

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for N-CDMA base station applications with frequencies from 1805 to 1880 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 N-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1200$  mA,  $P_{out} = 29$  Watts Avg.,  $f = 1877.5$  MHz, 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 — 16 dB  
Drain Efficiency — 27.5%  
IM3 @ 2.5 MHz Offset — -36 dBc in 1.2288 MHz Bandwidth  
ACPR @ 885 kHz Offset — -50.5 dBc in 30 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 1840 MHz, 140 Watts CW Output Power

### Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- Integrated ESD Protection
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF6S18140HR3**  
**MRF6S18140HSR3**

**1805-1880 MHz, 29 W AVG., 28 V**  
**2 x N-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**

**CASE 465B-03, STYLE 1**  
**NI-880**  
**MRF6S18140HR3**

**CASE 465C-02, STYLE 1**  
**NI-880S**  
**MRF6S18140HSR3**

**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
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Case Operating Temperature	$T_C$	150	°C
Operating Junction Temperature (1,2)	$T_J$	225	°C

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 140 W CW Case Temperature 73°C, 29 W CW	$R_{\theta JC}$	0.31 0.35	°C/W

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. 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)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 300\ \mu\text{Adc}$ )	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 1200\ \text{mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	2	2.7	3.8	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 3\text{ Adc}$ )	$V_{DS(on)}$	0.1	0.22	0.3	Vdc

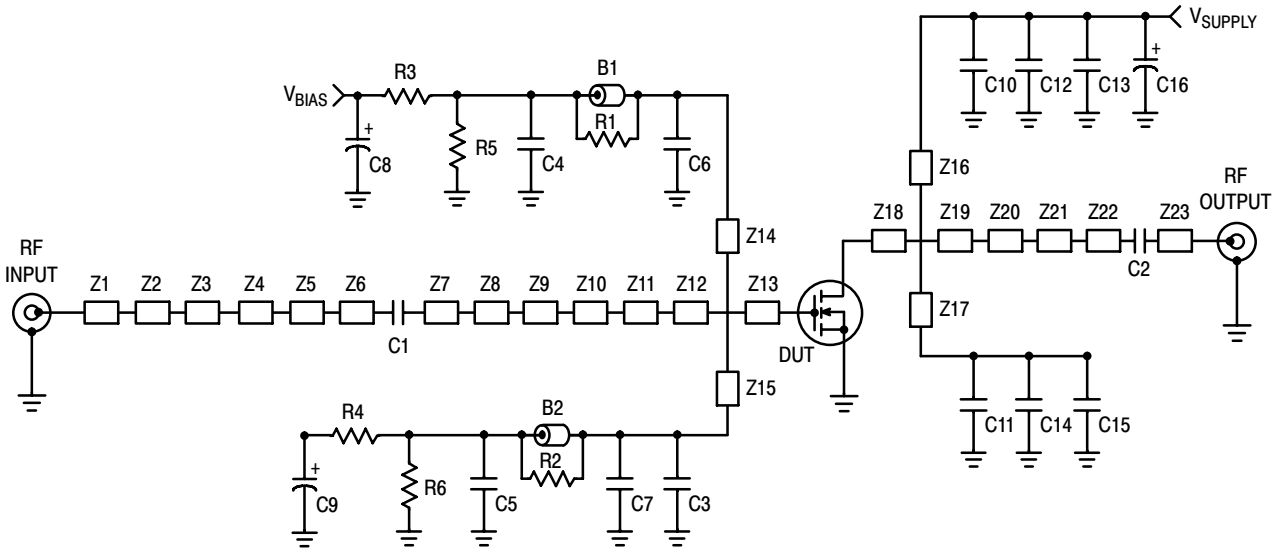
**Dynamic Characteristics (1)**

Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	2.2	—	pF
Output Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\ \text{mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	685	—	pF

**Functional Tests** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1200\ \text{mA}$ ,  $P_{out} = 29\ \text{W Avg.}$ ,  $f_1 = 1877.5\ \text{MHz}$ ,  $f_2 = 1880\ \text{MHz}$ , 2-Carrier N-CDMA, 1.2288 MHz Channel Bandwidth Carriers. ACPR measured in 30 kHz Channel Bandwidth @  $\pm 885\ \text{kHz}$  Offset. IM3 measured in 1.2288 MHz Channel Bandwidth @  $\pm 2.5\ \text{MHz}$  Offset. PAR = 9.8 dB @ 0.01% Probability on CCDF.

