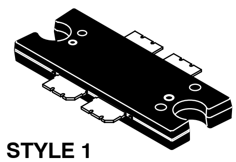
- Typical 2-Carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 1050 mA, P_{out} = 23 Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 14.5 dB
  Drain Efficiency — 25.5%
  IM3 @ 10 MHz Offset — -37 dBc in 3.84 MHz Bandwidth
  ACPR @ 5 MHz Offset — -40 dBc in 3.84 MHz Bandwidth
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2140 MHz, 100 Watts CW Output Power

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- 200°C Capable Plastic Package
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF6S21100NR1



CASE 1484-04, STYLE 1
TO-272 WB-4
PLASTIC
MRF6S21100NBR1

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +68	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +12	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	307 1.75	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +175	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 100 W CW Case Temperature 73°C, 23 W CW	$R_{\theta JC}$	 0.57 0.66	°C/W

1. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

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Table 3. ESD Protection Characteristics

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

Table 4. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD 22-A113, IPC/JEDEC J-STD-020	3	260	°C

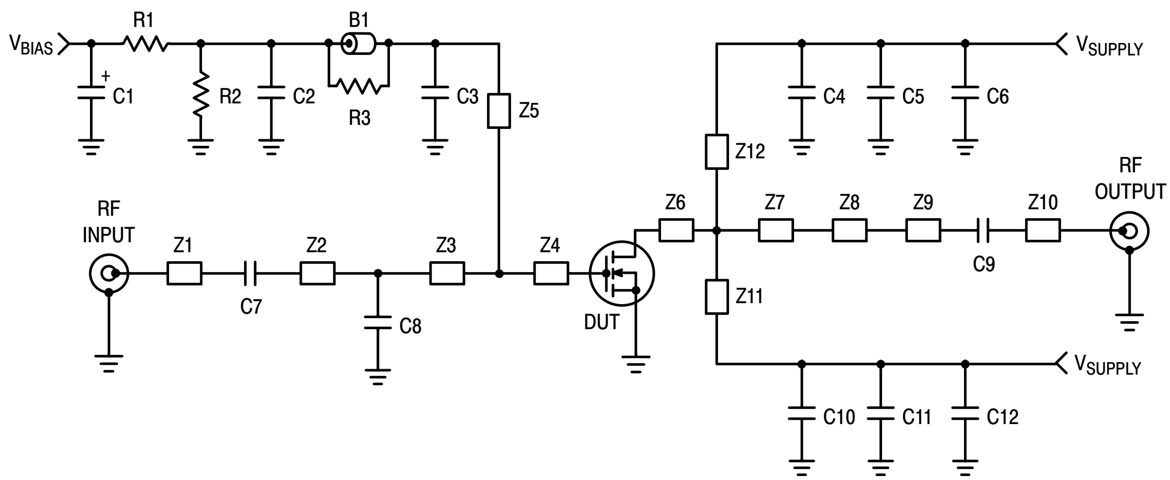
Table 5. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 68 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 330 μAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 1050 mAdc)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.3 Adc)	$V_{DS(on)}$	—	0.24	—	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 2.2 Adc)	g_{fs}	—	5.3	—	S
Dynamic Characteristics(1)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.5	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1050 mA, P_{out} = 23 W Avg., f1 = 2112.5 MHz, f2 = 2122.5 MHz and f1 = 2157.5 MHz, f2 = 2167.5 MHz, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers, ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. IM3 measured in 3.84 MHz Bandwidth @ ±10 MHz Offset.. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	13	14.5	16	dB
Drain Efficiency	η_D	24	25.5	36	%
Intermodulation Distortion)	IM3	-47	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	-50	-40	-38	dBc
Input Return Loss	IRL	—	-12	-10	dB

1. Part is internally matched both on input and output.



Z1, Z10	0.743″ x 0.084″ Microstrip	Z7	0.259″ x 0.880″ Microstrip
Z2	0.893″ x 0.084″ Microstrip	Z8	0.215″ x 0.230″ Microstrip
Z3	0.175″ x 0.084″ Microstrip	Z9	0.787″ x 0.084″ Microstrip
Z4	0.420″ x 0.800″ Microstrip	Z11, Z12	1.171″ x 0.120″ Microstrip
Z5	1.231″ x 0.040″ Microstrip	PCB	Arlon AD250, 0.030″, ε_r = 2.5
Z6	0.100″ x 0.880″ Microstrip		

Figure 1. MRF6S21100NR1(NBR1) Test Circuit Schematic

Table 6. MRF6S21100NR1(NBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead (0805)	25008051107Y0	Fair-Rite
C1	10 μF, 35 V Tantalum Capacitor	T491D106K035AS	Kemet
C2	0.01 μF Chip Capacitor (1825)	C1825C103J1GAC	Kemet
C3, C4, C10	5.1 pF 600B Chip Capacitors	600B5R1BT250XT	ATC
C5, C6, C11, C12	10 μF, 50 V Chip Capacitors	GRM55DR61H106KA88L	Murata
C7	10 pF 600B Chip Capacitor	600B100BT250XT	ATC
C8	1.1 pF 600B Chip Capacitor	600B1R1BT250XT	ATC
C9	5.1 pF 600 B Chip Capacitor (MRF6S21100NR1) 8.2 pF 600 B Chip Capacitor (MRF6S21100NBR1)	600B5R1BT250XT 600B8R2BT250XT	ATC ATC
R1	1 kΩ, 1/4 W Chip Resistor (1206)		
R2	10 kΩ, 1/4 W Chip Resistor (1206)		
R3	10 Ω, 1/4 W Chip Resistor (1206)		

