Freescale Semiconductor
Technical Data

Document Number: MRF6S9125
Rev. 1, 7/2005

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for broadband commercial and industrial applications with frequencies up to 1000 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 28 volt base station equipment.

N-CDMA Application

- Typical Single-Carrier N-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 950 mA, P_{out} = 27 Watt Avg., Full Frequency Band (865-895 MHz), IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  Power Gain — 20.2 dB
  Drain Efficiency — 31%
  ACPR @ 750 kHz Offset = -47.1 dBc @ 30 kHz Bandwidth

GSM EDGE Application

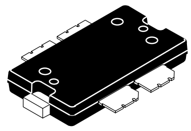
- Typical GSM EDGE Performance: V_{DD} = 28 Volts, I_{DQ} = 700 mA, P_{out} = 60 Watts Avg., Full Frequency Band (865-895 MHz or 921-960 MHz)
  Power Gain — 20 dB
  Drain Efficiency — 40% (Typ)
  Spectral Regrowth @ 400 kHz Offset = -63 dBc
  Spectral Regrowth @ 600 kHz Offset = -78 dBc
  EVM — 1.5% rms

GSM Application

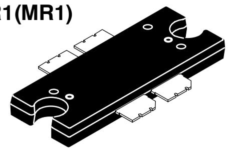
- Typical GSM Performance: V_{DD} = 28 Volts, I_{DQ} = 700 mA, P_{out} = 125 Watts, Full Frequency Band (921-960 MHz)
  Power Gain — 19 dB
  Drain Efficiency — 62%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, @ P1dB Output Power, @ f = 880 MHz
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- N Suffix Indicates Lead-Free Terminations
- 200°C Capable Plastic Package
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

MRF6S9125NR1
MRF6S9125NBR1
MRF6S9125MR1
MRF6S9125MBR1

880 MHz, 27 W AVG., 28 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF6S9125NR1(MR1)



CASE 1484-02, STYLE 1
TO-272 WB-4
PLASTIC
MRF6S9125NBR1(MBR1)

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	398 2.3	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

NOTE - **CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 125 W CW Case Temperature 76°C, 27 W CW	$R_{\theta JC}$	 0.44 0.45	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1B (Minimum)
Machine Model (per EIA/JESD22-A115)	C (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)

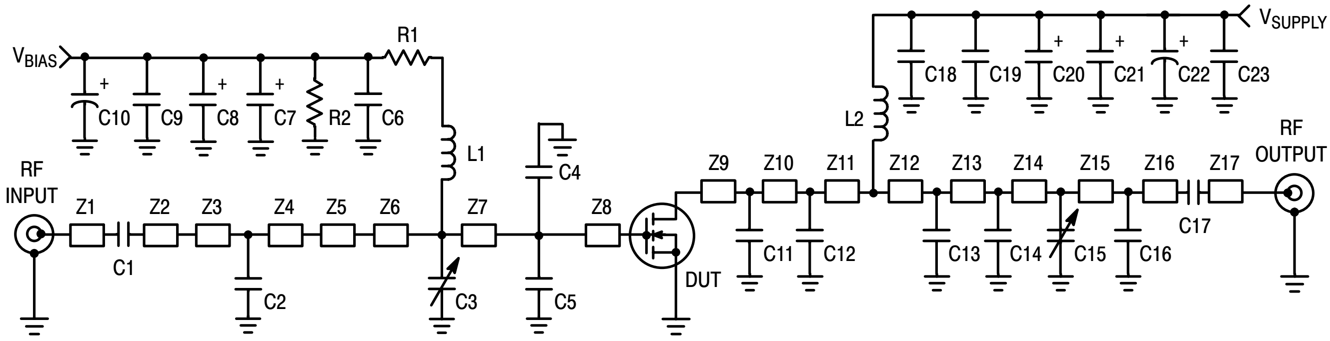
Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 68 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 400 μAdc)	$V_{GS(th)}$	1	2.1	3	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 950 mAdc)	$V_{GS(Q)}$	2	2.89	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.74 Adc)	$V_{DS(on)}$	0.05	0.23	0.3	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 8 Adc)	g_{fs}	—	6	—	S
Dynamic Characteristics (3)					
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	60	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	2	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 27 W, f = 880 MHz					
Power Gain	G_{ps}	19	20.2	24	dB
Drain Efficiency	η_D	29	31	—	%
Adjacent Channel Power Ratio	ACPR	—	-47.1	-45	dBc
Input Return Loss	IRL	—	-16	-9	dB

