



**THE DATASHEET OF  
MRF21085LSR5**



# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

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.

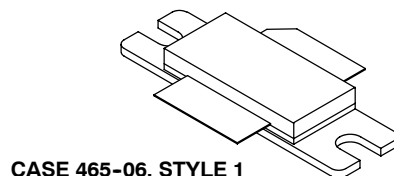
- Typical 2-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1000$  mA,  $P_{out} = 19$  Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, Peak/Avg. = 8.5 dB @ 0.01% Probability on CCDF.  
Power Gain — 13.6 dB  
Drain Efficiency — 23%  
IM3 @ 10 MHz Offset — -37.5 dBc in 3.84 MHz Channel Bandwidth  
ACPR @ 5 MHz Offset — -41 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2140 MHz, 90 Watts CW Output Power

### Features

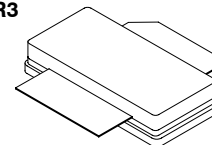
- Internally Matched for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Available with Low Gold Plating Thickness on Leads. L Suffix Indicates 40 $\mu$ " Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF21085LR3**  
**MRF21085LSR3**

**2110-2170 MHz, 90 W, 28 V**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF21085LR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF21085LSR3**

**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 @ $T_C = 25^\circ\text{C}$ Derate above 25 $^\circ\text{C}$	$P_D$	224 1.28	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	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.78	$^\circ\text{C}/\text{W}$

**Table 3. ESD Protection Characteristics**

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M3 (Minimum)

**Table 4. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Drain-Source Breakdown Voltage ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 100\ \mu\text{Adc}$ )	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics (DC)</b>					
Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 200\ \mu\text{Adc}$ )	$V_{GS(th)}$	2	—	4	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ Vdc}$ , $I_D = 1000\text{ mAdc}$ )	$V_{GS(Q)}$	3	3.9	5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2\text{ Adc}$ )	$V_{DS(on)}$	—	0.18	0.21	Vdc
<b>Dynamic Characteristics (1)</b>					
Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1.0\text{ MHz}$ )	$C_{rss}$	—	3.6	—	pF
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system) 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers, ACPR and IM3 measured in 3.84 MHz Bandwidth. Peak/Avg. = 8.3 dB @ 0.01% Probability on CCDF.					
Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 19\text{ W Avg.}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2112.5\text{ MHz}$ , $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$ , $f_2 = 2167.5\text{ MHz}$ )	$G_{ps}$	12	13.6	—	dB
Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 19\text{ W Avg.}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2112.5\text{ MHz}$ , $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$ , $f_2 = 2167.5\text{ MHz}$ )	$\eta$	20	23	—	%
Third Order Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 19\text{ W Avg.}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2112.5\text{ MHz}$ , $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$ , $f_2 = 2167.5\text{ MHz}$ ; IM3 measured over 3.84 MHz BW at $f_1 - 10\text{ MHz}$ and $f_2 + 10\text{ MHz}$ referenced to carrier channel power.)	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 19\text{ W Avg.}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2112.5\text{ MHz}$ , $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$ , $f_2 = 2167.5\text{ MHz}$ ; ACPR measured over 3.84 MHz at $f_1 - 5\text{ MHz}$ and $f_2 + 5\text{ MHz}$ .)	ACPR	—	-41	-38	dBc
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 19\text{ W Avg.}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2112.5\text{ MHz}$ , $f_2 = 2122.5\text{ MHz}$ and $f_1 = 2157.5\text{ MHz}$ , $f_2 = 2167.5\text{ MHz}$ )	IRL	—	-12	-9	dB