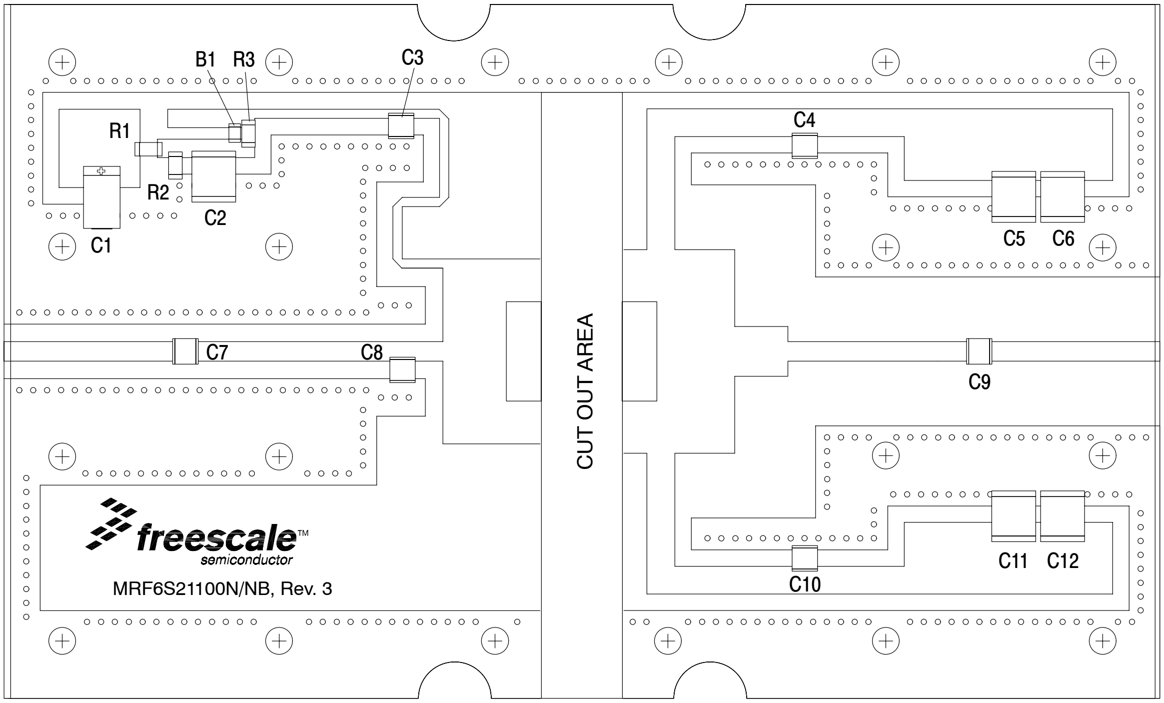


Figure 2. MRF6S21100NR1(NBR1) Test Circuit Component Layout

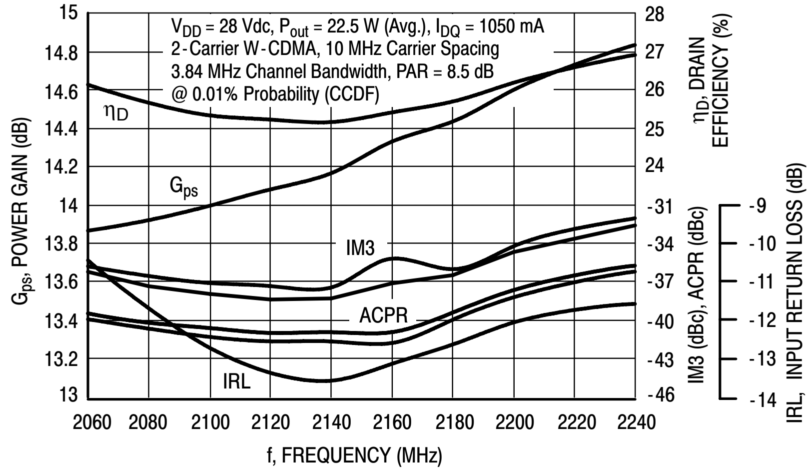


Figure 3. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 22.5 Watts Avg.