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.
3. Part is internally input matched.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Typical GSM EDGE Performances (In Freescale GSM EDGE Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 60 W Avg., 921 MHz<Frequency<960 MHz					
Power Gain	G_{ps}	—	20	—	dB
Drain Efficiency	η_D	—	40	—	%
Error Vector Magnitude	EVM	—	1.5	—	% rms
Spectral Regrowth at 400 kHz Offset	SR1	—	-63	—	dBc
Spectral Regrowth at 600 kHz Offset	SR2	—	-78	—	dBc
Typical CW Performances (In Freescale GSM Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 700 mA, P_{out} = 125 W, 921 MHz<Frequency<960 MHz					
Power Gain	G_{ps}	—	19	—	dB
Drain Efficiency	η_D	—	62	—	%
Input Return Loss	IRL	—	-12	—	dB
P_{out} @ 1 dB Compression Point, CW (f = 880 MHz)	P1dB	—	125	—	W



Z1, Z17	0.200″ x 0.080″ Microstrip	Z10	0.057″ x 0.620″ Microstrip
Z2	1.060″ x 0.080″ Microstrip	Z11	0.119″ x 0.620″ Microstrip
Z3	0.382″ x 0.220″ Microstrip	Z12	0.450″ x 0.220″ Microstrip
Z4	0.108″ x 0.220″ Microstrip	Z13	0.061″ x 0.220″ Microstrip
Z5	0.200″ x 0.420″ x 0.620″ Taper	Z14	0.078″ x 0.220″ Microstrip
Z6	0.028″ x 0.620″ Microstrip	Z15	0.692″ x 0.080″ Microstrip
Z7	0.236″ x 0.620″ Microstrip	Z16	0.368″ x 0.080″ Microstrip
Z8	0.050″ x 0.620″ Microstrip	PCB	Arlon GX-0300-55-22, 0.030″, ε_r = 2.55
Z9	0.238″ x 0.620″ Microstrip		

Figure 1. MRF6S9125NR1(NBR1)/MR1(MBR1) Test Circuit Schematic

Table 6. MRF6S9125NR1(NBR1)/MR1(MBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	20 pF Chip Capacitor	600B200FT250XT	ATC
C2	6.2 pF Chip Capacitor	600B6R2BT250XT	ATC
C3, C15	0.8-8.0 pF Variable Capacitors, Gigatrim	27291SL	Johanson
C4, C5	11 pF Chip Capacitors	600B110FT250XT	ATC
C6, C18, C19	0.56 μF, 50 V Chip Capacitors	C1825C564J5RAC	Kemet
C7, C8	47 μF, 16 V Tantalum Capacitors	593D476X9016D2T	Vishay
C9, C23	47 pF Chip Capacitors	700B470FW500XT	ATC
C10	100 μF, 50 V Electrolytic Capacitor	515D107M050BB6A	Vishay
C11, C12	12 pF Chip Capacitors	600B120FT250XT	ATC
C13, C14	5.1 pF Chip Capacitors	600B5R1BT250XT	ATC
C16	0.3 pF Chip Capacitor	700B0R3BW500XT	ATC
C17	39 pF Chip Capacitor	700B390FW500XT	ATC
C20, C21	22 μF, 35 V Tantalum Capacitors	T491X226K035AS	Kemet
C22	470 μF, 63 V Electrolytic Capacitor	SME63V471M12X25LL	United Chemi-Con
L1	7.15 nH Inductor	1606-7J	CoilCraft
L2	8.0 nH Inductor	A03T	CoilCraft
R1	15 Ω, 1/4 W Chip Resistor (1210)		Dale/Vishay
R2	560 kΩ, 1/8 W Resistor (1206)		Dale/Vishay

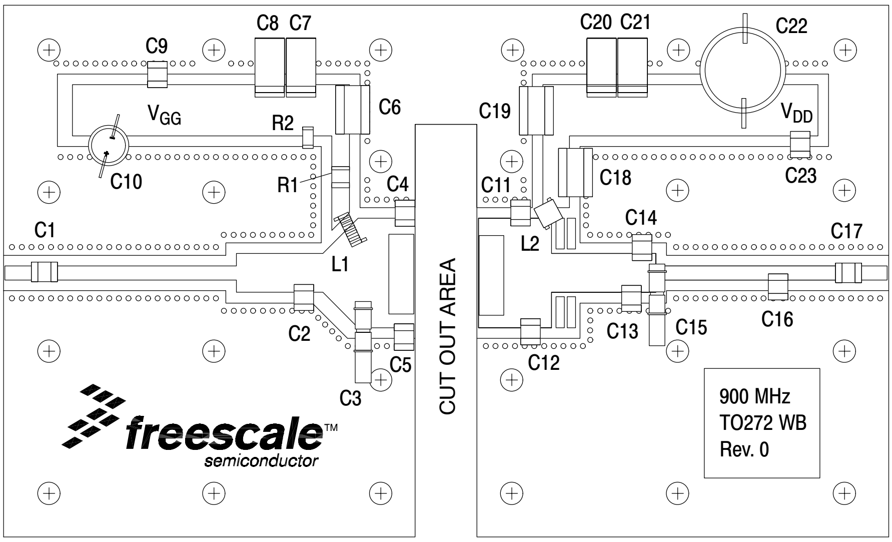


Figure 2. MRF6S9125NR1(NBR1)/MR1(MBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

