

The RF Sub-Micron MOSFET Line

RF Power Field Effect Transistor

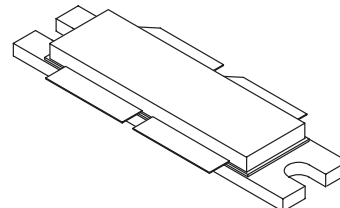
N-Channel Enhancement-Mode Lateral MOSFET

Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

- Typical 2-carrier W-CDMA Performance for $V_{DD} = 28$ Volts,
 $I_{DQ} = 2 \times 800$ mA, $f_1 = 2135$ MHz, $f_2 = 2145$ MHz,
Channel Bandwidth = 3.84 MHz, Adjacent Channels Measured over
3.84 MHz BW @ $f_1 - 5$ MHz and $f_2 + 5$ MHz. Distortion Products
Measured over a 3.84 MHz BW @ $f_1 - 10$ MHz and $f_2 + 10$ MHz,
Each Carrier Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.
Output Power — 38 Watts Avg.
Power Gain — 14 dB
Efficiency — 25.5%
IM3 — 37.5 dBc
ACPR — -41 dBc
- Internally Matched, Controlled Q, 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, @ 28 Vdc, 2140 MHz, 180 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Qualified Up to a Maximum of 32 V_{DD} Operation

MRF5P21180

**2170 MHz, 38 W AVG.,
2 x W-CDMA, 28 V
LATERAL N-CHANNEL
RF POWER MOSFET**



**CASE 375D-04, STYLE 1
NI-1230**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +15	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	437.5 2.5	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C , 180 W CW Case Temperature 80°C , 38 W CW	$R_{\theta JC}$	0.43 0.47	$^\circ\text{C}/\text{W}$

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

ESD PROTECTION CHARACTERISTICS

Test Conditions	Class
Human Body Model	2 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C7 (Minimum)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (1)

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} = 28 Vdc, V _{GS} = 0)	I _{DSS}	—	—	1	μAdc
Gate–Source Leakage Current (V _{GS} = 5 Vdc, V _{DS} = 0 Vdc)	I _{GSS}	—	—	1	μAdc

ON CHARACTERISTICS (1)

Gate Threshold Voltage (V _{DS} = 10 Vdc, I _D = 200 μAdc)	V _{GS(th)}	2.5	2.8	3.5	Vdc
Gate Quiescent Voltage (V _{DS} = 28 Vdc, I _D = 800 mAdc)	V _{GS(Q)}	—	3.6	—	Vdc
Drain–Source On–Voltage (V _{GS} = 10 Vdc, I _D = 2 Adc)	V _{DS(on)}	—	0.26	0.3	Vdc
Forward Transconductance (V _{DS} = 10 Vdc, I _D = 2 Adc)	g _{fs}	—	5	—	S

DYNAMIC CHARACTERISTICS (1)

