Freescale Semiconductor
Technical Data

Document Number: MRF5S19060N
Rev. 4, 8/2005

RF Power Field Effect Transistors

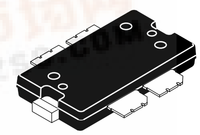
N-Channel Enhancement-Mode Lateral MOSFETs

MRF5S19060NR1
MRF5S19060NBR1
MRF5S19060MR1
MRF5S19060MBR1

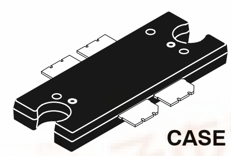
1990 MHz, 12 W AVG., 28 V
2 x N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

Designed for broadband commercial and industrial applications with frequencies from 1930 to 1990 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.

- Typical 2-carrier N-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 750 mA, P_{out} = 12 Watts Avg., Full Frequency Band. IS-95 (Pilot, Sync, Paging, Traffic Codes 8 Through 13) Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.
  - Power Gain — 14 dB
  - Drain Efficiency — 23%
  - IM3 @ 2.5 MHz Offset — -37 dBc @ 1.2288 MHz Channel Bandwidth
  - ACPR @ 885 kHz Offset — -51 dBc @ 30 kHz Channel Bandwidth
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 1990 MHz, 12 Watts Avg. Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- 200°C Capable Plastic Package
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF5S19060NR1(MR1)



CASE 1484-02, STYLE 1
TO-272 WB-4
PLASTIC
MRF5S19060NBR1(MBR1)

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +15	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	218.8 1.25	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 75°C, 12 W CW	$R_{\theta JC}$	0.80	°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.

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

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Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1C (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} = 65 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 = 225 μAdc)	$V_{GS(th)}$	2.5	—	3.5	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 750 mAdc)	$V_{GS(Q)}$	—	3.8	—	Vdc
Drain-Source On-Voltage (V_{GS} = 5 Vdc, I_D = 2.25 Adc)	$V_{DS(on)}$	—	0.26	—	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 2.25 Adc)	g_{fs}	—	5	—	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} = 750 mA, P_{out} = 12 W Avg., f1 = 1930 MHz, f2 = 1932.5 MHz and f1 = 1987.5 MHz, f2 = 1990 MHz., 2-carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carriers. ACPR measured in 30 kHz Channel Bandwidth @ ±885 kHz Offset. IM3 measured in 1.2288 MHz Channel Bandwidth @ ±2.5 MHz Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

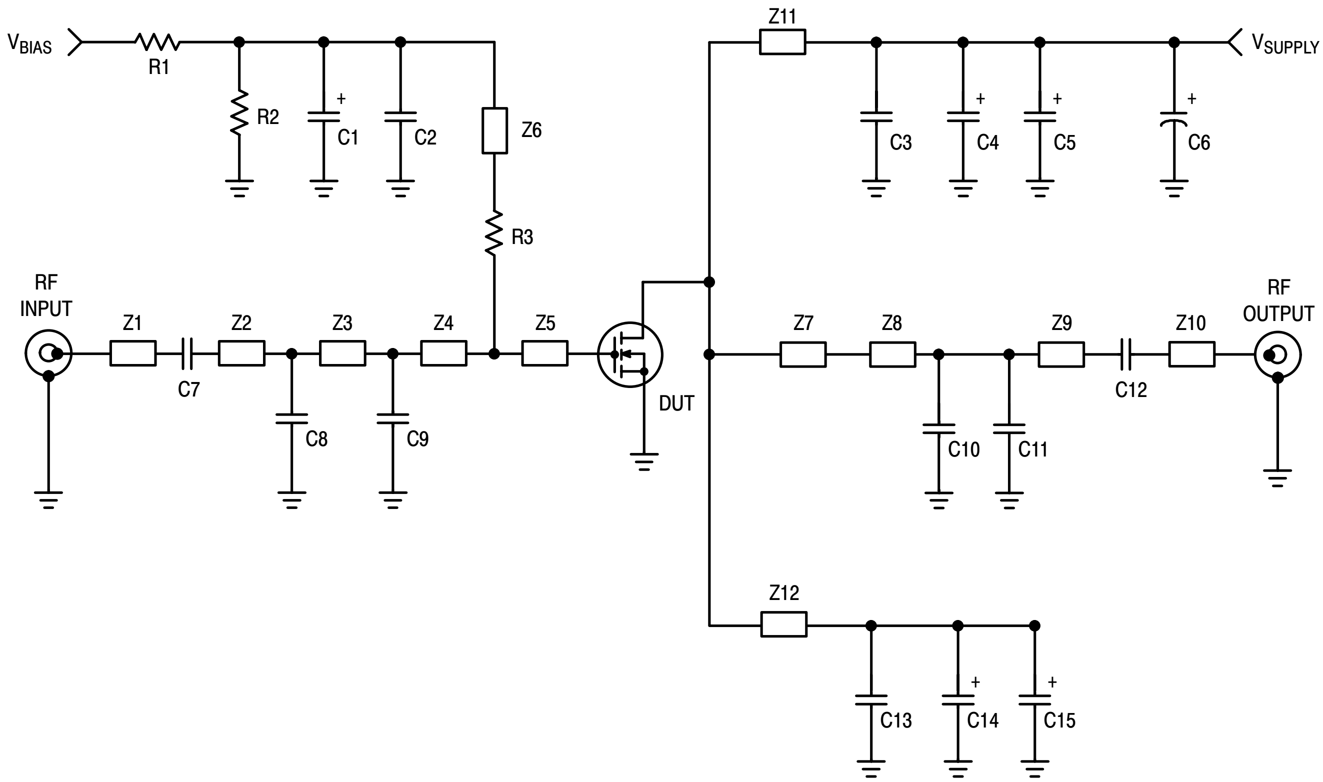
Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	12.5	14	16	dB
Drain Efficiency	η_D	21	23	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-51	-48	dBc
Input Return Loss	IRL	—	-12	-9	dB