Power Gain	$G_{ps}$	15	16	18	dB
Drain Efficiency	$\eta_D$	25.5	27.5	—	%
Intermodulation Distortion	IM3	—	-36	-34.5	dBc
Adjacent Channel Power Ratio	ACPR	—	-50.5	-48	dBc
Input Return Loss	IRL	—	-10.5	—	dB

1. Part internally matched both on input and output.



Z1	0.166" x 0.082" Microstrip	Z13	0.108" x 1.070" Microstrip
Z2	0.250" x 0.334" Microstrip	Z14	0.960" x 0.046" Microstrip
Z3	0.140" x 0.340" Microstrip	Z15	0.084" x 0.046" Microstrip
Z4	0.092" x 0.164" Microstrip	Z16	0.996" x 0.080" Microstrip
Z5	0.130" x 0.234" Microstrip	Z17	1.015" x 0.080" Microstrip
Z6	0.109" x 0.082" Microstrip	Z18	0.099" x 1.070" Microstrip
Z7	0.070" x 0.082" Microstrip	Z19	0.516" x 1.070" Microstrip
Z8	0.350" x 0.644" Microstrip	Z20	0.292" x 0.288" Microstrip
Z9	0.092" x 0.420" Microstrip	Z21	0.198" x 0.114" Microstrip
Z10	0.720" x 0.082" Microstrip	Z22	0.372" x 0.080" Microstrip
Z11	0.090" x 0.485" x 0.580" Taper	Z23	1.181" x 0.080" Microstrip
Z12	0.342" x 1.070" Microstrip	PCB	DS Electronics GX0300, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF6S18140HR3(HSR3) Test Circuit Schematic

Table 5. MRF6S18140HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	47 $\Omega$ , 100 MHz Small Ferrite Beads, Surface Mount	2743019447	Fair-Rite
C1, C2	39 pF Chip Capacitors	ATC700B390FT500XT	ATC
C3	0.1 pF Chip Capacitor	ATC100B0R1BT500XT	ATC
C4, C5, C12, C13, C14, C15	10 $\mu$ F, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C6, C7, C10, C11	9.1 pF Chip Capacitors	ATC100B9R1BT500XT	ATC
C8, C9	47 $\mu$ F, 50 V Electrolytic Capacitors	EMVY500ADA470MF80G	Nippon Chemi-Con
C16	470 $\mu$ F, 63 V Electrolytic Capacitor	EMVY630GTR471MMH0S	Nippon Chemi-Con
R1, R2	12 $\Omega$ , 1/4 W Resistors	CRCW120612R0FKEA	Vishay
R3, R4	1.0 K $\Omega$ , 1/4 W Resistors	CRCW12061001FKEA	Vishay
R5, R6	560 K $\Omega$ , 1/4 W Chip Resistors	CRCW12065602FKEA	Vishay