1. Part is internally matched both on input and output.

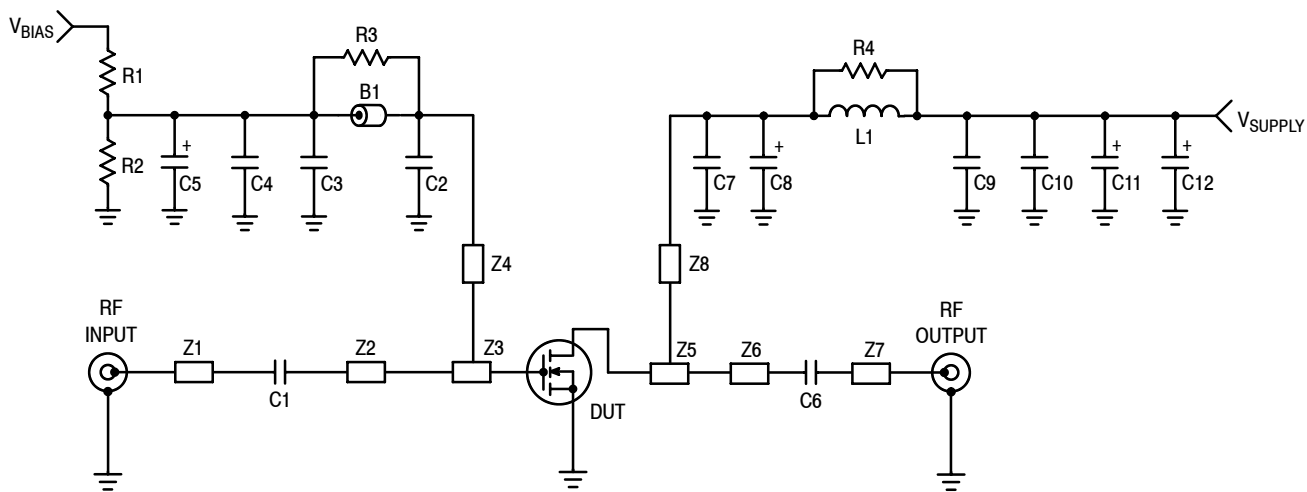
(continued)

**Table 4. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system) <b>(continued)</b>					
Two-Tone Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 90\text{ W PEP}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	$G_{ps}$	—	13.6	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 90\text{ W PEP}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	$\eta$	—	36	—	%
Two-Tone Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 90\text{ W PEP}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	IMD	—	-31	—	dBc
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 90\text{ W PEP}$ , $I_{DQ} = 1000\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	IRL	—	-12	—	dB
$P_{out}$ , 1 dB Compression Point ( $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 1000\text{ mA}$ , $f = 2170\text{ MHz}$ )	P1dB	—	100	—	W

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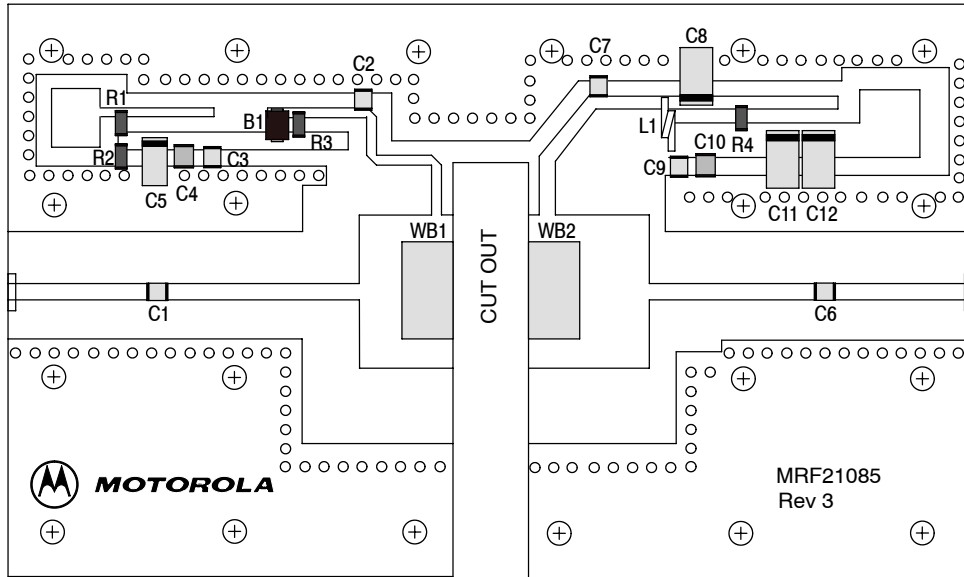


Z1	0.750" x 0.084" Microstrip	Board	0.030" Glass Teflon®, Keene GX-0300-55-22, $\epsilon_r = 2.55$
Z2	1.015" x 0.084" Microstrip	PCB	Etched Circuit Boards
Z3	0.480" x 0.800" Microstrip		MRF21085 Rev. 3, CMR
Z4	0.750" x 0.050" Microstrip		
Z5	0.610" x 0.800" Microstrip		
Z6	0.885" x 0.084" Microstrip		
Z7	0.720" x 0.084" Microstrip		
Z8	0.800" x 0.070" Microstrip		

