

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA base station applications with frequencies from 1805 to 1880 MHz. Suitable for CDMA and multicarrier amplifier applications. To be used in Class AB and Class C for PCN - PCS/cellular radio and WLL applications.

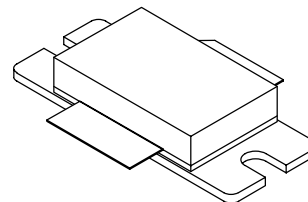
- Typical Single-Carrier W-CDMA Performance: $V_{DD} = 28$ Volts, $I_{DQ} = 1400$ mA, $P_{out} = 50$ Watts Avg., Full Frequency Band, 3GPP Test Model 1, 64 DPCH with 50% Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.
Power Gain — 17.5 dB
Drain Efficiency — 31%
Device Output Signal PAR — 6.2 dB @ 0.01% Probability on CCDF
ACPR @ 5 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 5:1 VSWR, @ 32 Vdc, 1840 MHz, 170 Watts CW Output Power
- P_{out} @ 1 dB Compression Point ≥ 170 Watts CW

Features

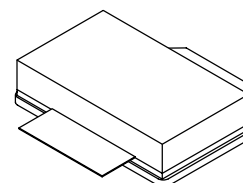
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF7S18170HR3
MRF7S18170HSR3

1805 - 1880 MHz, 50 W AVG., 28 V
SINGLE W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465B-03, STYLE 1
NI-880
MRF7S18170HR3



CASE 465C-02, STYLE 1
NI-880S
MRF7S18170HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Operating Voltage	V_{DD}	32, +0	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	$R_{\theta JC}$		°C/W
Case Temperature 84°C, 170 W CW		0.27	
Case Temperature 79°C, 50 W CW		0.30	

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)	IA (Minimum)
Machine Model (per EIA/JESD22-A115)	B (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
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Off Characteristics

Zero Gate Voltage Drain Leakage Current ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	1	μAdc

On Characteristics

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 372\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1400\text{ mAdc}$)	$V_{GS(Q)}$	—	2.7	—	Vdc
Fixture Gate Quiescent Voltage ⁽¹⁾ ($V_{DD} = 28\text{ Vdc}$, $I_D = 1400\text{ mAdc}$, Measured in Functional Test)	$V_{GG(Q)}$	4	5.4	7.6	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 3.72\text{ Adc}$)	$V_{DS(on)}$	0.1	0.15	0.3	Vdc

Dynamic Characteristics ⁽²⁾

Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{rss}	—	0.87	—	pF
Output Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{oss}	—	703	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1400\text{ mA}$, $P_{out} = 50\text{ W Avg.}$, $f = 1807.5\text{ MHz}$ and $f = 1877.5\text{ MHz}$, Single-Carrier W-CDMA, 3GPP Test Model 1, 64 DPCH, 50% Clipping, PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset.

Power Gain	G_{ps}	16	17.5	19	dB
Drain Efficiency	η_D	29	31	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF MRF7S18170HR3 MRF7S18170HSR3	PAR	5.8 5.7	6.2 6.2	— —	dB
Adjacent Channel Power Ratio	ACPR	—	-37	-35	dBc
Input Return Loss	IRL	—	-15	-9	dB

- $V_{GG} = 2 \times V_{GS(Q)}$. Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
- Part 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
Typical Performances (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1400\text{ mA}$, 1805-1880 MHz Bandwidth					
Video Bandwidth @ 170 W PEP P_{out} where $IM3 = -30\text{ dBc}$ (Tone Spacing from 100 kHz to VBW) $\Delta IMD3 = IMD3 @ \text{VBW frequency} - IMD3 @ 100\text{ kHz} < 1\text{ dBc}$ (both sidebands)	VBW	—	25	—	MHz
Gain Flatness in 75 MHz Bandwidth @ $P_{out} = 50\text{ W Avg.}$	G_F	—	0.4	—	dB
Average Deviation from Linear Phase in 75 MHz Bandwidth @ $P_{out} = 170\text{ W CW}$	Φ	—	2.5	—	°
Average Group Delay @ $P_{out} = 170\text{ W CW}$, $f = 1840\text{ MHz}$	Delay	—	4.2	—	ns
Part-to-Part Insertion Phase Variation @ $P_{out} = 170\text{ W CW}$, $f = 1840\text{ MHz}$, Six Sigma Window	$\Delta\Phi$	—	15	—	°
Gain Variation over Temperature (-30°C to $+85^\circ\text{C}$)	ΔG	—	0.015	—	dB/°C
Output Power Variation over Temperature (-30°C to $+85^\circ\text{C}$)	ΔP_{1dB}	—	0.01	—	dBm/°C

