Freescale Semiconductor
Technical Data

Document Number: MRF6P9220H
Rev. 1, 11/2005

RoHS

RF Power Field Effect Transistor

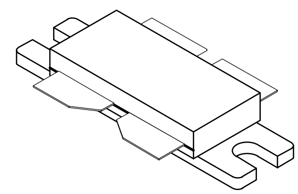
N-Channel Enhancement-Mode Lateral MOSFET

MRF6P9220HR3

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.

- Typical Single-Carrier N-CDMA Performance @ 880 MHz: V_{DD} = 28 Volts, I_{DQ} = 1600 mA, P_{out} = 47 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 — 20 dB
  Drain Efficiency — 30%
  ACPR @ 750 kHz Offset — -47.1 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 880 MHz, 220 Watts CW Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Device Designed for Push-Pull Operation Only
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- Low Gold Plating Thickness on Leads, 40μ″ Nominal.
- Pb-Free and RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**880 MHz, 47 W AVG., 28 V
SINGLE N-CDMA
LATERAL N-CHANNEL
RF POWER MOSFET**



**CASE 375G-04, STYLE 1
NI-860C3**

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	700 4	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Operating Junction Temperature	T_J	200	°C
CW Operation	CW	220	W

Table 2. Thermal Characteristics

Characteristic	Symbol	Value(1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 220 W CW Case Temperature 76°C, 47 W CW	$R_{\theta JC}$	 0.25 0.28	°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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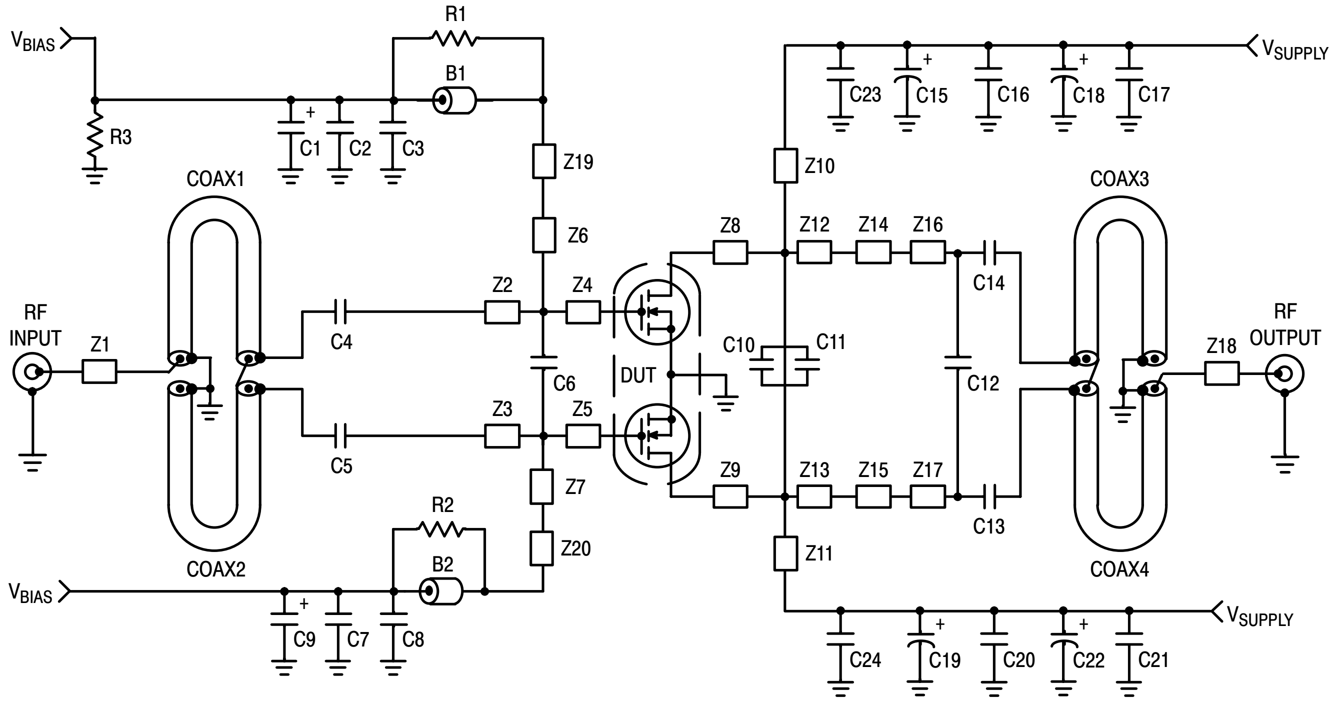
Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	3B (Minimum)
Machine Model (per EIA/JESD22-A115)	C (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics[1]					
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 = 350 μAdc)	$V_{GS(th)}$	1	2.2	3	Vdc
Gate Quiescent Voltage[3] (V_{DS} = 28 Vdc, I_D = 1600 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage[1] (V_{GS} = 10 Vdc, I_D = 2.4 Adc)	$V_{DS(on)}$	0.1	0.22	0.3	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 2.4 Adc)	g_{fs}	—	7.4	—	S
Dynamic Characteristics [1,2]					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	2.1	—	pF
Functional Tests[3] (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1600 mA, P_{out} = 47 W Avg. N-CDMA, f = 880 MHz, Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @ ±750 kHz Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.					
Power Gain	G_{ps}	18.5	20	23	dB
Drain Efficiency	η_D	28.5	30	—	%
Adjacent Channel Power Ratio	ACPR	—	-47.1	-45	dBc
Input Return Loss	IRL	—	-14	-9	dB