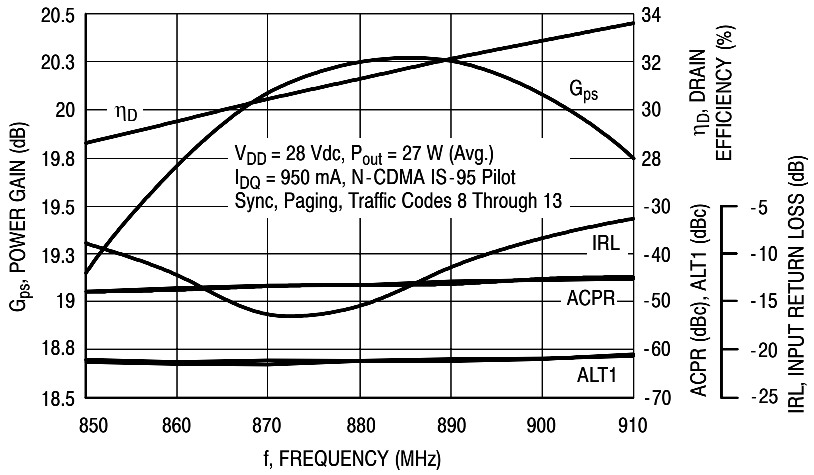


Figure 3. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 27 Watts Avg.

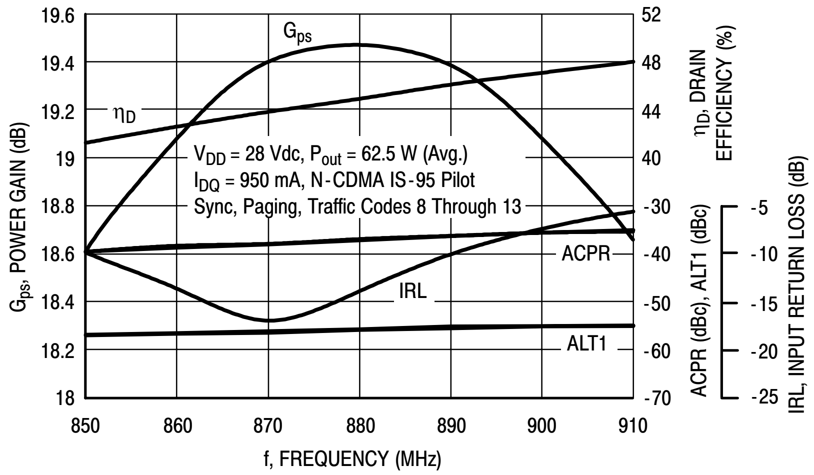


Figure 4. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 62.5 Watts Avg.