Figure 1. MRF21085L Test Circuit Schematic

Table 5. MRF21085 Test Circuit Component Designations and Values

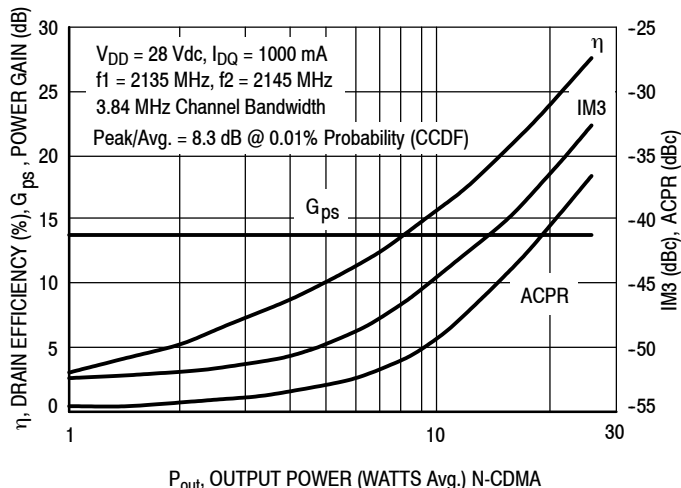
Designators	Description
B1	Short Ferrite Bead, Fair Rite, #2743019447
C1, C6	43 pF Chip Capacitors, ATC #100B430JCA500X
C2	10 pF Chip Capacitor, ATC #100B100JCA500X
C3, C9	1000 pF Chip Capacitors, ATC #100B102JCA500X
C4, C10	0.1 $\mu$ F Chip Capacitors, Kemet #CDR33BX104AKWS
C5	1.0 $\mu$ F Tantalum Chip Capacitor, Kemet #T491C105M050
C7	2.7 pF Chip Capacitor, ATC #100B2R7JCA500X
C8	10 $\mu$ F Tantalum Chip Capacitor, Kemet #T495X106K035AS4394
C11, C12	22 $\mu$ F Tantalum Chip Capacitors, Kemet #T491X226K035AS4394
L1	1 Turn, #20 AWG, 0.100" ID
N1, N2	Type N Flange Mounts, Omni Spectra #3052-1648-10
R1	1.0 k $\Omega$ , 1/8 W Chip Resistor
R2	180 k $\Omega$ , 1/8 W Chip Resistor
R3, R4	10 $\Omega$ , 1/8 W Chip Resistors



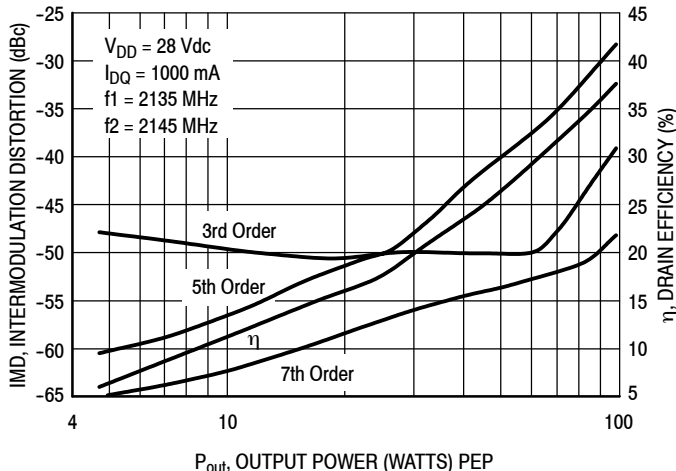
Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF21085L Test Circuit Component Layout**