1. Each side of device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in push-pull configuration.



Z1, Z18	0.401″ x 0.081″ Microstrip	Z10, Z11	1.054″ x 0.150″ Microstrip
Z2, Z3	0.563″ x 0.081″ Microstrip	Z12, Z13	0.225″ x 0.507″ Microstrip
Z4, Z5	0.416″ x 0.727″ Microstrip	Z14, Z15	0.440″ x 0.335″ Microstrip
Z6, Z7	0.058″ x 1.01″ Microstrip	Z16, Z17	0.123″ x 0.140″ Microstrip
Z8, Z9	0.191″ x 0.507″ Microstrip	Z19, Z20	0.165″ x 0.339″ Microstrip
		PCB	GX-0300, 0.030″, ε_r = 2.55

Figure 1. MRF6P9220HR3 Test Circuit Schematic

Table 5. MRF6P9220HR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Beads, Short	2743019447	Fair-Rite
C1, C9	1.0 μF, 50 V Tantalum Chip Capacitors	T491C105K050AS	Kemet
C2, C7, C17, C21	0.1 μF Chip Capacitors	CDR33BX104AKWS	Kemet
C3, C8, C16, C20	1000 pF 100B Chip Capacitors	100B102JP50X	ATC
C4, C5, C13, C14	100 pF 100B Chip Capacitors	100B101JP500X	ATC
C6, C12	8.2 pF 600B Chip Capacitors	600B8R2BT250XT	ATC
C10	9.1 pF 600B Chip Capacitor	600B9R1BT250XT	ATC
C11	1.8 pF 600B Chip Capacitor	600B1R8BT250XT	ATC
C15, C19	47 μF, 50 V Electrolytic Capacitors	MVK50VC47RM8X10TP	Nippon
C18, C22	470 μF, 63 V Electrolytic Capacitors	SME63V471M12X25LL	United Chemi-Con
C23, C24	22 pF 600B Chip Capacitors	600B220FT250XT	ATC
Coax1, 2, 3, 4	50 Ω, Semi Rigid Coax, 2.40″ Long	UT-141A-TP	Micro-Coax
R1, R2	10 Ω, 1/8 W Chip Resistors (1206)		
R3	1.0 kΩ, 1/8 W Chip Resistor (1206)		

