



# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

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.

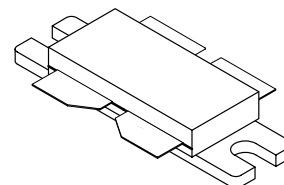
- Typical Single-Carrier N-CDMA Performance @ 880 MHz:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1600$  mA,  $P_{out} = 47$  Watts Avg., IS-95 CDMA (Pilot, Sync, Paging, Traffic Codes 8 Through 13). Channel Bandwidth = 1.2288 MHz. PAR = 9.8 dB @ 0.01% Probability on CCDF.  
 Power Gain — 20 dB  
 Drain Efficiency — 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

### Features

- 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, 40 $\mu$ " Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6P9220HR3**

**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 @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	700 4	W W/ $^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
Case Operating Temperature	$T_C$	150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value <sup>(1,2)</sup>	Unit
Thermal Resistance, Junction to Case Case Temperature $80^\circ\text{C}$ , 220 W CW Case Temperature $76^\circ\text{C}$ , 47 W CW	$R_{\theta JC}$	0.25 0.28	$^\circ\text{C}/\text{W}$

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.

**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** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b> <sup>(1)</sup>					
Zero Gate Voltage Drain Leakage Current <sup>(4)</sup> ( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current <sup>(4)</sup> ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics</b>					
Gate Threshold Voltage <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 350\ \mu\text{Adc}$ )	$V_{GS(th)}$	1	2.2	3	Vdc
Gate Quiescent Voltage <sup>(3)</sup> ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1600\text{ mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage <sup>(1)</sup> ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.4\text{ Adc}$ )	$V_{DS(on)}$	0.1	0.22	0.3	Vdc
Forward Transconductance <sup>(1)</sup> ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2.4\text{ Adc}$ )	$g_{fs}$	—	7.4	—	S
<b>Dynamic Characteristics</b> <sup>(1,2)</sup>					
Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	2.1	—	pF

**Functional Tests** <sup>(3)</sup> (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1600\text{ mA}$ ,  $P_{out} = 47\text{ W Avg}$ . N-CDMA,  $f = 880\text{ MHz}$ , Single-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carrier. ACPR measured in 30 kHz Channel Bandwidth @  $\pm 750\text{ kHz}$  Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	18.5	20	23	dB
Drain Efficiency	$\eta_D$	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.
4. Drains are tied together internally as this is a total device value.

