Freescale Semiconductor
Technical Data

Document Number: MRF9135L
Rev. 7, 8/2005

RF Power Field Effect Transistors

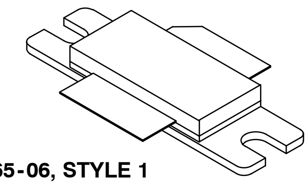
N-Channel Enhancement-Mode Lateral MOSFETs

MRF9135LR3
MRF9135LSR3

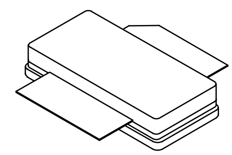
Designed for broadband commercial and industrial applications with frequencies from 865 to 895 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 26 volt base station equipment.

- Typical N-CDMA Performance @ 880 MHz, 26 Volts, I_{DQ} = 1100 mA
  IS-95 CDMA Pilot, Sync, Paging, Traffic Codes 8 Through 13
  Output Power — 25 Watts Avg.
  Power Gain — 17.8 dB
  Efficiency — 25%
  Adjacent Channel Power —
  750 kHz: -47 dBc @ 30 kHz BW
- Internally Matched, for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 880 MHz, 135 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Low Gold Plating Thickness on Leads, 40μ″ Nominal.
- Pb-Free and RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 32 mm, 13 inch Reel.

880 MHz, 135 W, 26 V
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF9135LR3



CASE 465A-06, STYLE 1
NI-780S
MRF9135LSR3

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	298 1.7	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +200	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

Table 3. ESD Protection Characteristics

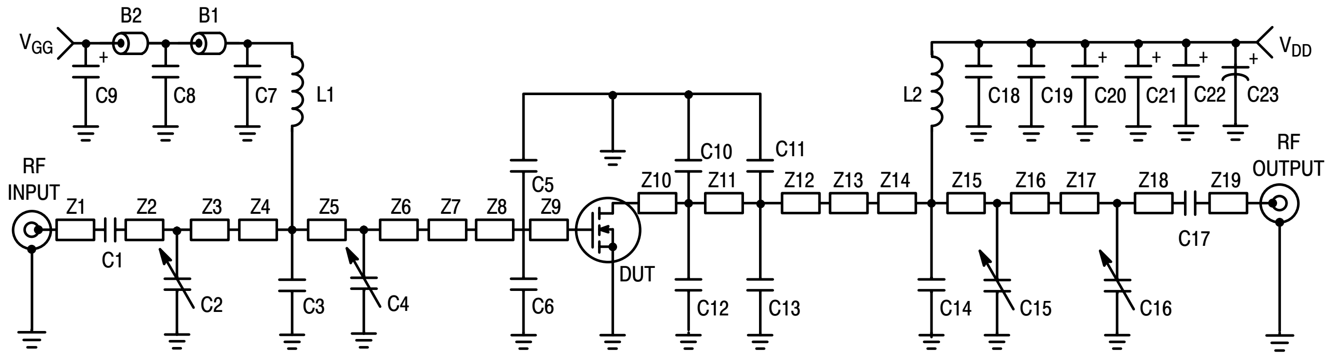
Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M2 (Minimum)
Charge Device Model	C7 (Minimum)

1. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.