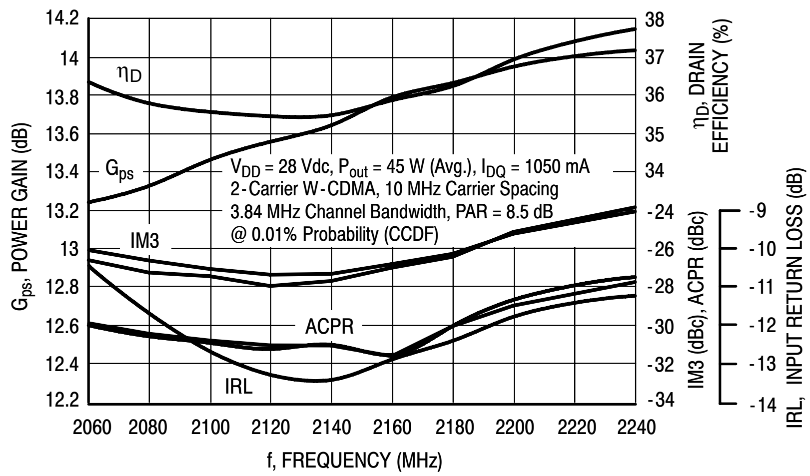


Figure 4. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 45 Watts Avg.