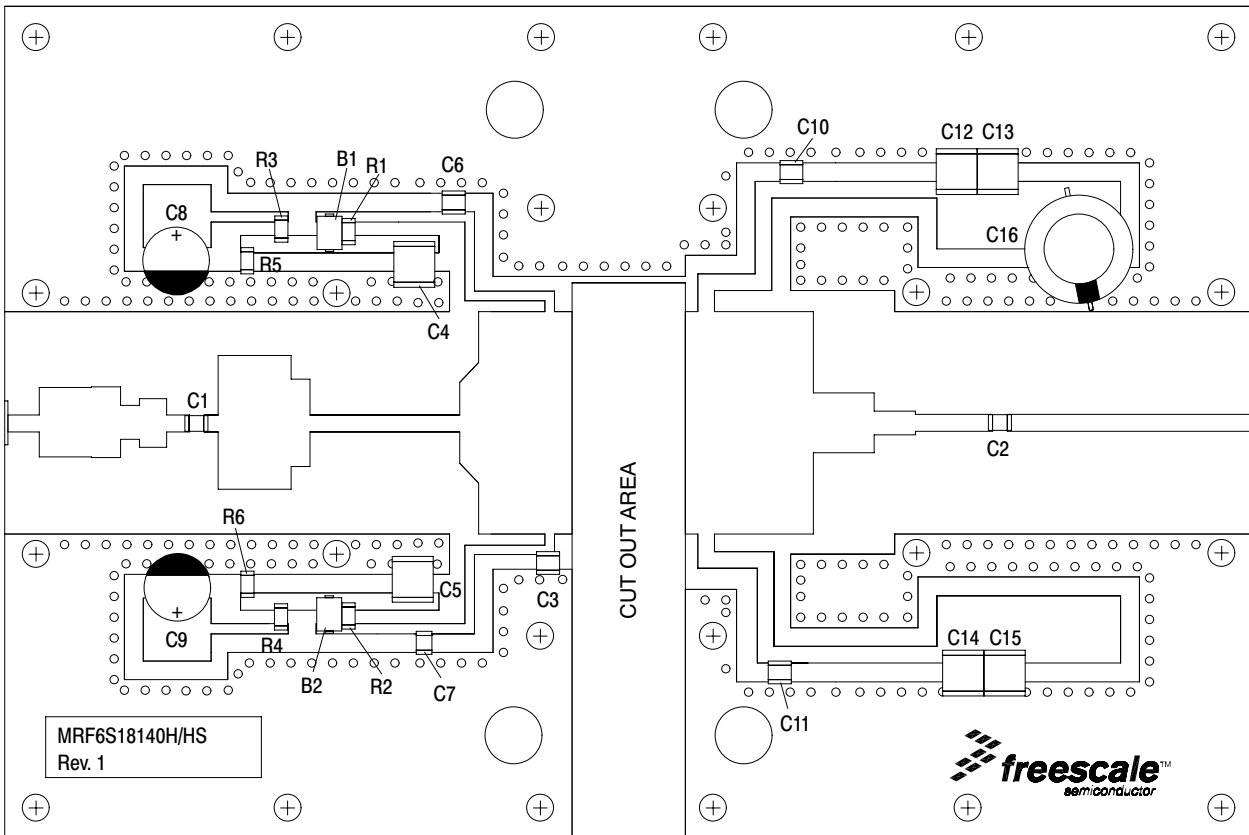


Figure 2. MRF6S18140HR3(HSR3) Test Circuit Component Layout

### TYPICAL CHARACTERISTICS

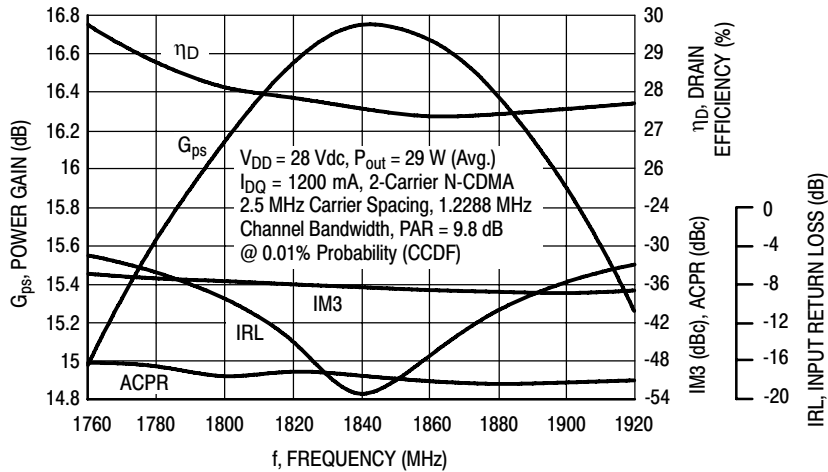


Figure 3. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 29$  Watts Avg.

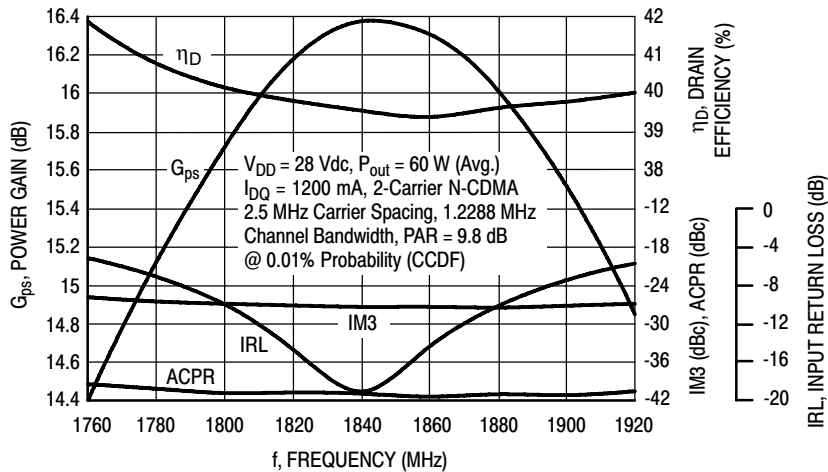


Figure 4. 2-Carrier N-CDMA Broadband Performance @  $P_{out} = 60$  Watts Avg.