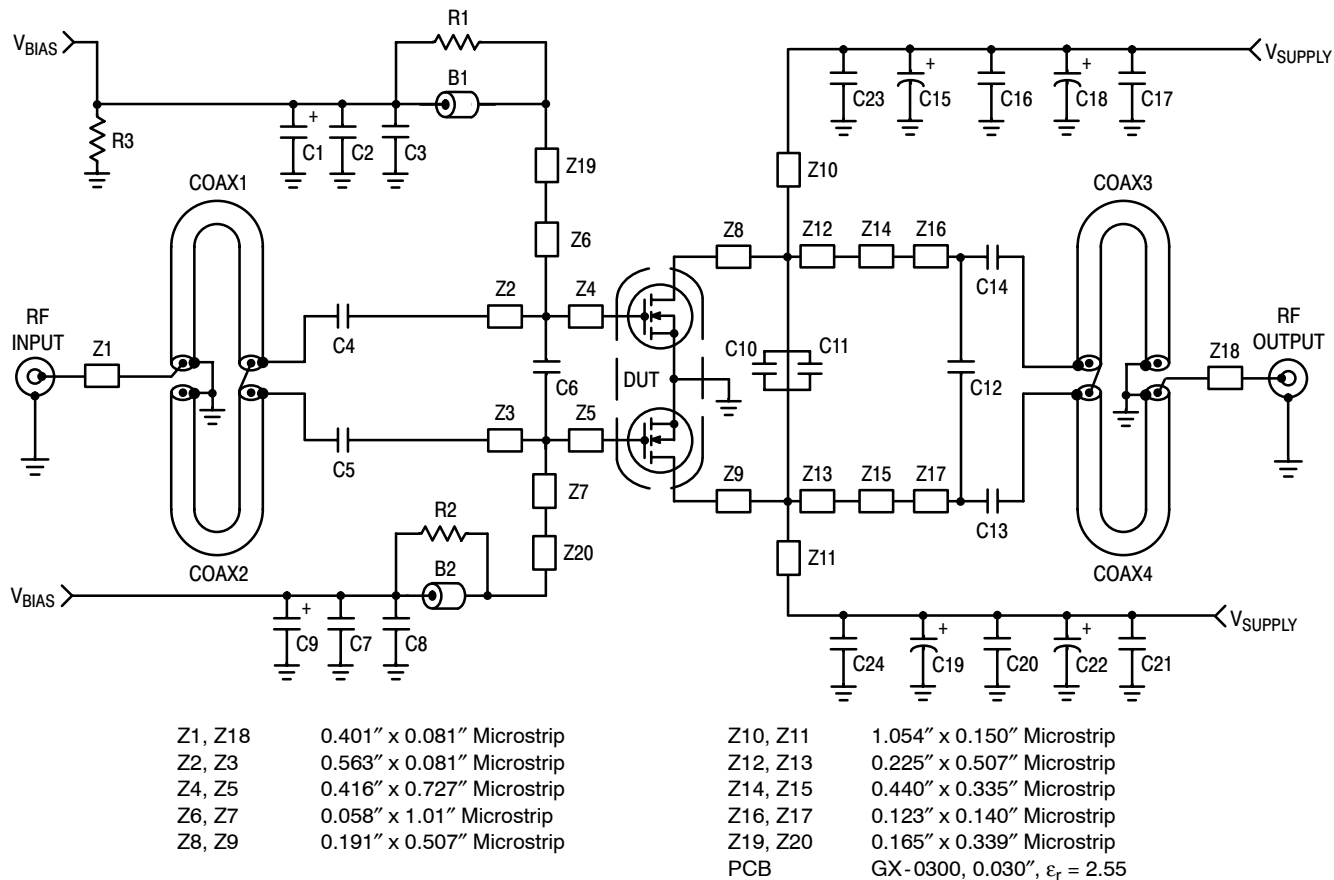


Figure 1. MRF6P9220HR3 Test Circuit Schematic

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 $\mu$ F, 50 V Tantalum Chip Capacitors	T491C105K050AS	Kemet
C2, C7, C17, C21	0.1 $\mu$ F 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 $\mu$ F, 50 V Electrolytic Capacitors	MVK50VC47RM8X10TP	Nippon
C18, C22	470 $\mu$ F, 63 V Electrolytic Capacitors	SME63V471M12X25LL	United Chemi-Con
C23, C24	22 pF 600B Chip Capacitors	600B220FT250XT	ATC
Coax1, 2, 3, 4	50 $\Omega$ , Semi Rigid Coax, 2.40" Long	UT-141A-TP	Micro-Coax
R1, R2	10 $\Omega$ , 1/8 W Chip Resistors (1206)		
R3	1.0 k $\Omega$ , 1/8 W Chip Resistor (1206)		