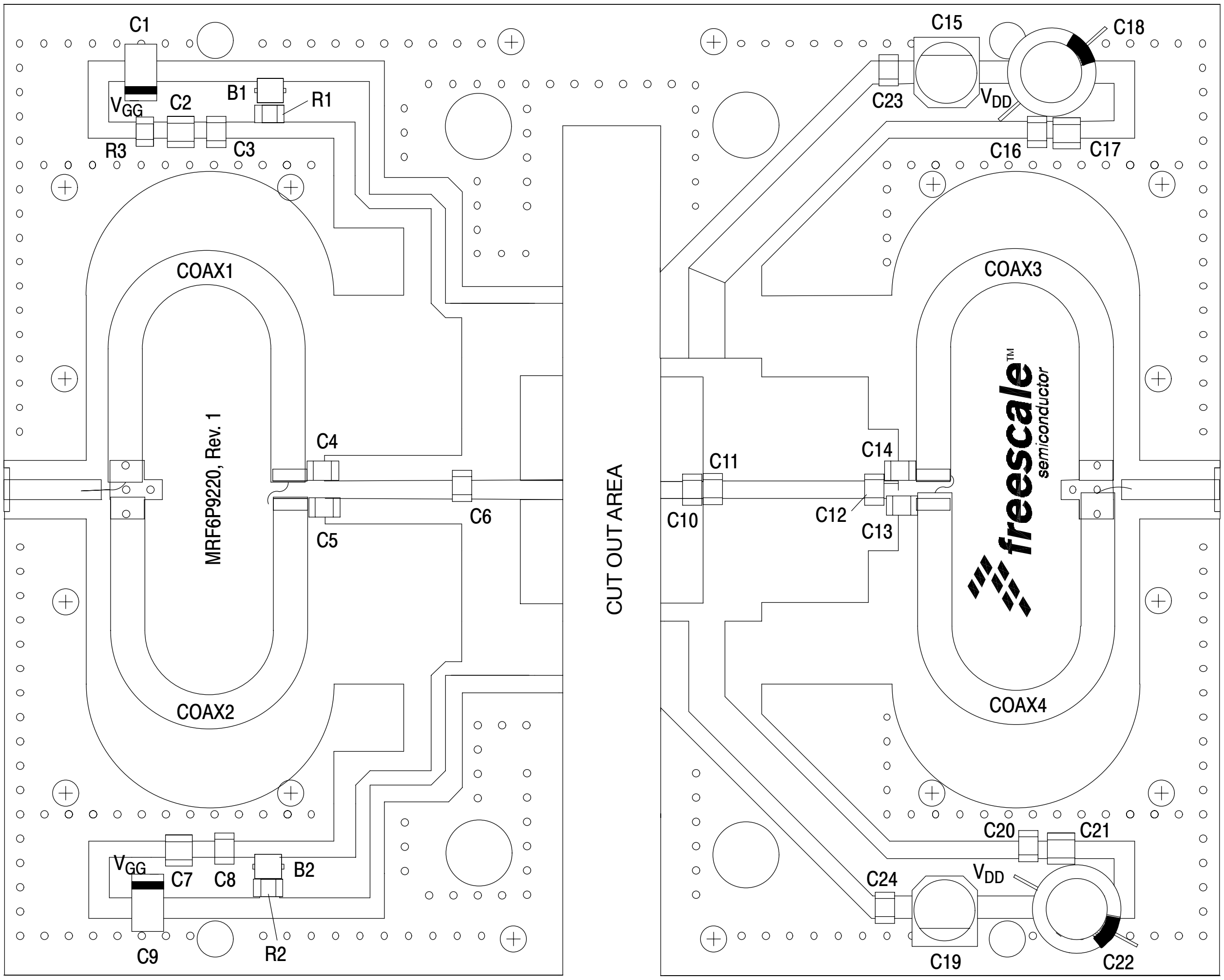


Figure 2. MRF6P9220HR3 Test Circuit Component Layout

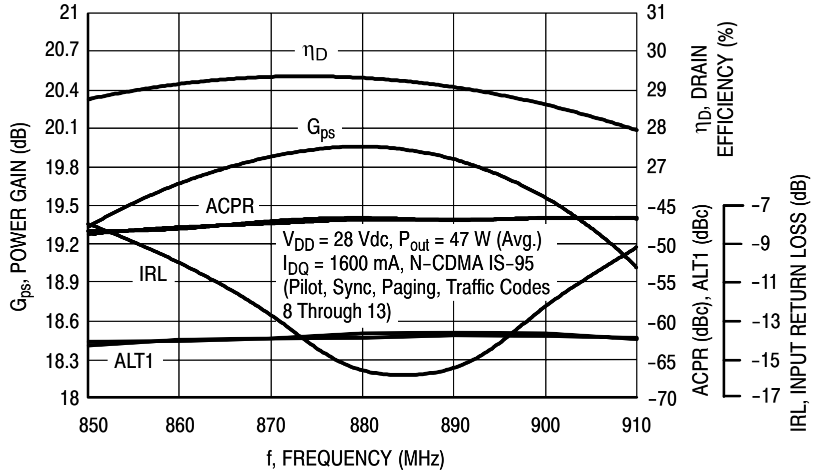


Figure 3. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 47 Watts Avg.