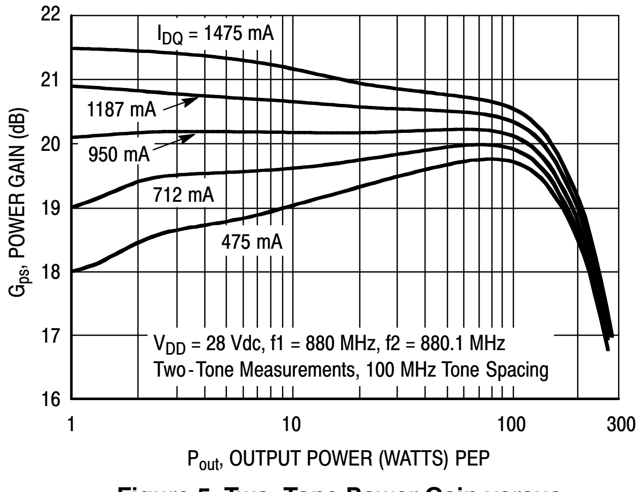


Figure 5. Two-Tone Power Gain versus Output Power

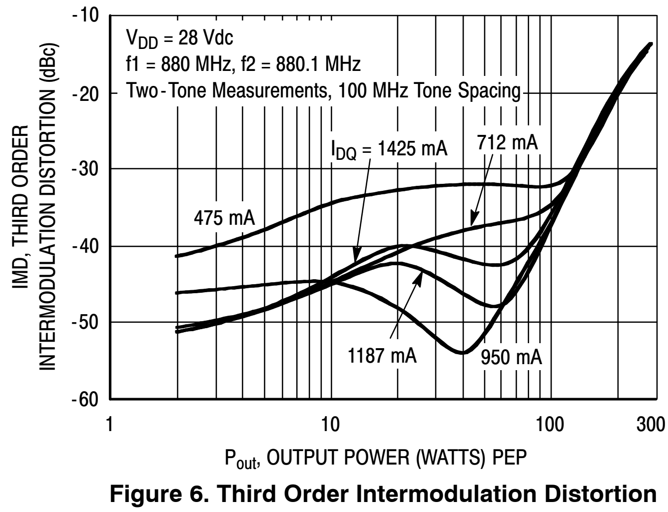


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

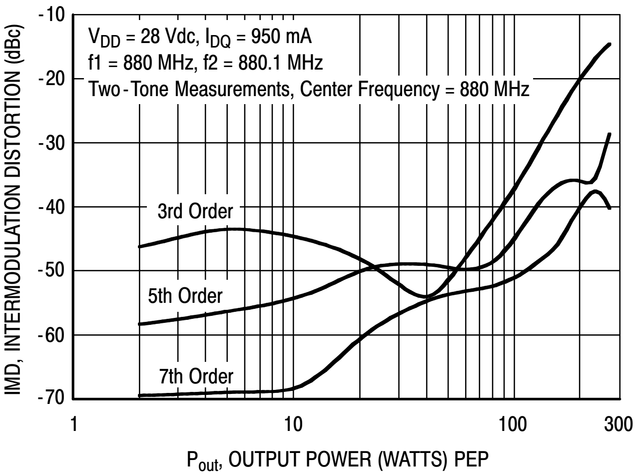


Figure 7. Intermodulation Distortion Products versus Output Power

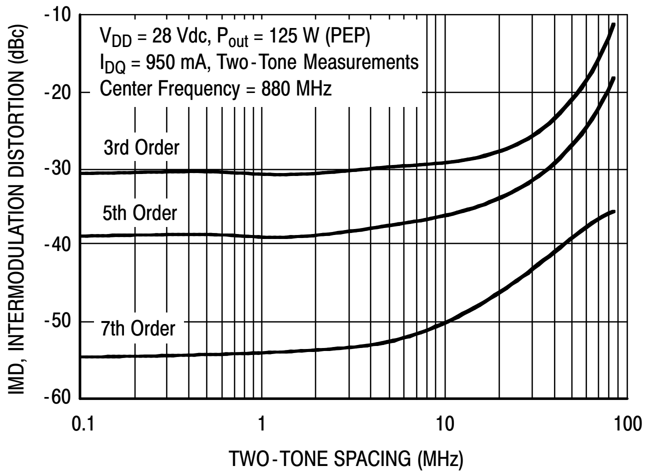


Figure 8. Intermodulation Distortion Products versus Tone Spacing

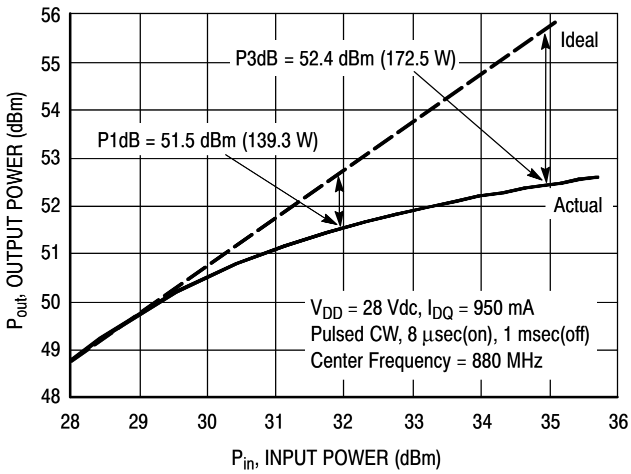


Figure 9. Pulse CW Output Power versus Input Power

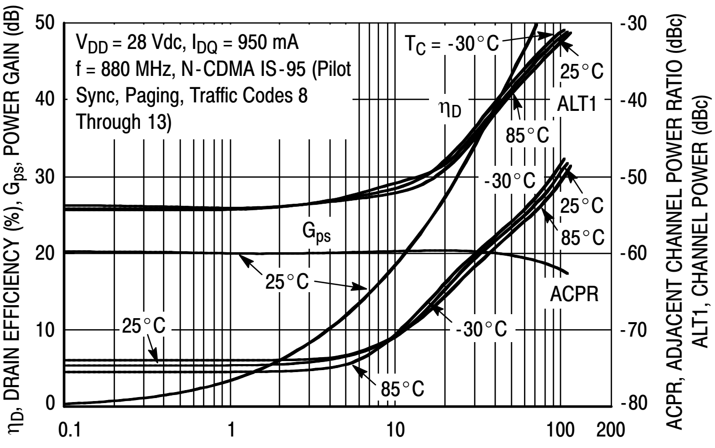


Figure 10. Single-Carrier N-CDMA ACPR, ALT1, Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS