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

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Typical RF Performance (50 ohm system)					
Pulse Peak Power (V_{DD} = 28 Vdc, 1-Tone CW Pulsed, I_{DQ} = 750 mA, t_{ON} = 8 μs, 1% Duty Cycle)	P_{sat}	—	110	—	W
Video Bandwidth (V_{DD} = 28 Vdc, P_{out} = 60 W PEP, I_{DQ} = 750 mA, Tone Spacing = 1 MHz to VBW, Δ IM3<2dB)	VBW	—	35	—	MHz



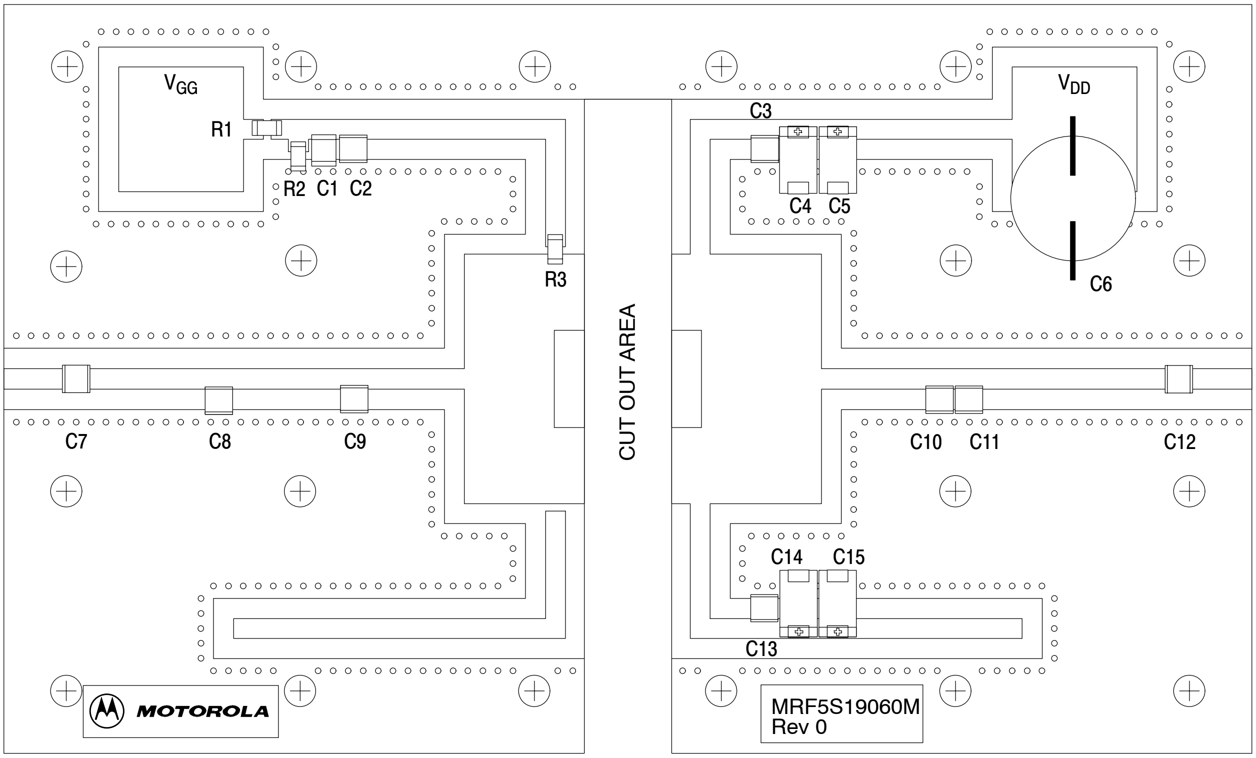
Z1	0.250″ x 0.083″ Microstrip
Z2*	0.500″ x 0.083″ Microstrip
Z3*	0.500″ x 0.083″ Microstrip
Z4*	0.515″ x 0.083″ Microstrip
Z5	0.480″ x 1.000″ Microstrip
Z6	1.140″ x 0.080″ Microstrip
Z7	0.600″ x 1.000″ Microstrip
Z8*	0.420″ x 0.083″ Microstrip
Z9*	0.975″ x 0.083″ Microstrip
Z10	0.250″ x 0.083″ Microstrip
Z11	0.700″ x 0.080″ Microstrip
Z12	0.700″ x 0.080″ Microstrip
PCB	Taconic TLX8-0300, 0.030″, ε_r = 2.55