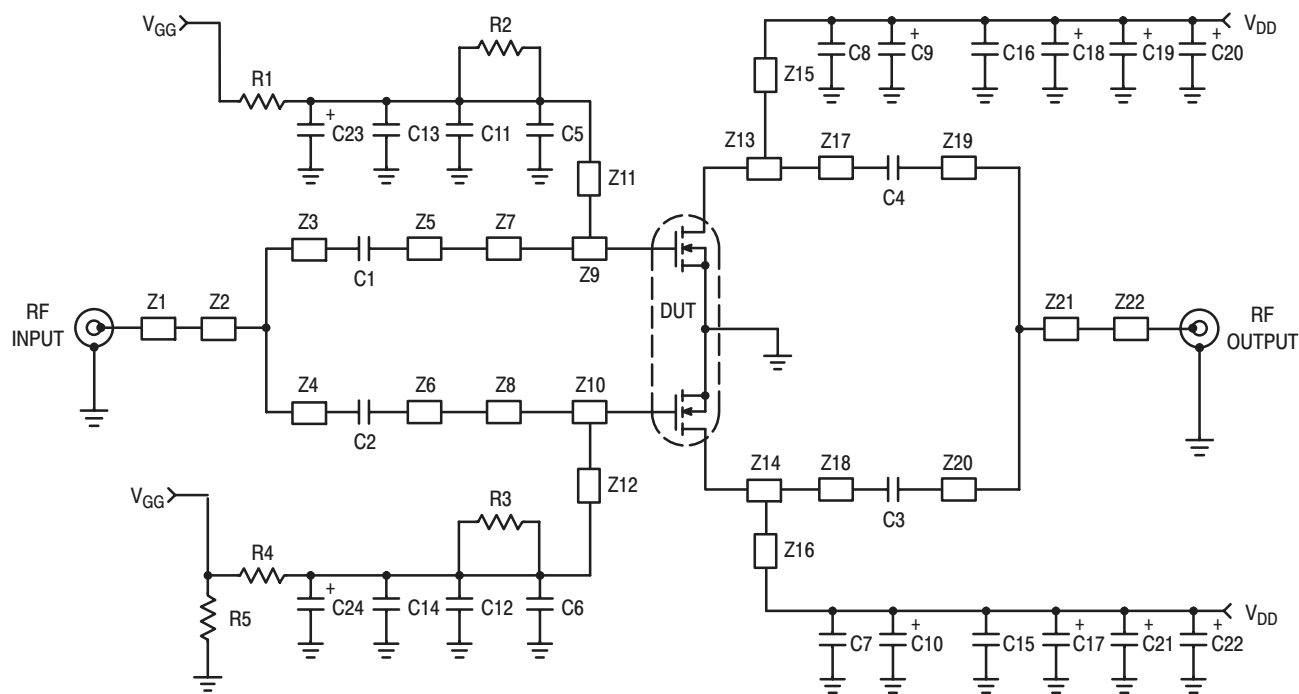
Reverse Transfer Capacitance (V _{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V _{GS} = 0 Vdc)	C _{rss}	—	1.7	—	pF
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FUNCTIONAL TESTS (In Motorola Test Fixture, 50 ohm system) (2) 2–carrier W–CDMA, 3.84 MHz Channel Bandwidth Carriers, ACPR and IM3 measured in 3.84 MHz Bandwidth. Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.

Common–Source Amplifier Power Gain (V _{DD} = 28 Vdc, P _{out} = 38 W Avg., I _{DQ} = 2 x 800 mA, f ₁ = 2112.5 MHz, f ₂ = 2122.5 MHz and f ₁ = 2157.5 MHz, f ₂ = 2167.5 MHz)	G _{ps}	12.5	14	—	dB
Drain Efficiency (V _{DD} = 28 Vdc, P _{out} = 38 W Avg., I _{DQ} = 2 x 800 mA, f ₁ = 2112.5 MHz, f ₂ = 2122.5 MHz and f ₁ = 2157.5 MHz, f ₂ = 2167.5 MHz)	η	23	25.5	—	%
Third Order Intermodulation Distortion (V _{DD} = 28 Vdc, P _{out} = 38 W Avg., I _{DQ} = 2 x 800 mA, f ₁ = 2112.5 MHz, f ₂ = 2122.5 MHz and f ₁ = 2157.5 MHz, f ₂ = 2167.5 MHz; IM3 measured over 3.84 MHz BW @ f ₁ –10 MHz and f ₂ +10 MHz referenced to carrier channel power.)	IM3	—	–37.5	–35	dBc
Adjacent Channel Power Ratio (V _{DD} = 28 Vdc, P _{out} = 38 W Avg., I _{DQ} = 2 x 800 mA, f ₁ = 2112.5 MHz, f ₂ = 2122.5 MHz and f ₁ = 2157.5 MHz, f ₂ = 2167.5 MHz; ACPR measured over 3.84 MHz BW @ f ₁ –5 MHz and f ₂ +5 MHz.)	ACPR	—	–41	–38	dBc
Input Return Loss (V _{DD} = 28 Vdc, P _{out} = 38 W Avg., I _{DQ} = 2 x 800 mA, f ₁ = 2112.5 MHz, f ₂ = 2122.5 MHz and f ₁ = 2157.5 MHz, f ₂ = 2167.5 MHz)	IRL	—	–14	–9	dB

(1) Each side of device measured separately. Part is internally matched both on input and output.

(2) Measurements made with device in push–pull configuration.