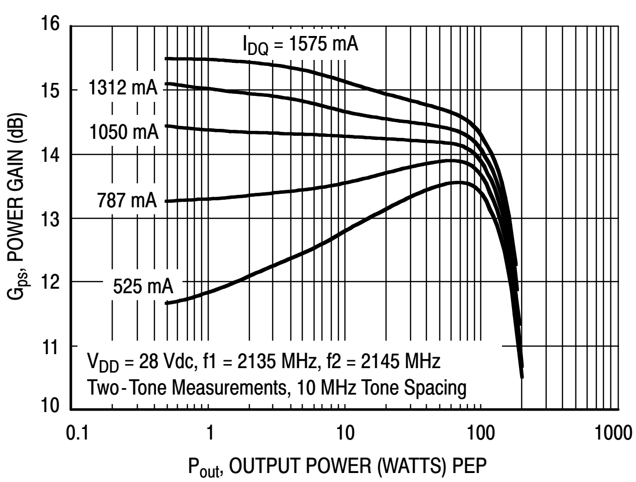


Figure 5. Two-Tone Power Gain versus Output Power

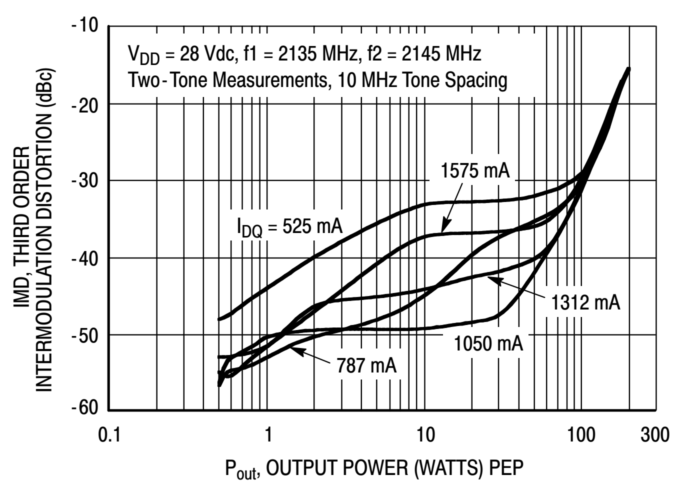


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

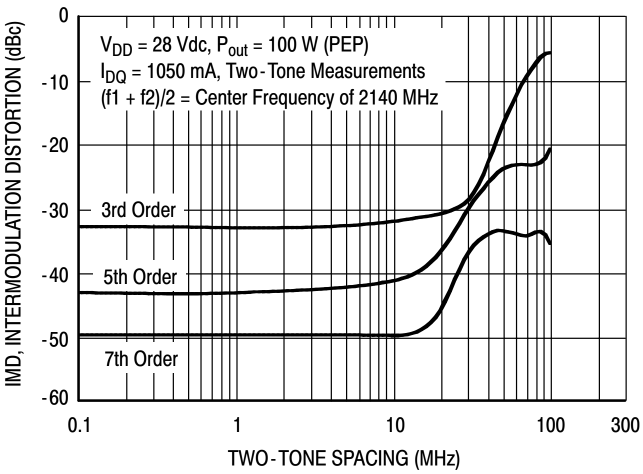


Figure 7. Intermodulation Distortion Products versus Tone Spacing

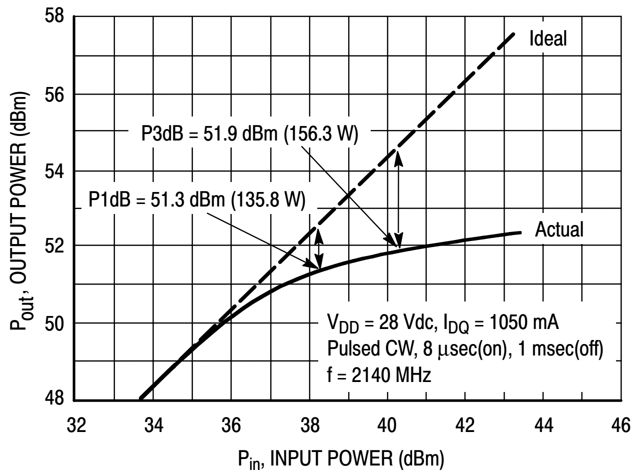


Figure 8. Pulse CW Output Power versus Input Power

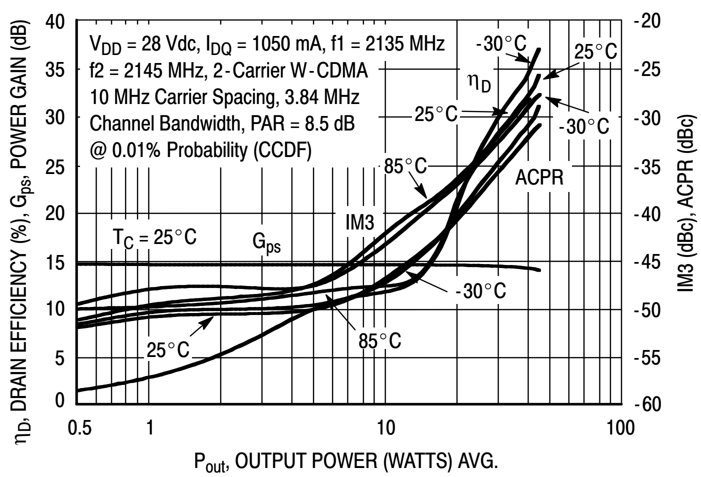


Figure 9. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

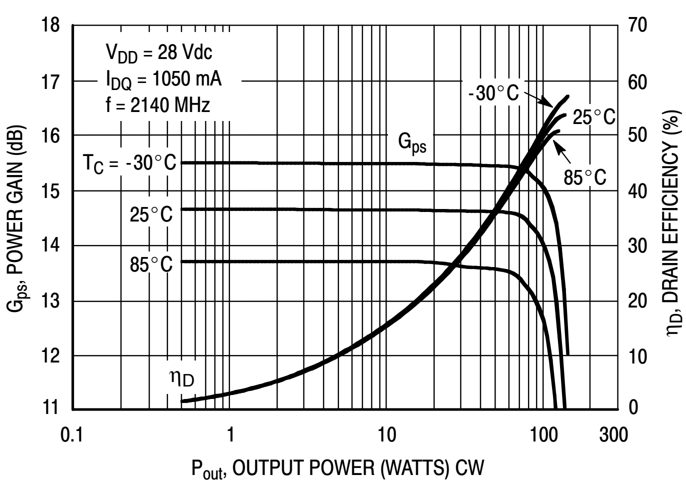


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

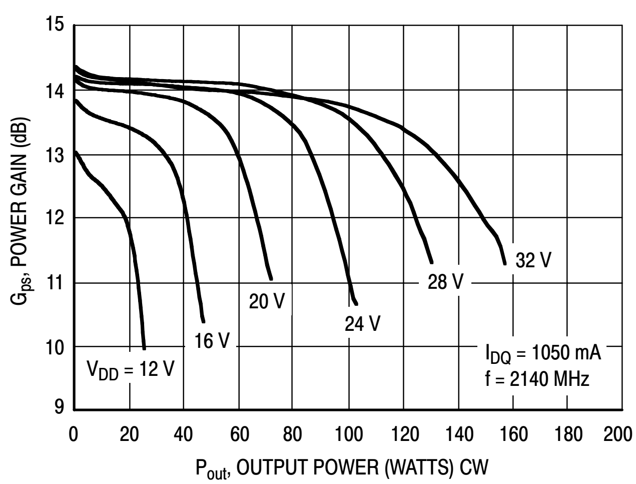
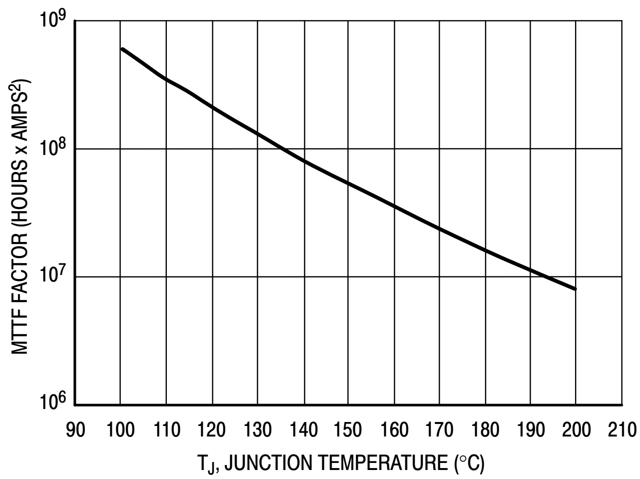


Figure 11. Power Gain versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 12. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