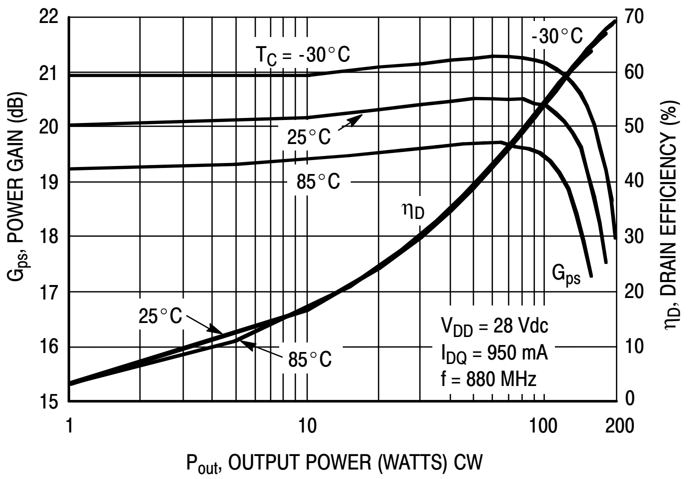


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

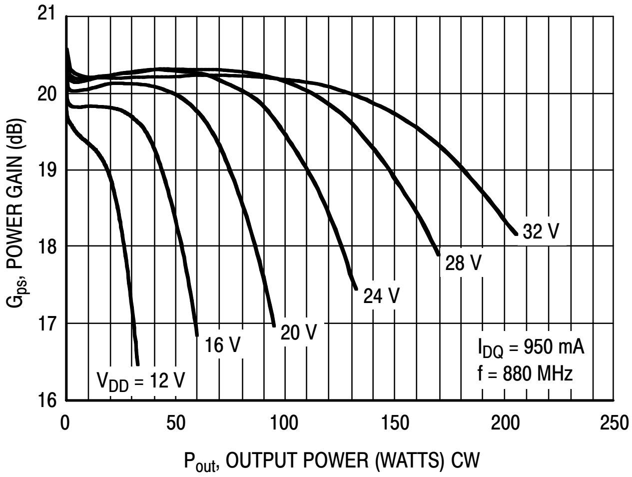
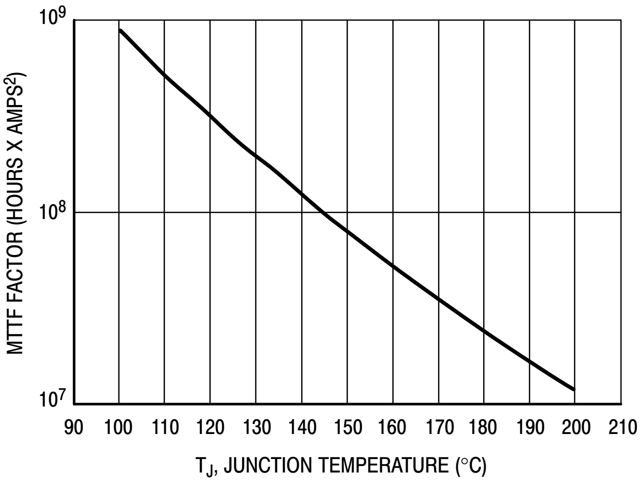


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours x ampere² 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 13. MTTF Factor versus Junction Temperature