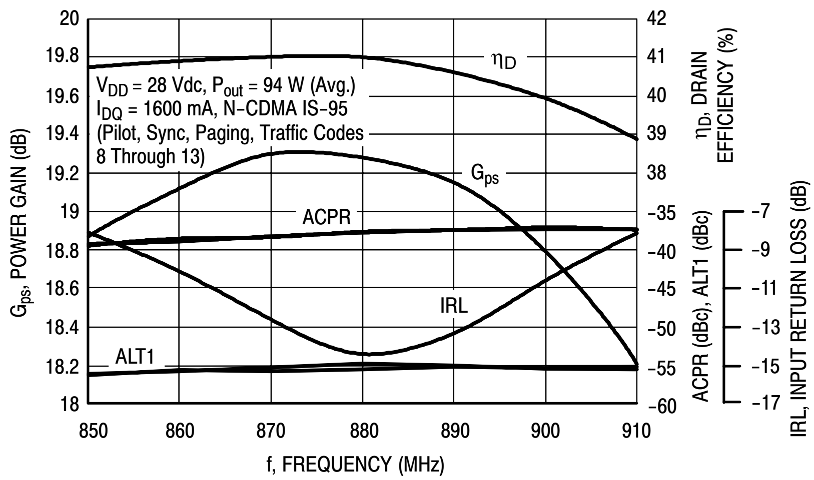


Figure 4. Single-Carrier N-CDMA Broadband Performance @ P_{out} = 94 Watts Avg.

