Freescale Semiconductor
Technical Data

Document Number: MRF5S9080N
Rev. 1, 5/2006

RoHS

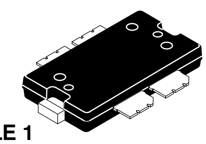
RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

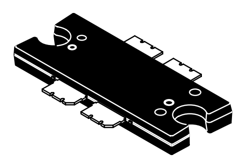
Designed for GSM and GSM EDGE base station applications with frequencies from 869 to 960 MHz. Suitable for TDMA, CDMA, and multicarrier amplifier applications.

MRF5S9080NR1
MRF5S9080NBR1

869-960 MHz, 80 W, 26 V
GSM/GSM EDGE
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 1486-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF5S9080NR1



CASE 1484-04, STYLE 1
TO-272 WB-4
PLASTIC
MRF5S9080NBR1

GSM Application

- Typical GSM Performance: V_{DD} = 26 Volts, I_{DQ} = 600 mA, P_{out} = 80 Watts CW, Full Frequency Band (869-894 MHz or 921-960 MHz).
  Power Gain — 18.5 dB
  Drain Efficiency — 60%

GSM EDGE Application

- Typical GSM EDGE Performance: V_{DD} = 26 Volts, I_{DQ} = 550 mA, P_{out} = 36 Watts Avg., Full Frequency Band (869-894 MHz or 921-960 MHz).
  Power Gain — 19 dB
  Drain Efficiency — 42%
  Spectral Regrowth @ 400 kHz Offset = -63 dBc
  Spectral Regrowth @ 600 kHz Offset = -78 dBc
  EVM — 2.5% rms
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 960 MHz, 80 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
- 200°C Capable Plastic Package
- RoHS Compliant
- In Tape and Reel. R1 Suffix = 500 Units per 44 mm, 13 inch Reel.

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
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 79°C, 80 W CW Case Temperature 80°C, 36 W CW	$R_{\theta JC}$	 0.50 0.54	°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.

freescale semiconductor

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)

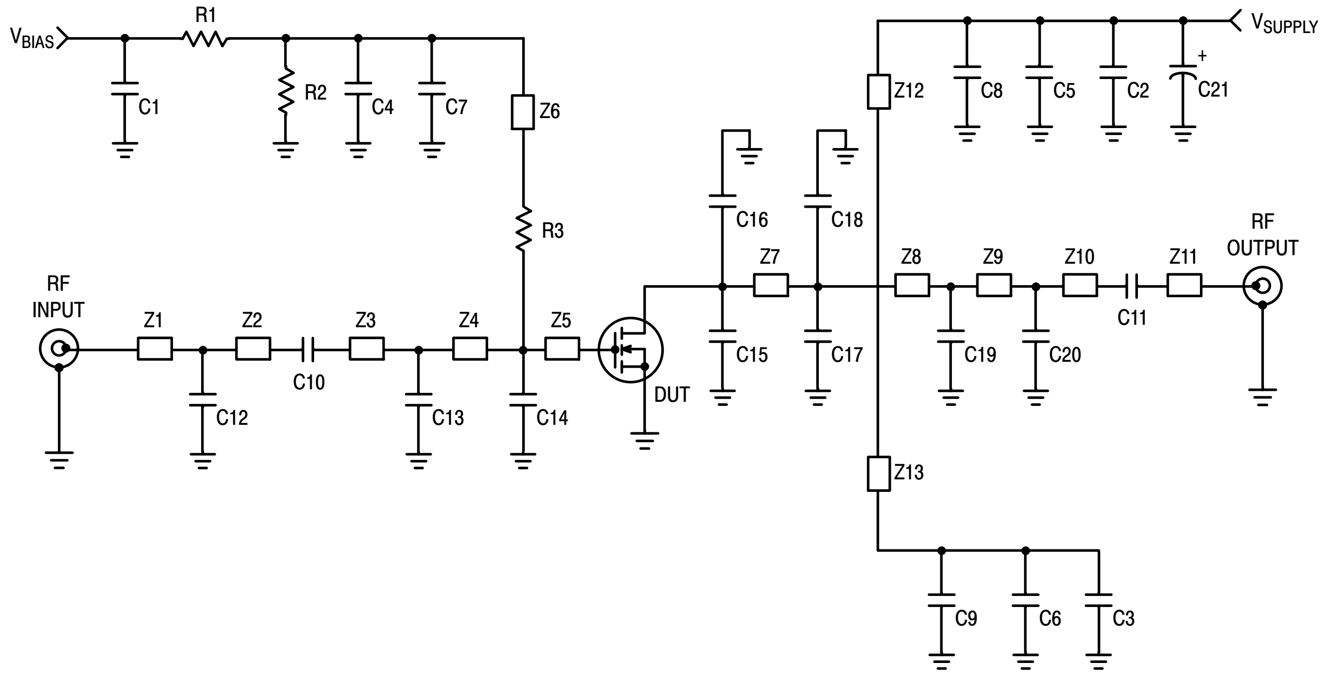
Table 4. Moisture Sensitivity Level

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} = 65 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}	—	—	500	nAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 400 µAdc)	$V_{GS(th)}$	2	2.8	3.5	Vdc
Gate Quiescent Voltage (V_{DS} = 26 Vdc, I_D = 600 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	3.5	3.9	4.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2 Adc)	$V_{DS(on)}$	—	0.27	0.3	Vdc
Dynamic Characteristics (1)					
Reverse Transfer Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.8	—	pF
Output Capacitance (V_{DS} = *26* Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	600	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 26 Vdc, I_{DQ} = 600 mA, P_{out} = 80 W CW, f = 960 MHz					
Power Gain	G_{ps}	17	18.5	20	dB
Drain Efficiency	η_D	55	60	—	%
Input Return Loss	IRL	—	-15	-9	dB
P_{out} @ 1 dB Compression Point	P1dB	80	90	—	W
Typical GSM EDGE Performances (In Freescale GSM EDGE Test Fixture, 50 ohm system) V_{DD} = 26 Vdc, I_{DQ} = 550 mA, P_{out} = 36 W Avg., 869-894 MHz, 920-960 MHz GSM EDGE Modulation					
Power Gain	G_{ps}	—	19	—	dB
Drain Efficiency	η_D	—	42	—	%
Error Vector Magnitude	EVM	—	2.5	—	% rms
Spectral Regrowth at 400 kHz Offset	SR1	—	-63	—	dBc
Spectral Regrowth at 600 kHz Offset	SR2	—	-77	—	dBc

1. Part is internally matched on input.



Z1	1.220″ x 0.087″ Microstrip	Z8	0.138″ x 0.087″ Microstrip
Z2	1.110″ x 0.087″ Microstrip	Z9	0.411″ x 0.087″ Microstrip
Z3	0.536″ x 0.087″ Microstrip	Z10	0.403″ x 0.087″ Microstrip
Z4	0.310″ x 0.087″ Microstrip	Z11	0.560″ x 0.087″ Microstrip
Z5	0.430″ x 0.591″ Microstrip	Z12, Z13	1.693″ x 0.087″ Microstrip
Z6	1.567″ x 0.059″ Microstrip	PCB	Taconic TLX8-0300, 0.030″, ε_r = 2.55
Z7	0.734″ x 0.788″ Microstrip		

