Freescale Semiconductor
Technical Data

Document Number: MRF5S9100
Rev. 3, 7/2005

RF Power Field Effect Transistors

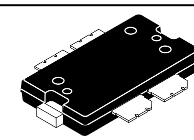
N-Channel Enhancement-Mode Lateral MOSFETs

MRF5S9100NR1
MRF5S9100NBR1
MRF5S9100MR1
MRF5S9100MBR1

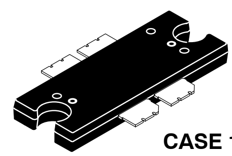
Designed for broadband commercial and industrial applications with frequencies up to 1000 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- Typical Single-Carrier N-CDMA Performance @ 880 MHz, V_{DD} = 26 Volts, I_{DQ} = 950 mA, P_{out} = 20 Watts Avg., 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 — 19.5 dB
  Drain Efficiency — 28%
  ACPR @ 750 kHz Offset — -46.8 dBc @ 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 880 MHz, 100 Watts CW Output Power
- 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.

880 MHz, 20 W AVG., 26 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF5S9100NR1(MR1)



CASE 1484-02, STYLE 1
TO-272 WB-4
PLASTIC
MRF5S9100NBR1(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, +15	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	336 1.92	W W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°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, 20 W CW	$R_{\theta JC}$	0.52	°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.

Table 3. ESD Protection Characteristics

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

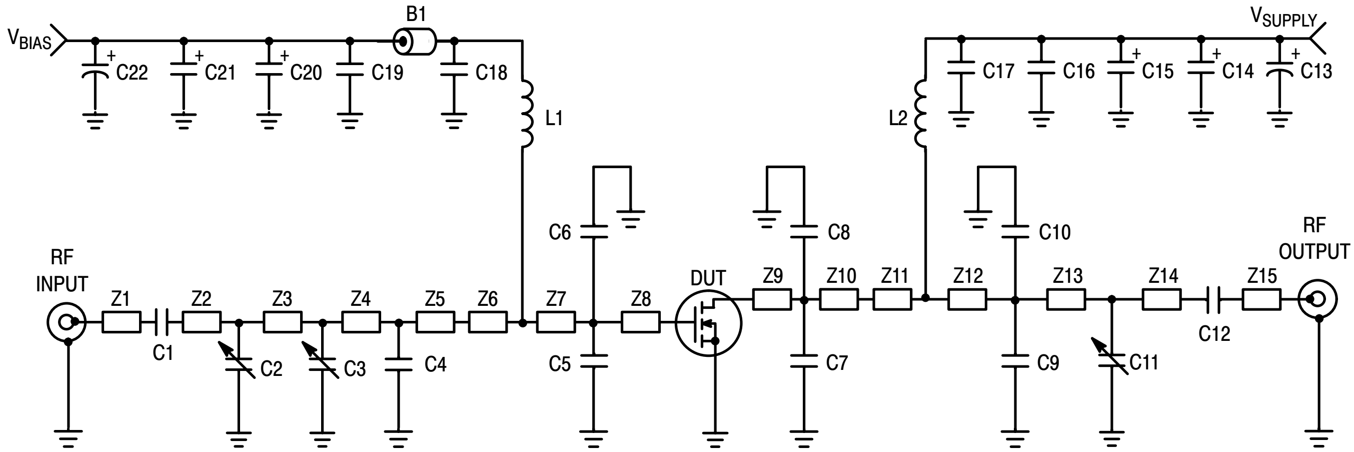
Table 4. Moisture Sensitivity Level

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} = 26 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 μA)	$V_{GS(th)}$	2	2.8	3.5	Vdc
Gate Quiescent Voltage (V_{DS} = 26 Vdc, I_D = 950 mAdc)	$V_{GS(Q)}$	—	3.7	—	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.0 Adc)	$V_{DS(on)}$	—	0.21	0.3	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 6 Adc)	g_{fs}	—	7	—	S
Dynamic Characteristics [1]					
Output Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	2.2	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 26 Vdc, I_{DQ} = 950 mA, P_{out} = 20 W Avg. N-CDMA, f = 880 MHz, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Bandwidth @ ±750 kHz Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF					
Power Gain	G_{ps}	18	19.5	—	dB
Drain Efficiency	η_D	26	28	—	%
Adjacent Channel Power Ratio	ACPR	—	-46.8	-45	dBc
Input Return Loss	IRL	—	-19	-9	dB