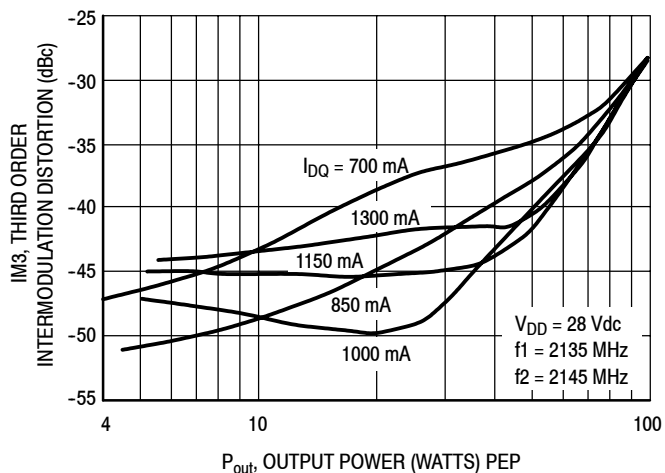
### TYPICAL CHARACTERISTICS



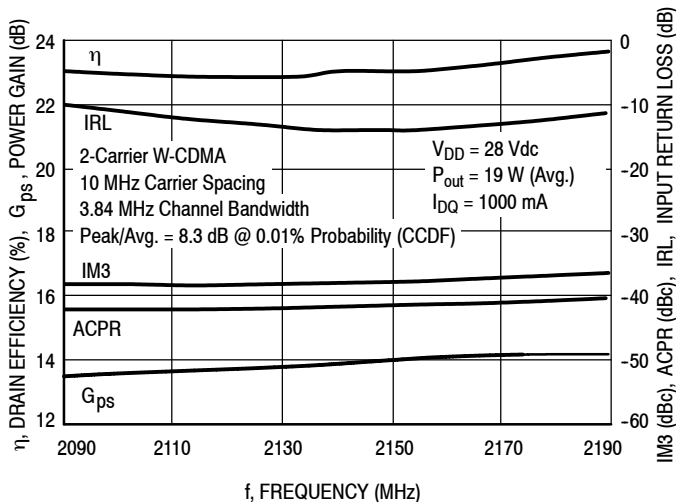
**Figure 3. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



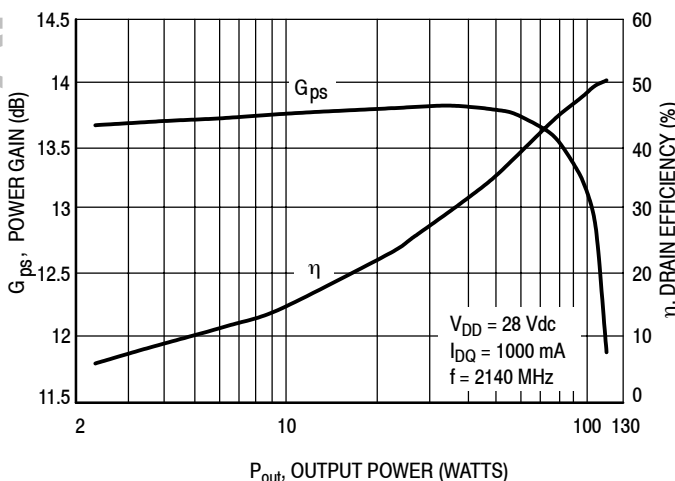
**Figure 4. Intermodulation Distortion Products versus Output Power**



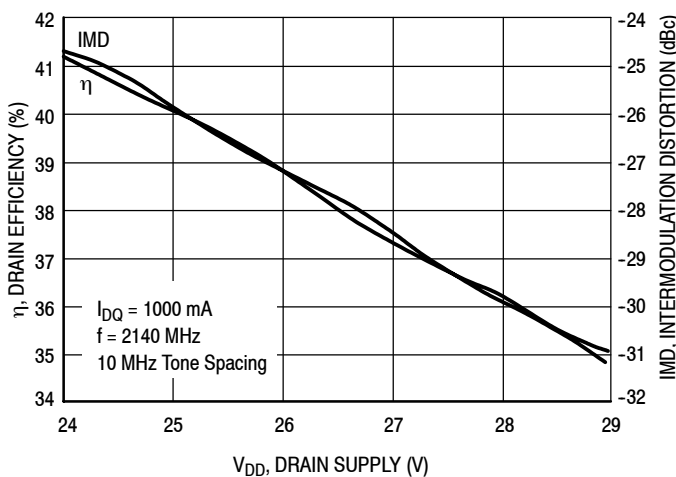
**Figure 5. Third Order Intermodulation Distortion versus Output Power**