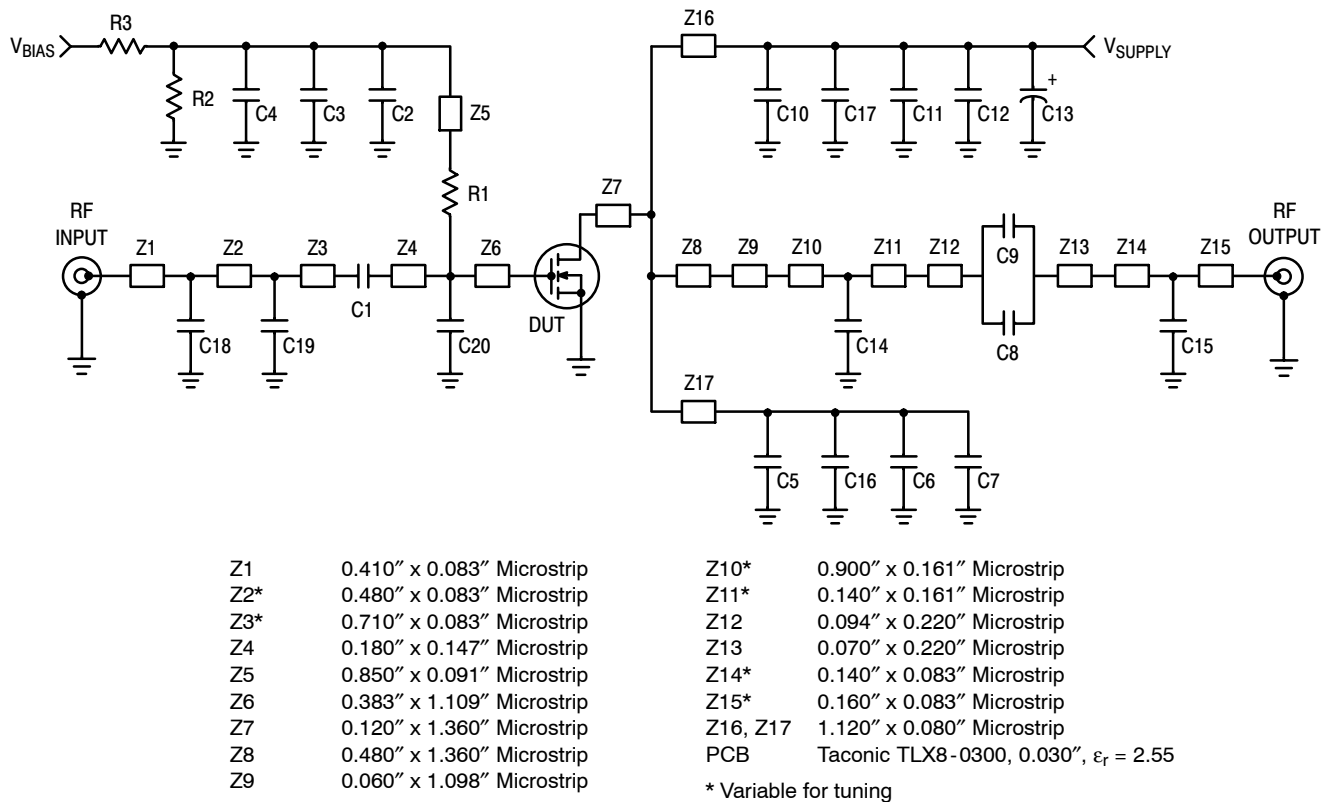


Figure 1. MRF7S18170HR3 Test Circuit Schematic — NI-880

Table 5. MRF7S18170HR3 Test Circuit Component Designations and Values — NI-880

Part	Description	Part Number	Manufacturer
C1	0.8 pF Chip Capacitor	ATC100B0R8BT500XT	ATC
C2, C8, C9	6.8 pF Chip Capacitors	ATC100B6R8BT500XT	ATC
C3	100 pF Chip Capacitor	ATC100B101JT500XT	ATC
C4	100 nF Chip Capacitor	ATC100B104JT500XT	ATC
C5, C10	5.6 pF Chip Capacitors	ATC100B5R6BT500XT	ATC
C6, C7, C11, C12	10 μ F Chip Capacitors	C5750X5R1H106MT	TDK
C13	470 μ F, 63 V Electrolytic Capacitor, Radial	477KXM063M	Illinois Capacitor
C14	0.5 pF Chip Capacitor	ATC100B0R5BT500XT	ATC
C15, C20	0.2 pF Chip Capacitors	ATC100B0R2BT500XT	ATC
C16, C17	4.7 pF Chip Capacitors	ATC100B4R7BT500XT	ATC
C18	2 pF Chip Capacitor	ATC100B2R0BT500XT	ATC
C19	0.3 pF Chip Capacitor	ATC100B0R3BT500XT	ATC
R1	10 Ω , 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay
R2, R3	10 k Ω , 1/4 W Chip Resistors	CRCW12061002FKEA	Vishay