1. Part is internally input matched.

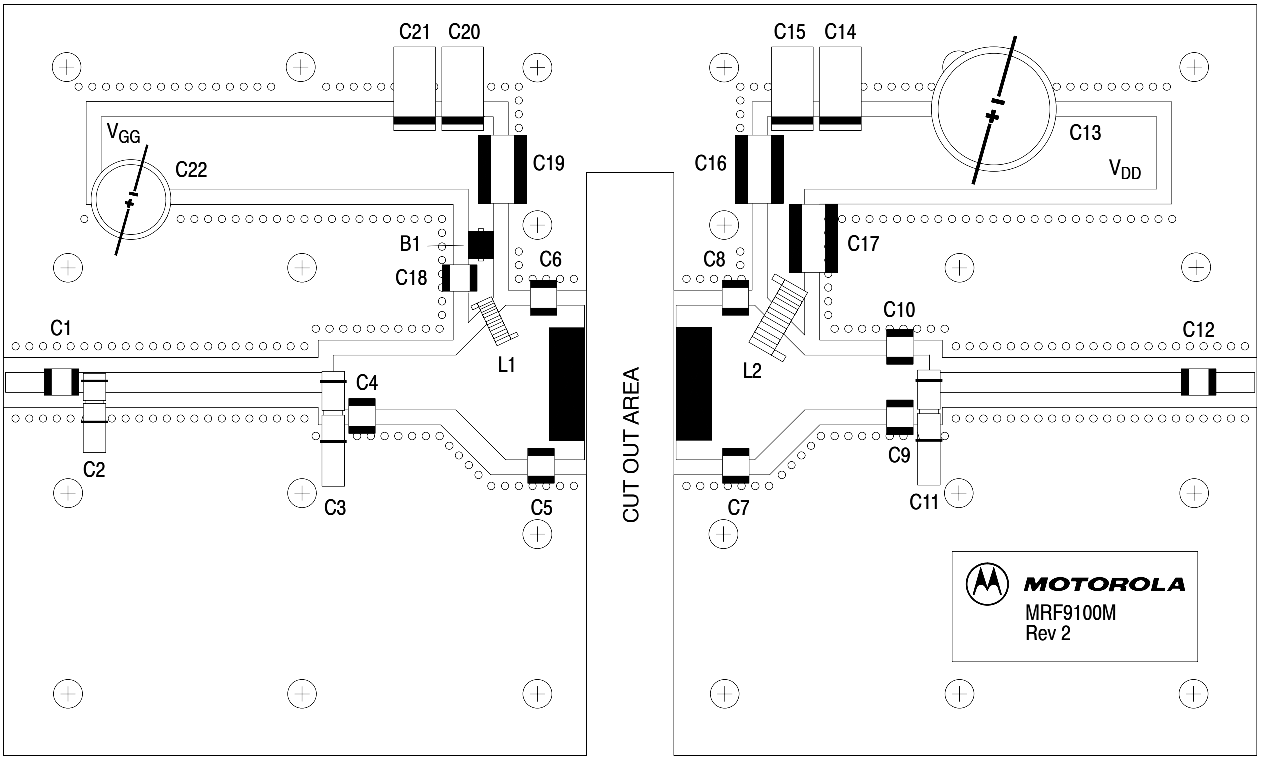


Z1, Z15	0.200″ x 0.080″ Microstrip	Z8	0.163″ x 0.620″ Microstrip
Z2	0.105″ x 0.080″ Microstrip	Z9	0.238″ x 0.620″ Microstrip
Z3	0.954″ x 0.080″ Microstrip	Z10	0.077″ x 0.620″ Microstrip
Z4	0.115″ x 0.220″ Microstrip	Z12	0.381″ x 0.220″ Microstrip
Z5	0.375″ x 0.220″ Microstrip	Z13	0.114″ x 0.220″ Microstrip
Z6, Z11	0.200″ x 0.220″ x 0.620″ Taper	Z14	1.052″ x 0.080″ Microstrip
Z7	0.152″ x 0.620″ Microstrip	PCB	Arlon GX0300, 0.030″, ε_r = 2.55