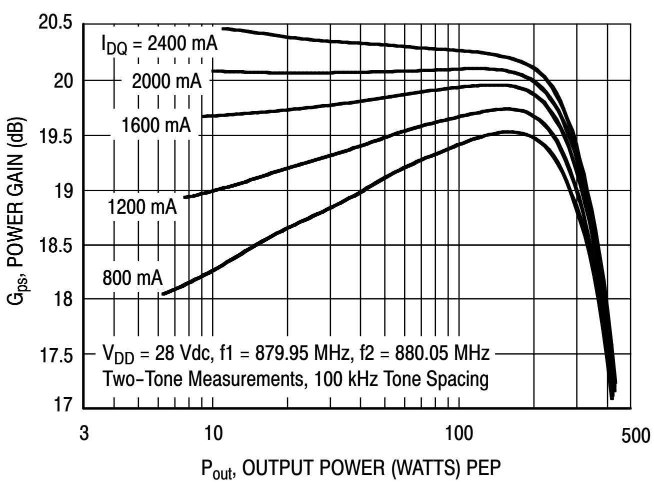


Figure 5. Two-Tone Power Gain versus Output Power

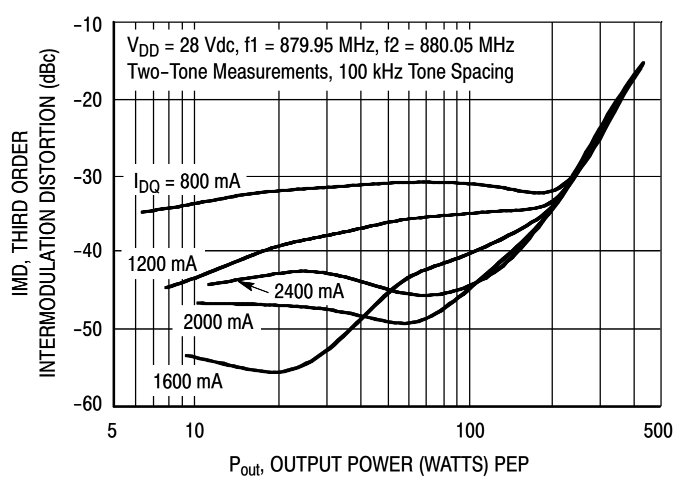


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

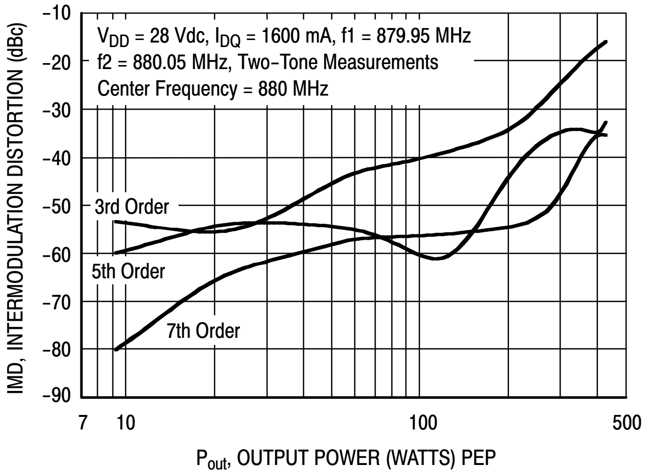


Figure 7. Intermodulation Distortion Products versus Output Power

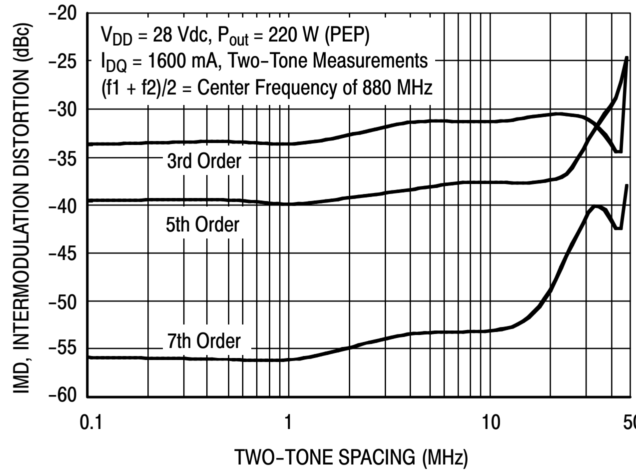


Figure 8. Intermodulation Distortion Products versus Tone Spacing

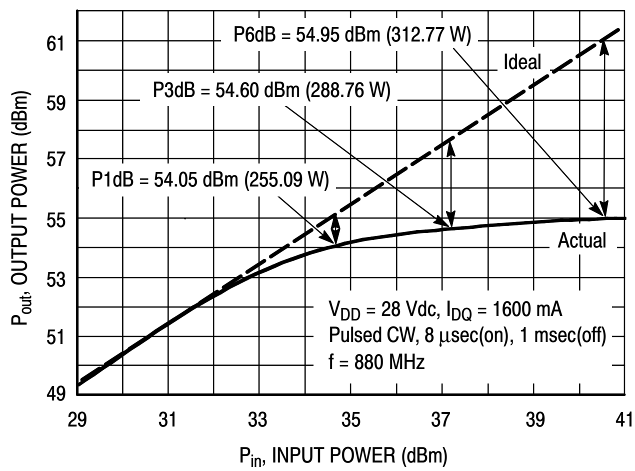


Figure 9. Pulse CW Output Power versus Input Power

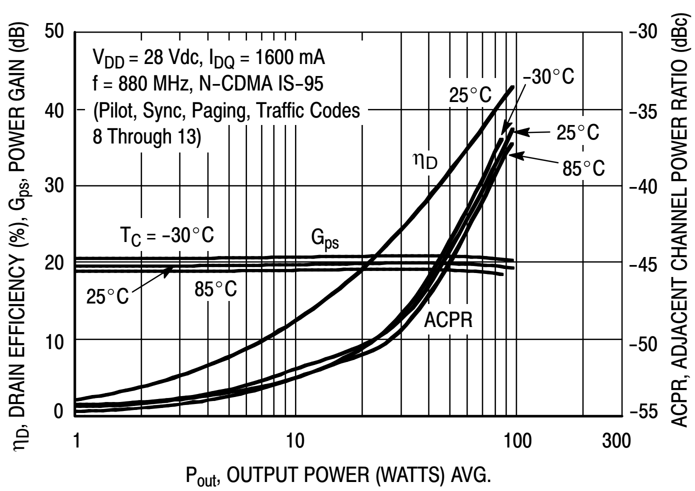


Figure 10. Single-Carrier N-CDMA ACPR, Power Gain and Drain Efficiency versus Output Power