**Figure 6. 2-Carrier W-CDMA Broadband Performance**



**Figure 7. CW Performance**

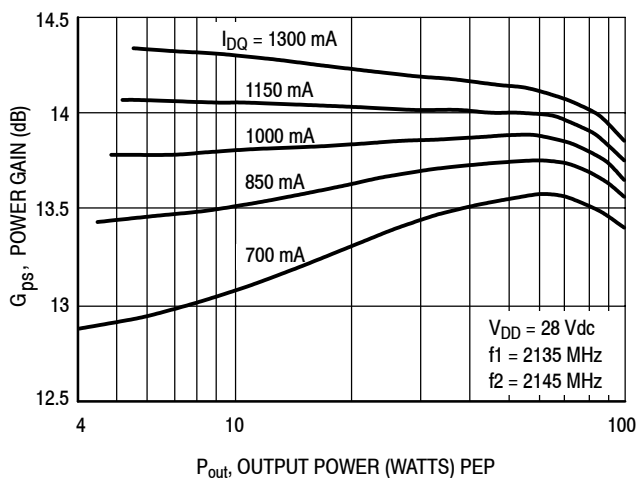


**Figure 8. Two-Tone Intermodulation Distortion and Drain Efficiency versus Drain Supply**

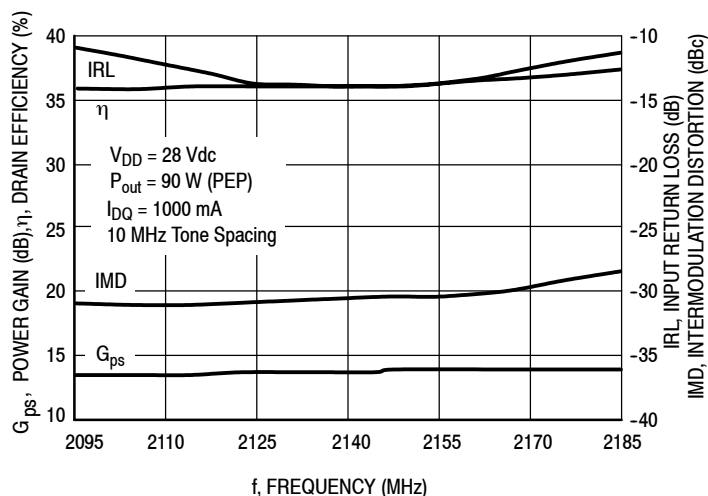
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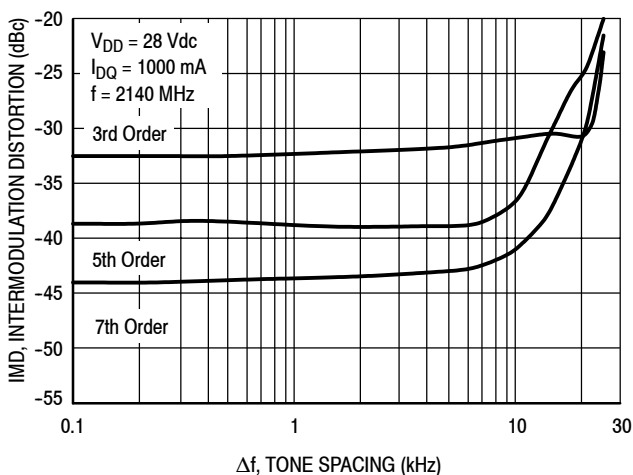
### TYPICAL CHARACTERISTICS



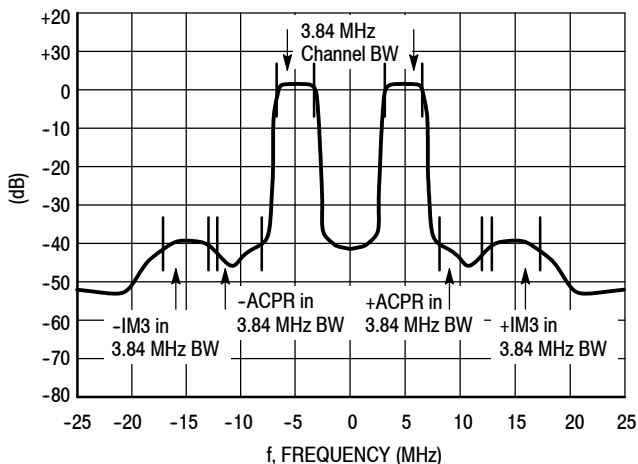
**Figure 9. Two-Tone Power Gain versus Output Power**