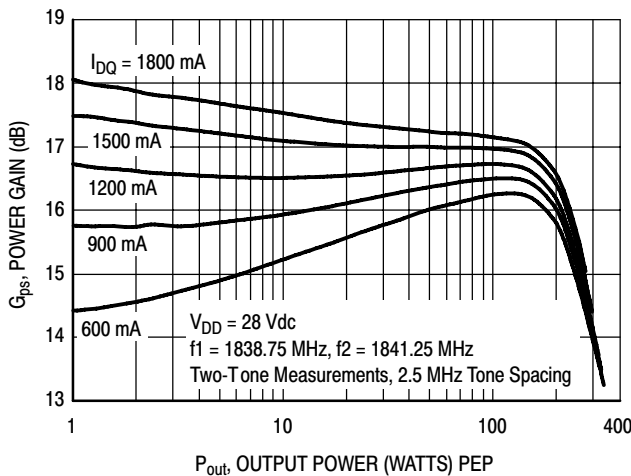


Figure 5. Two-Tone Power Gain versus Output Power

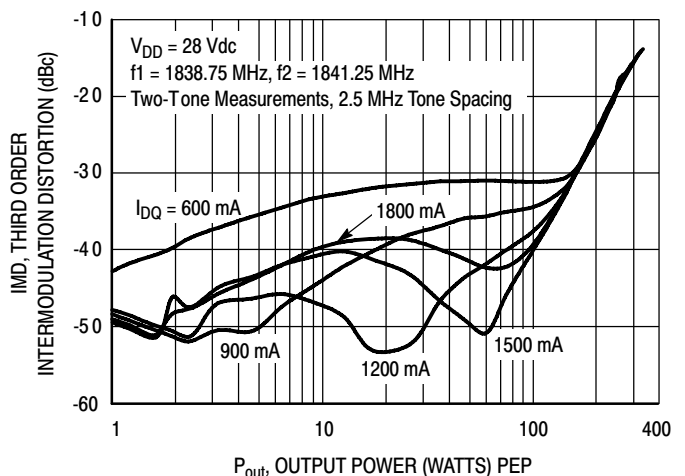
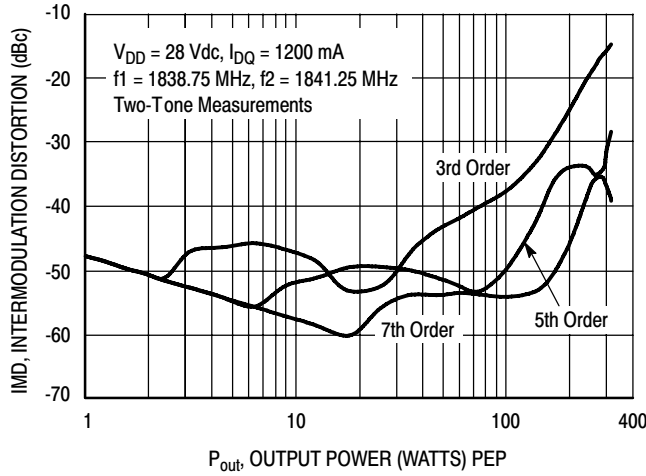