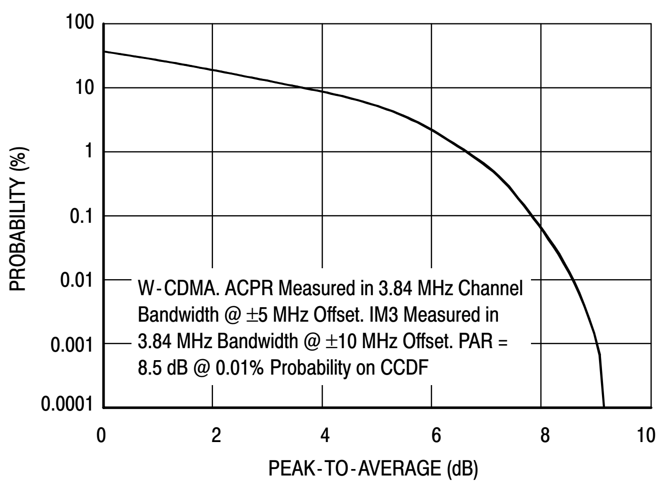


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

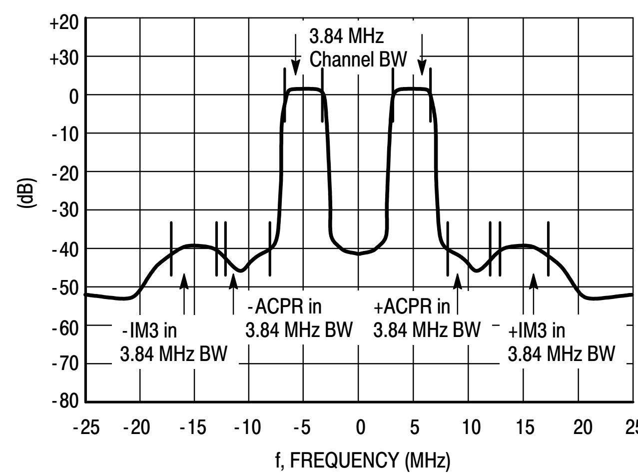
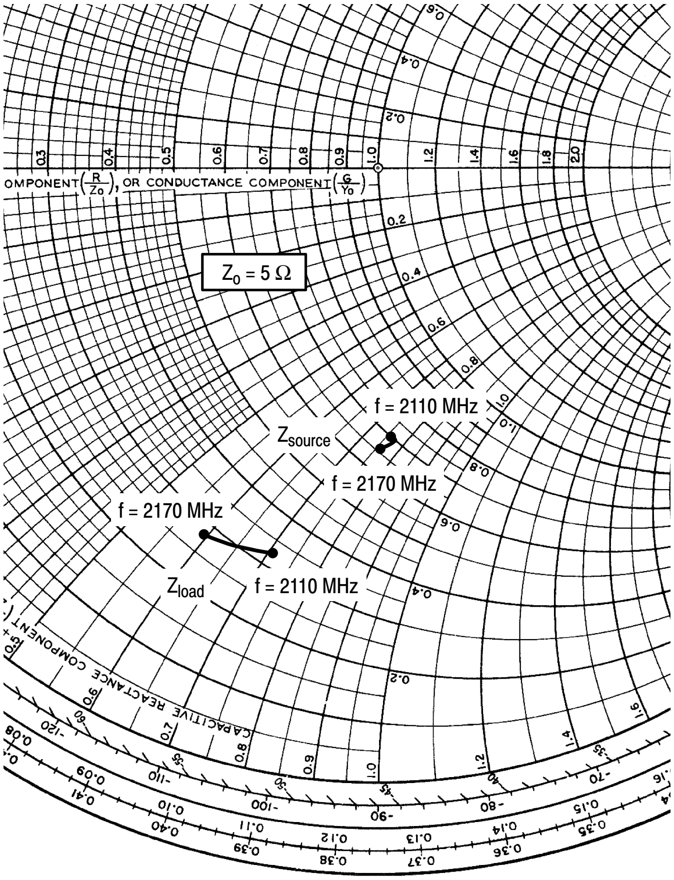


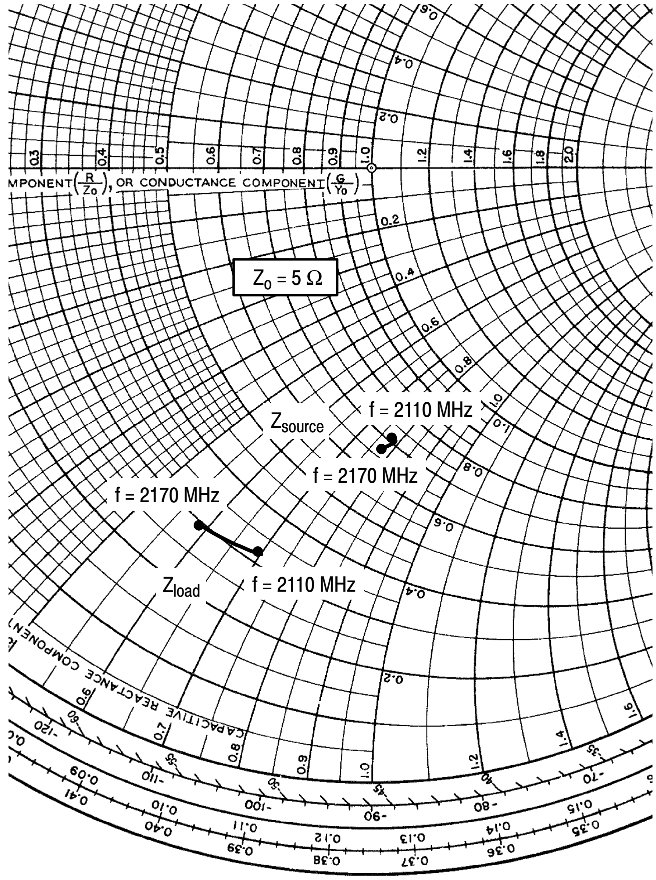
Figure 14. 2-Carrier W-CDMA Spectrum



MRF6S21100NR1

V_{DD} = 28 Vdc, I_{DQ} = 1050 mA, P_{out} = 23 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2110	3.51 - j3.78	1.62 - j3.54
2140	3.50 - j3.83	1.51 - j3.26
2170	3.29 - j3.78	1.41 - j2.95