Figure 1. MRF5S9080NR1(NBR1) Test Circuit Schematic — 900 MHz

Table 6. MRF5S9080NR1(NBR1) Test Circuit Component Designations and Values — 900 MHz

Part	Description	Part Number	Manufacturer
C1, C2, C3	4.7 μF Chip Capacitors (1812)	C4532X5R1H475MT	TDK
C4, C5, C6	10 nF 200B Chip Capacitors	200B103MW	ATC
C7, C8, C9	33 pF 600B Chip Capacitors	600B330JW	ATC
C10, C11	22 pF 600B Chip Capacitors	600B220FW	ATC
C12	1.8 pF 600B Chip Capacitor	600B1R8BW	ATC
C13	9.1 pF 600B Chip Capacitor	600B9R1BW	ATC
C14, C17, C18	8.2 pF 600B Chip Capacitors	600B8R2BW	ATC
C15, C16	10 pF 600B Chip Capacitors	600B100FW	ATC
C19	4.7 pF 600B Chip Capacitor	600B4R7BW	ATC
C20	3.6 pF 600B Chip Capacitor	600B3R6BW	ATC
C21	220 μF, 63 V Electrolytic Capacitor, Axial	13668221	Philips
R1, R2	10 kΩ, 1/4 W Chip Resistors (1206)		
R3	10 Ω, 1/4 W Chip Resistor (1206)		

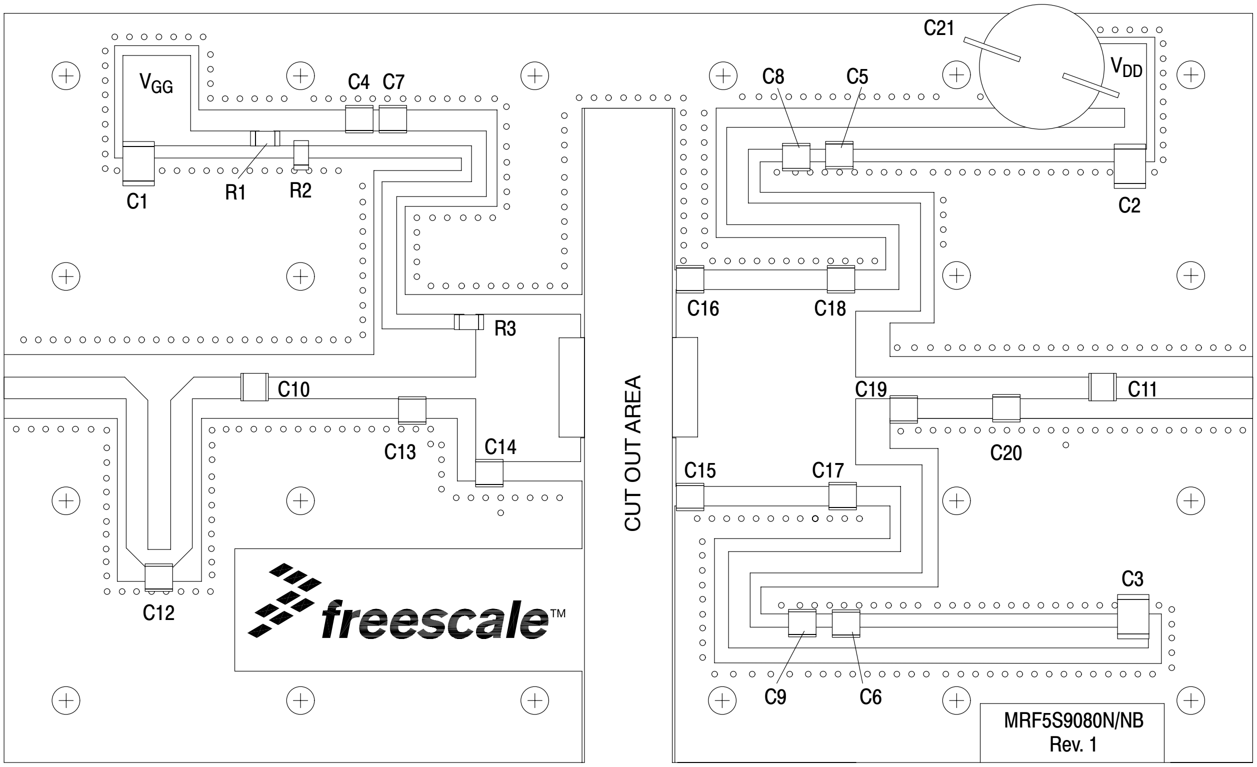


Figure 2. MRF5S9080NR1(NBR1) Test Circuit Component Layout — 900 MHz

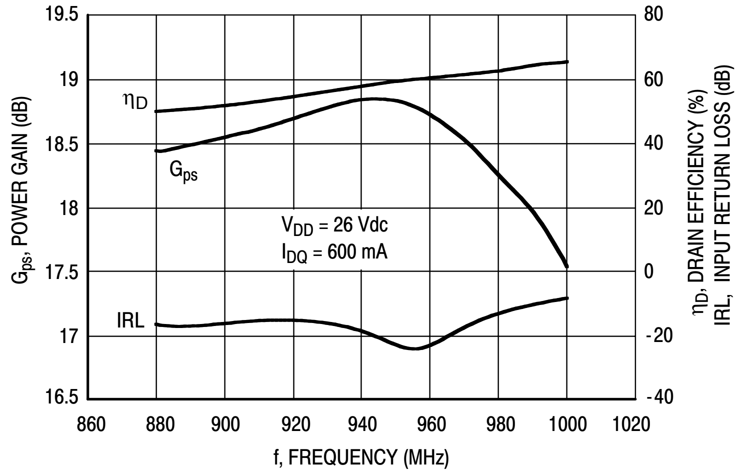


Figure 3. Power Gain, Input Return Loss and Drain Efficiency versus Frequency @ P_{out} = 80 Watts CW

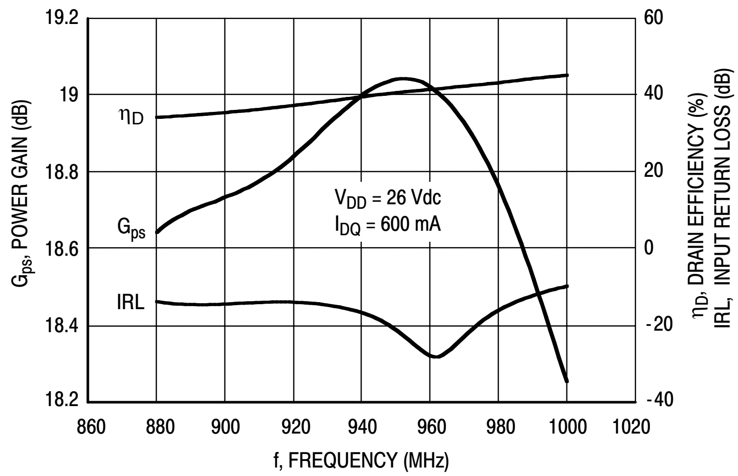


Figure 4. Power Gain, Input Return Loss and Drain Efficiency versus Frequency @ P_{out} = 36 Watts CW