Figure 6. Third Order Intermodulation Distortion versus Output Power

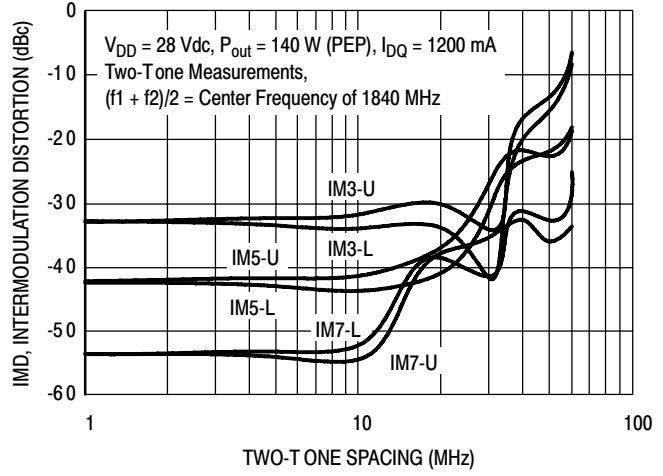
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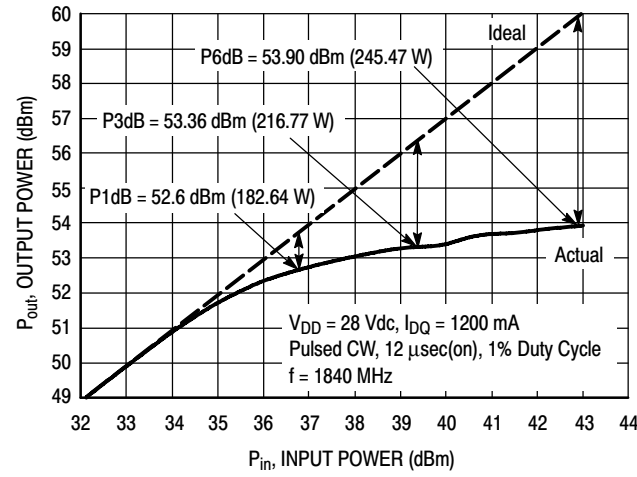
### TYPICAL CHARACTERISTICS



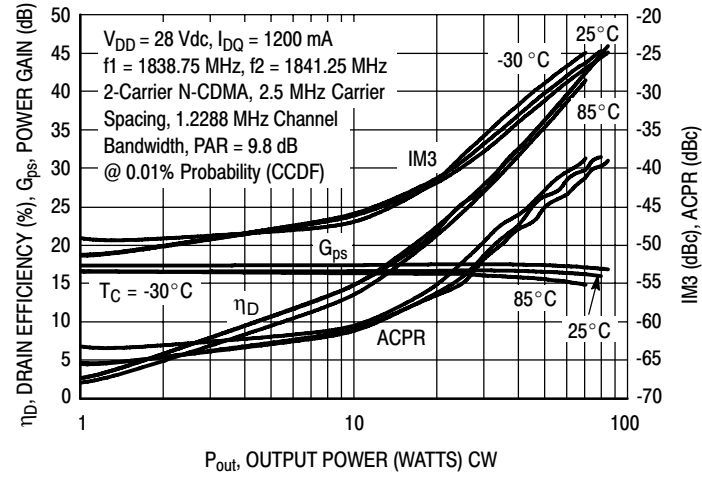
**Figure 7. Intermodulation Distortion Products versus Output Power**