Figure 1. MRF5S9100NR1(NBR1)/MR1(MBR1) Test Circuit Schematic

Table 6. MRF5S9100NR1(NBR1)/MR1(MBR1) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead, Surface Mount	2743019447	Fair-Rite
C1, C12, C18	18 pF Chip Capacitors	100B180JP 500X	ATC
C2	0.6-4.5 pF Variable Capacitor, Gigatrim	27271SL	Johanson Dielectrics
C3, C11	0.8-8.0 pF Variable Capacitors, Gigatrim	27291SL	Johanson Dielectrics
C4	6.2 pF Chip Capacitor	100B6R2JP 500X	ATC
C5, C6	12 pF Chip Capacitors	100B120JP 500X	ATC
C7, C8	11 pF Chip Capacitors	100B110JP 500X	ATC
C9, C10	5.1 pF Chip Capacitors	100B5R1JP 500X	ATC
C13	470 μF, 63 V Electrolytic Capacitor	NACZF471M63V	Nippon
C14, C15	22 μF, 50 V Tantalum Capacitors	T491X226K035AS	Kemet
C16, C17, C19	0.56 μF, 50 V Chip Capacitors	C1825C564J5GAC	Kemet
C20, C21	47 μF, 16 V Tantalum Capacitors	T491D4T6K016AS	Kemet
C22	100 μF, 50 V Electrolytic Capacitor	515D107M050BB6A	Multicomp
L1	7.15 nH Inductor	1606-7	CoilCraft
L2	22 nH Inductor	B07T-5	CoilCraft



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. MRF5S9100NR1(NBR1)/MR1(MBR1) Test Circuit Component Layout

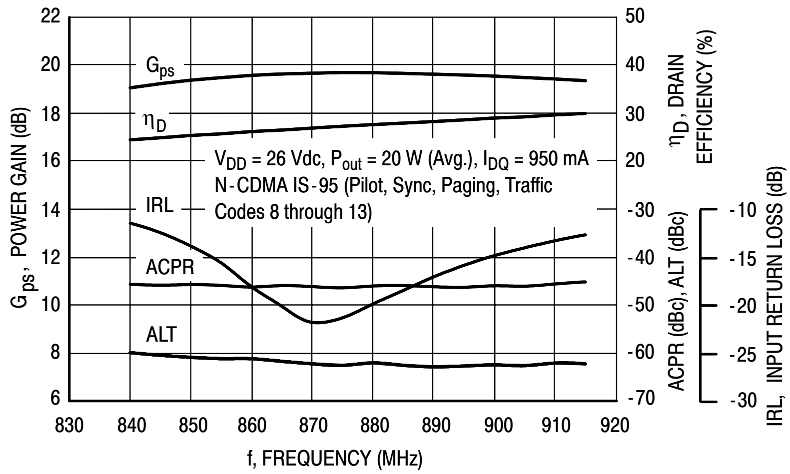


Figure 3. IS-95 Broadband Performance @ P_{out} = 20 Watts Avg.

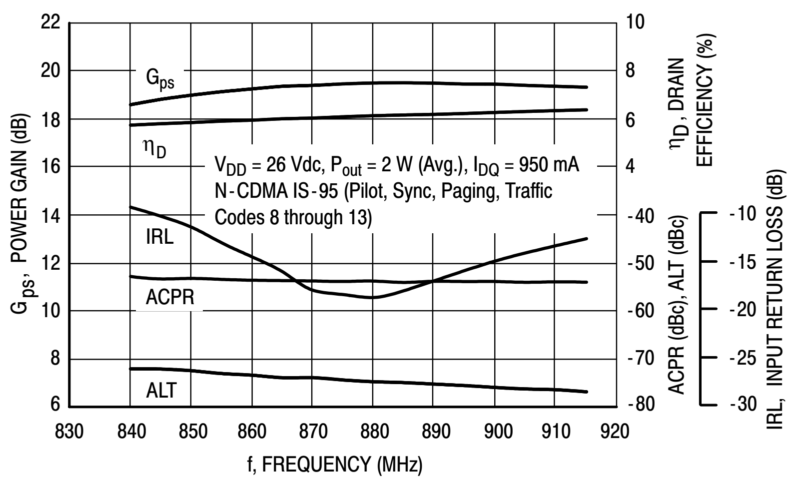


Figure 4. IS-95 Broadband Performance @ P_{out} = 2 Watts Avg.