* Variable for tuning

Figure 1. MRF5S19060NR1(NBR1)/MR1(MBR1) Test Circuit Schematic

Table 6. MRF5S19060NR1(NBR1)/MR1(MBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	1 μF, 35 V Tantalum Capacitor	TAJB105K35	AVX
C2	10 pF 100B Chip Capacitor	100B10R0CW	ATC
C3, C7, C12, C13	6.8 pF 100B Chip Capacitors	100B6R8CW	ATC
C4, C5, C14, C15	10 μF, 35 V Tantalum Capacitors	TAJD106K035	AVX
C6	220 μF, 63 V Electrolytic Capacitor, Radial	13668221	Philips
C8	0.8 pF 100B Chip Capacitor	100B0R8BW	ATC
C9	1.5 pF 100B Chip Capacitor	100B1R5BW	ATC
C10	1.0 pF 100B Chip Capacitor	100B1R0BW	ATC
C11	0.2 pF 100B Chip Capacitor	100B0R2BW	ATC
R1, R2	10 kΩ, 1/4 W Chip Resistors (1206)		
R3	10 Ω, 1/4 W Chip Resistors (1206)		



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 2. MRF5S19060NR1(NBR1)/MR1(MBR1) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

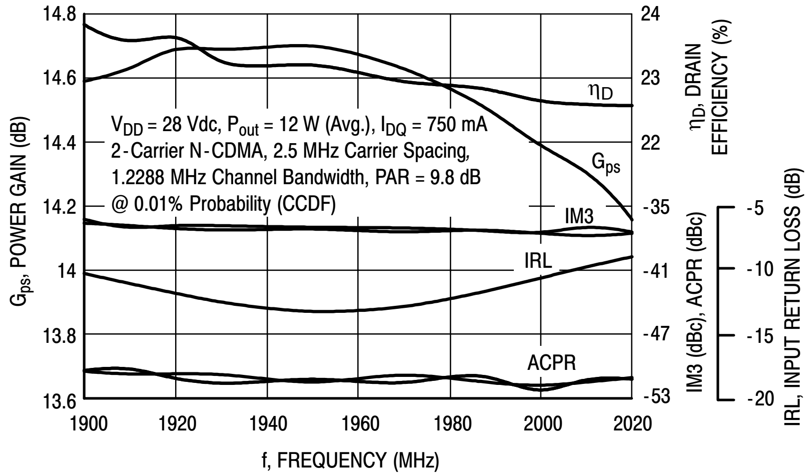


Figure 3. 2-Carrier N-CDMA Broadband Performance @ P_{out} = 12 Watts Avg.

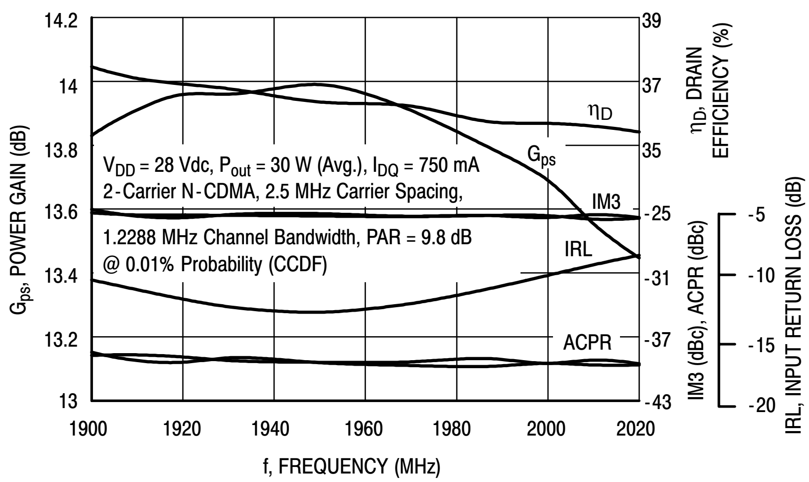


Figure 4. 2-Carrier N-CDMA Broadband Performance @ P_{out} = 30 Watts Avg.