**Figure 10. Two-Tone Broadband Performance**



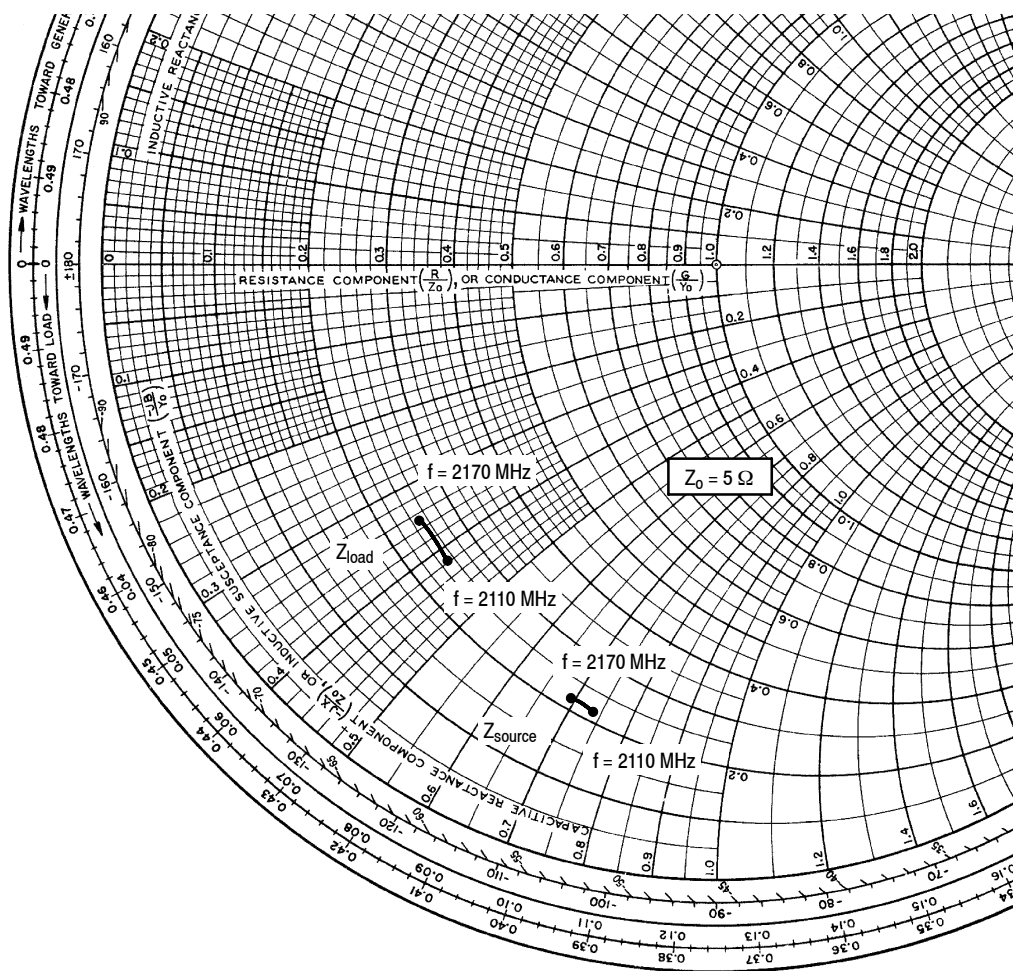
**Figure 11. Intermodulation Distortion Products versus Two-Tone Spacing**



**Figure 12. 2-Carrier W-CDMA Spectrum**

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$V_{DD} = 28$  V,  $I_{DQ} = 1000$  mA,  $P_{out} = 19$  W Avg.