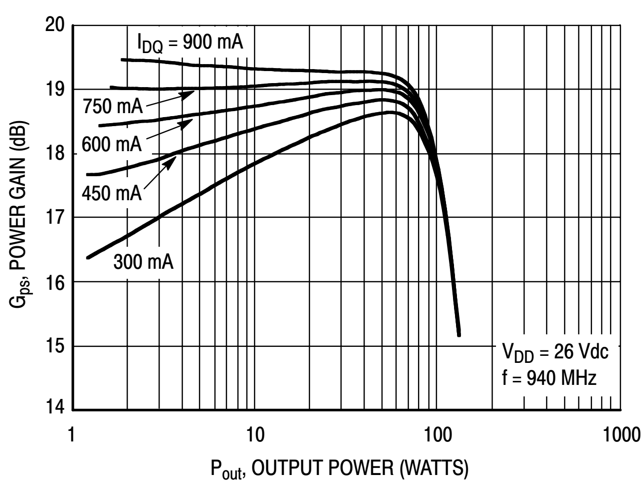


Figure 5. Power Gain versus Output Power

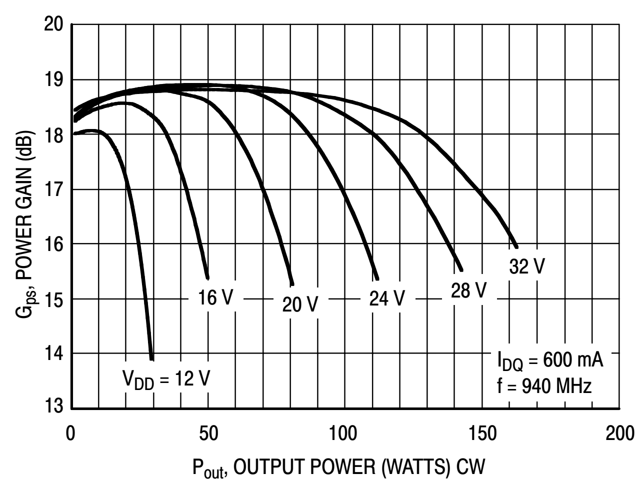


Figure 6. Power Gain versus Output Power

TYPICAL CHARACTERISTICS - 900 MHz

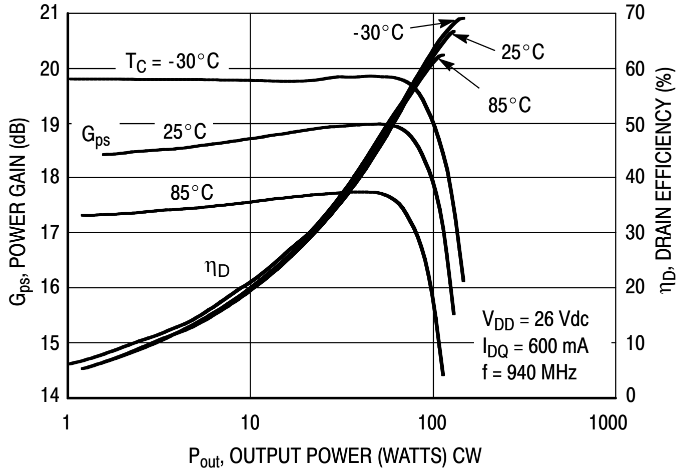


Figure 7. Power Gain and Drain Efficiency versus CW Output Power

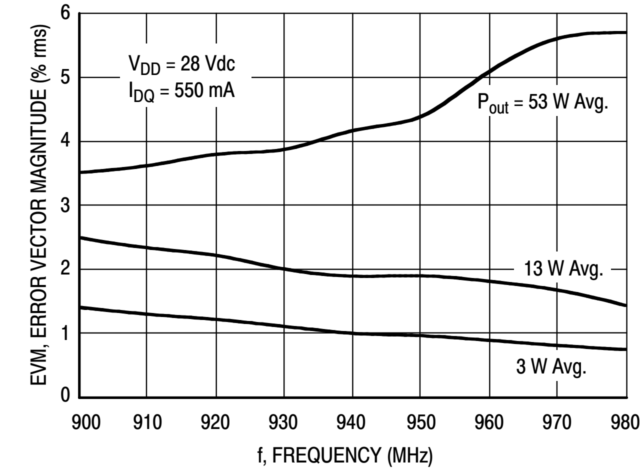


Figure 8. EVM versus Frequency

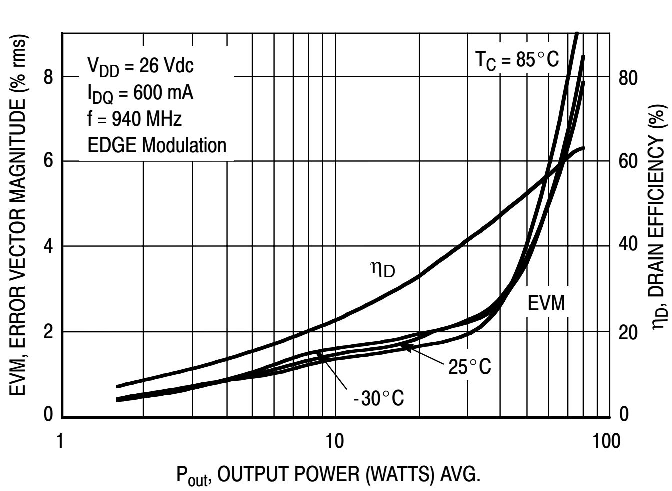


Figure 9. EVM and Drain Efficiency versus Output Power

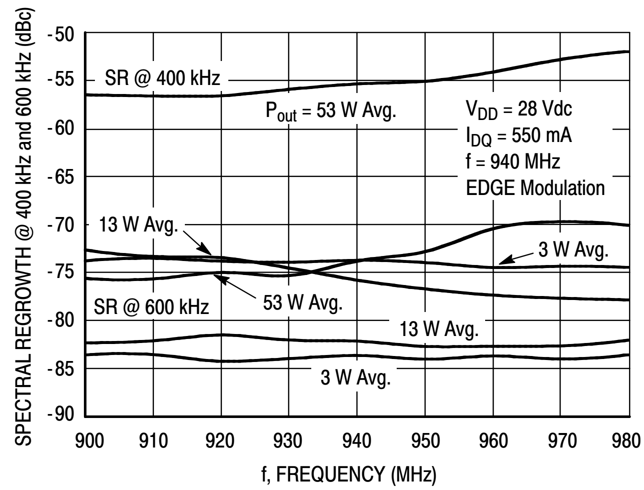