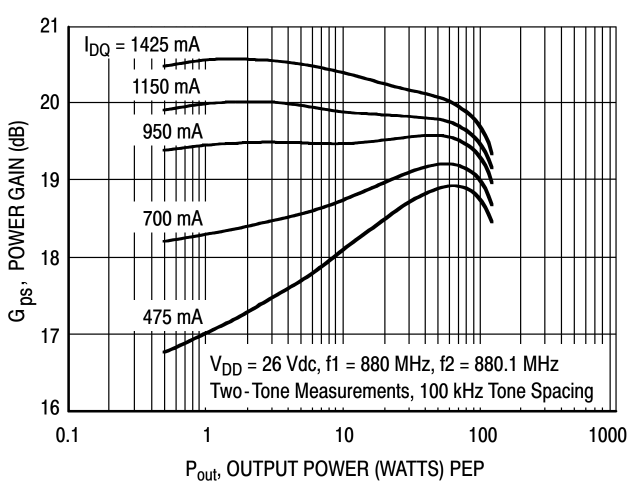


Figure 5. Two-Tone Power Gain versus Output Power

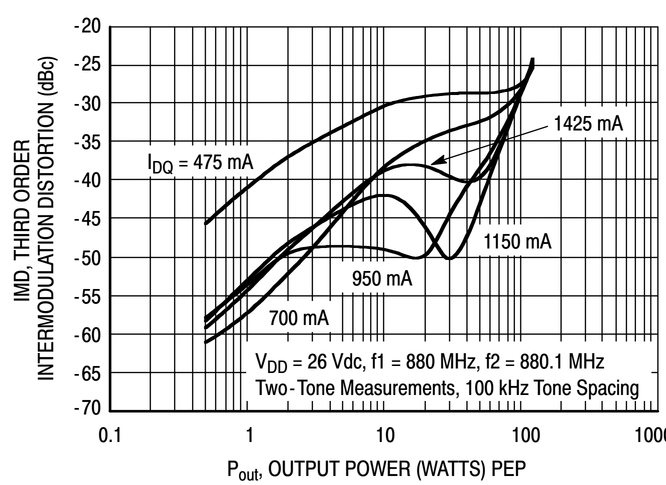


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

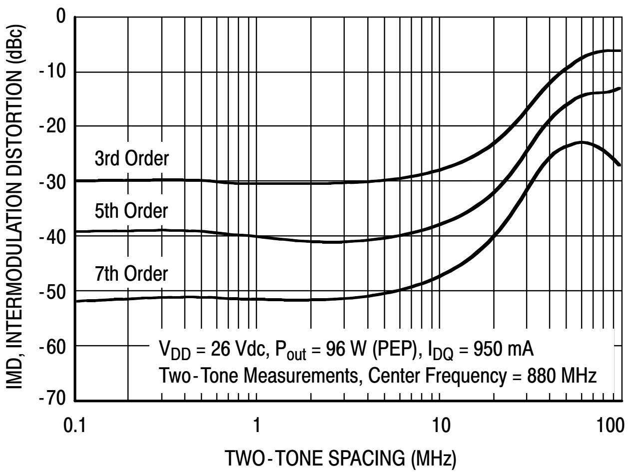


Figure 7. Intermodulation Distortion Products versus Tone Spacing

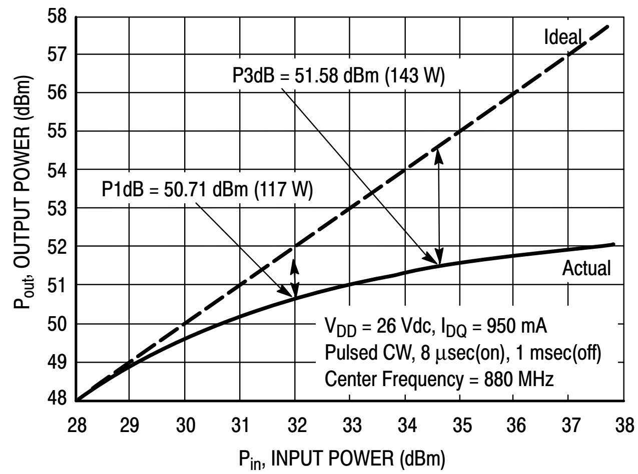


Figure 8. Pulse CW Output Power versus Input Power

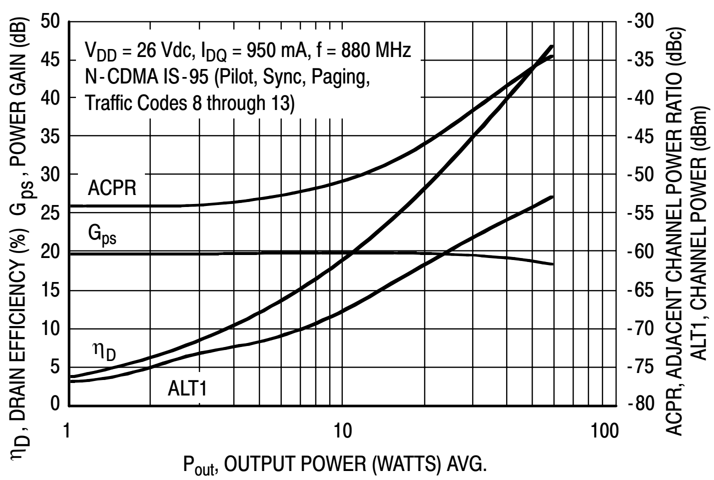


Figure 9. Single-Carrier N-CDMA ACPR, Power Gain, Efficiency and ALT1 versus Output Power