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

Table 4. Electrical Characteristics (T_C = 25°C, 50 ohm system 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}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 450 μA)	$V_{GS(th)}$	2	2.8	4	Vdc
Gate Quiescent Voltage (V_{DS} = 26 Vdc, I_D = 1100 mAdc)	$V_{GS(Q)}$	3.25	3.7	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3 Adc)	$V_{DS(on)}$	—	0.19	0.4	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 9 Adc)	g_{fs}	—	12	—	S
Dynamic Characteristics					
Output Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	109	—	pF
Reverse Transfer Capacitance (V_{DS} = 26 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	4.4	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier, PAR = 9.8 dB @ 0.01% Probability on CCDF					
Common-Source Amplifier Power Gain (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 880.0 MHz)	G_{ps}	16	17.8	—	dB
Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 880.0 MHz)	η	22	25	—	%
Adjacent Channel Power Ratio (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 880.0 MHz; ACPR @ 25 W, 1.23 MHz Bandwidth, 750 kHz Channel Spacing)	ACPR	—	-47	-45	dBc
Input Return Loss (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 880.0 MHz)	IRL	—	-13.5	-9	dB
Common-Source Amplifier Power Gain (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 865 MHz and 895 MHz)	G_{ps}	—	17	—	dB
Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 865 MHz and 895 MHz)	η	—	24	—	%
Adjacent Channel Power Ratio (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 865 MHz and 895 MHz; ACPR @ 25 W, 1.23 MHz Bandwidth, 750 kHz Channel Spacing)	ACPR	—	-46	—	dBc
Input Return Loss (V_{DD} = 26 Vdc, P_{out} = 25 W Avg. N-CDMA, I_{DQ} = 1100 mA, f = 865 MHz and 895 MHz)	IRL	—	-12.5	—	dB
Output Mismatch Stress (V_{DD} = 26 Vdc, P_{out} = 135 W CW, I_{DQ} = 1100 mA, f = 880.0 MHz, VSWR = 10:1, All Phase Angles at Frequency of Tests)	Ψ	No Degradation In Output Power			