Z1, Z22	1.000" x 0.066" Microstrip	Z9, Z10	0.256" x 0.650" Microstrip
Z2, Z21	0.760" x 0.113" Microstrip	Z11, Z12	1.030" x 0.035" Microstrip
Z3, Z20	0.068" x 0.066" Microstrip	Z13, Z14	0.500" x 0.650" Microstrip
Z4, Z19	1.672" x 0.066" Microstrip	Z15, Z16	0.550" x 0.058" Microstrip
Z5, Z6	0.318" x 0.066" Microstrip	Z17, Z18	0.353" x 0.066" Microstrip
Z7, Z8	0.284" x 0.180" Microstrip	PCB	Taconic RF-35, 0.030", $\epsilon_r = 3.5$

Figure 1. MRF5P21180 Test Circuit Schematic

Table 1. MRF5P21180 Test Circuit Component Designations and Values

Part	Description	Value, P/N or DWG	Manufacturer
C1, C2, C3, C4	30 pF Chip Capacitors	100B300JCA500X	ATC
C5, C6, C7, C8	5.6 pF Chip Capacitors	100B5R6JCA500X	ATC
C9, C10	10 μ F Tantalum Capacitors	T495X106K035AS4394	Kemet
C11, C12	1000 pF Chip Capacitors	100B102JCA500X	ATC
C13, C14, C15, C16	0.1 μ F Chip Capacitors	CDR33BX104AKWS	Kemet
C17, C18, C19, C20, C21, C22	22 μ F Tantalum Capacitors	T491X226K035AS4394	Kemet
C23, C24	1.0 μ F Tantalum Capacitors	T491C105M050	Kemet
R1, R2, R3, R4	10 Ω , 1/8 W Chip Resistors		
R5	1.0 k Ω , 1/8 W Chip Resistor		
WB1, WB2, WB3, WB4	Wear Blocks	5 x 180 x 500 mil Brass Shim	Motorola