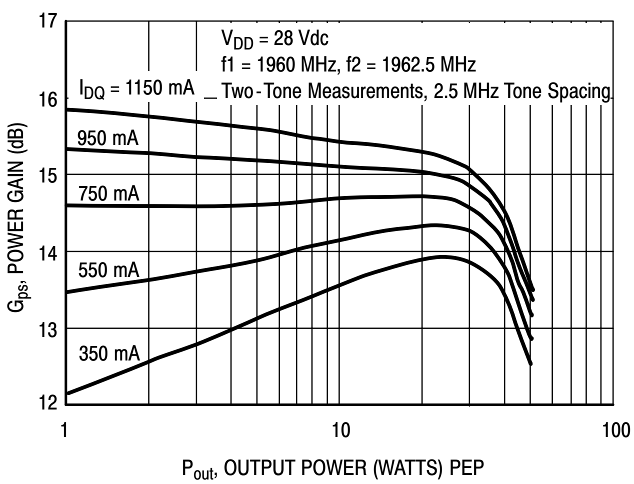


Figure 5. Two-Tone Power Gain versus Output Power

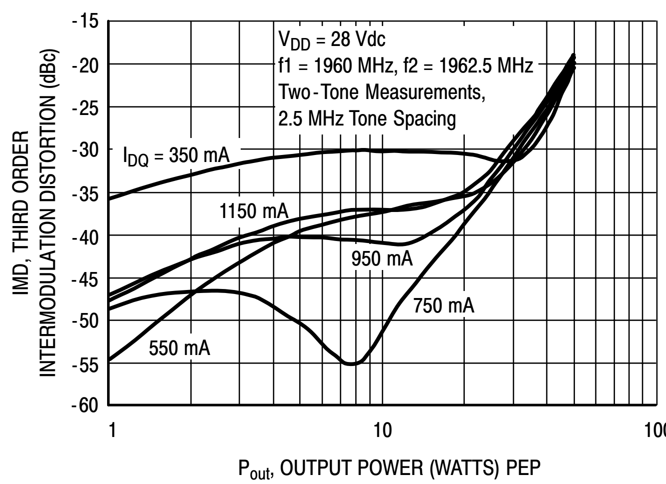


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

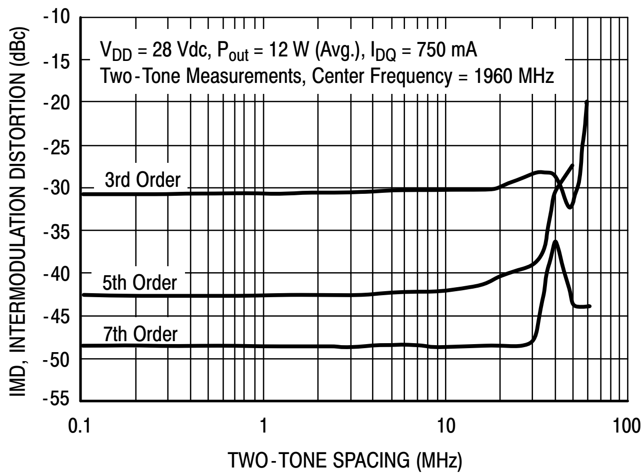


Figure 7. Intermodulation Distortion Products versus Tone Spacing

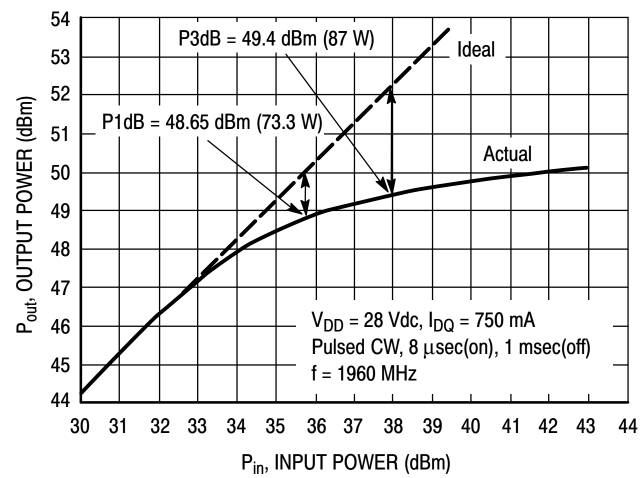