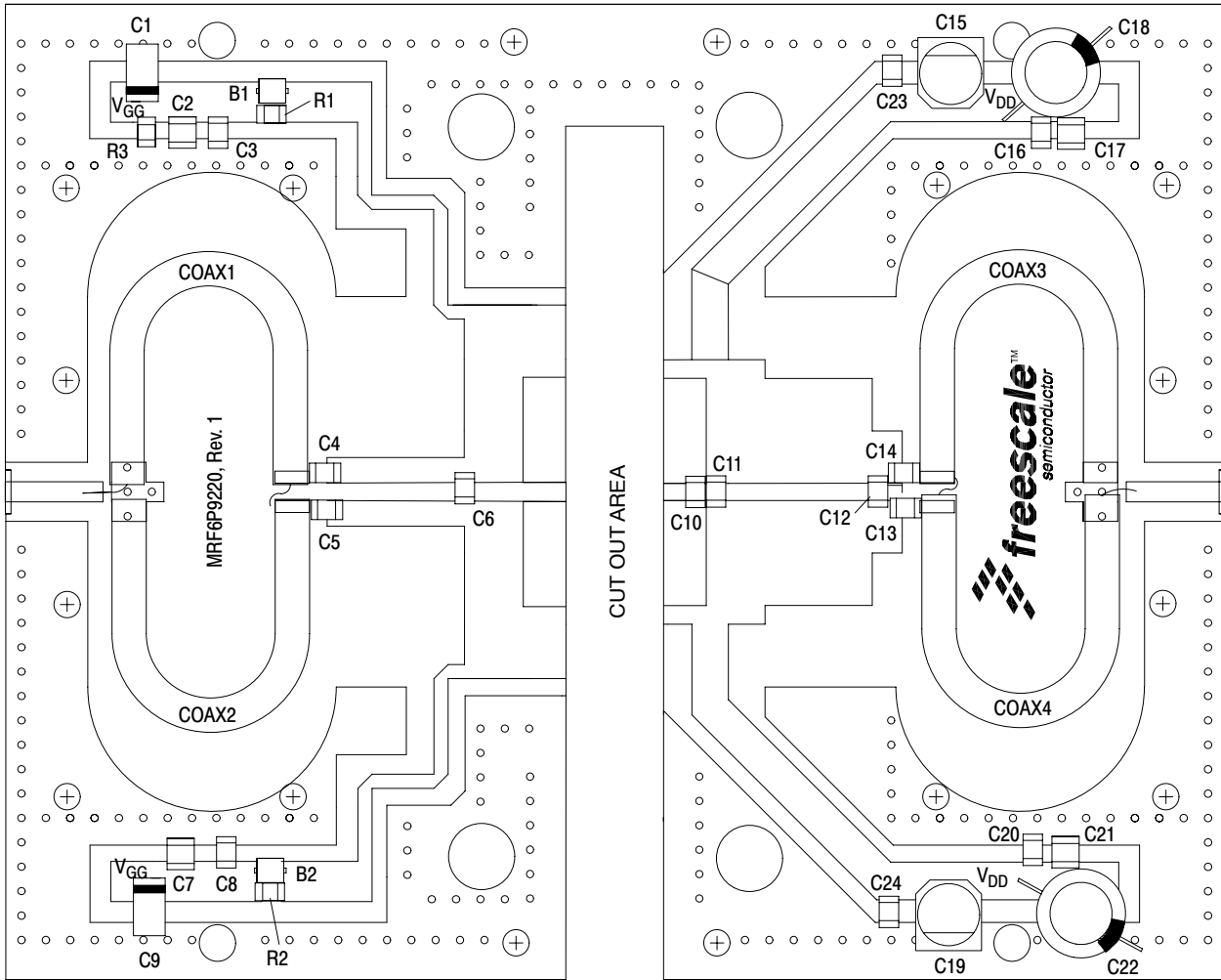
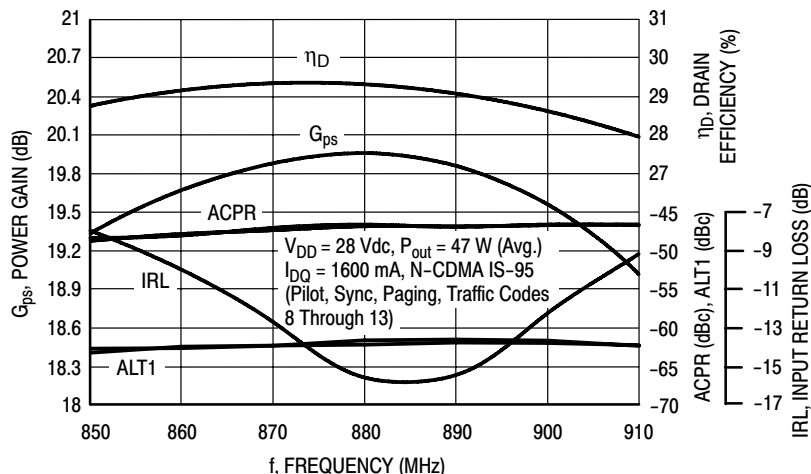
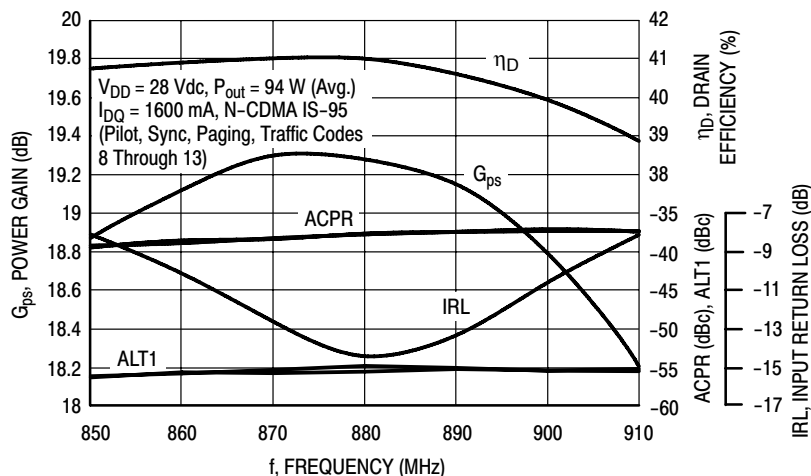