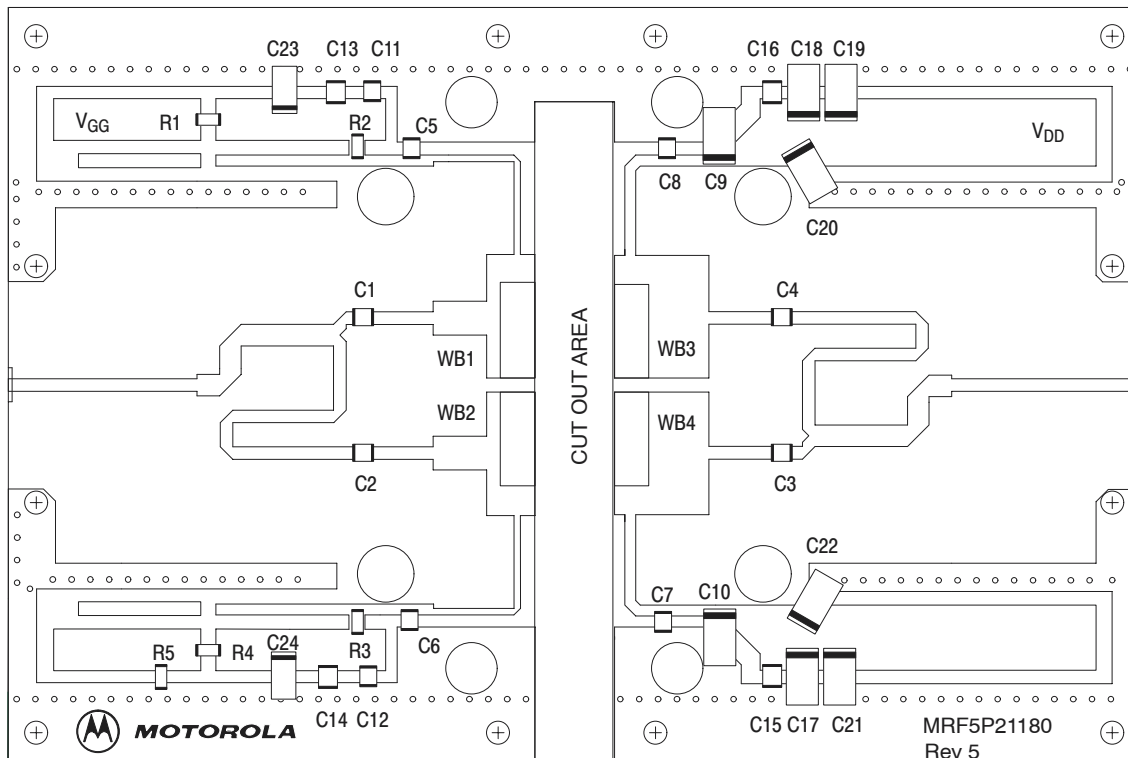


Figure 2. MRF5P21180 Test Circuit Component Layout

TYPICAL CHARACTERISTICS

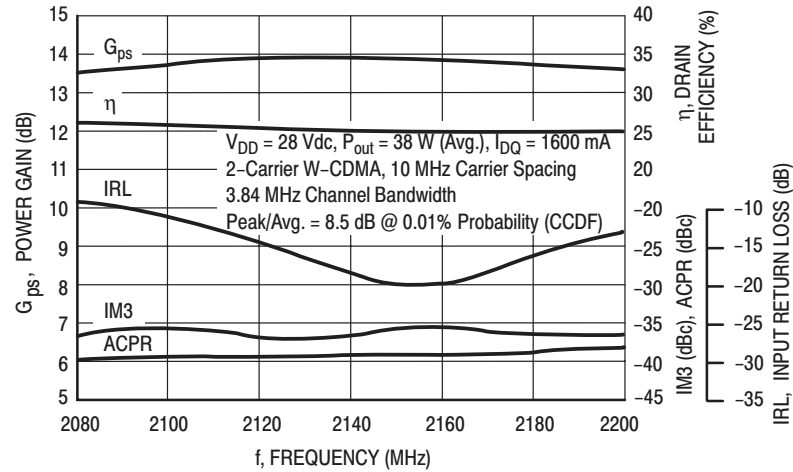


Figure 3. 2-Carrier W-CDMA Broadband Performance

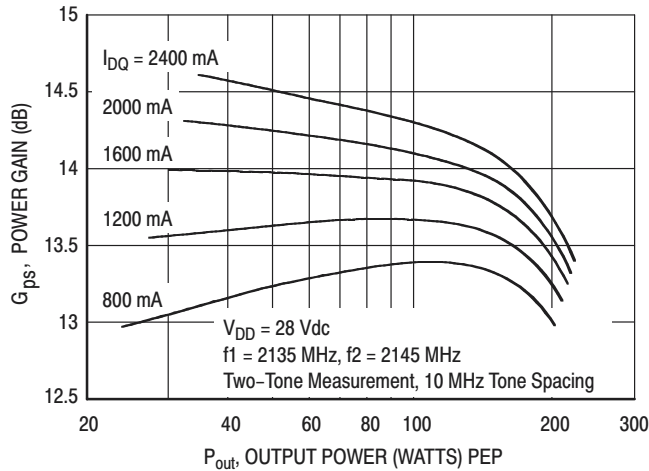


Figure 4. Two-Tone Power Gain versus Output Power

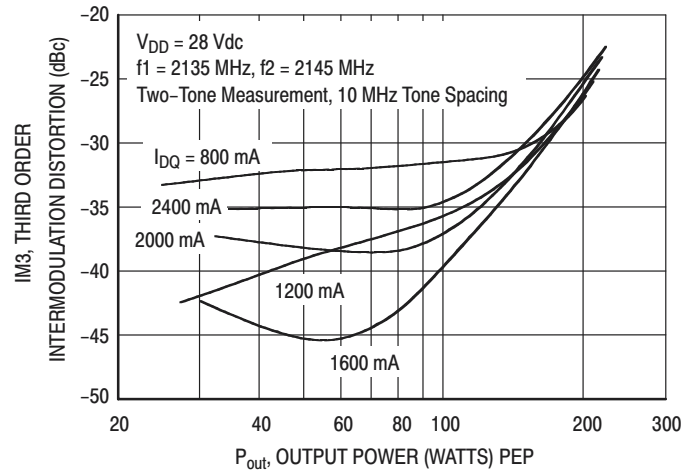