TYPICAL CHARACTERISTICS

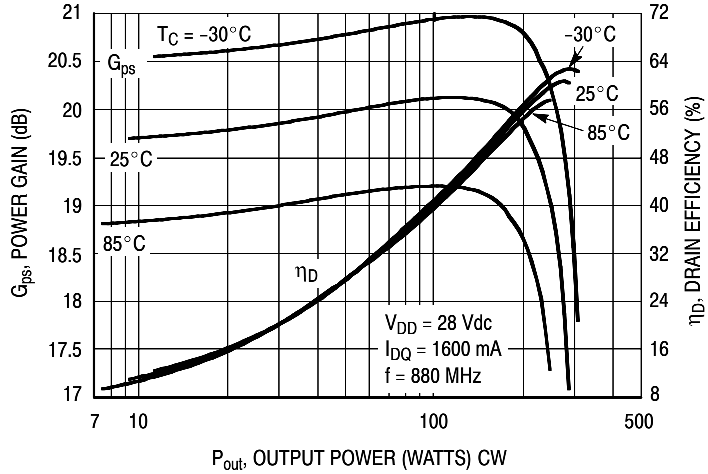


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

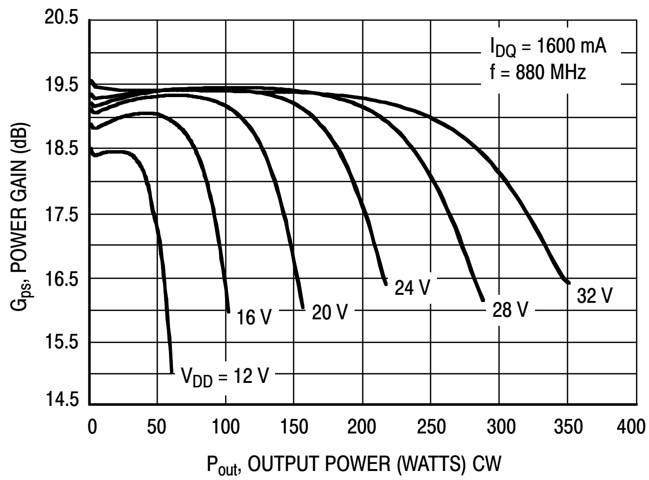
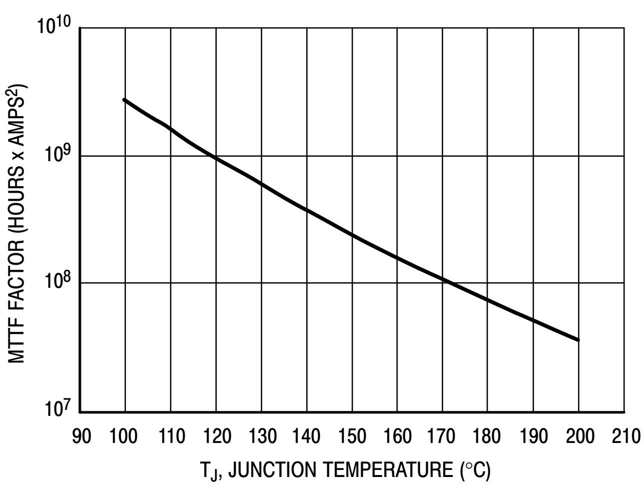


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours x $ampere^2$ 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