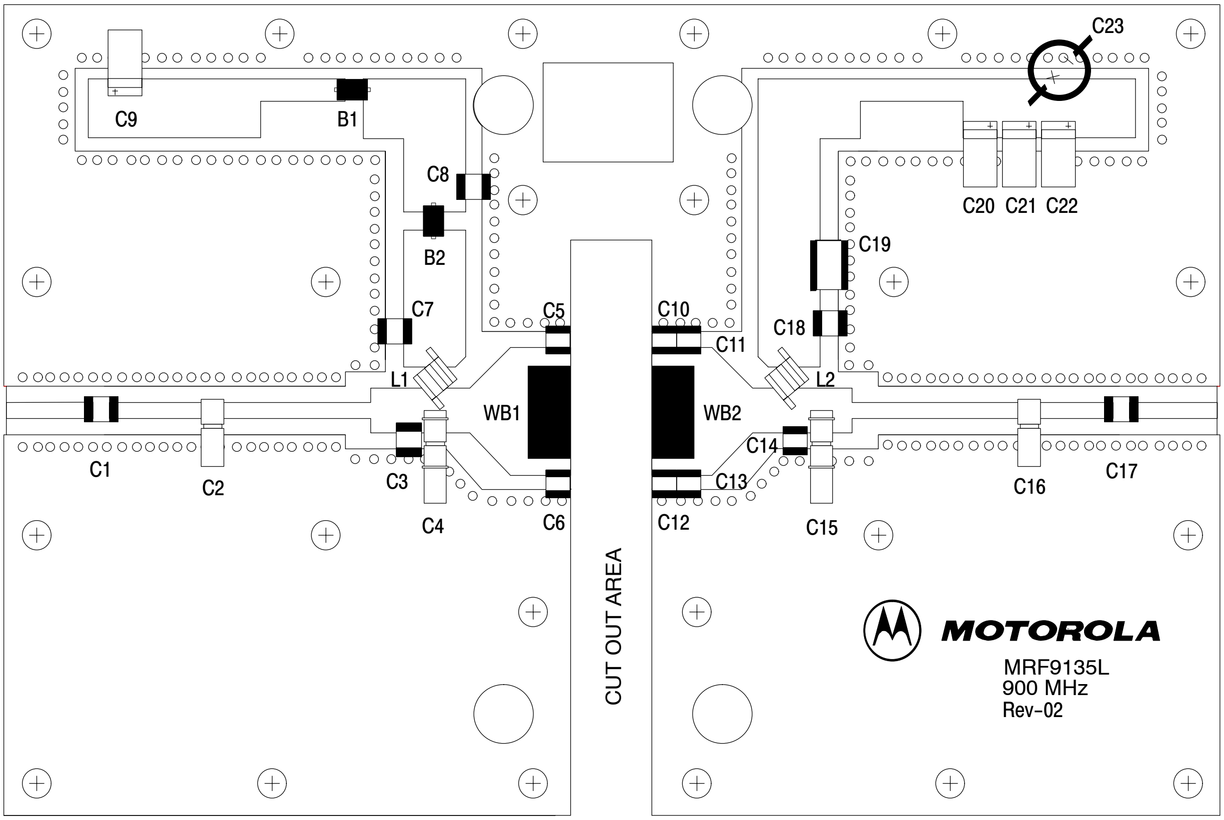


Z1	0.430″ x 0.080″ Microstrip	Z11	0.105″ x 0.630″ Microstrip
Z2	0.430″ x 0.080″ Microstrip	Z12	0.145″ x 0.630″ Microstrip
Z3	0.800″ x 0.080″ Microstrip	Z13	0.200″ x 0.630″ x 0.220″ Taper
Z4	0.200″ x 0.220″ Microstrip	Z14	0.180″ x 0.220″ Microstrip
Z5	0.110″ x 0.220″ Microstrip	Z15	0.110″ x 0.220″ Microstrip
Z6	0.175″ x 0.220″ Microstrip	Z16	0.200″ x 0.220″ Microstrip
Z7	0.200″ x 0.220″ x 0.630″ Taper	Z17	0.900″ x 0.080″ Microstrip
Z8	0.250″ x 0.630″ Microstrip	Z18	0.360″ x 0.080″ Microstrip
Z9	0.050″ x 0.630″ Microstrip	Z19	0.410″ x 0.080″ Microstrip
Z10	0.050″ x 0.630″ Microstrip	PCB	Arlon GX-0300-55-22, 0.030″, ε_r = 2.55

Figure 1. 880 MHz Test Circuit Schematic

Table 5. 880 MHz Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Beads, Short	2743019447	Fair Rite
C1, C7, C17, C18	47 pF Chip Capacitors	100B470JP 500X	ATC
C2, C16	0.6-4.5 Variable Capacitors, Gigatrim	27271SL	Johanson
C3	8.2 pF Chip Capacitor	100B8R2BP 500X	ATC
C4, C15	0.8-8.0 Variable Capacitors, Gigatrim	27291SL	Johanson
C5, C6	12 pF Chip Capacitors	100B120JP 500X	ATC
C8	20K pF Chip Capacitor	200B203MP50X	ATC
C9, C20, C21, C22	10 μF, 35 V Tantalum Capacitors	T491D106K035AS	Kemet
C10, C11, C12, C13	7.5 pF Chip Capacitors	100B7R5JP 500X	ATC
C14	11 pF Chip Capacitor	100B110JP 500X	ATC
C19	0.56 μF, 50 V Chip Capacitor	C1825C564K5RA7800	Kemet
C23	470 μF, 63 V Electrolytic Capacitor	SME63VB471M12X25LL	United Chemi-Con
L1, L2	12.5 nH Coilcraft inductors	A04T-5	Coilcraft
WB1, WB2	10 mil Brass Shim (0.205 x 0.530)	RF-Design Lab	RF-Design Lab



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. 880 MHz Test Circuit Component Layout