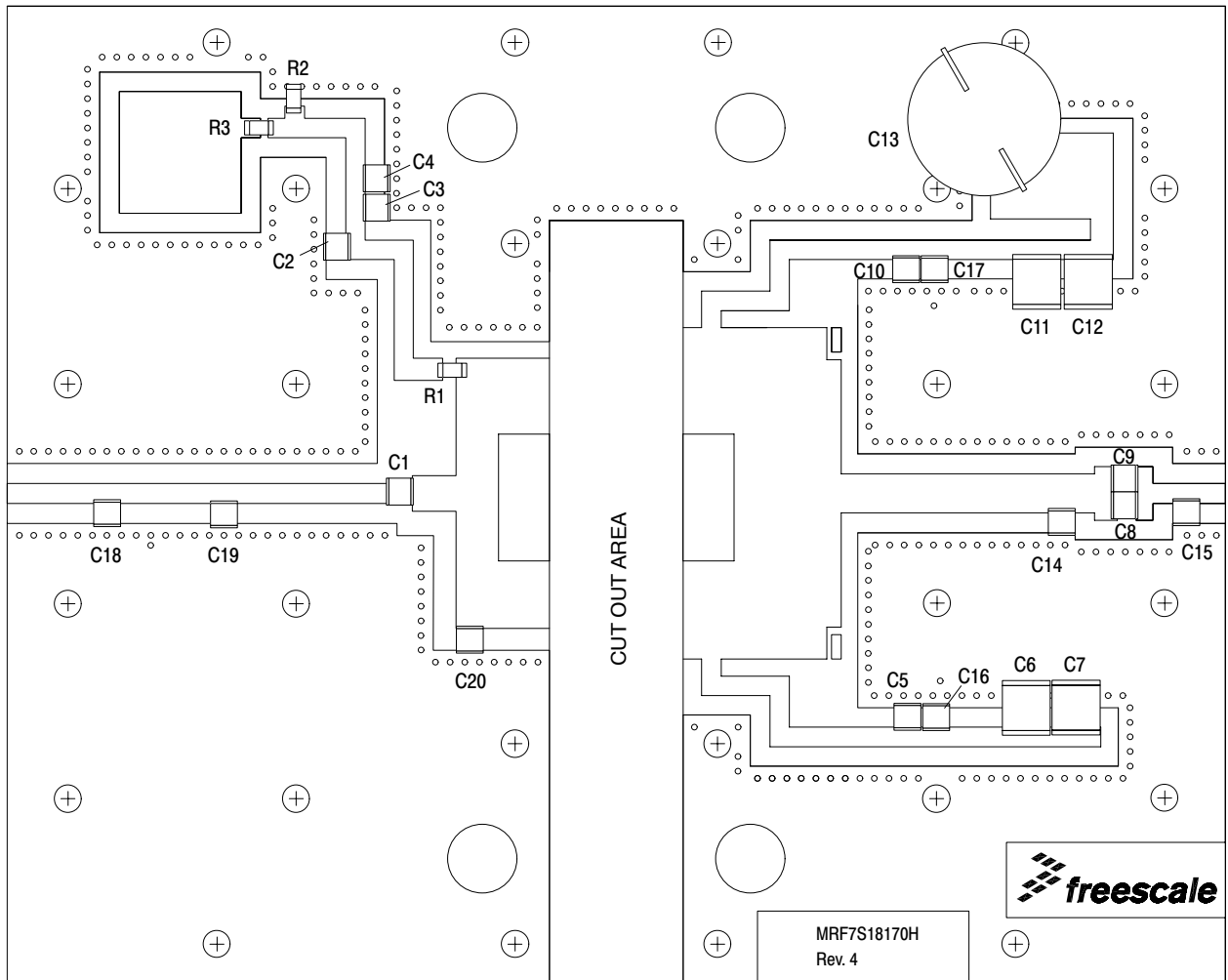
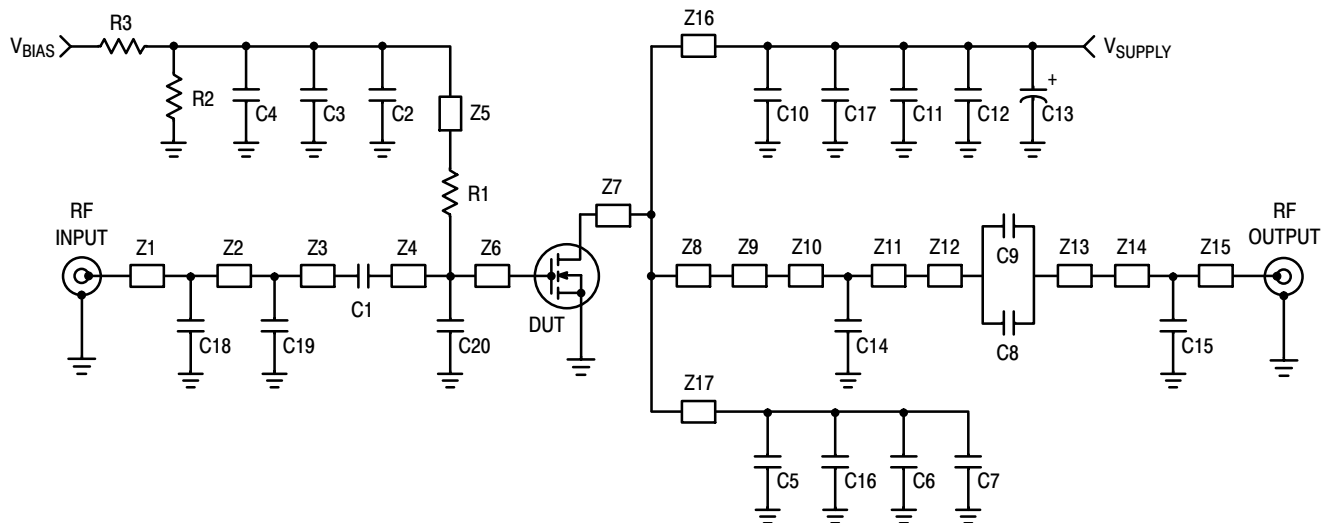


Figure 2. MRF7S18170HR3 Test Circuit Component Layout — NI-880



Z1*	0.500" x 0.083" Microstrip	Z10*	0.900" x 0.161" Microstrip
Z2*	0.290" x 0.083" Microstrip	Z11*	0.140" x 0.161" Microstrip
Z3*	0.810" x 0.083" Microstrip	Z12	0.094" x 0.220" Microstrip
Z4	0.180" x 0.147" Microstrip	Z13	0.070" x 0.220" Microstrip
Z5	0.850" x 0.091" Microstrip	Z14*	0.140" x 0.083" Microstrip
Z6	0.383" x 1.109" Microstrip	Z15*	0.160" x 0.083" Microstrip
Z7	0.117" x 1.360" Microstrip	Z16, Z17	1.120" x 0.080" Microstrip
Z8	0.480" x 1.360" Microstrip	PCB	Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$
Z9	0.060" x 1.098" Microstrip		
* Variable for tuning			