Figure 5. Third Order Intermodulation Distortion versus Output Power

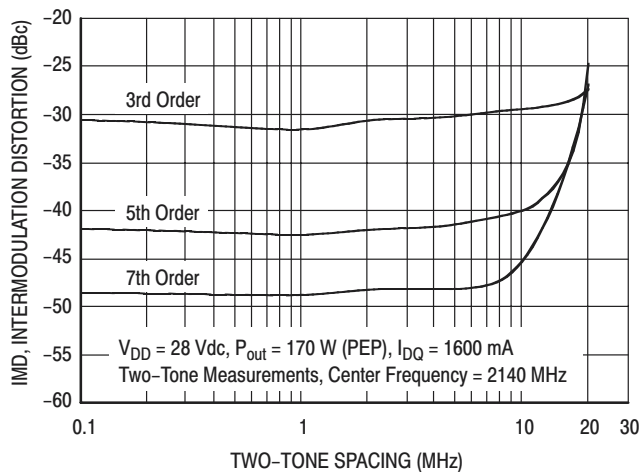


Figure 6. Intermodulation Distortion Products versus Tone Spacing

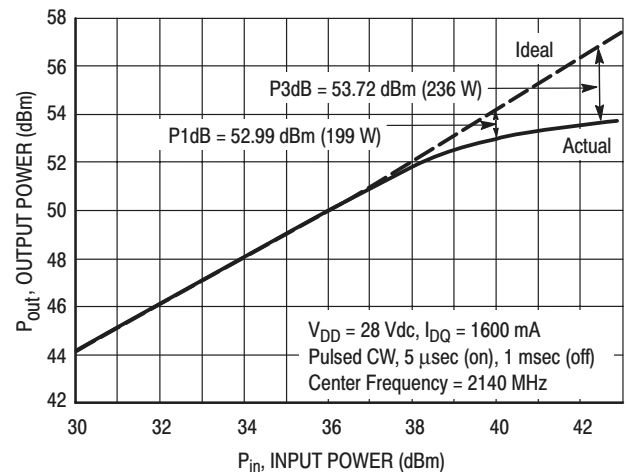


Figure 7. Pulse CW Output Power versus Input Power

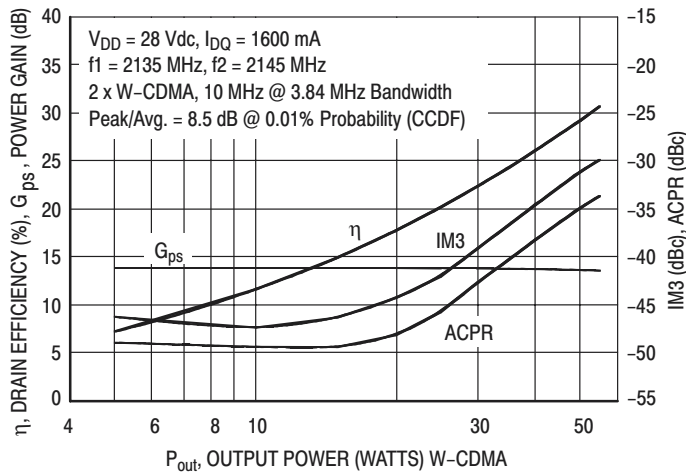


Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

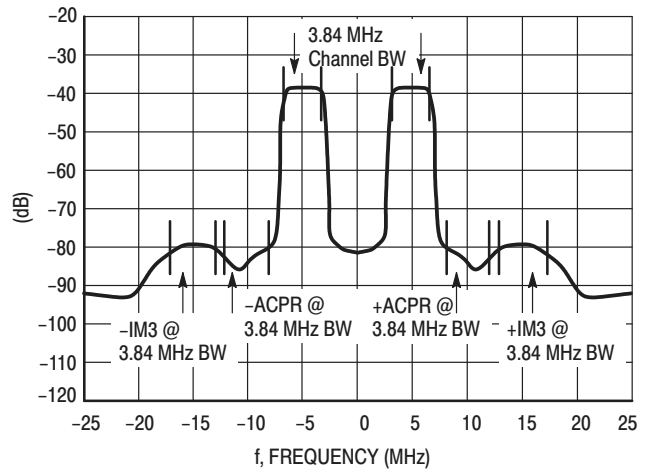