N-CDMA TEST SIGNAL

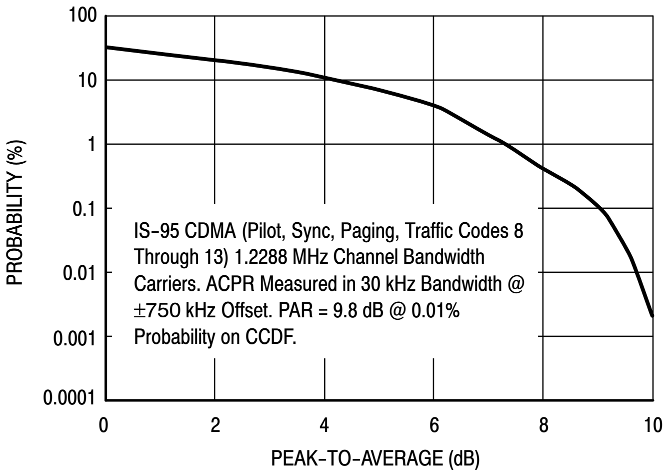


Figure 14. Single-Carrier CCDF N-CDMA

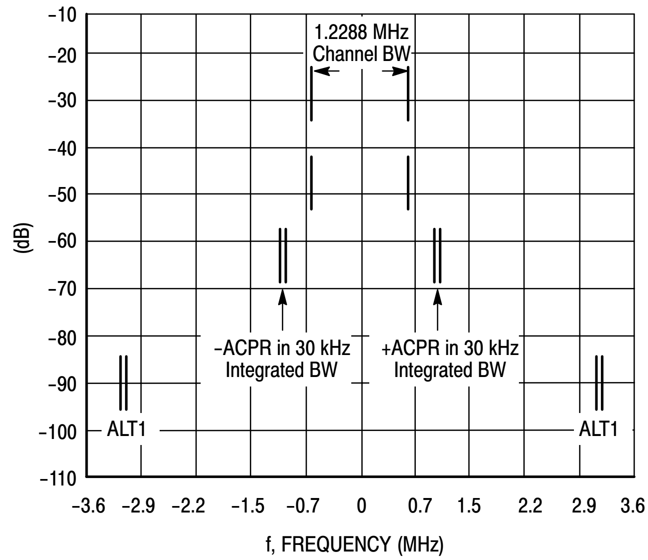
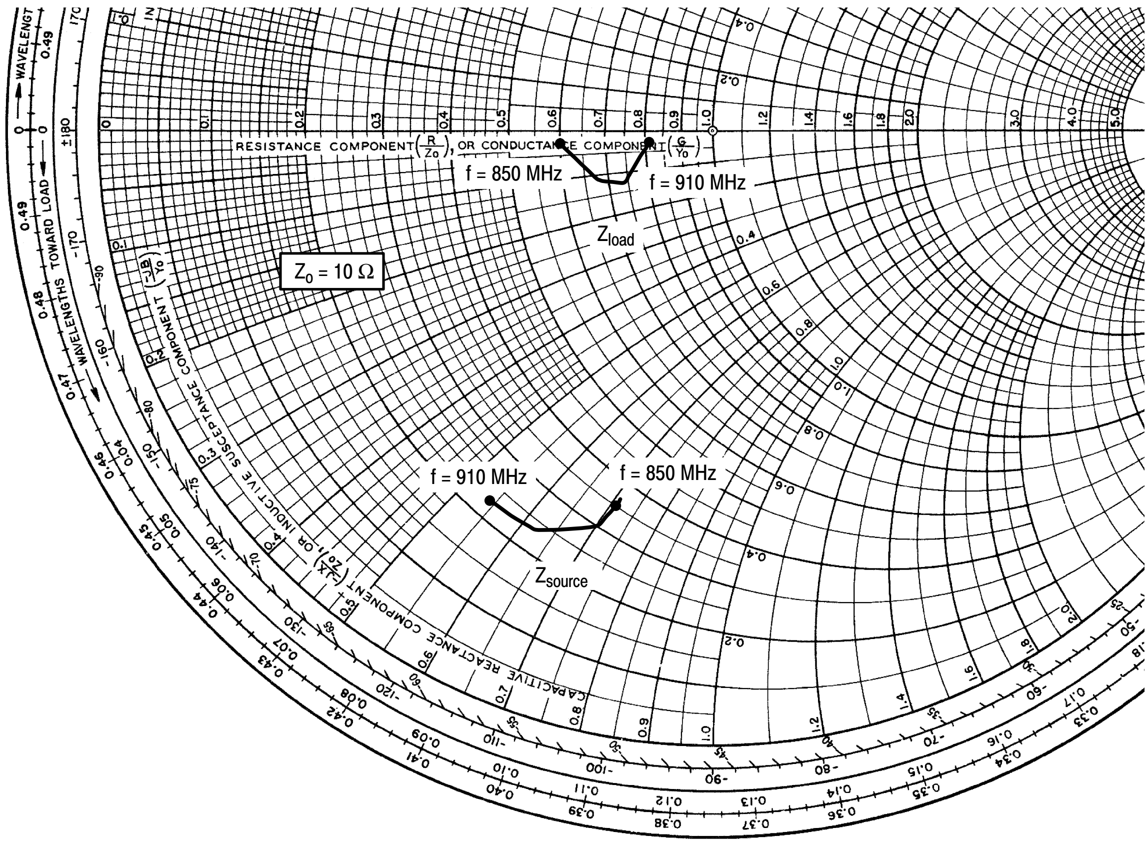


Figure 15. Single-Carrier N-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 1600 mA, P_{out} = 47 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
850	3.50 - j7.10	6.04 - j0.49
865	3.59 - j7.07	6.83 - j1.14
880	3.03 - j6.98	7.41 - j1.19
895	2.42 - j6.20	7.60 - j0.98
910	2.26 - j5.39	8.06 - j0.45

Z_{source} = Test circuit impedance as measured from gate to gate, balanced configuration.