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



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

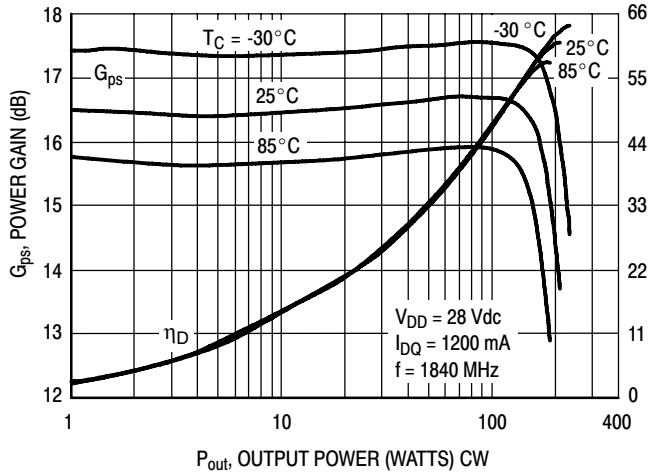


**Figure 10. 2-Carrier N-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**

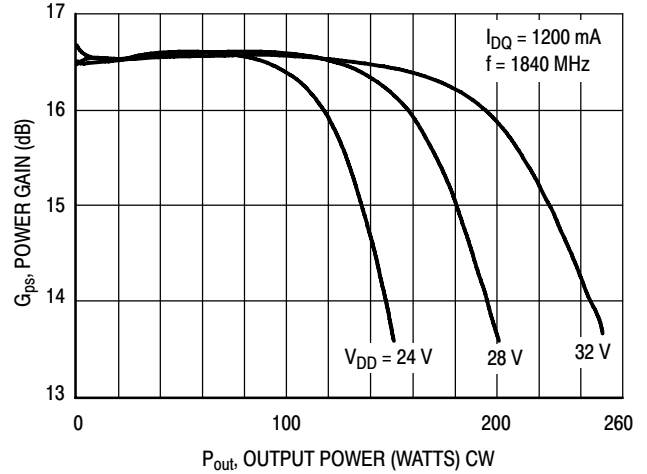
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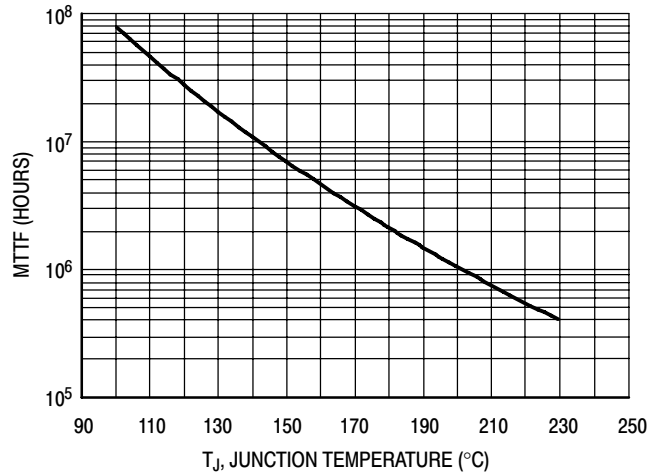
### TYPICAL CHARACTERISTICS



**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 when the device is operated at  $V_{DD} = 28$  Vdc,  $P_{out} = 29$  W Avg., and  $\eta_D = 27.5\%$ .  
 MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