Figure 9. 2-Carrier W-CDMA Spectrum

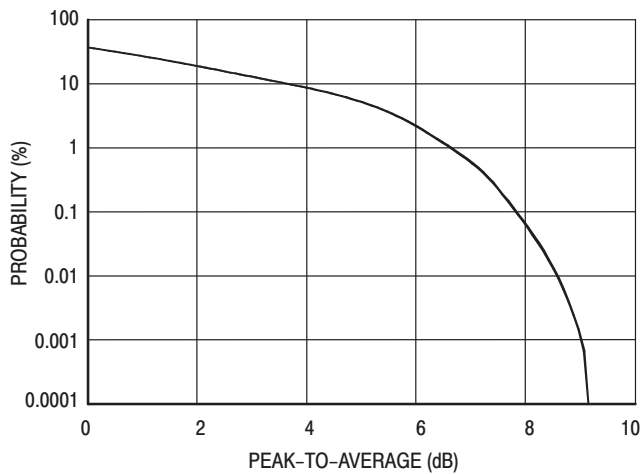
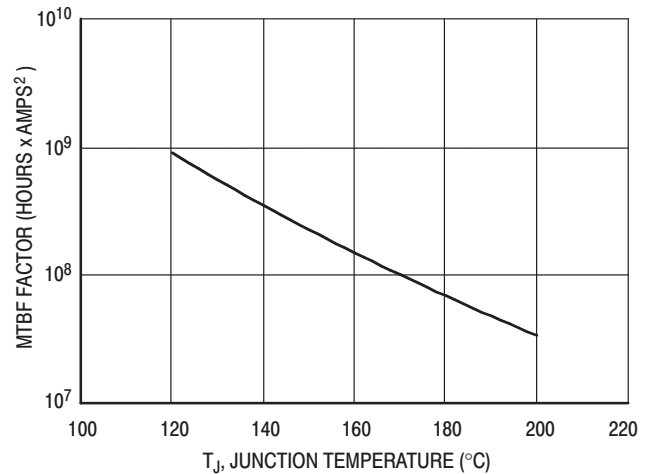
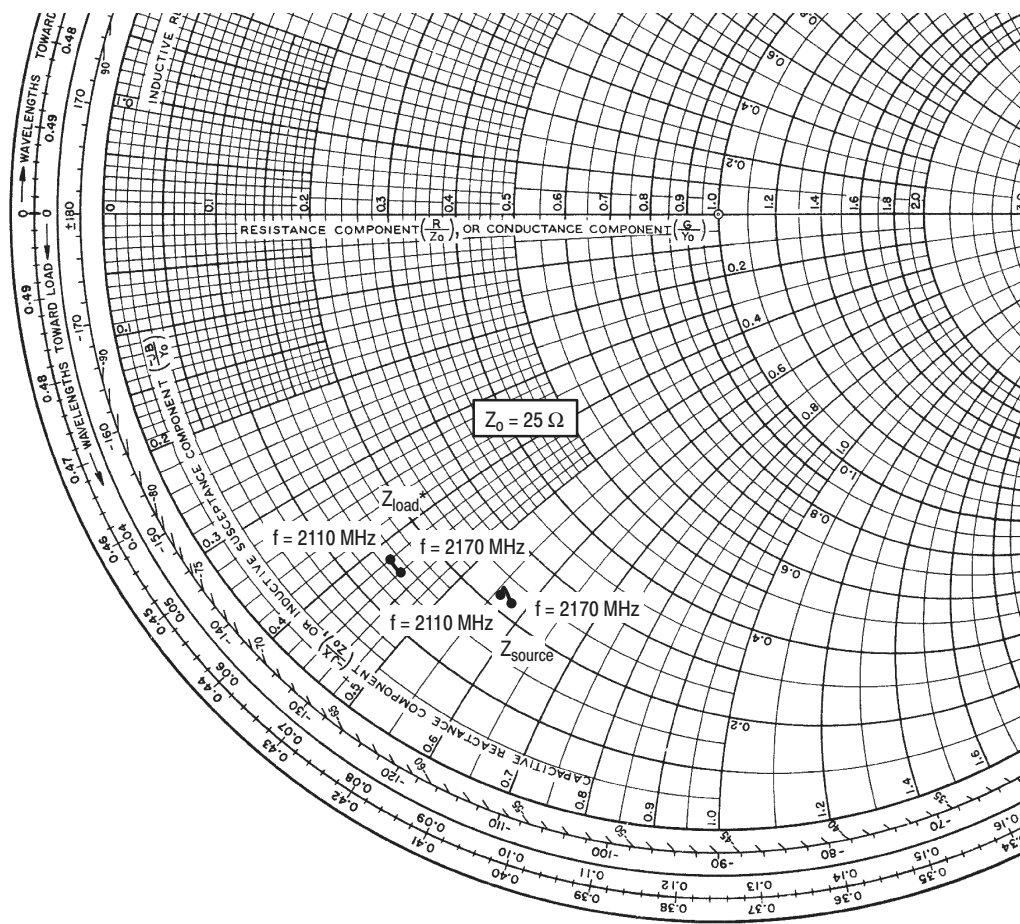


Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal



This above graph displays calculated MTBF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTBF factor by I_D^2 for MTBF in a particular application.