Z_{load} = Test circuit impedance as measured from drain to drain, balanced configuration.

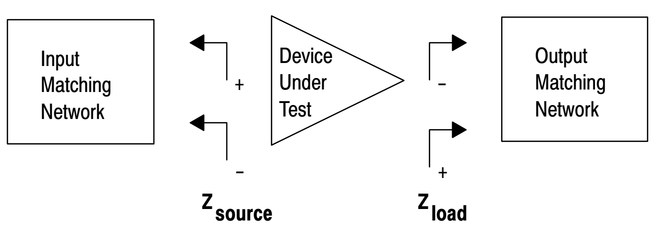
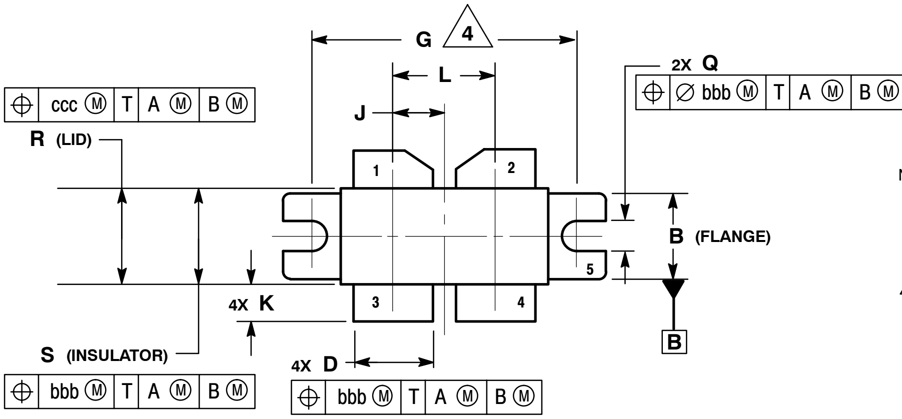
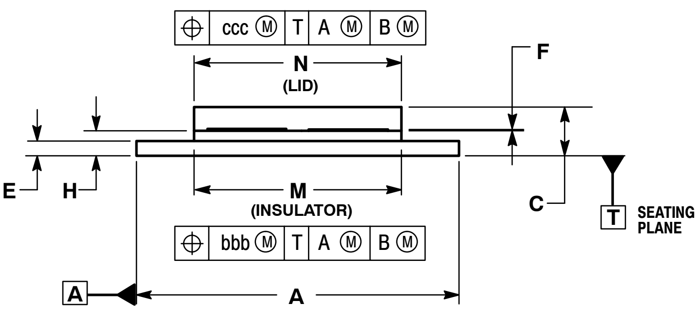


Figure 16. Series Equivalent Source and Load Impedance

NOTES

PACKAGE DIMENSIONS





NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.
3. DIMENSION H TO BE MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.140 (28.96) BASED ON 3M SCREW.

	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	0.180	0.224	4.57	5.69
D	0.325	0.335	8.26	8.51
E	0.060	0.070	1.52	1.78
F	0.004	0.006	0.10	0.15
G	1.100 BSC		27.94 BSC	
H	0.097	0.107	2.46	2.72
J	0.2125 BSC		5.397 BSC	
K	0.135	0.165	3.43	4.19
L	0.425 BSC		10.8 BSC	
M	0.852	0.868	21.64	22.05
N	0.851	0.869	21.62	22.07
Q	0.118	0.138	3.00	3.30
R	0.395	0.405	10.03	10.29
S	0.394	0.406	10.01	10.31
bbb	0.010 REF		0.25 REF	
ccc	0.015 REF		0.38 REF	

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

CASE 375G-04
ISSUE G
NI-860C3

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