Figure 10. Spectral Regrowth at 400 kHz and 600 kHz versus Frequency

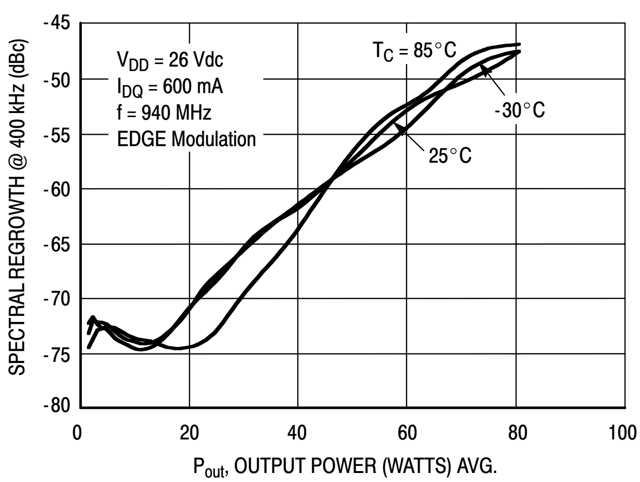


Figure 11. Spectral Regrowth @ 400 kHz versus Output Power

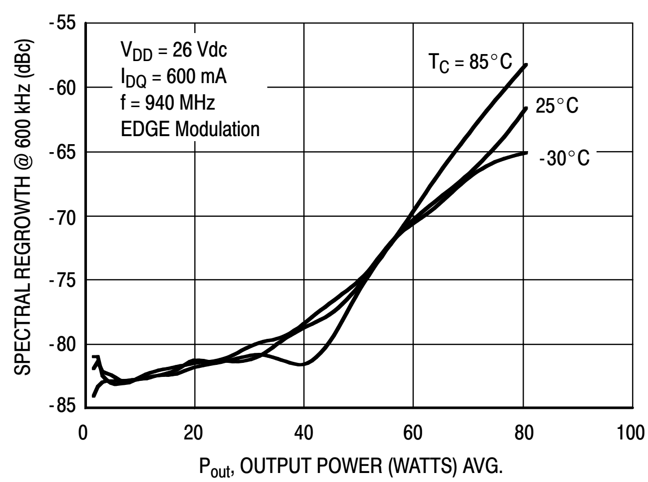
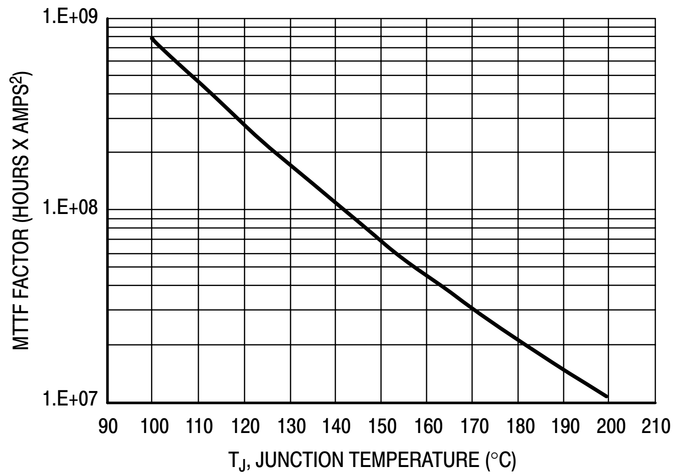


Figure 12. Spectral Regrowth @ 600 kHz versus Output Power



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 13. MTTF Factor versus Junction Temperature

GSM TEST SIGNAL

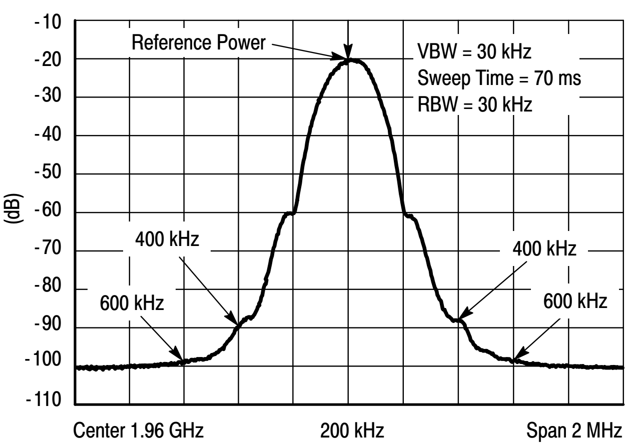
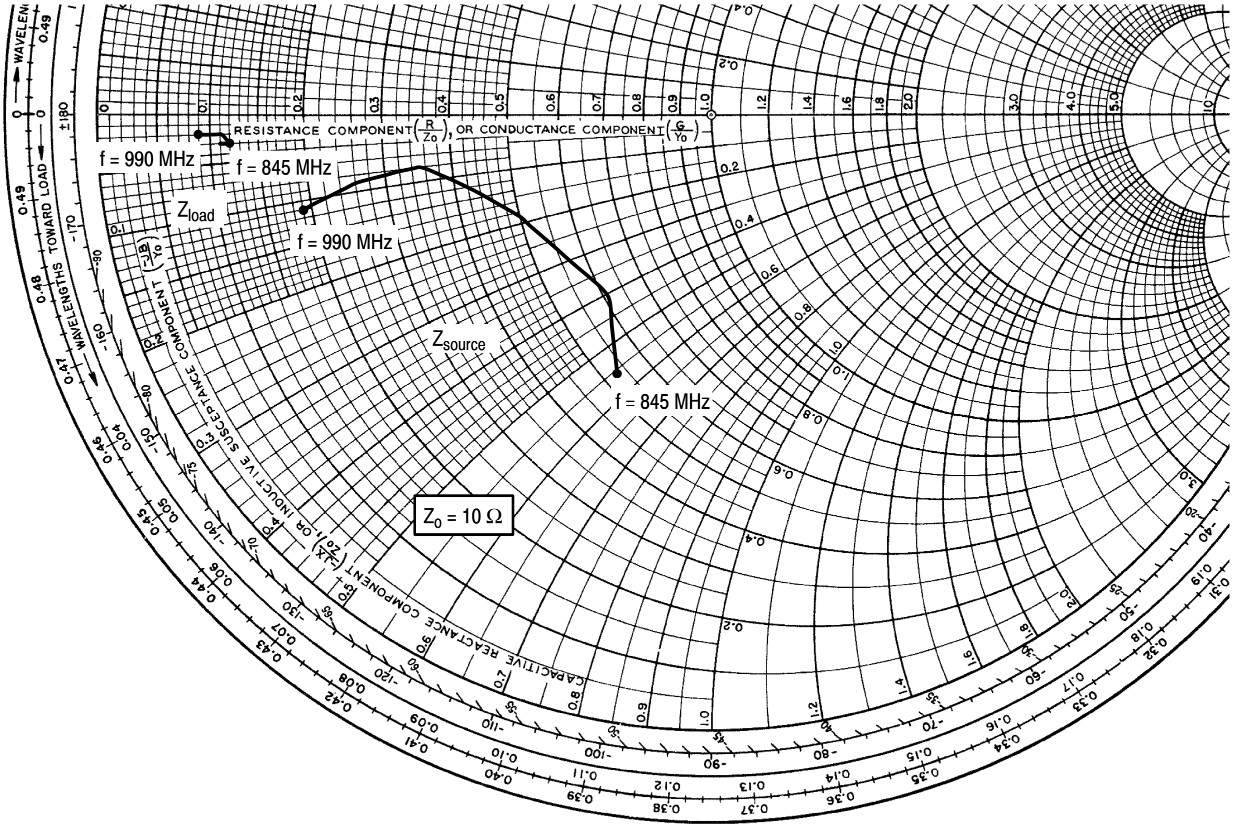