Figure 2. MRF6P9220HR3 Test Circuit Component Layout

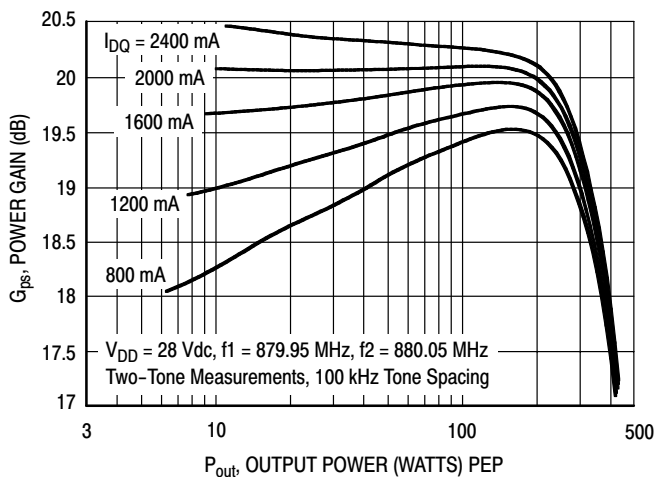
## TYPICAL CHARACTERISTICS



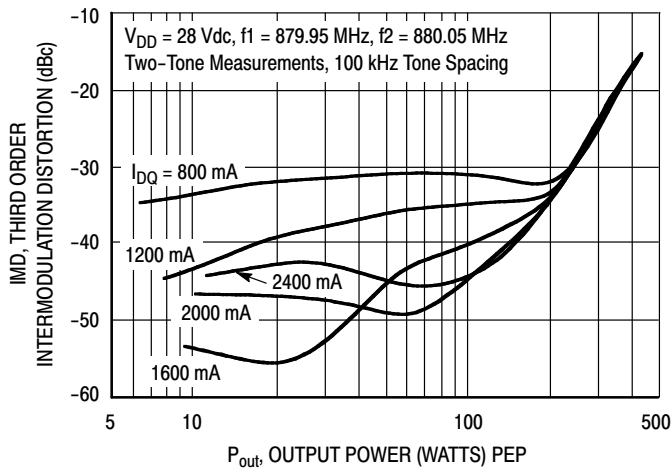
**Figure 3. Single-Carrier N-CDMA Broadband Performance @  $P_{out} = 47$  Watts Avg.**