Figure 3. MRF7S18170HSR3 Test Circuit Schematic — NI-880S

Table 6. MRF7S18170HSR3 Test Circuit Component Designations and Values — NI-880S

Part	Description	Part Number	Manufacturer
C1	0.8 pF Chip Capacitor	ATC100B0R8BT500XT	ATC
C2, C8, C9	6.8 pF Chip Capacitors	ATC100B6R8BT500XT	ATC
C3	100 pF Chip Capacitor	ATC100B101JT500XT	ATC
C4	100 nF Chip Capacitor	ATC100B104JT500XT	ATC
C5, C10	5.6 pF Chip Capacitors	ATC100B5R6BT500XT	ATC
C6, C7, C11, C12	10 μ F Chip Capacitors	C5750X5R1H106MT	TDK
C13	470 μ F, 63 V Electrolytic Capacitor, Radial	477KXM063M	Illinois Capacitor
C14	0.5 pF Chip Capacitor	ATC100B0R5BT500XT	ATC
C15	0.2 pF Chip Capacitor	ATC100B0R2BT500XT	ATC
C16, C17	4.7 pF Chip Capacitors	ATC100B4R7BT500XT	ATC
C18	2 pF Chip Capacitor	ATC100B2R0BT500XT	ATC
C19	0.3 pF Chip Capacitor	ATC100B0R3BT500XT	ATC
C20	0.1 pF Chip Capacitor	ATC100B0R2BT500XT	ATC
R1	10 Ω , 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay
R2, R3	10 k Ω , 1/4 W Chip Resistors	CRCW12061002FKEA	Vishay