Figure 8. Pulse CW Output Power versus Input Power

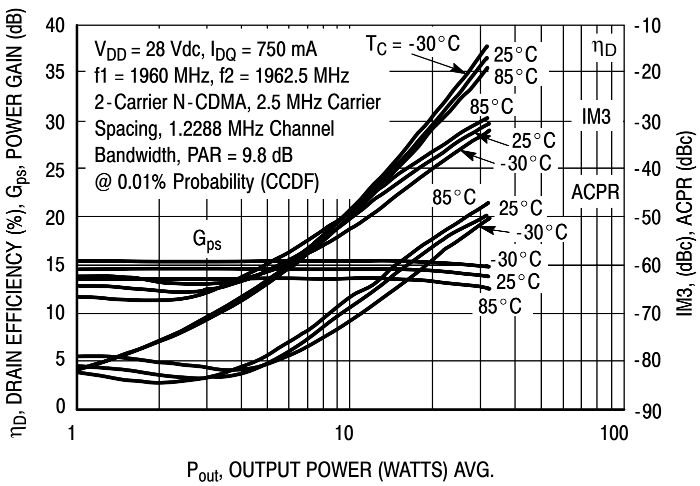


Figure 9. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

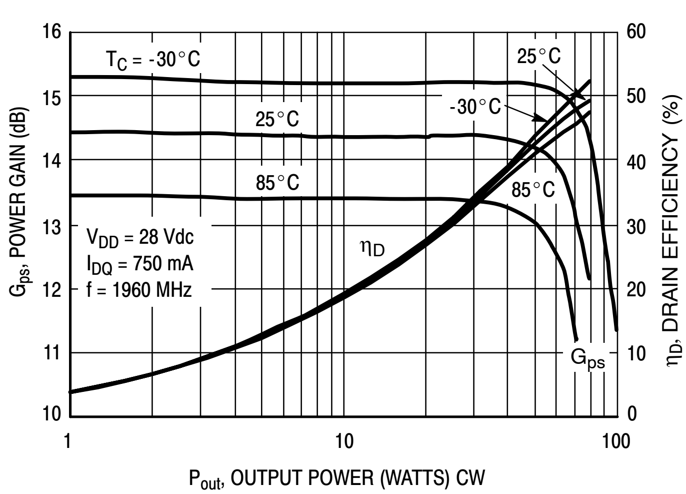


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

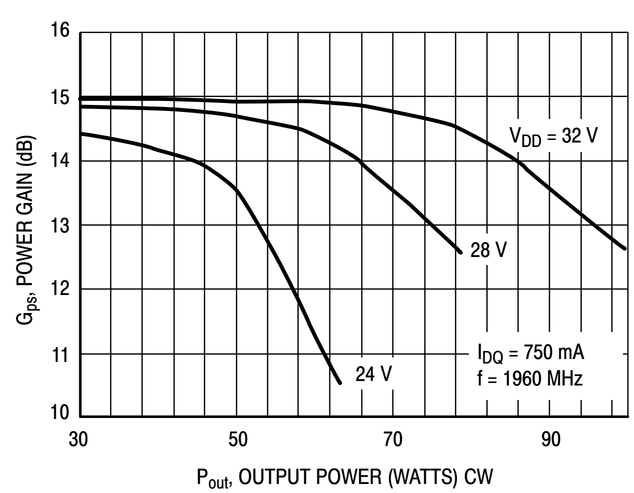
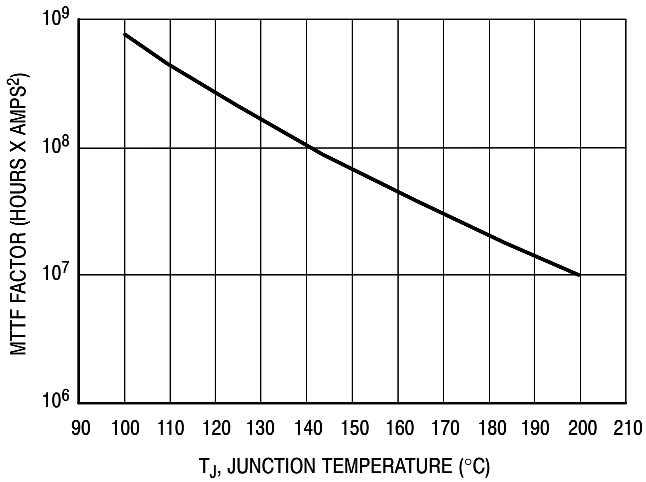