TYPICAL CHARACTERISTICS

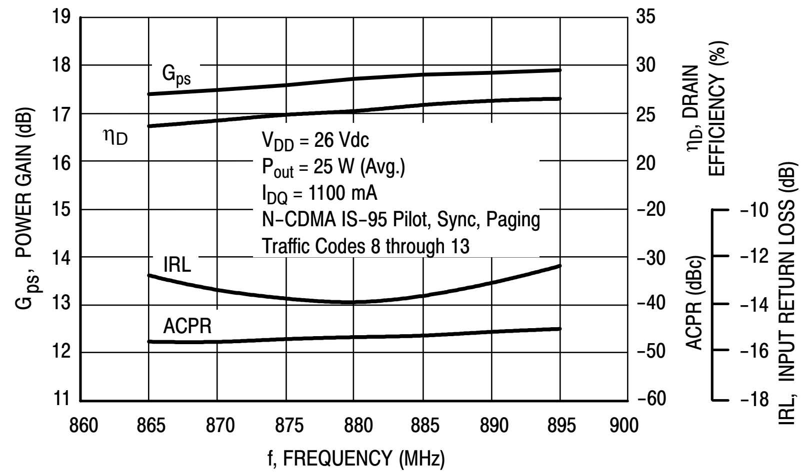


Figure 3. Class AB Broadband Circuit Performance

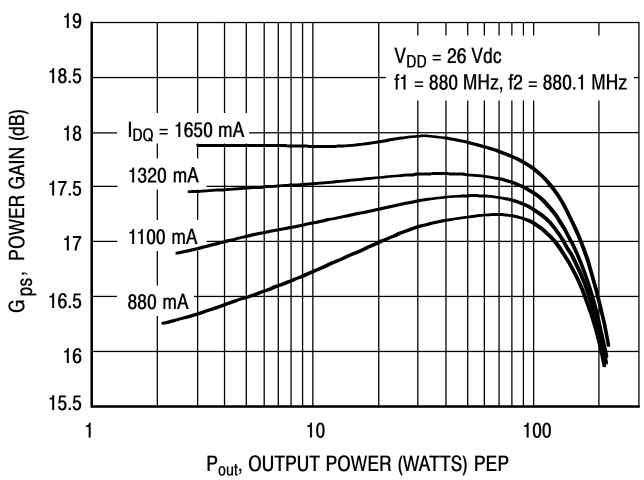


Figure 4. Power Gain versus Output Power

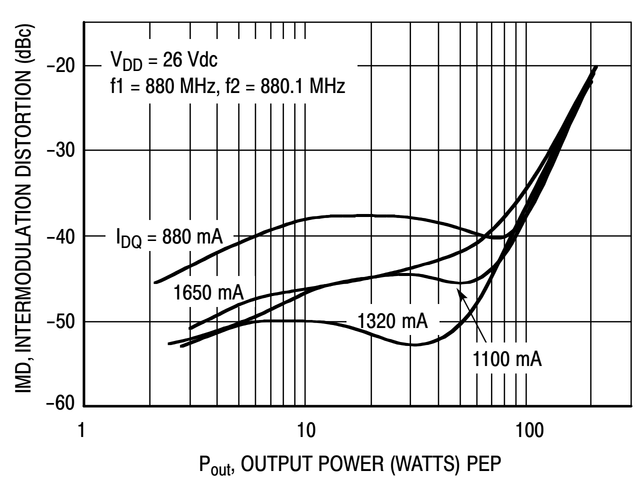


Figure 5. Intermodulation Distortion versus Output Power

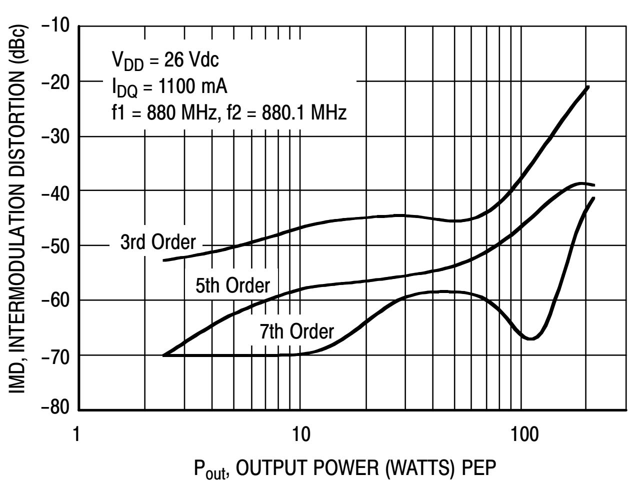