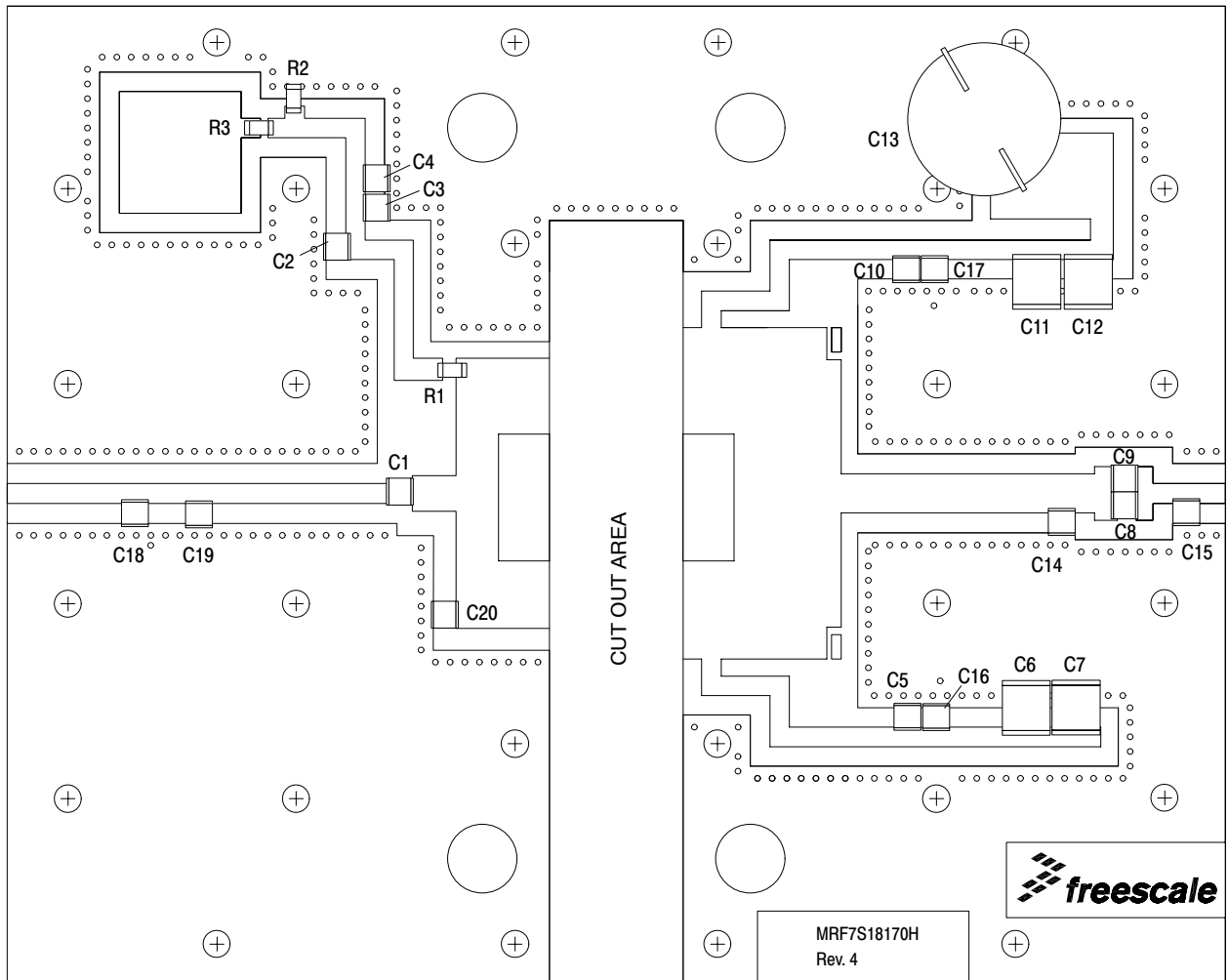
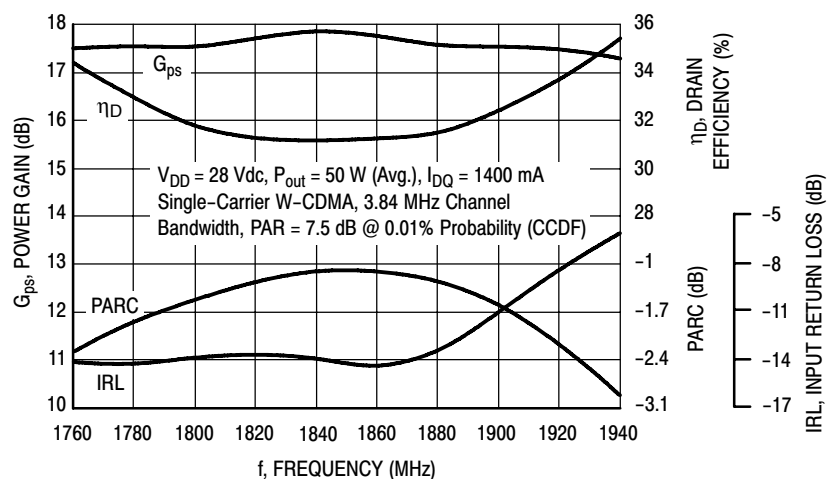
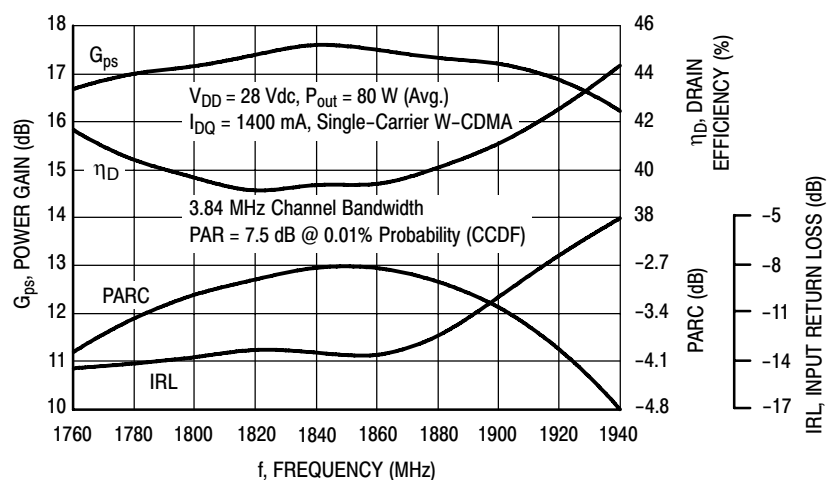