N-CDMA TEST SIGNAL

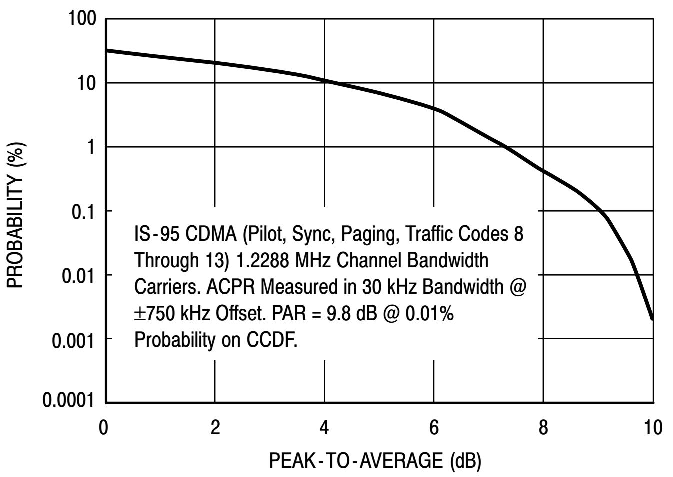


Figure 14. Single-Carrier CCDF N-CDMA

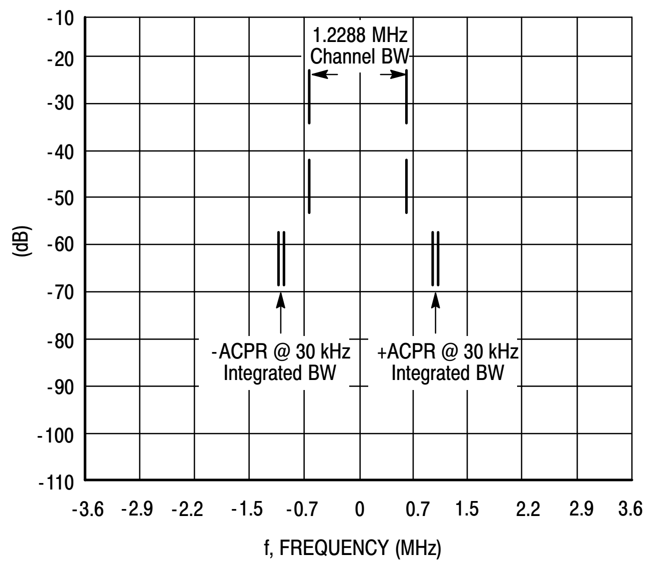
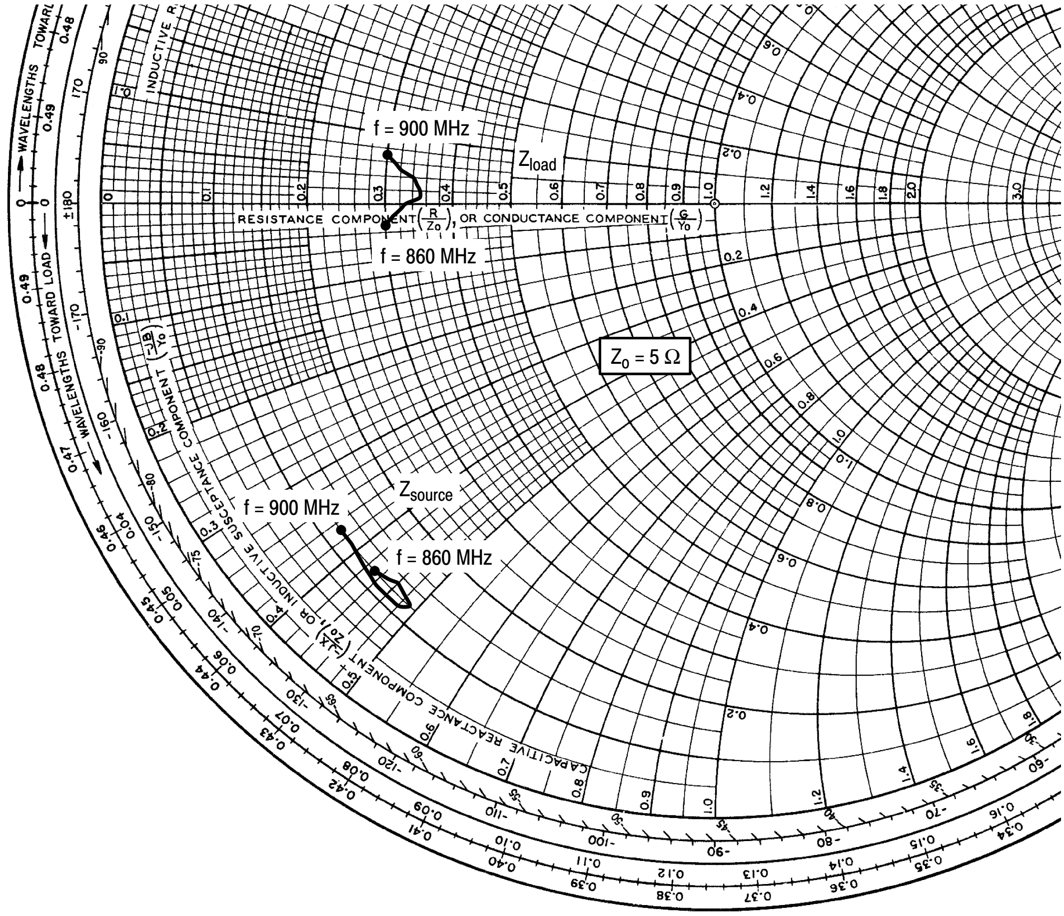


Figure 15. Single-Carrier N-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 27 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
860	0.62 - j2.13	1.48 - j0.14
865	0.64 - j2.31	1.56 - j0.09
870	0.62 - j2.45	1.66 - j0.02
875	0.59 - j2.43	1.73 + j0.04
880	0.57 - j2.42	1.74 + j0.11
885	0.54 - j2.36	1.68 + j0.19
890	0.57 - j2.18	1.61 + j0.25
895	0.58 - j1.94	1.52 + j0.33
900	0.59 - j1.86	1.48 + j0.37

Z_{source} = Test circuit impedance as measured from gate to ground.