MRF6S21100NBR1

V_{DD} = 28 Vdc, I_{DQ} = 1050 mA, P_{out} = 23 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2110	3.56 - j3.92	1.62 - j3.47
2140	3.55 - j3.97	1.53 - j3.19
2170	3.34 - j3.90	1.44 - j2.89

Z_{source} = Test circuit impedance as measured from gate to gate, balanced configuration.

Z_{load} = Test circuit impedance as measured from drain to drain, balanced configuration.

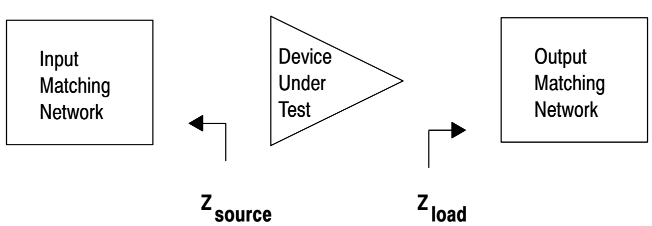


Figure 15. Series Equivalent Source and Load Impedance

NOTES

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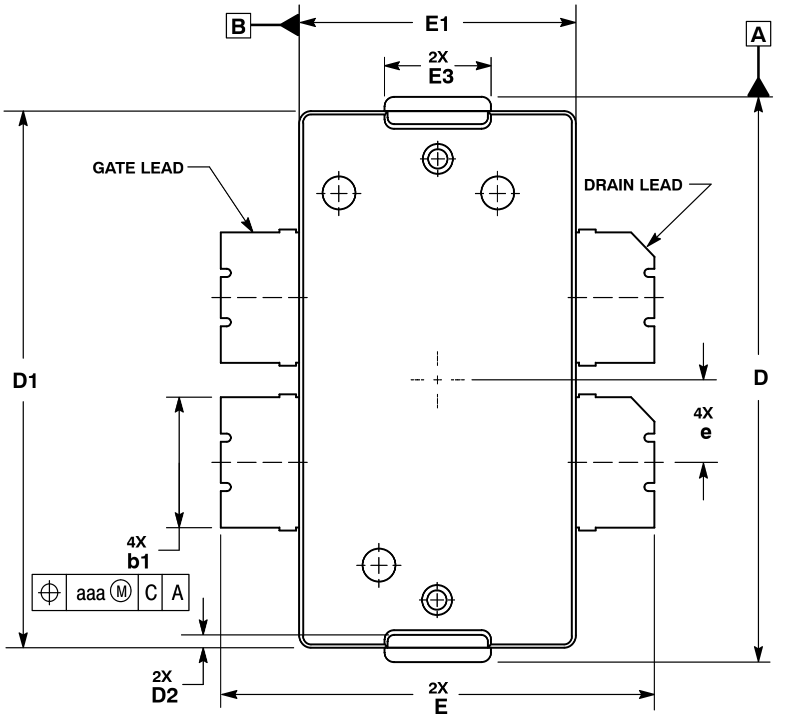
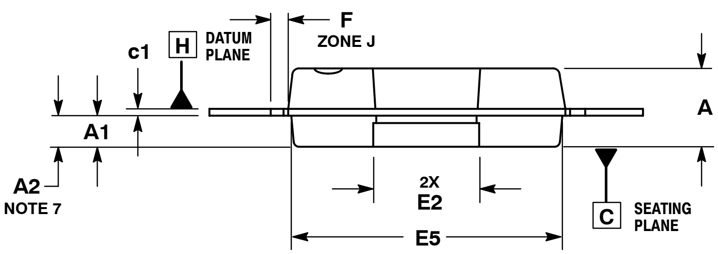
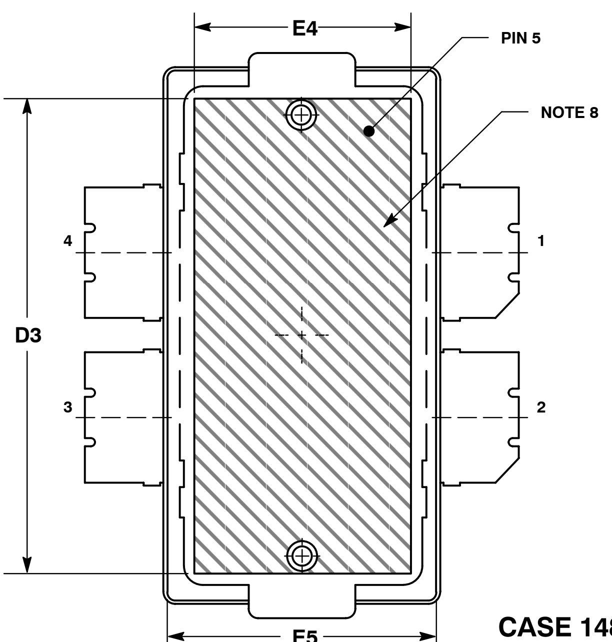
PACKAGE DIMENSIONS