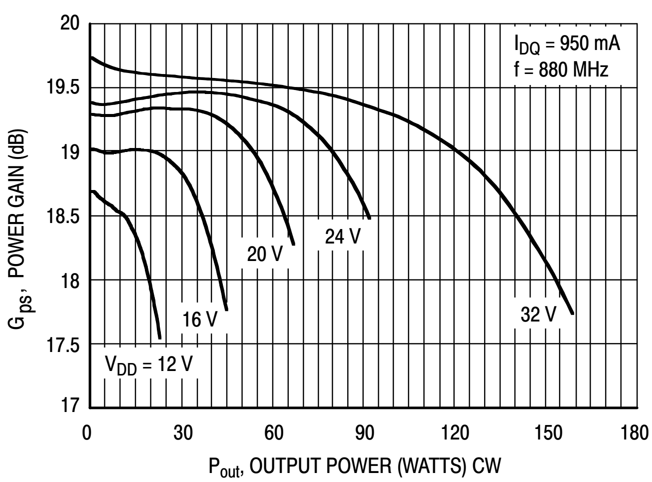
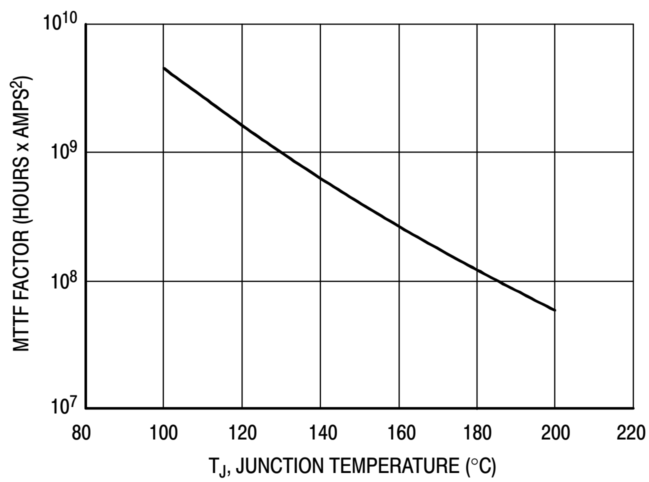
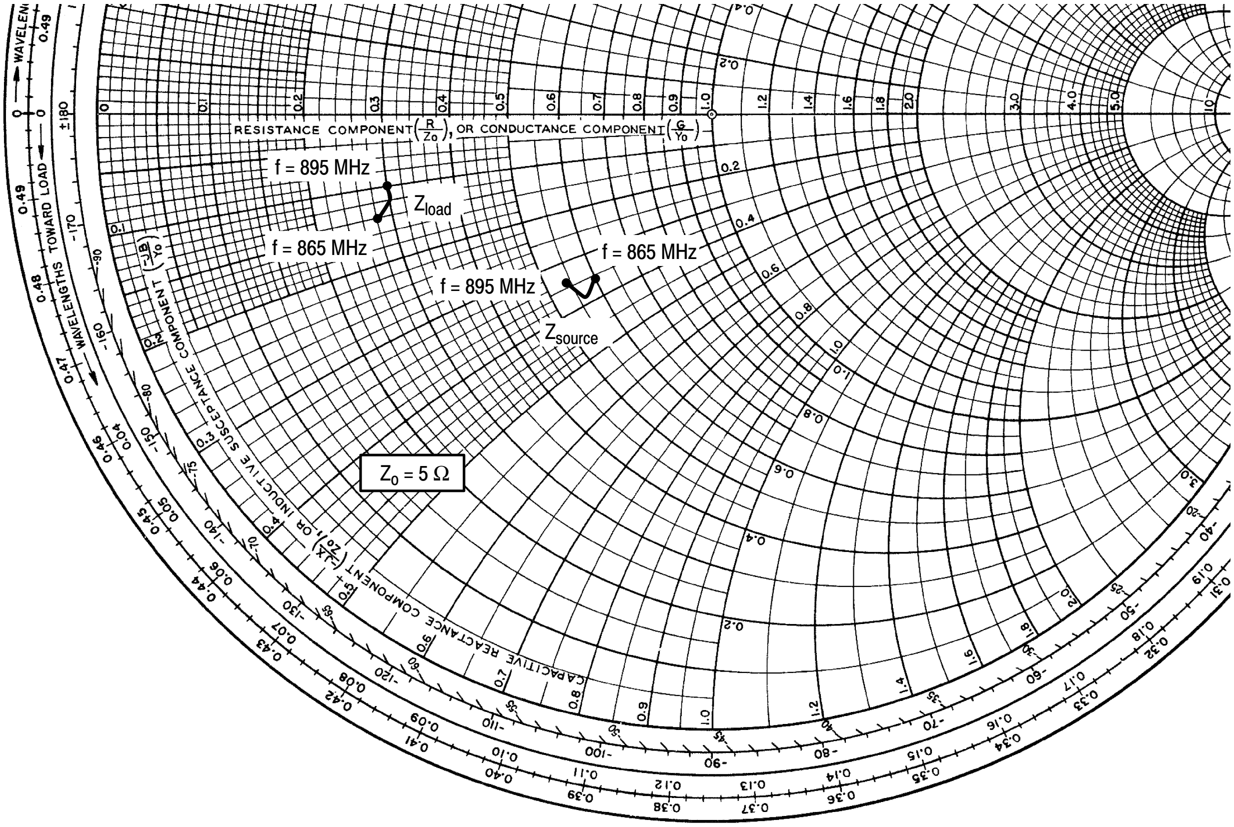


Figure 10. Power Gain versus Output Power



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 11. MTTF Factor versus Junction Temperature



V_{DD} = 26 Vdc, I_{DQ} = 950 mA, P_{out} = 20 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
865	3.0 - j1.8	1.4 - j0.7
880	2.8 - j1.9	1.5 - j0.6
895	2.7 - j1.7	1.5 - j0.5