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



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

N-CDMA TEST SIGNAL

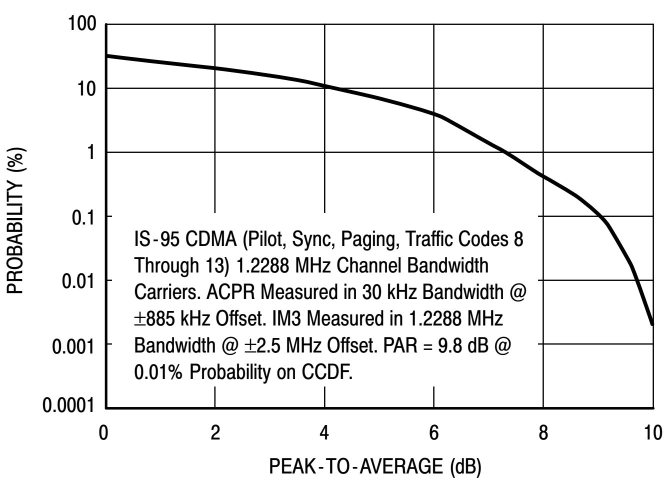


Figure 13. 2-Carrier CCDF N-CDMA

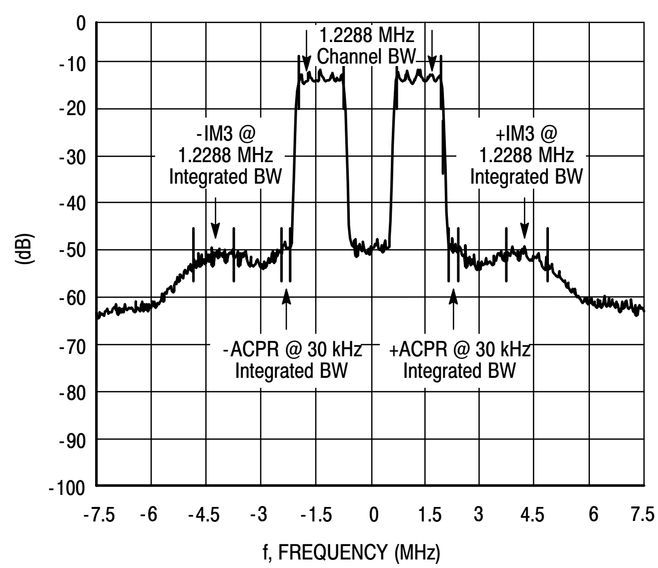
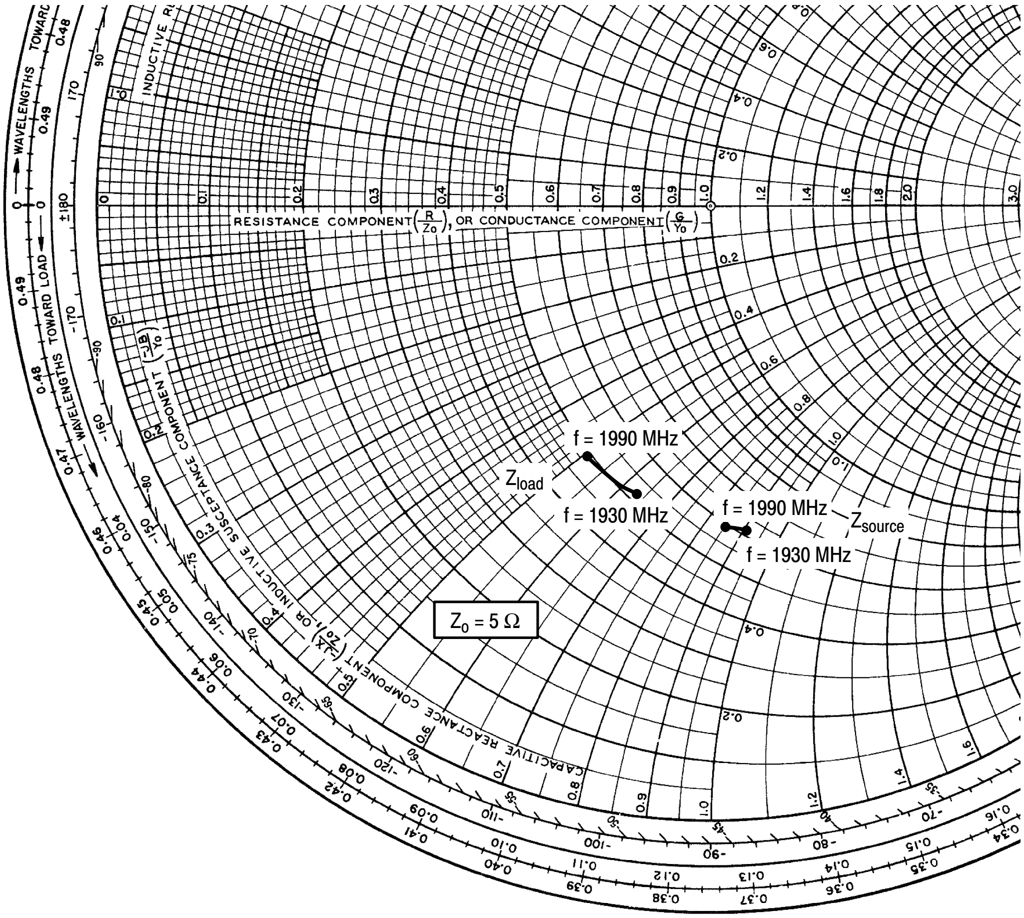