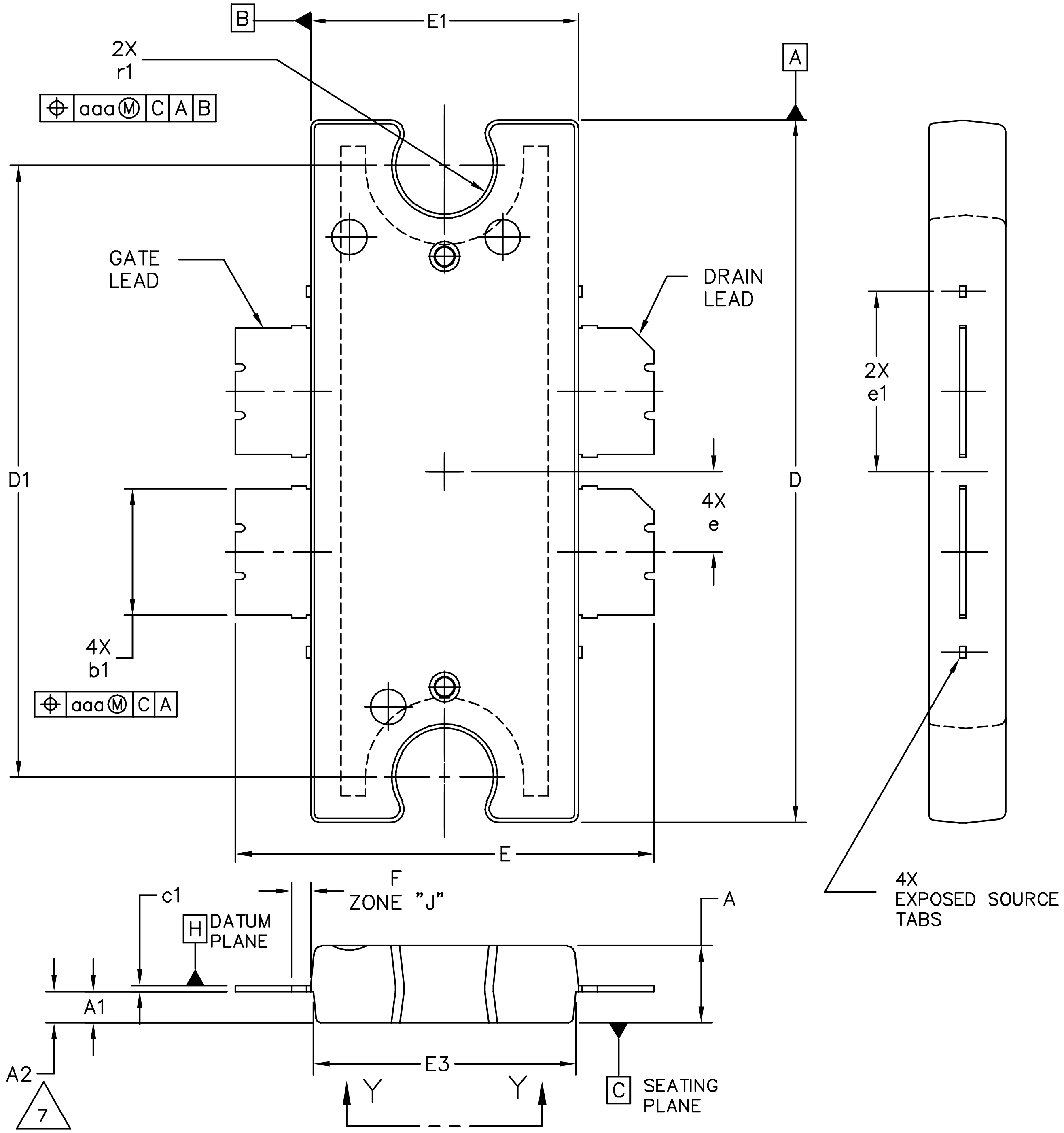
BOTTOM VIEW

CASE 1486-03
ISSUE C
TO-270 WB-4
PLASTIC
MRF6S21100NR1

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 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION 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 AREA OF THE HEAT SLUG.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.100	.104	2.54	2.64
A1	.039	.043	0.99	1.09
A2	.040	.042	1.02	1.07
D	.712	.720	18.08	18.29
D1	.688	.692	17.48	17.58
D2	.011	.019	0.28	0.48
D3	.600	---	15.24	---
E	.551	.559	14	14.2
E1	.353	.357	8.97	9.07
E2	.132	.140	3.35	3.56
E3	.124	.132	3.15	3.35
E4	.270	---	6.86	---
E5	.346	.350	8.79	8.89
F	.025 BSC		0.64 BSC	
b1	.164	.170	4.17	4.32
c1	.007	.011	0.18	0.28
e	.106 BSC		2.69 BSC	
aaa	.004		0.10	