Figure 11. MTBF Factor versus Junction Temperature



$V_{DD} = 28 \text{ V}$, $I_{DQ} = 2 \times 800 \text{ mA}$, $P_{out} = 38 \text{ W Avg.}$

f MHz	Z_{source} Ω	Z_{load} Ω
2110	$5.39 - j13.89$	$3.69 - j10.51$
2140	$5.66 - j13.99$	$3.81 - j10.66$
2170	$5.53 - j14.51$	$3.79 - j11.05$

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.

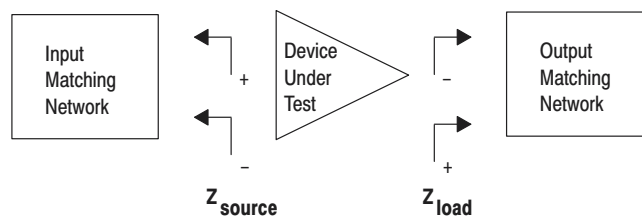
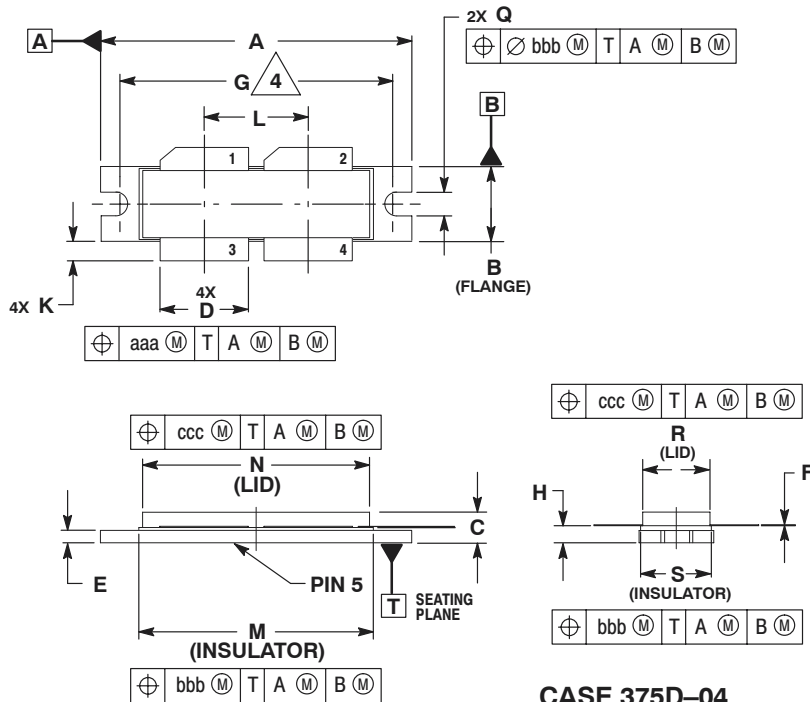


Figure 12. Series Equivalent Input and Output Impedance

PACKAGE DIMENSIONS



NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 (38.61) BASED ON M3 SCREW.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.615	1.625	41.02	41.28
B	0.395	0.405	10.03	10.29
C	0.150	0.200	3.81	5.08
D	0.455	0.465	11.56	11.81
E	0.062	0.066	1.57	1.68
F	0.004	0.007	0.10	0.18
G	1.400 BSC		35.56 BSC	
H	0.079	0.089	2.01	2.26
K	0.117	0.137	2.97	3.48
L	0.540 BSC		13.72 BSC	
M	1.219	1.241	30.96	31.52
N	1.218	1.242	30.94	31.55
Q	0.120	0.130	3.05	3.30
R	0.355	0.365	9.01	9.27
S	0.365	0.375	9.27	9.53
aaa	0.013 REF		0.33 REF	
bbb	0.010 REF		0.25 REF	
ccc	0.020 REF		0.51 REF	

STYLE 1:

- PIN 1. DRAIN
- DRAIN
- GATE
- GATE
- SOURCE

**CASE 375D-04
ISSUE C
NI-1230**

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