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

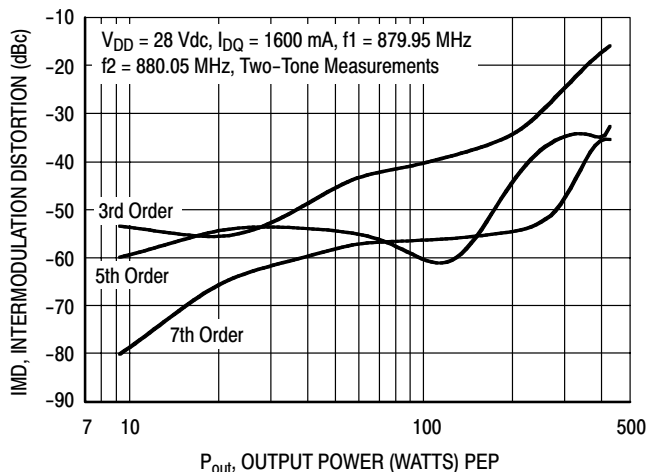


**Figure 5. Two-Tone Power Gain versus Output Power**

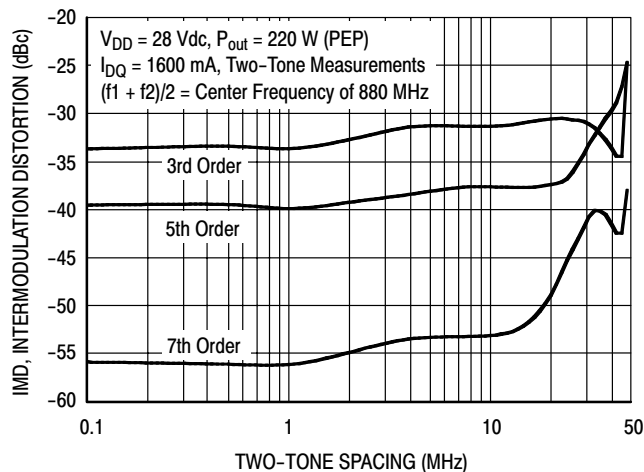


**Figure 6. Third Order Intermodulation Distortion versus Output Power**

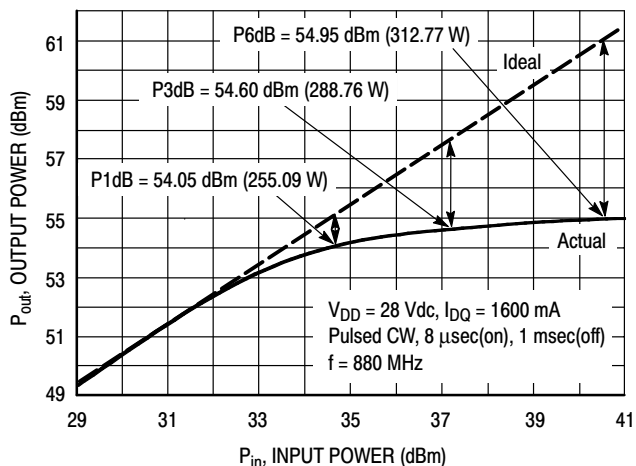
## TYPICAL CHARACTERISTICS



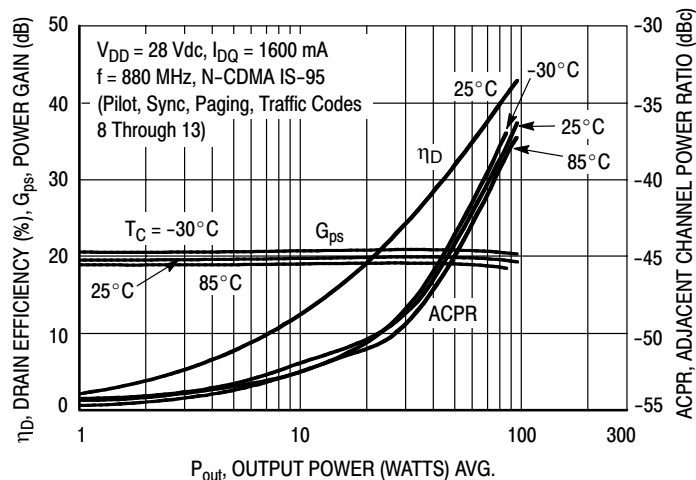
**Figure 7. Intermodulation Distortion Products versus Output Power**