Figure 14. EDGE Spectrum



V_{DD} = 26 Vdc, I_{DQ} = 600 mA, P_{out} = 80 W CW

f MHz	Z_{source} Ω	Z_{load} Ω
845	5.31 - j5.59	1.18 - j0.34
865	6.07 - j4.16	1.09 - j0.29
890	5.05 - j1.99	1.22 - j0.29
920	3.47 - j0.81	1.10 - j0.21
960	2.64 - j0.88	1.05 - j0.15
990	1.89 - j1.14	0.91 - j0.18

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

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

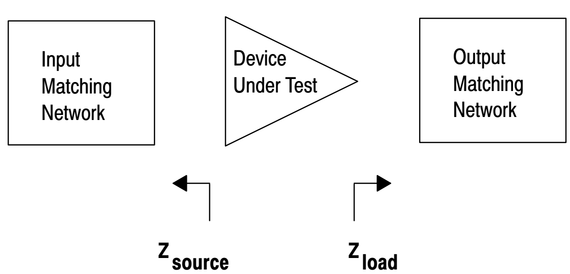
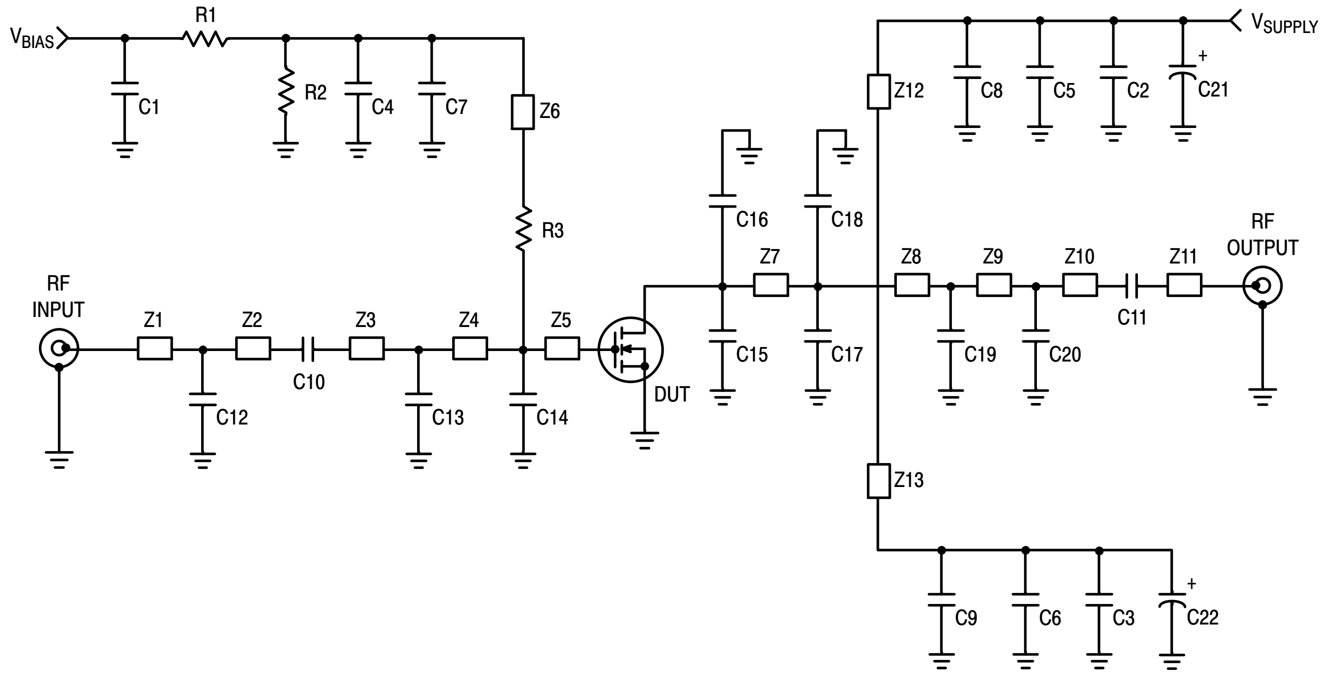


Figure 15. Series Equivalent Source and Load Impedance — 900 MHz



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Z5	0.430″ x 0.591″ Microstrip	Z12, Z13	1.693″ x 0.087″ Microstrip
Z6	1.567″ x 0.059″ Microstrip	PCB	Taconic TLX8-0300, 0.030″, ε_r = 2.55
Z7	0.734″ x 0.788″ Microstrip		

Figure 16. MRF5S9080NR1(NBR1) Test Circuit Schematic — 800 MHz

Table 7. MRF5S9080NR1(NBR1) Test Circuit Component Designations and Values — 800 MHz

Part	Description	Part Number	Manufacturer
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C7, C8, C9	33 pF 600B Chip Capacitors	600B330JW	ATC
C10, C11	22 pF 600B Chip Capacitors	600B220FW	ATC
C12	1.8 pF 600B Chip Capacitor	600B1R8BW	ATC
C13	9.1 pF 600B Chip Capacitor	600B9R1BW	ATC
C14, C17, C18	8.2 pF 600B Chip Capacitors	600B8R2BW	ATC
C15, C16	10 pF 600B Chip Capacitors	600B100FW	ATC
C19	4.7 pF 600B Chip Capacitor	600B4R7BW	ATC
C20	3.6 pF 600B Chip Capacitor	600B3R6BW	ATC
C21, C22	220 μF, 50 V Electrolytic Capacitors, Radial	678D227M050DM3D	Vishay
R1, R2	10 kΩ, 1/4 W Chip Resistors (1206)		
R3	10 Ω, 1/4 W Chip Resistor (1206)		