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

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

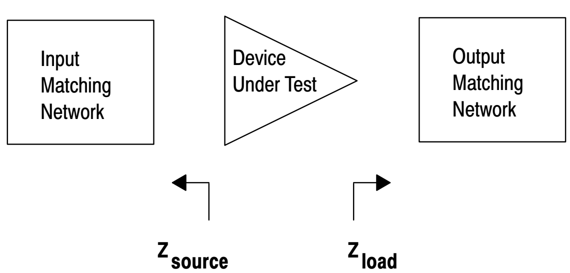
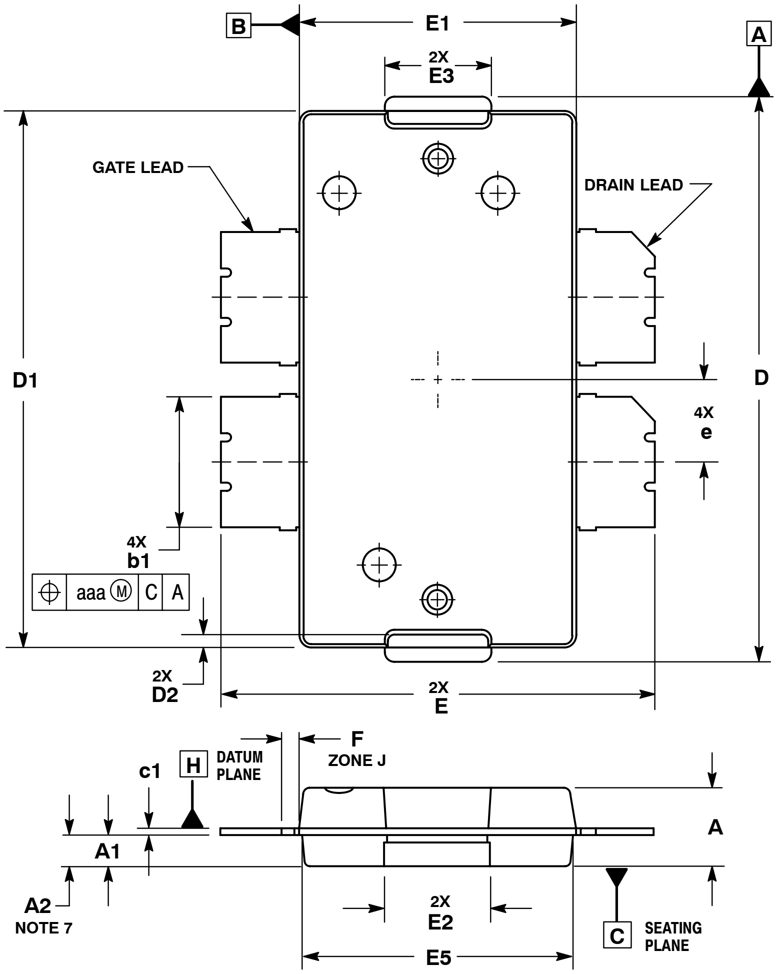


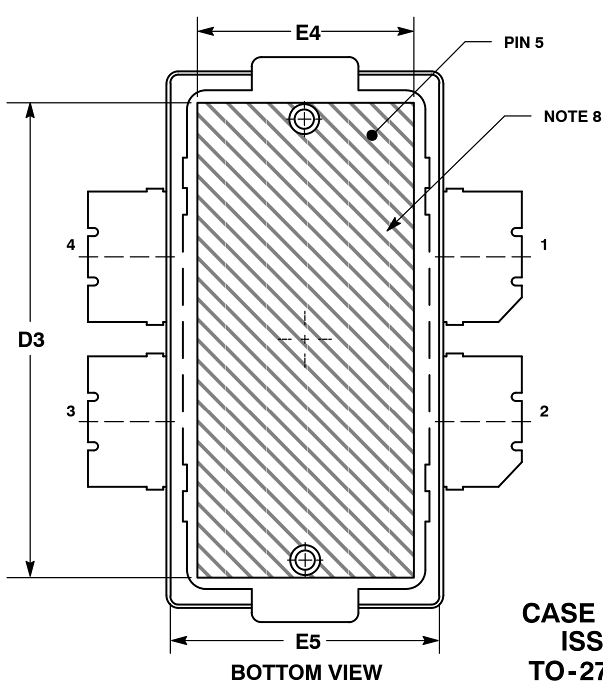
Figure 12. Series Equivalent Source and Load Impedance