Figure 6. Intermodulation Distortion Products versus Output Power

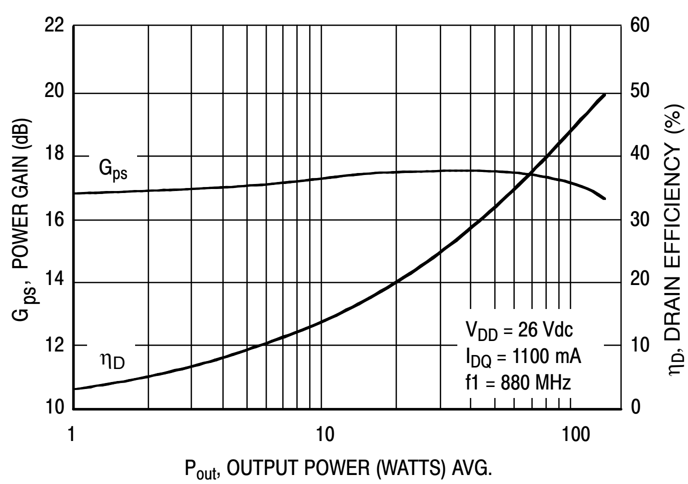


Figure 7. Power Gain and Efficiency versus Output Power

TYPICAL CHARACTERISTICS

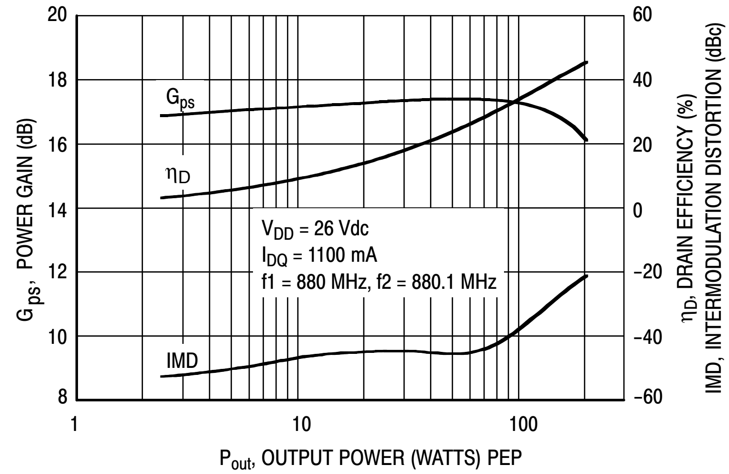


Figure 8. Power Gain, Efficiency and IMD versus Output Power

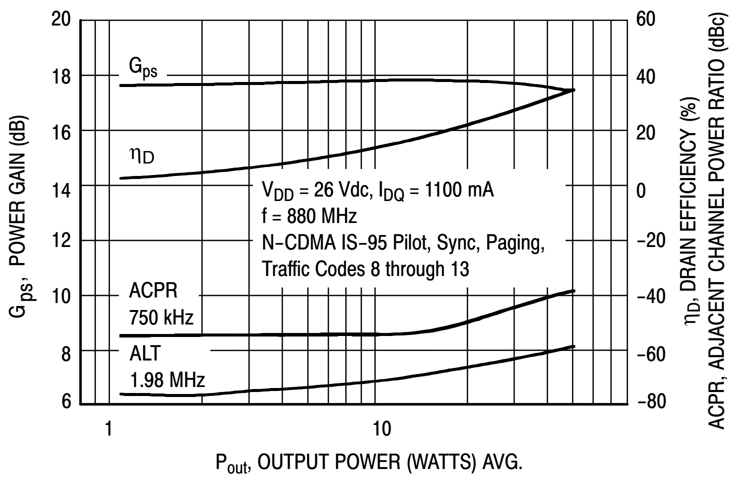
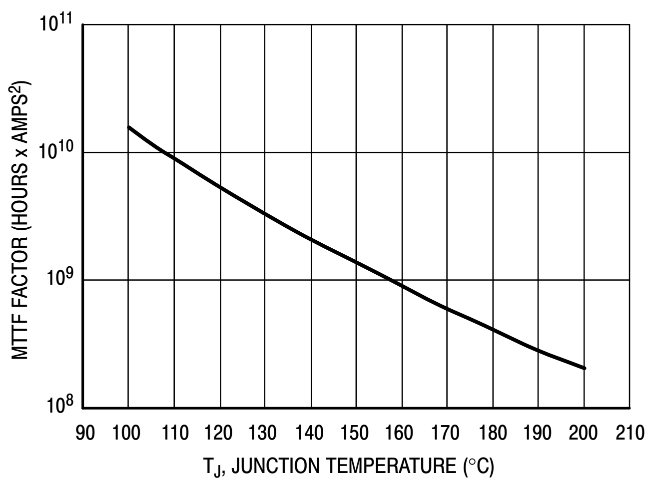