Z_{load} = Test circuit impedance as measured from drain to ground.

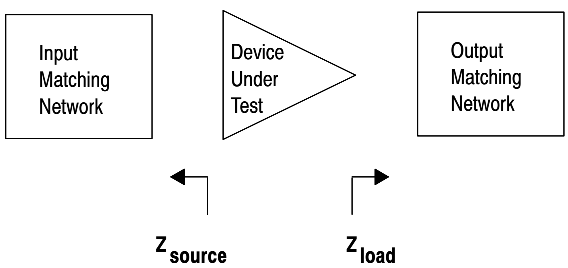


Figure 16. Series Equivalent Source and Load Impedance

NOTES

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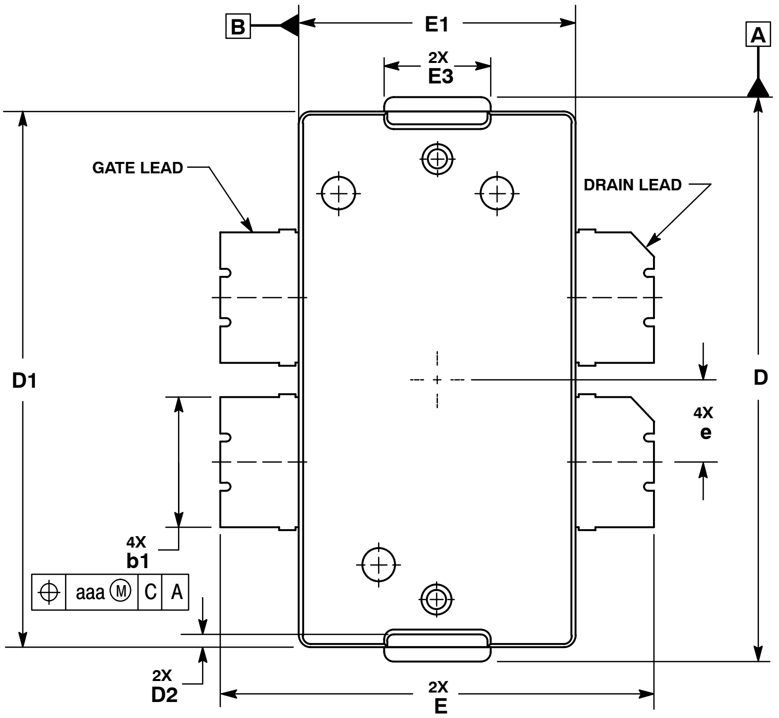
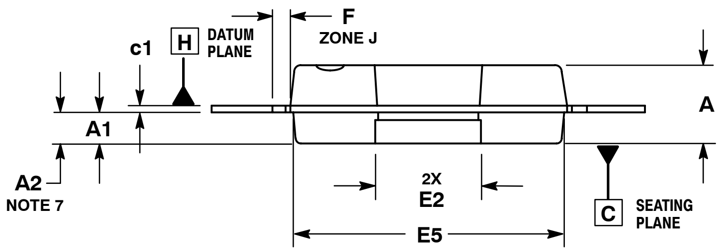
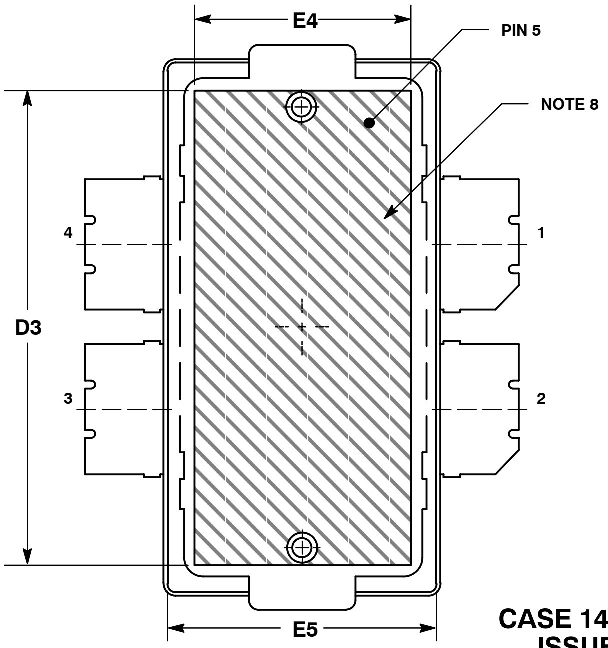
PACKAGE DIMENSIONS