**Figure 8. Intermodulation Distortion Products versus Tone Spacing**

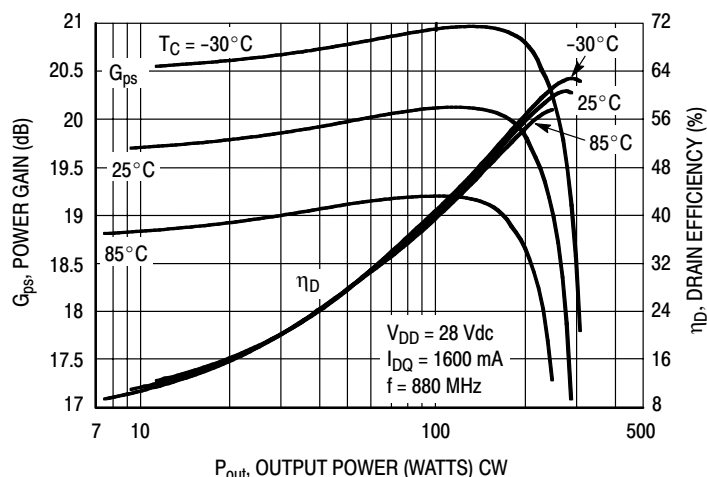


**Figure 9. Pulse CW Output Power versus Input Power**

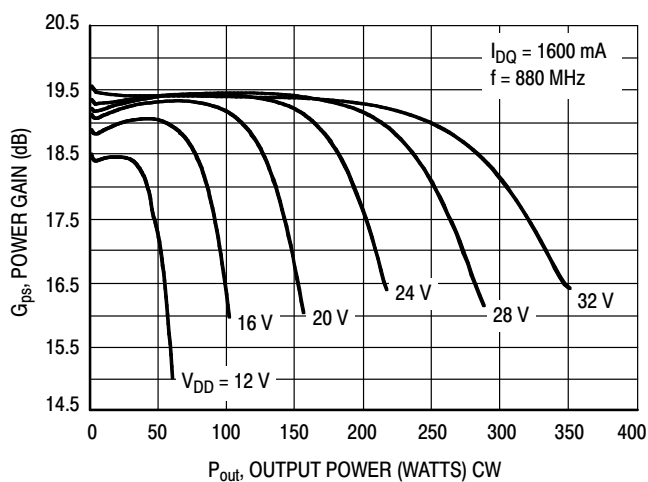


**Figure 10. Single-Carrier N-CDMA ACPR, Power Gain and Drain Efficiency versus Output Power**

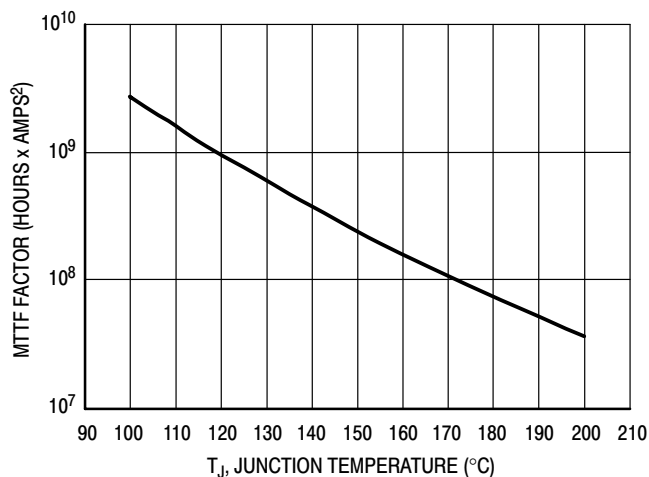
### TYPICAL CHARACTERISTICS



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



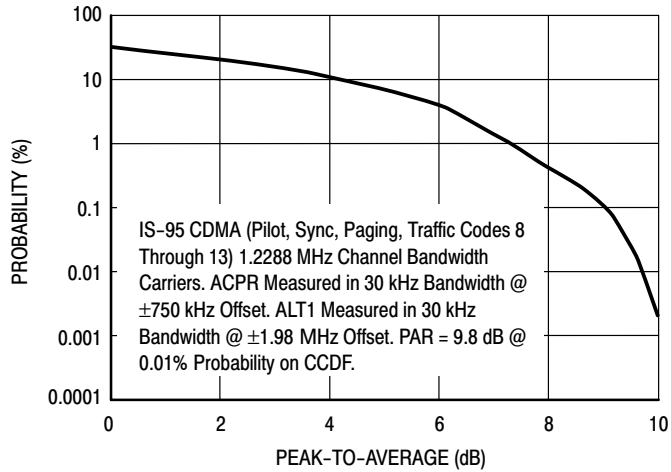
**Figure 12. Power Gain versus Output Power**



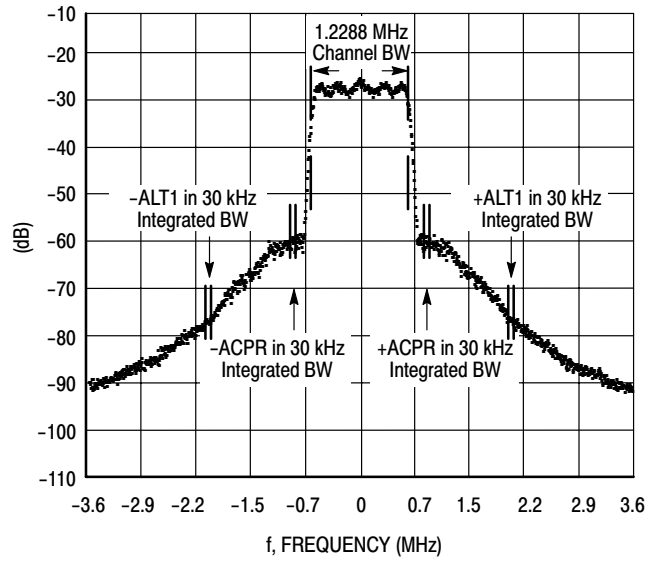
This above graph displays calculated MTTF in hours  $\times$  ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