Figure 4. MRF7S18170HSR3 Test Circuit Component Layout — NI-880S

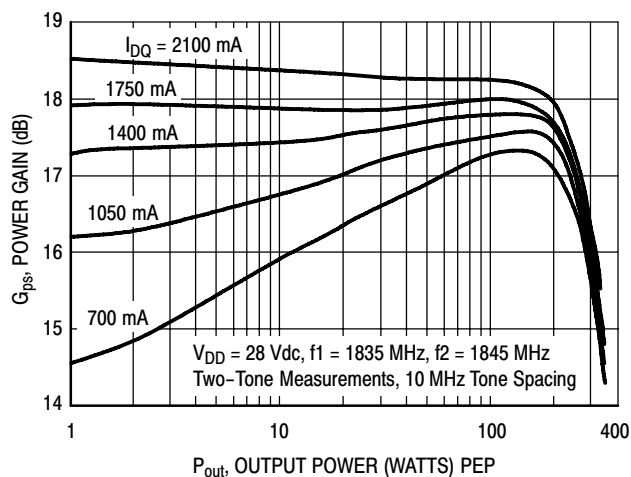
TYPICAL CHARACTERISTICS



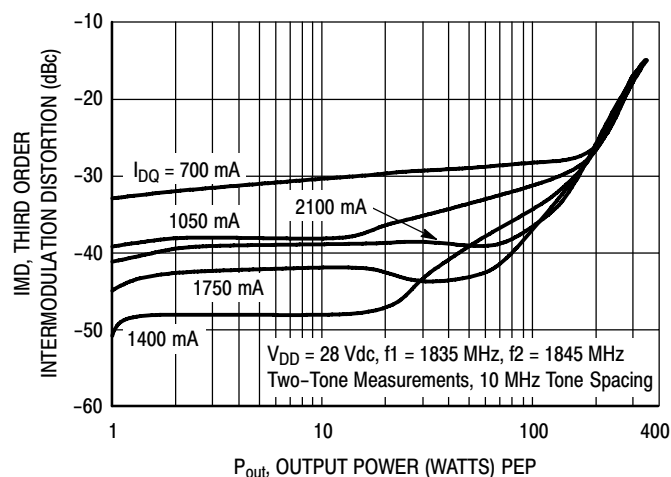
**Figure 5. Output Peak-to-Average Ratio Compression (PARC)
Broadband Performance @ $P_{out} = 50$ Watts Avg.**