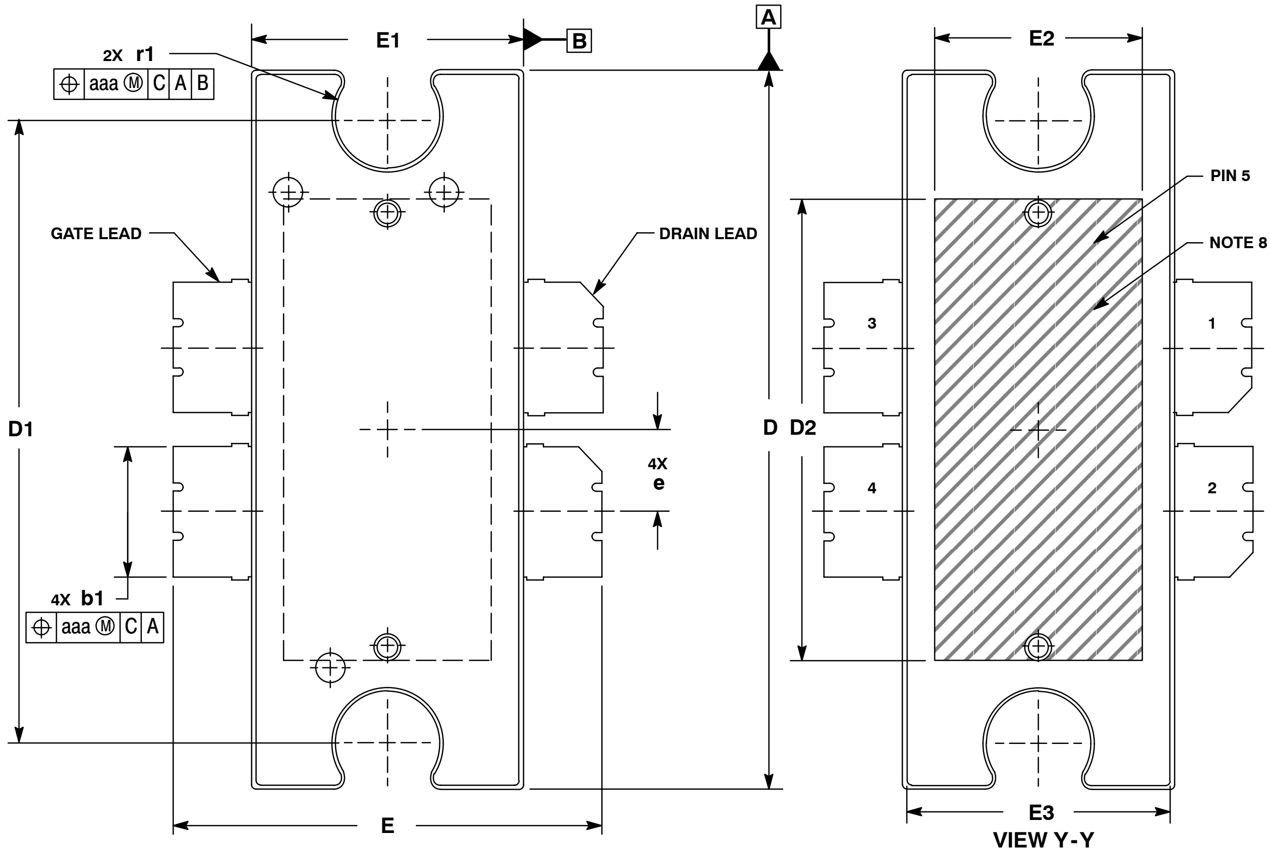
BOTTOM VIEW

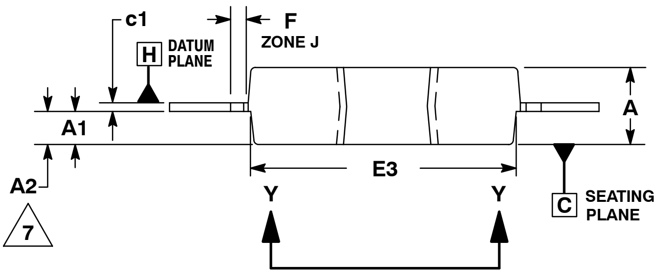
CASE 1486-03
ISSUE C
TO-270 WB-4
PLASTIC
MRF6S9125NR1(MR1)

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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DIM	INCHES		MILLIMETERS	
	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	.928	.932	23.57	23.67
D1	.810 BSC		20.57 BSC	
D2	.600	- - -	15.24	- - -
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	
b1	.164	.170	4.17	4.32
c1	.007	.011	.18	.28
r1	.063	.068	1.60	1.73
e	.106 BSC		2.69 BSC	
aaa	.004		.10	

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

CASE 1484-02
ISSUE B
TO-272 WB-4
PLASTIC
MRF6S9125NBR1(MBR1)

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