Figure 9. N-CDMA Performance Output Power versus Gain, ACPR, Efficiency



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 10. MTTF Factor versus Junction Temperature

N-CDMA TEST SIGNAL

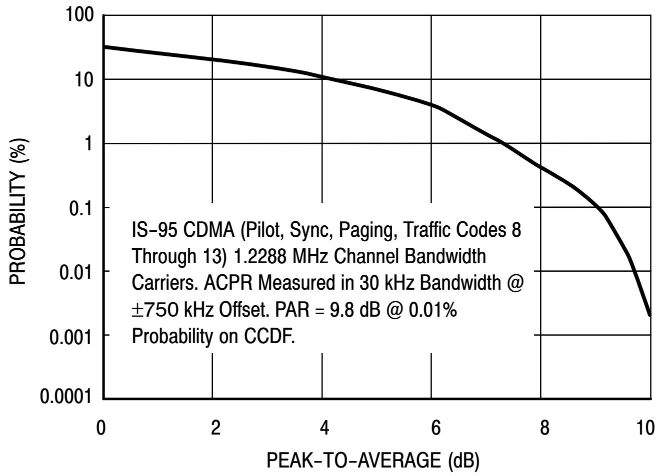


Figure 11. Single-Carrier CCDF N-CDMA

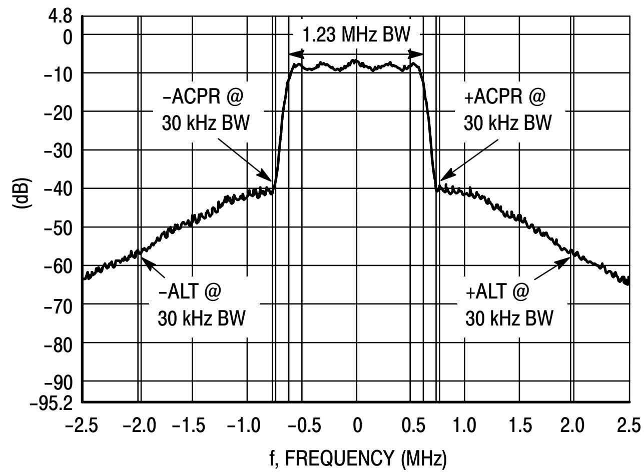
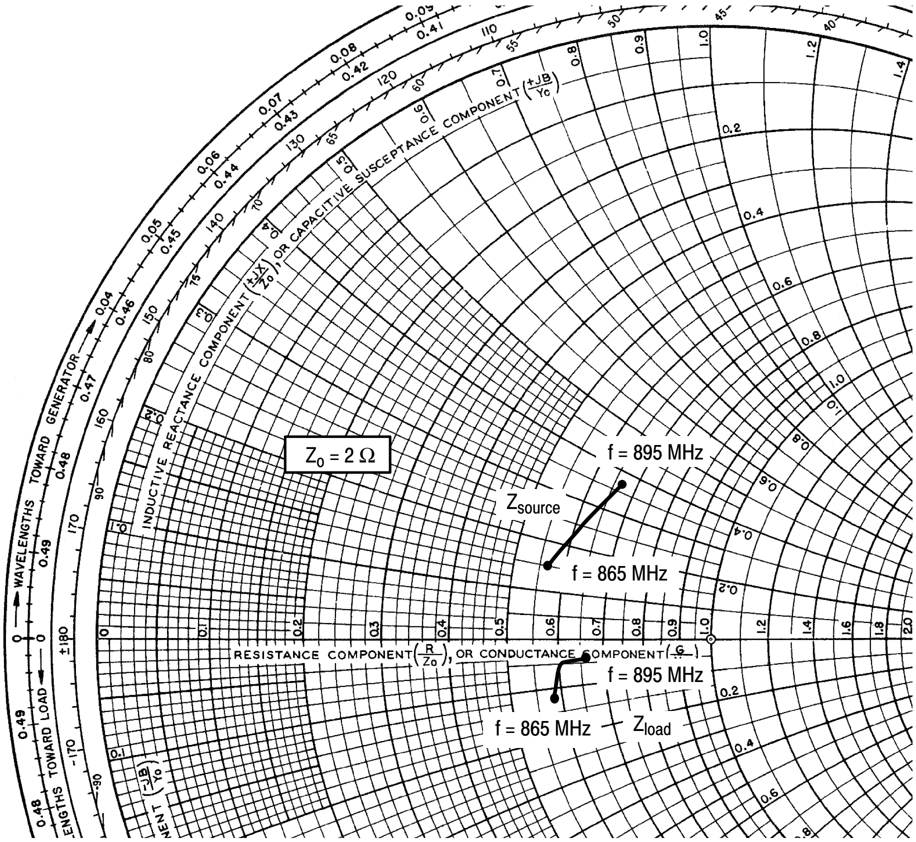


Figure 12. Typical CDMA Spectrum