Figure 14. 2-Carrier N-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 750 mA, P_{out} = 12 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
1930	3.11 - j4.55	2.60 - j3.18
1960	3.06 - j4.38	2.50 - j2.85
1990	2.93 - j4.28	2.44 - j2.53

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

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

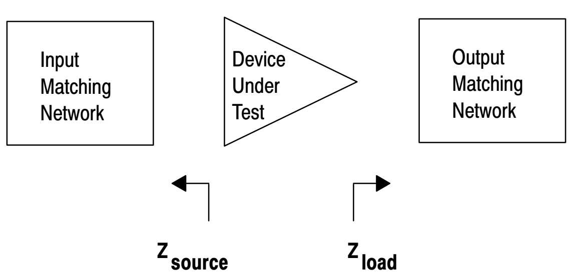
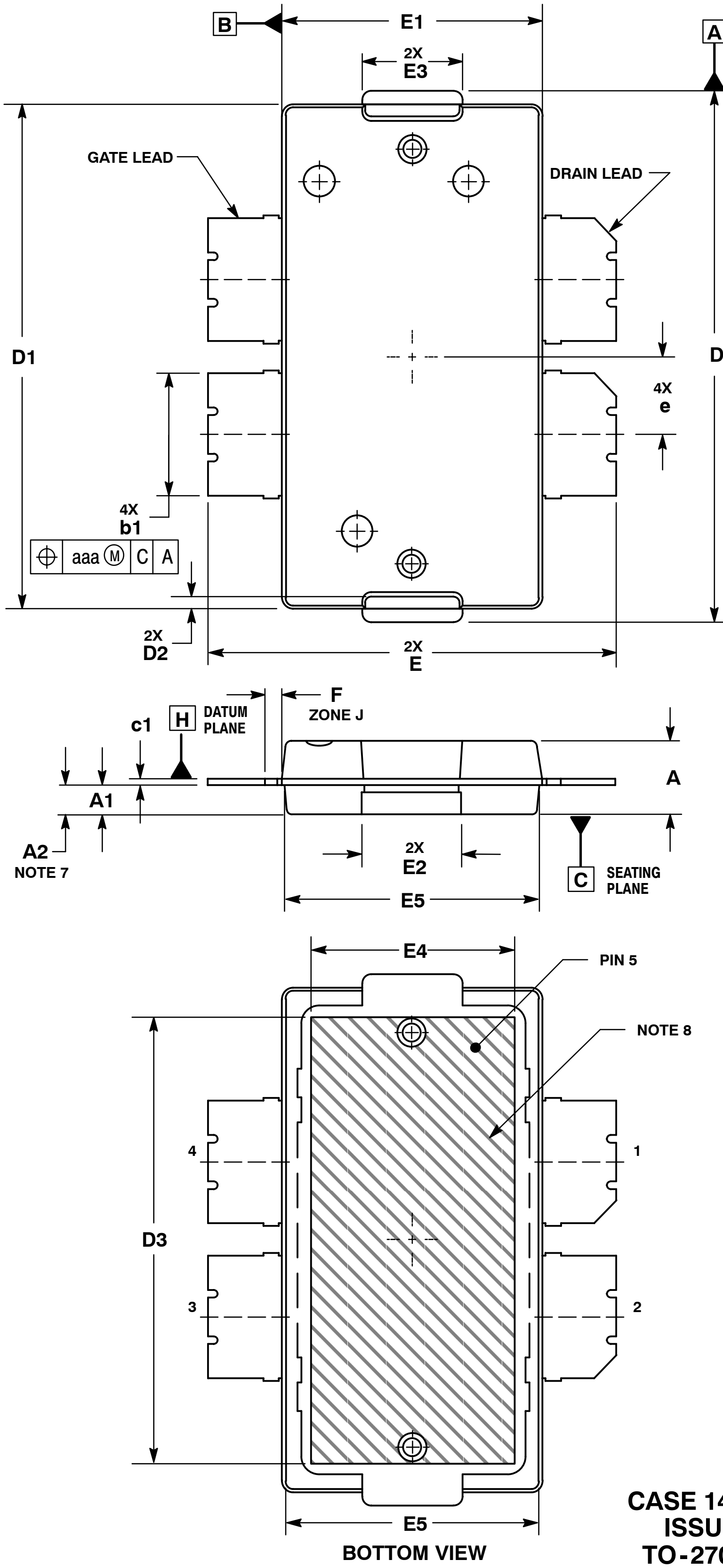