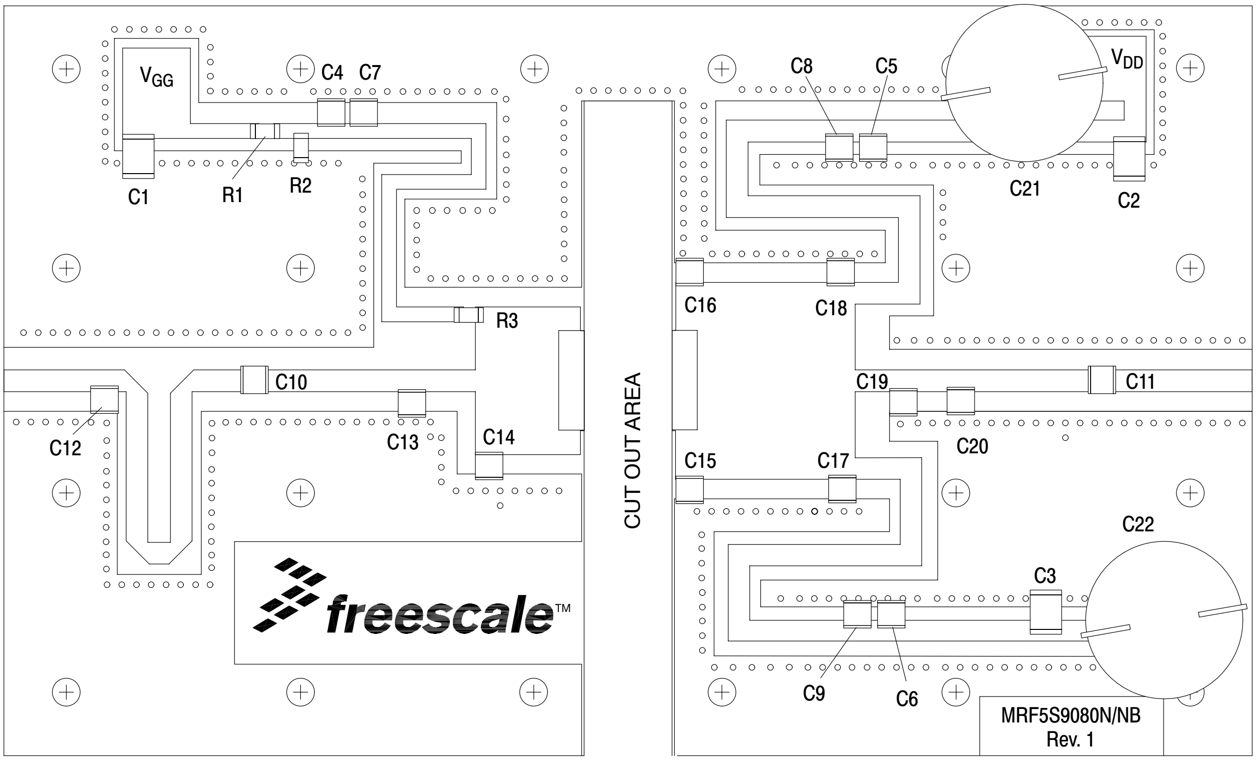


Figure 17. MRF5S9080NR1(NBR1) Test Circuit Component Layout — 800 MHz

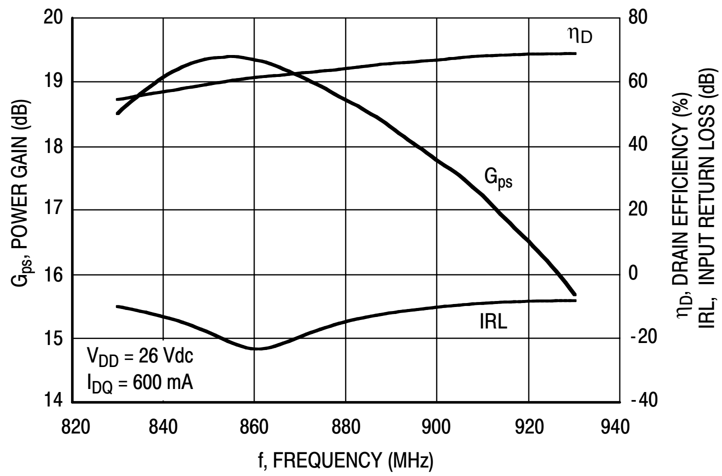


Figure 18. Power Gain, Input Return Loss and Drain Efficiency versus Frequency @ P_{out} = 80 Watts

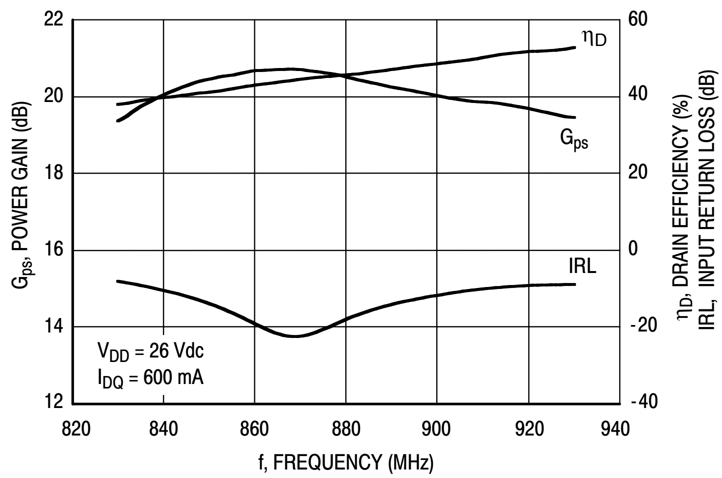


Figure 19. Power Gain, Input Return Loss and Drain Efficiency versus Frequency @ P_{out} = 36 Watts

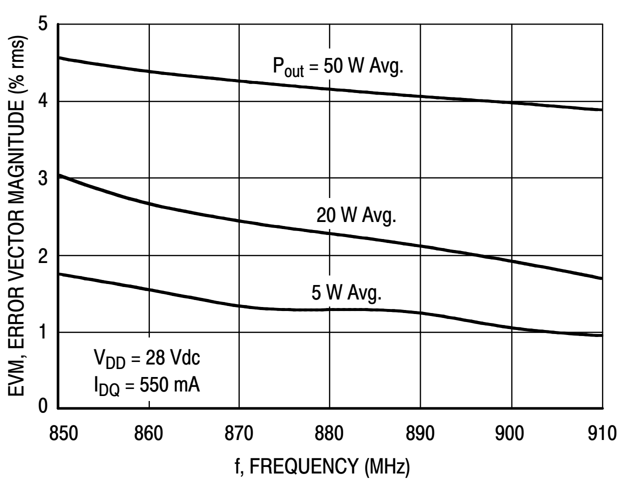


Figure 20. EVM versus Frequency

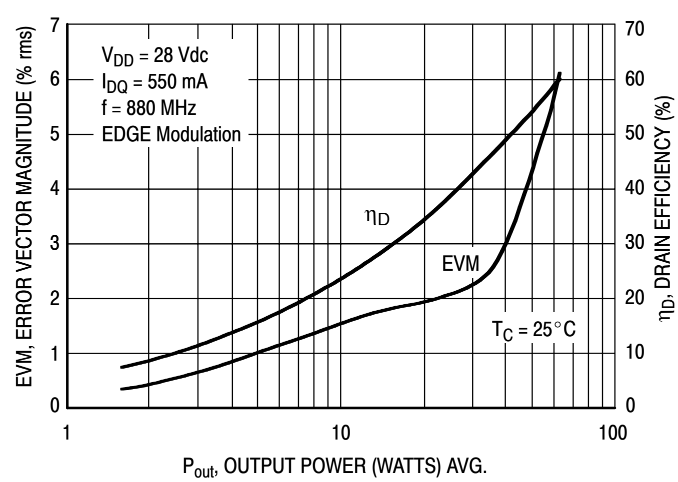


Figure 21. EVM and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS - 800 MHz