V_{DD} = 26 V, I_{DQ} =1100 mA, P_{out} = 25 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
865	1.15 + j0.3	1.17 - j0.24
880	1.25 + j0.5	1.22 - j0.1
895	1.35 + j0.75	1.32 - j0.07

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

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

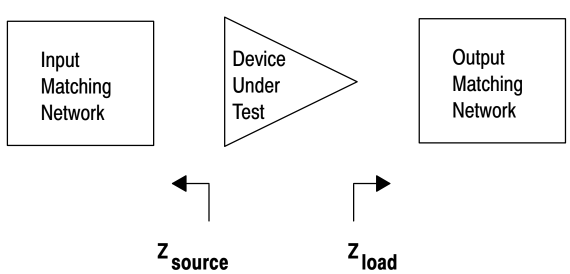
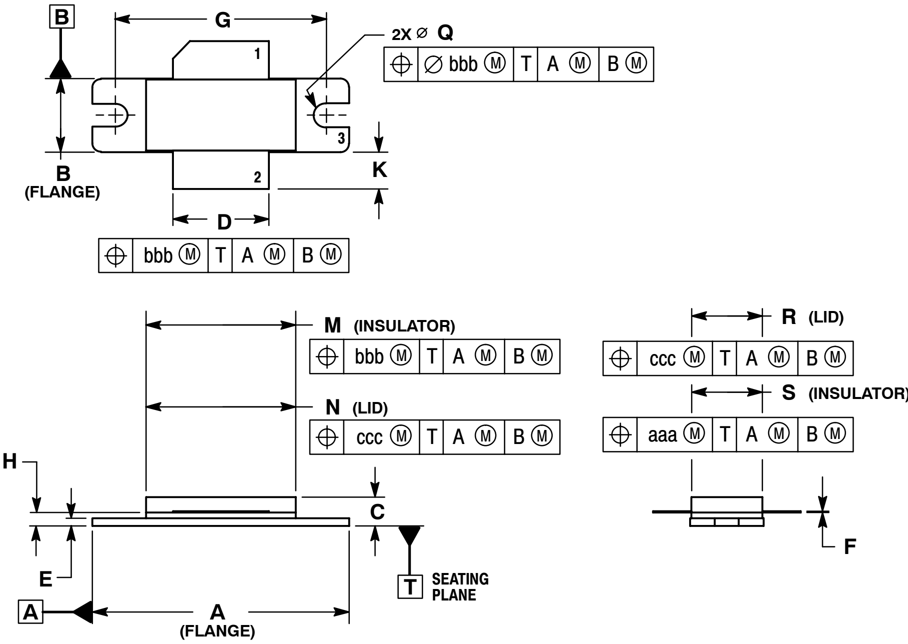