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

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### N-CDMA TEST SIGNAL

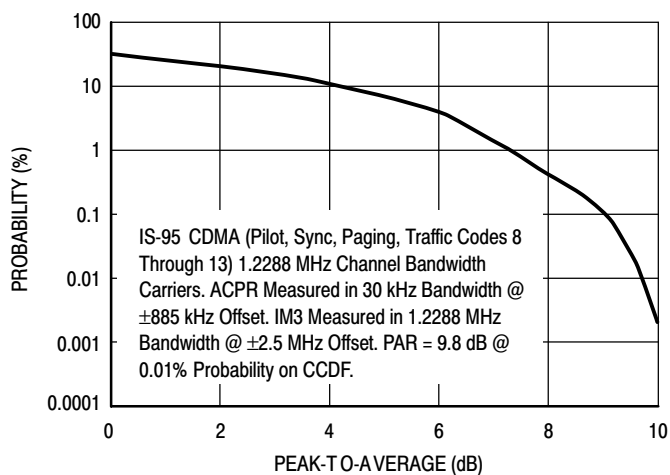


Figure 14. 2-Carrier CCDF N-CDMA

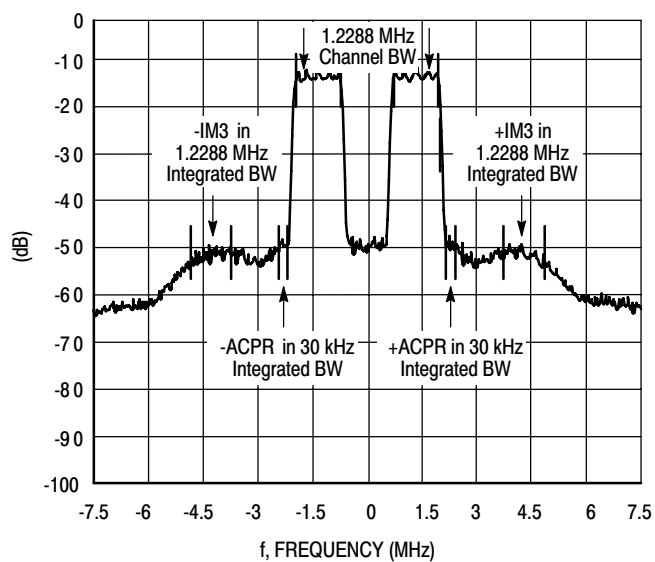
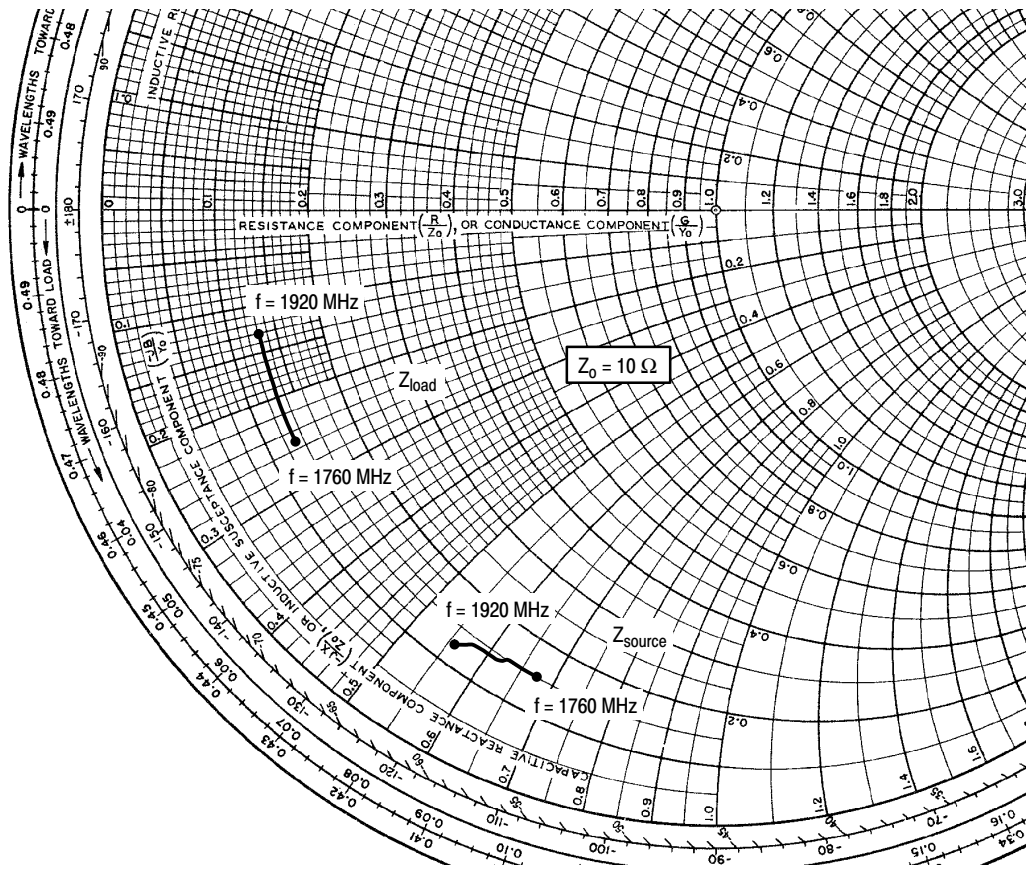


Figure 15. 2-Carrier N-CDMA Spectrum

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$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1200 \text{ mA}$ ,  $P_{out} = 29 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
1760	1.454 - j6.703	1.344 - j2.479
1780	1.465 - j6.511	1.338 - j2.299
1800	1.467 - j6.336	1.333 - j2.129
1820	1.448 - j6.193	1.325 - j1.966
1840	1.440 - j6.049	1.308 - j1.801
1860	1.414 - j5.938	1.301 - j1.687
1880	1.377 - j5.827	1.303 - j1.550
1900	1.311 - j5.710	1.301 - j1.419
1920	1.231 - j5.583	1.289 - j1.303

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

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

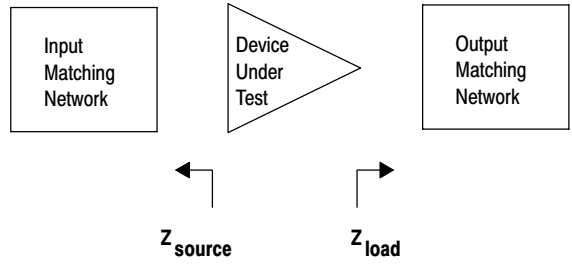
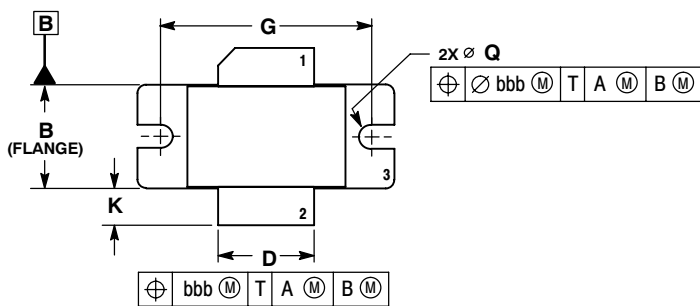