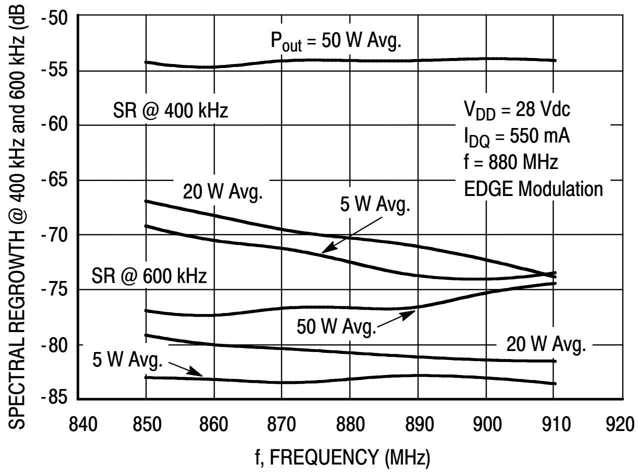


Figure 22. Spectral Regrowth at 400 kHz and 600 kHz versus Frequency

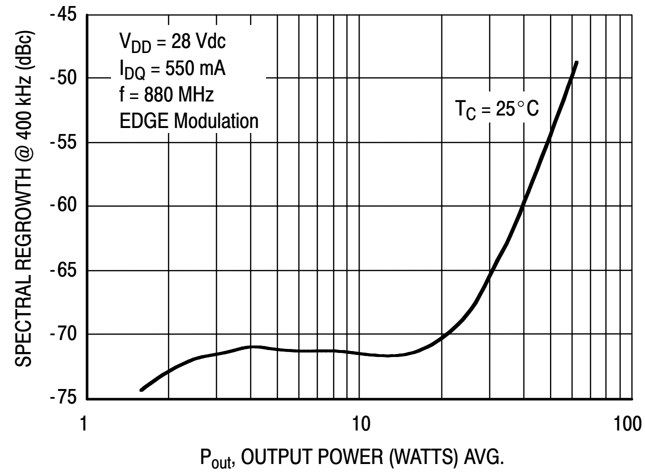


Figure 23. Spectral Regrowth @ 400 kHz versus Output Power

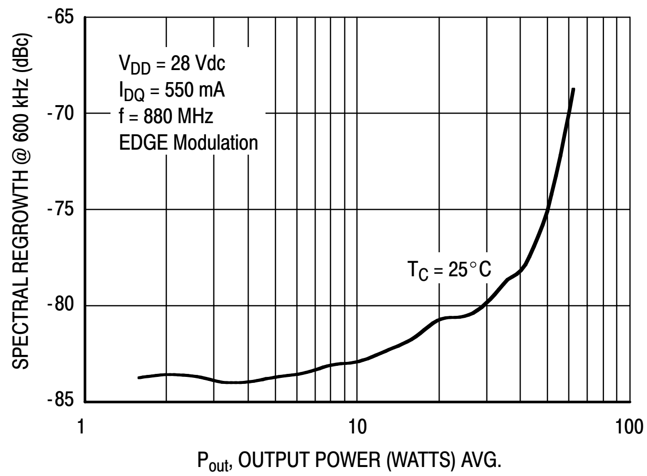


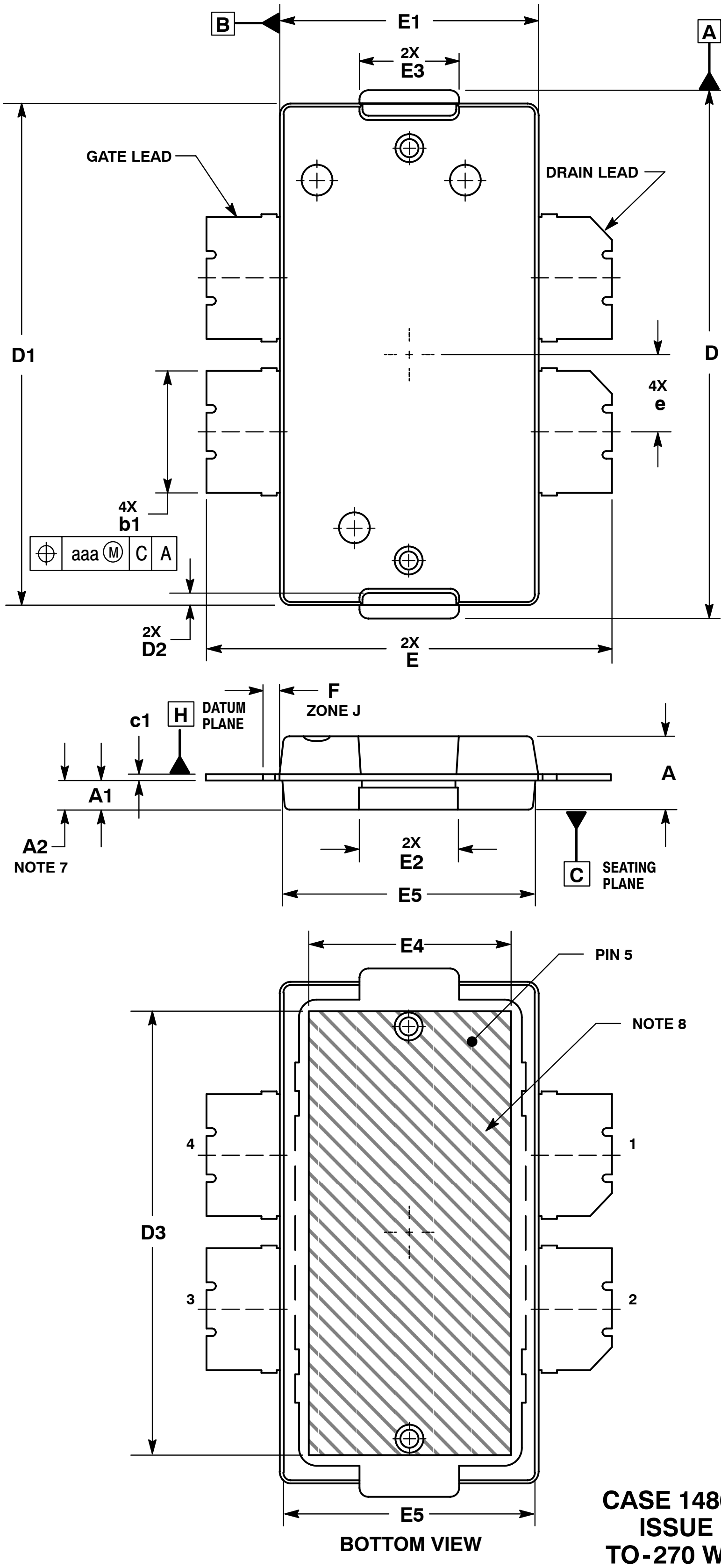
Figure 24. Spectral Regrowth @ 600 kHz versus Output Power