Figure 13. Series Equivalent Source and Load Impedance

NOTES

NOTES

PACKAGE DIMENSIONS

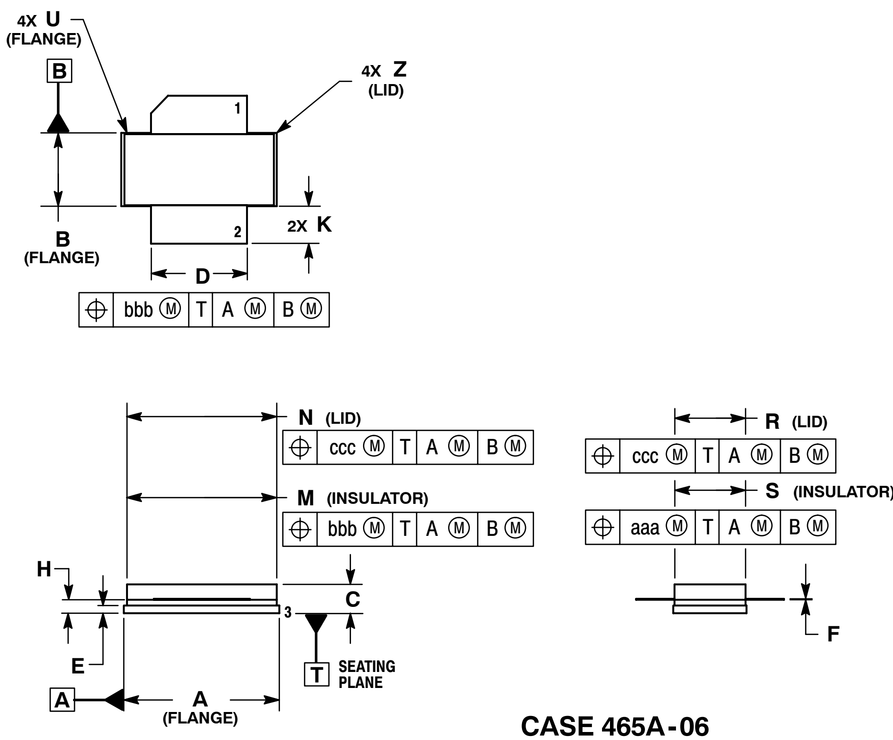


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
G	1.100 BSC		27.94 BSC	
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.774	0.786	19.66	19.96
N	0.772	0.788	19.60	20.00
Q	∅.118	∅.138	∅3.00	∅3.51
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
aaa	0.005 REF		0.127 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

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

CASE 465-06
ISSUE G
NI-780
MRF9135LR3



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	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.805	0.815	20.45	20.70
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.774	0.786	19.61	20.02
N	0.772	0.788	19.61	20.02
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
U	---	0.040	---	1.02
Z	---	0.030	---	0.76
aaa	0.005 REF		0.127 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

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

CASE 465A-06
ISSUE H
NI-780S
MRF9135LSR3

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