NOTES

NOTES

PACKAGE DIMENSIONS



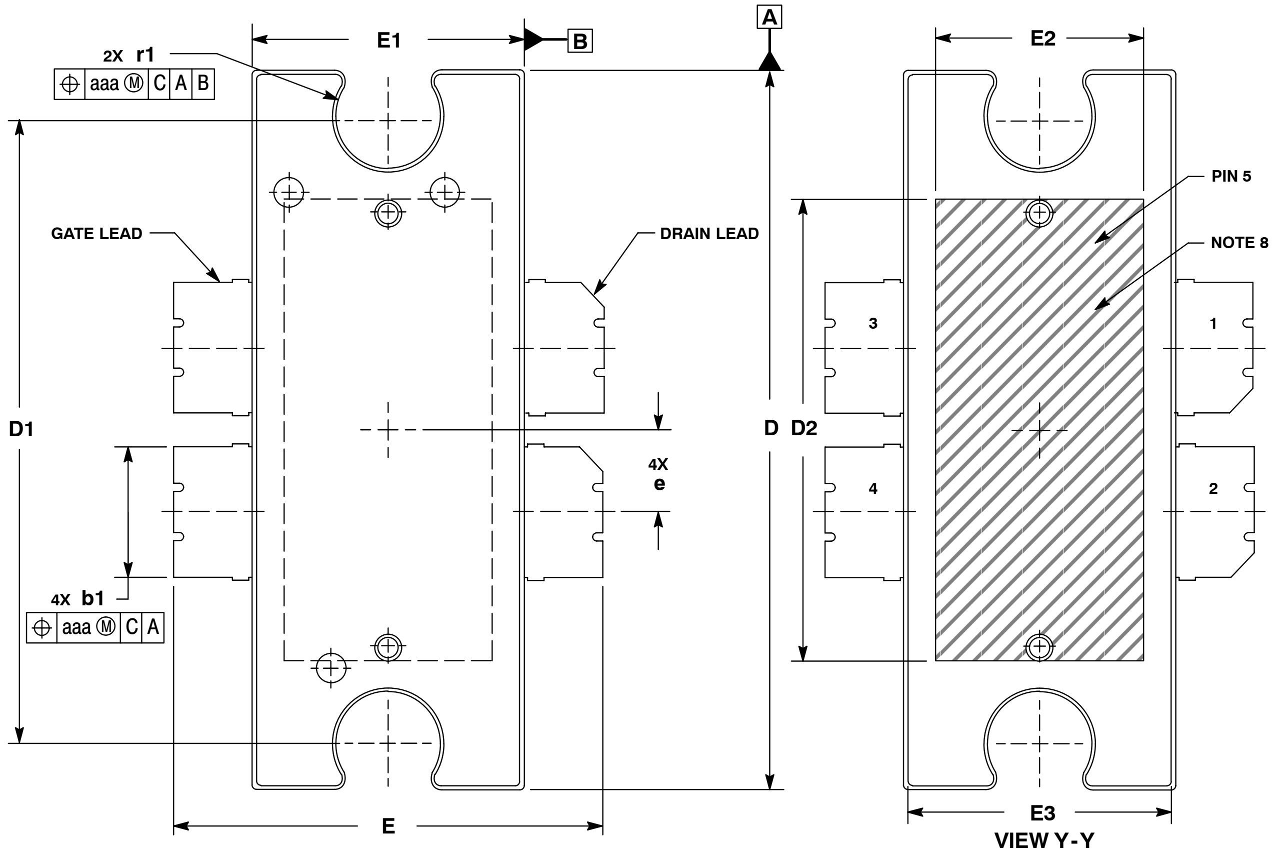


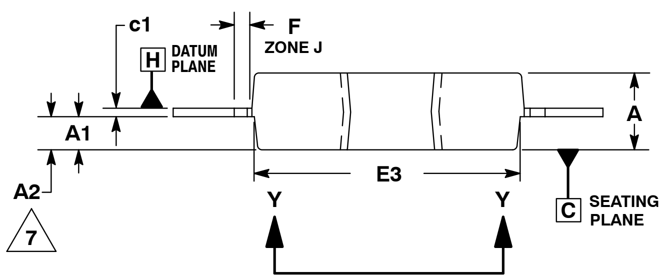
NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. 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
MRF5S9100NR1(MR1)





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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
MRF5S9100NBR1(MBR1)

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