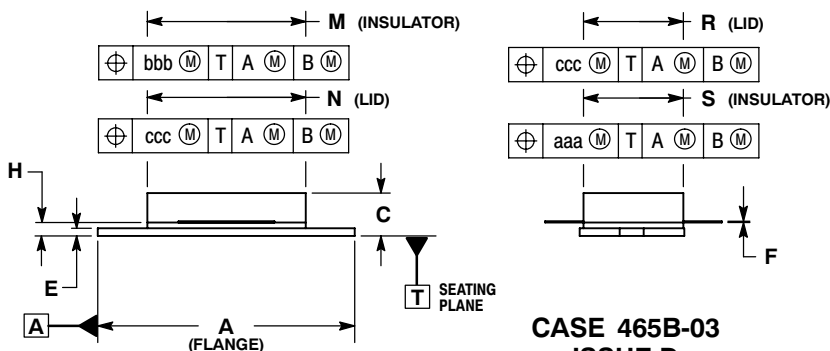
Figure 16. Series Equivalent Source and Load Impedance

### PACKAGE DIMENSIONS



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.535	0.545	13.6	13.8
C	0.147	0.200	3.73	5.08
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	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
Q	∅ .118	∅ .138	∅ 3.00	∅ 3.51
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

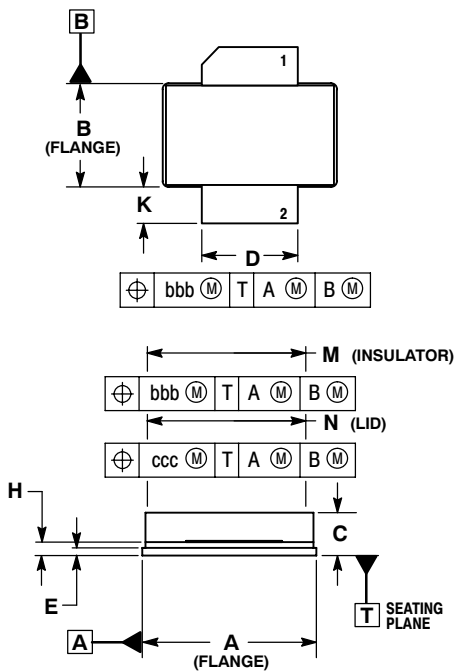


**CASE 465B-03  
ISSUE D  
NI-880  
MRF6S18140HR3**

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

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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.905	0.915	22.99	23.24
B	0.535	0.545	13.60	13.80
C	0.147	0.200	3.73	5.08
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	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

**CASE 465C-02  
ISSUE D  
NI-880S  
MRF6S18140HSR3**

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

## PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

### Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Sept. 2006	<ul style="list-style-type: none"> <li>• Initial Release of Data Sheet</li> </ul>
1	Dec. 2008	<ul style="list-style-type: none"> <li>• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 1, 2</li> <li>• Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1</li> <li>• Corrected <math>V_{DS}</math> to <math>V_{DD}</math> in the RF test condition voltage callout for <math>V_{GS(Q)}</math>, and added "Measured in Functional Test", On Characteristics table, p. 2</li> <li>• Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3</li> <li>• Adjusted scale for Fig. 8, Intermodulation Distortion Products versus Tone Spacing, to show wider dynamic range, p. 6</li> <li>• Replaced Fig. 13, MTTF versus Junction Temperature with updated graph. Removed Amps<sup>2</sup> and listed operating characteristics and location of MTTF calculator for device, p. 7</li> </ul>
1.1	Dec. 2009	<ul style="list-style-type: none"> <li>• Corrected data sheet to reflect RF Test Reduction frequency described in Product and Process Change Notification number, PCN13232, p. 1, 2</li> <li>• Data sheet archived. Part no longer manufactured.</li> </ul>

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Freescale Semiconductor Japan Ltd.  
Headquarters  
ARCO Tower 15F  
1-8-1, Shimo-Meguro, Meguro-ku,  
Tokyo 153-0064  
Japan  
0120 191014 or +81 3 5437 9125  
[support.japan@freescale.com](mailto:support.japan@freescale.com)

**Asia/Pacific:**

Freescale Semiconductor China Ltd.  
Exchange Building 23F  
No. 118 Jianguo Road  
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China  
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