**Figure 13. MTTF Factor versus Junction Temperature**

## N-CDMA TEST SIGNAL

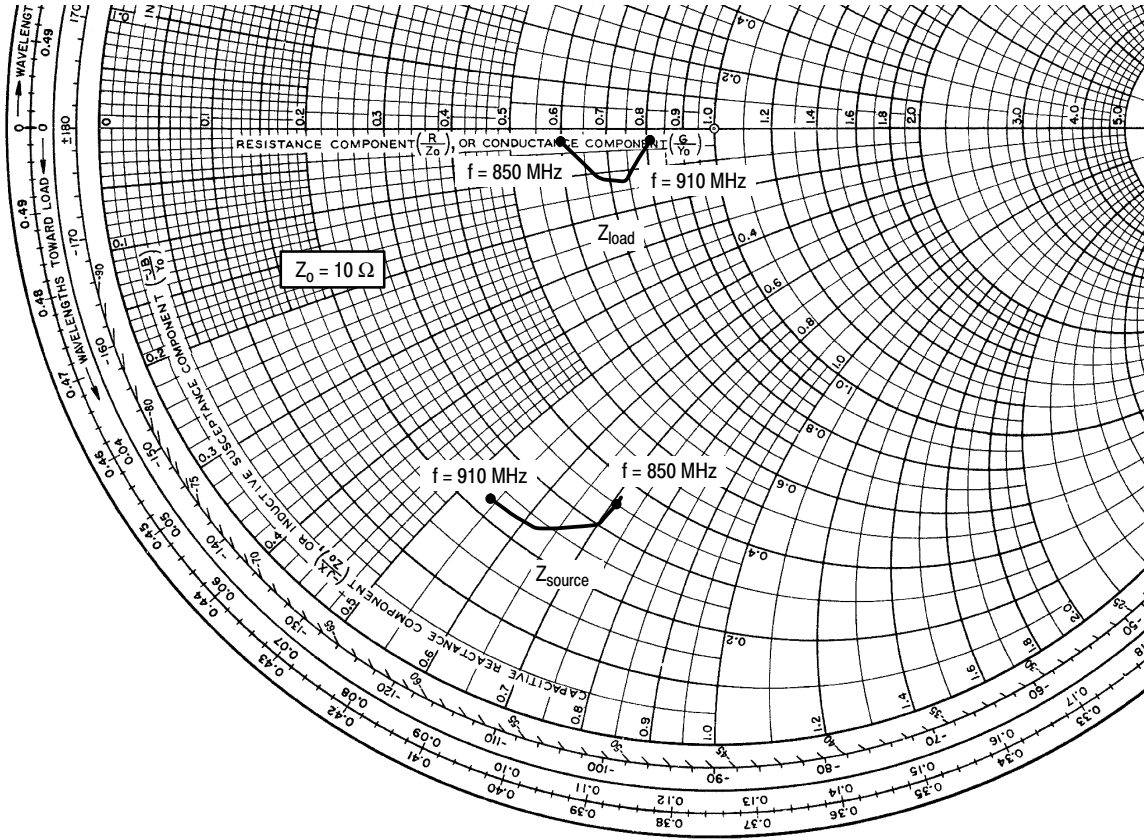


**Figure 14. Single-Carrier CCDF N-CDMA**



**Figure 15. Single-Carrier N-CDMA Spectrum**





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

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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.

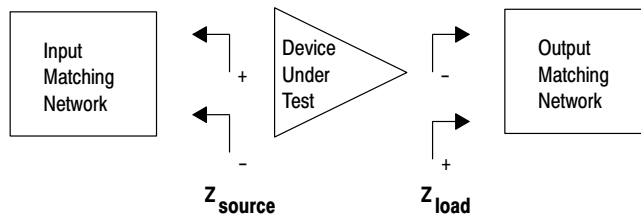
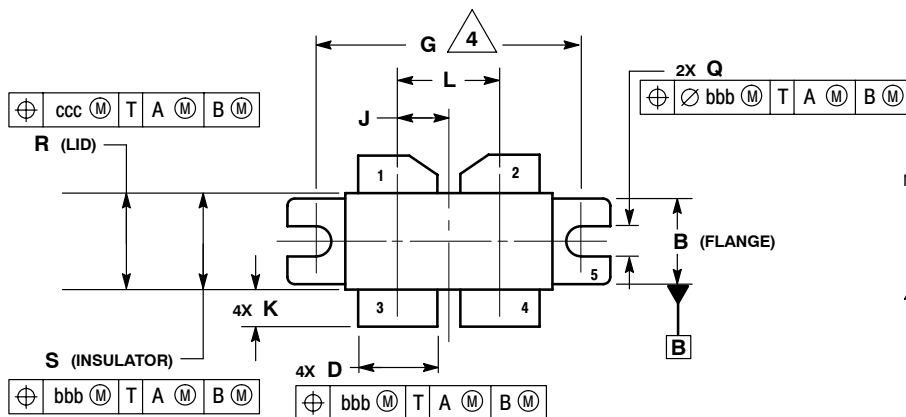


Figure 16. Series Equivalent Source and Load Impedance



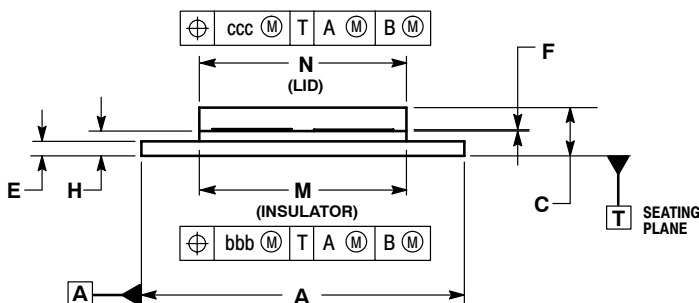
# NOTES

# 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.

DIM	INCHES		MILLIMETERS	
	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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