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
2110	$1.10 - j3.71$	$1.23 - j2.10$
2140	$1.11 - j3.57$	$1.26 - j1.92$
2170	$1.12 - j3.40$	$1.25 - j1.76$

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

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

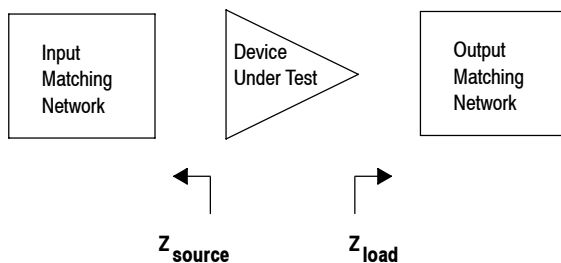


Figure 13. Series Equivalent Source and Load Impedance

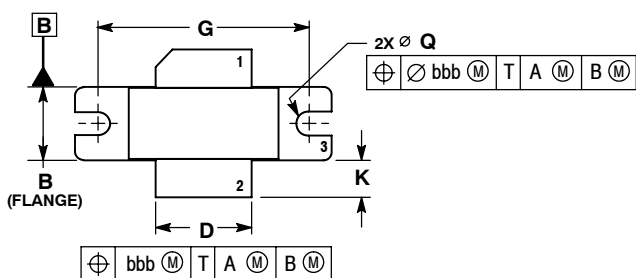
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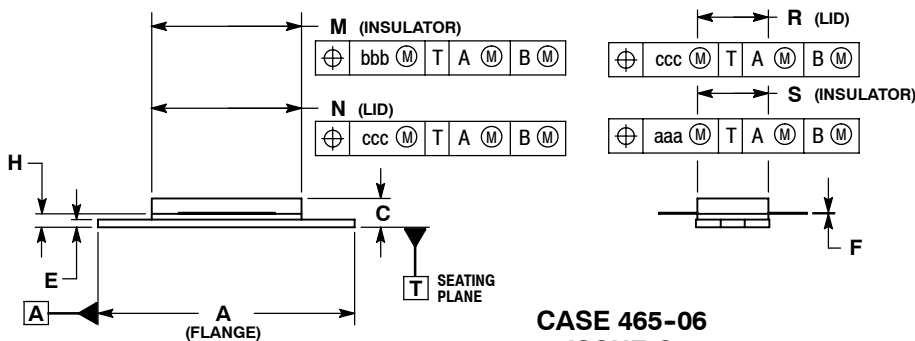
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### PACKAGE DIMENSIONS



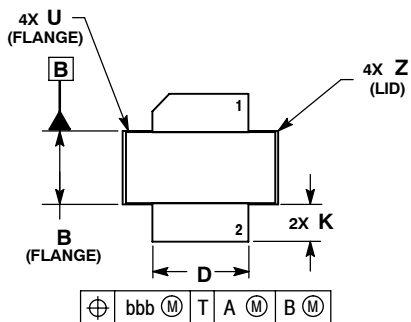
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
  2. CONTROLLING DIMENSION: INCH.
  3. DELETED
  4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

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	0.125	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	Ø.118	Ø.138	Ø3.00	Ø3.51
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:
1. DRAIN
  2. GATE
  3. SOURCE

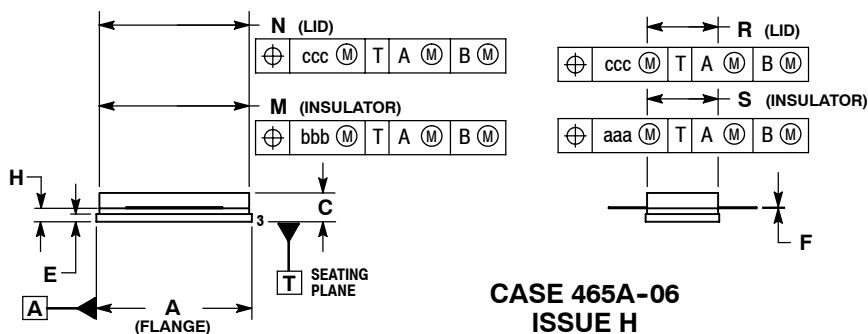
**CASE 465-06**  
**ISSUE G**  
**NI-780**  
**MRF21085LR3**



- 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.

DIM	INCHES		MILLIMETERS	
	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:
1. DRAIN
  2. GATE
  5. SOURCE



**CASE 465A-06**  
**ISSUE H**  
**NI-780S**  
**MRF21085LSR3**

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## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
9	Dec. 2010	<ul style="list-style-type: none"> <li>• MRF21085 Rev. 9 data sheet archived. Data sheet split due to change in part life cycle. See MRF21085-1 Rev. 10 for MRF21085LR3 and MRF21085-2 Rev. 11 for MRF21085LSR3.</li> </ul>

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