NOTES

NOTES

NOTES

PACKAGE DIMENSIONS

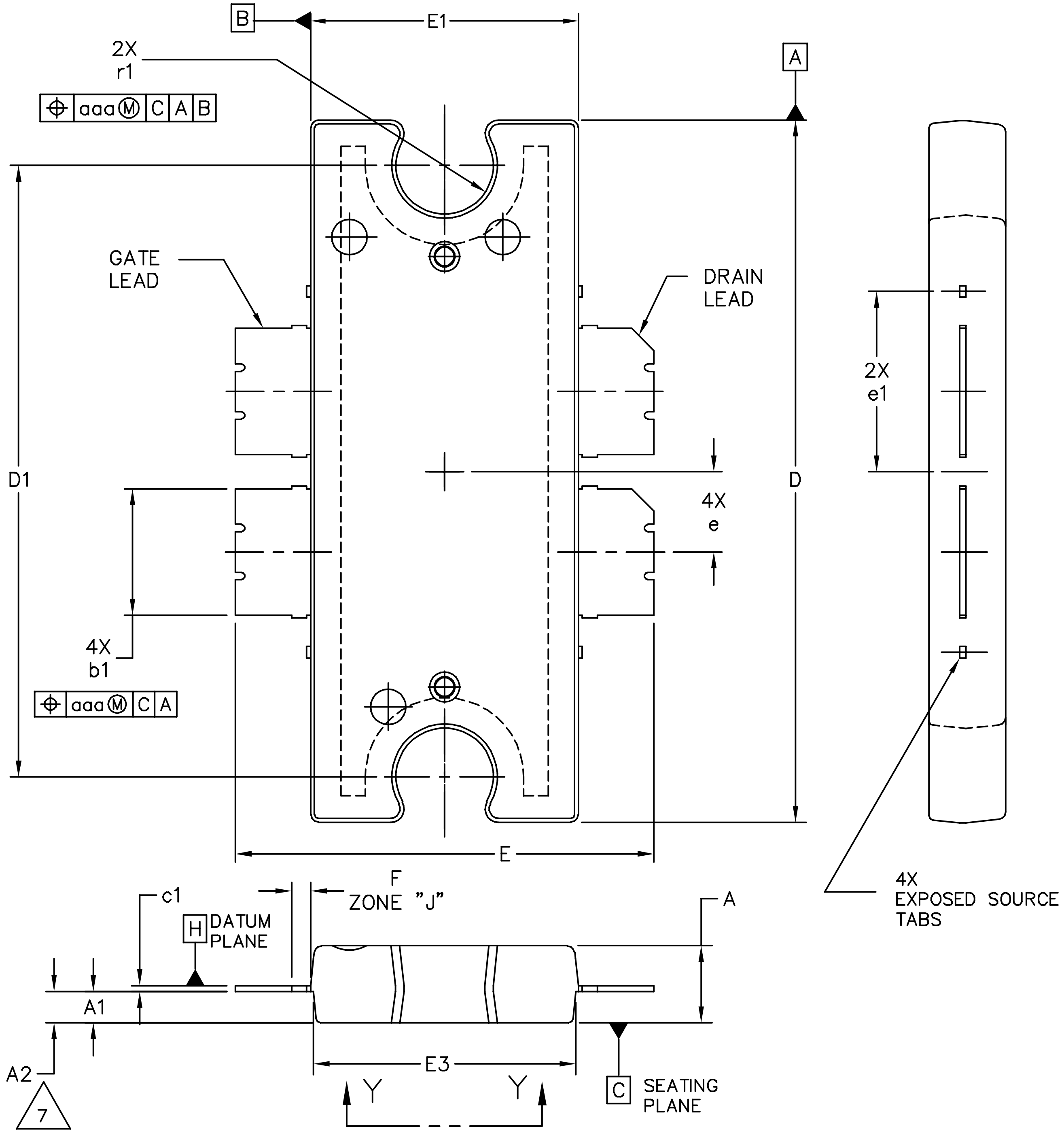


NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT THE TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. 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
MRF5S9080NR1



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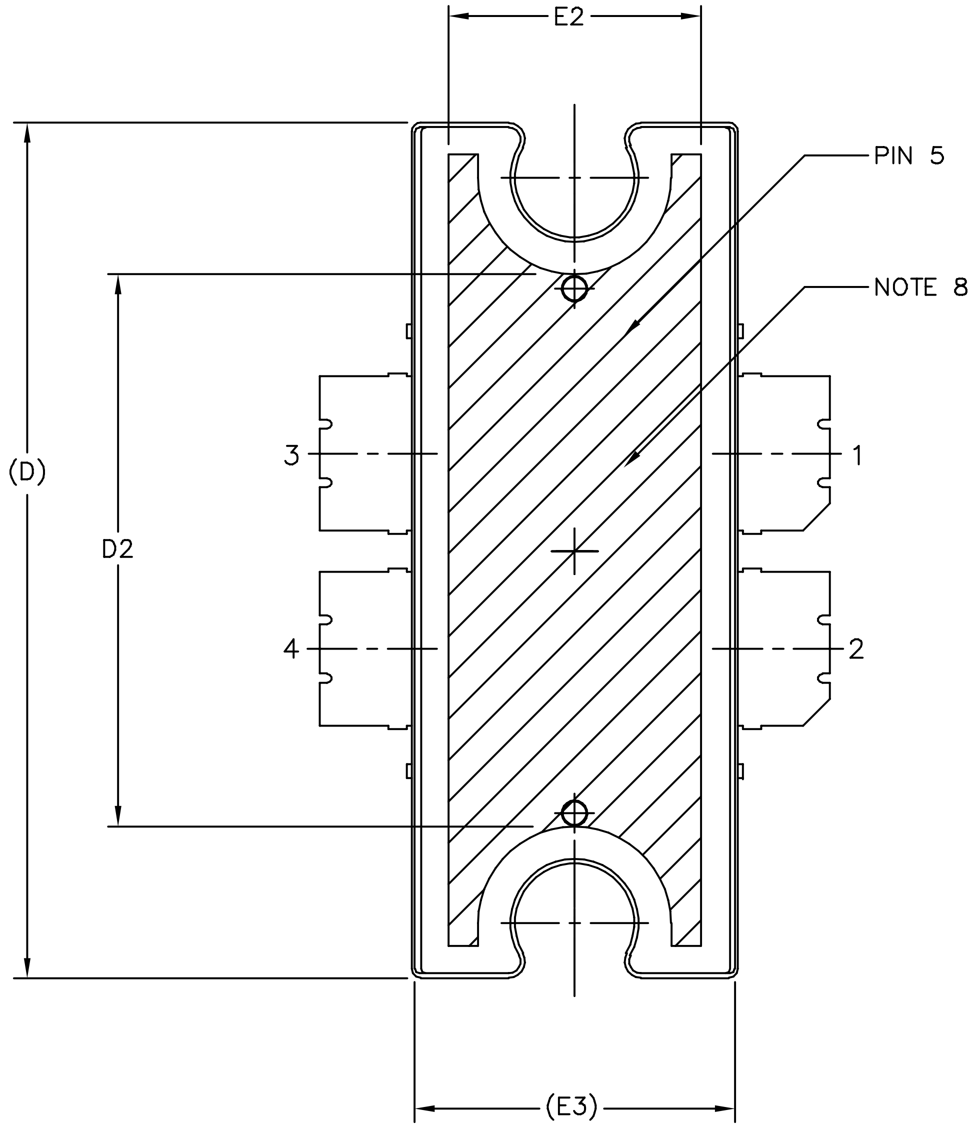
TITLE: TO−272 4 LEAD, WIDE BODY	DOCUMENT NO: 98ASA10575D	REV: D
	CASE NUMBER: 1484−04	05 APR 2006
	STANDARD: NON−JEDEC	



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NOTES:
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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
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