STYLE 1:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE



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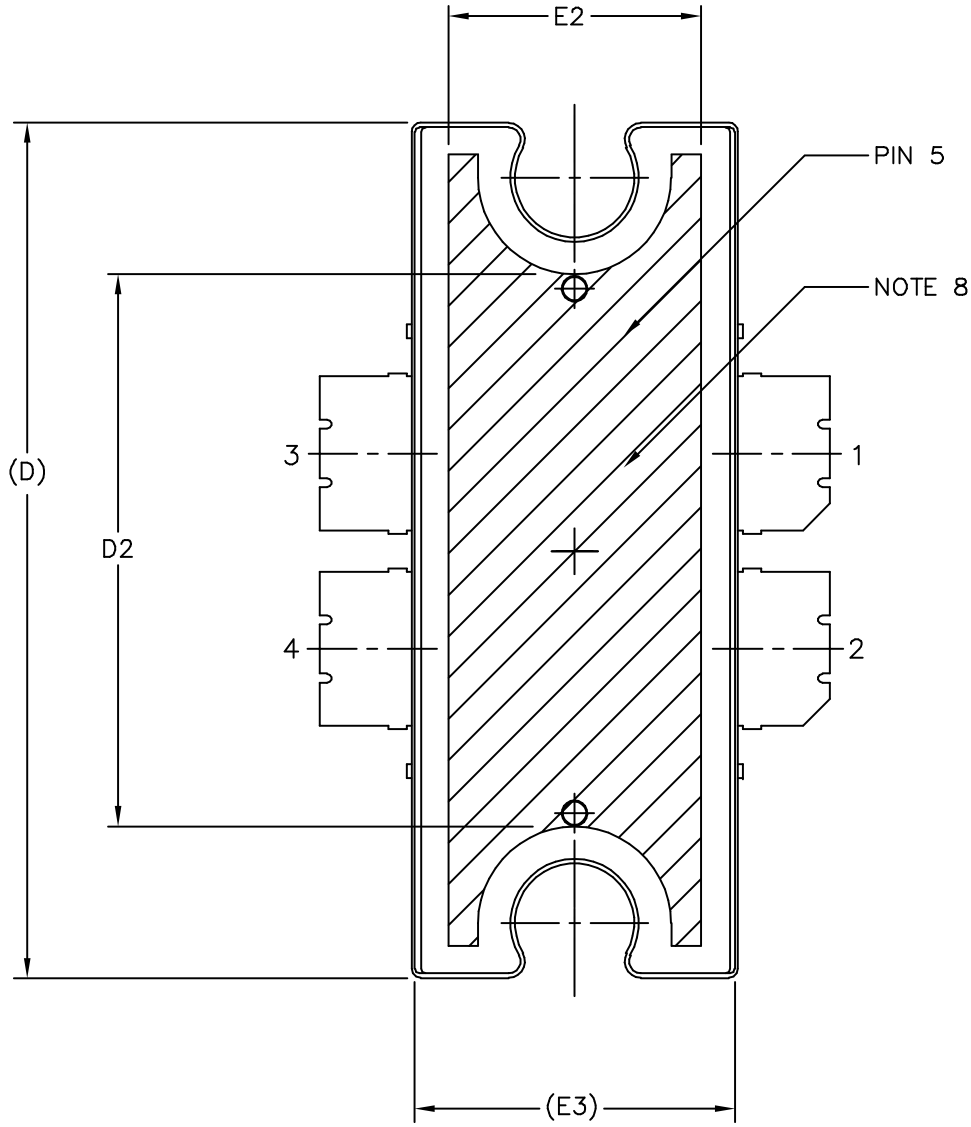
	CASE NUMBER: 1484-04	05 APR 2006
	STANDARD: NON-JEDEC	



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	CASE NUMBER: 1484-04		05 APR 2006
	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 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 PER SIDE. DIMENSIONS "D" AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
5. DIMENSIONS "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUM A AND B TO BE DETERMINED AT DATUM PLANE H.
7. DIMENSION A2 APPLIES WITHIN ZONE "J" ONLY.
8. HATCHING REPRESENTS EXPOSED AREA OF THE HEAT SLUG. HATCHED AREA SHOWN IS ON THE SAME PLANE.

STYLE 1:
PIN 1 − DRAIN   PIN 2 − DRAIN
PIN 3 − GATE   PIN 4 − GATE
PIN 5 − SOURCE

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.100	.104	2.54	2.64	b1	.164	.170	4.17	4.32
A1	.039	.043	0.99	1.09	c1	.007	.011	.18	.28
A2	.040	.042	1.02	1.07	r1	.063	.068	1.60	1.73
D	.928	.932	23.57	23.67	e	.106 BSC		2.69 BSC	
D1	.810 BSC		20.57 BSC		e1	.239 INFO ONLY		6.07 INFO ONLY	
D2	.600	−−−	15.24	−−−	aaa	.004		.10	
E	.551	.559	14	14.2					
E1	.353	.357	8.97	9.07					
E2	.270	−−−	6.86	−−−					
E3	.346	.350	8.79	8.89					
F	.025 BSC		0.64 BSC						

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
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	CASE NUMBER: 1484−04	05 APR 2006
	STANDARD: NON−JEDEC	

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