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

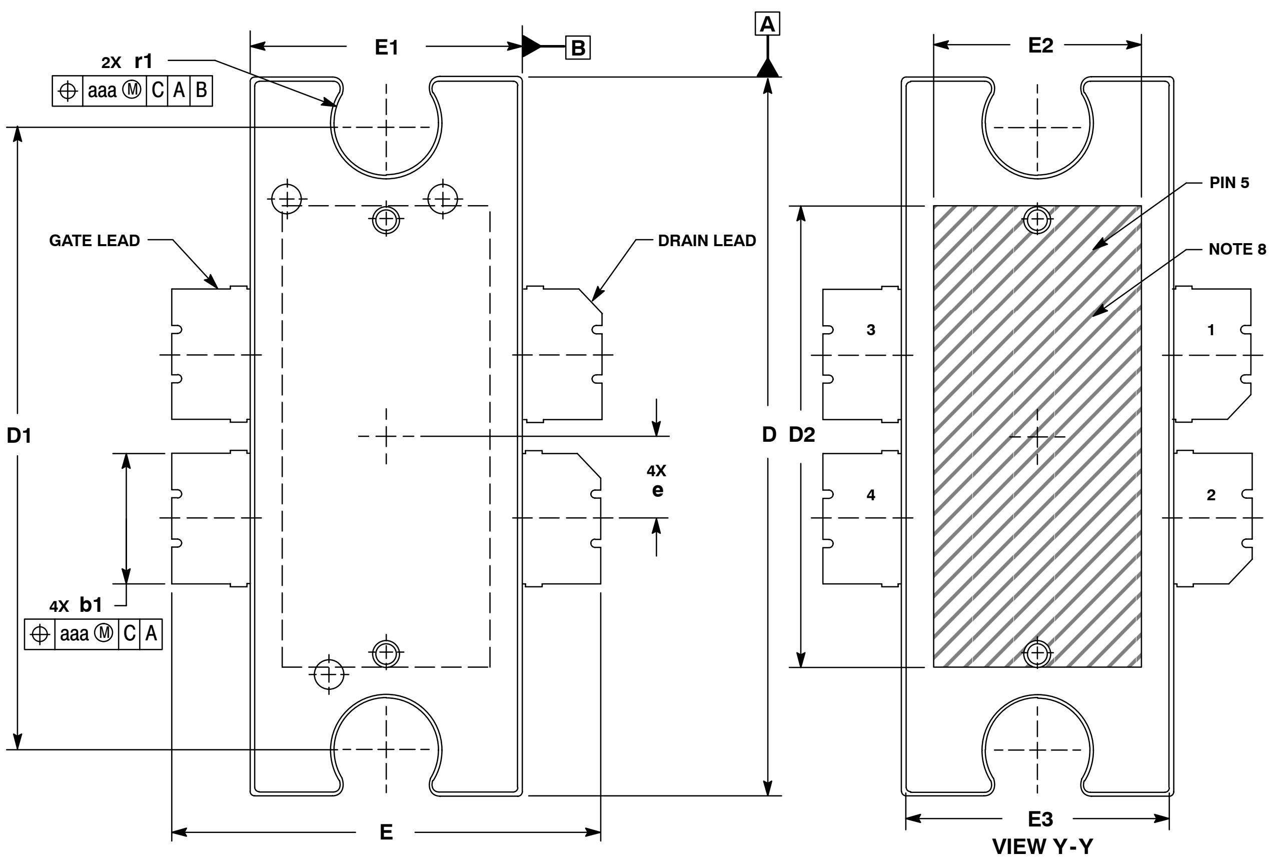


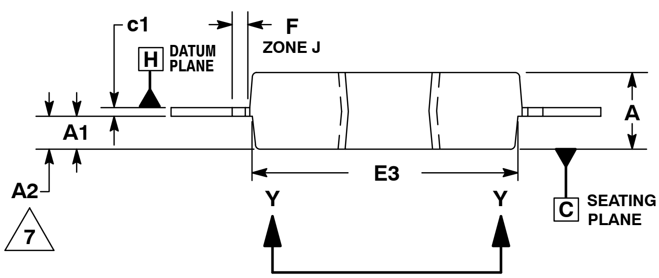
NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. 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

CASE 1486-03
ISSUE C
TO-270 WB-4
PLASTIC
MRF5S19060NR1(MR1)





NOTES:

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	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	.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
MRF5S19060NBR1(MBR1)

How to Reach Us:

Home Page:
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E-mail:
support@freescale.com

USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
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