**Figure 6. Output Peak-to-Average Ratio Compression (PARC)
Broadband Performance @ $P_{out} = 80$ Watts Avg.**



**Figure 7. Two-Tone Power Gain versus
Output Power**



**Figure 8. Third Order Intermodulation Distortion
versus Output Power**

TYPICAL CHARACTERISTICS

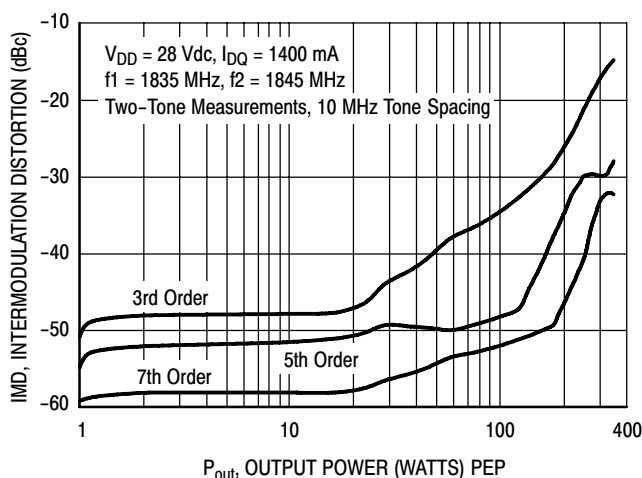


Figure 9. Intermodulation Distortion Products versus Output Power

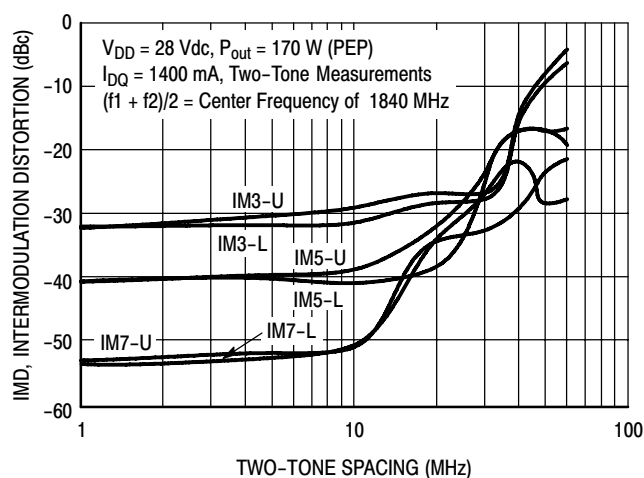


Figure 10. Intermodulation Distortion Products versus Tone Spacing

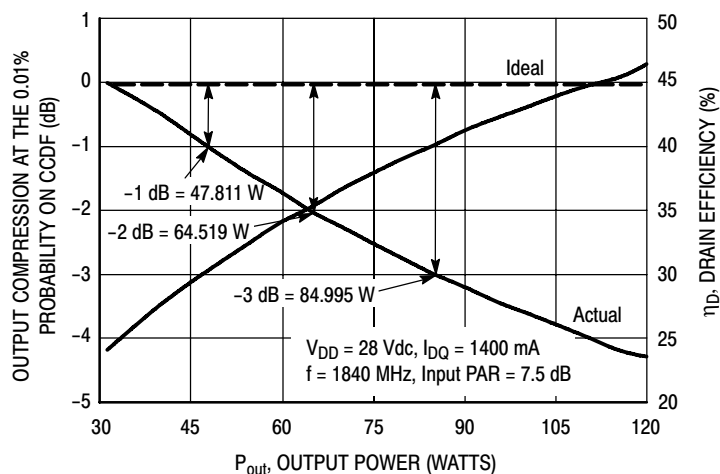


Figure 11. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

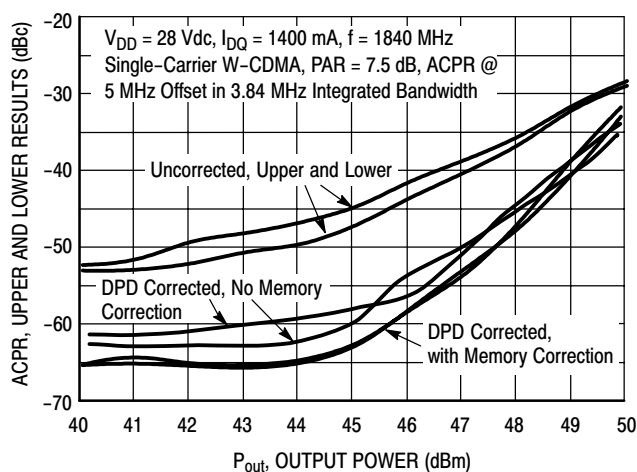


Figure 12. Digital Predistortion Correction versus ACPR and Output Power

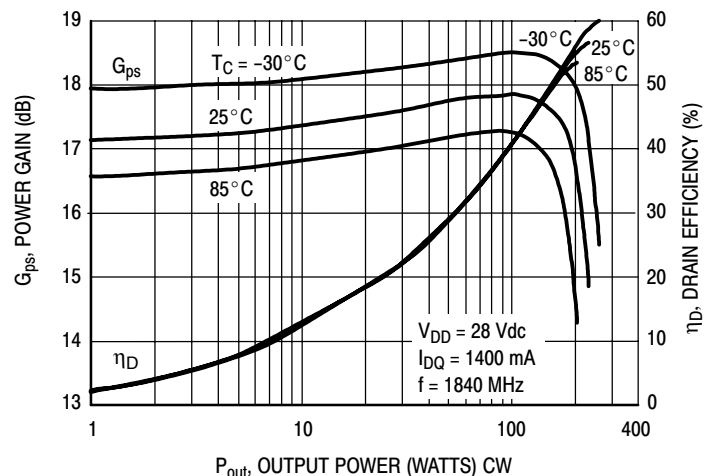


Figure 13. Power Gain and Drain Efficiency versus CW Output Power

MRF7S18170HR3 MRF7S18170HSR3

TYPICAL CHARACTERISTICS

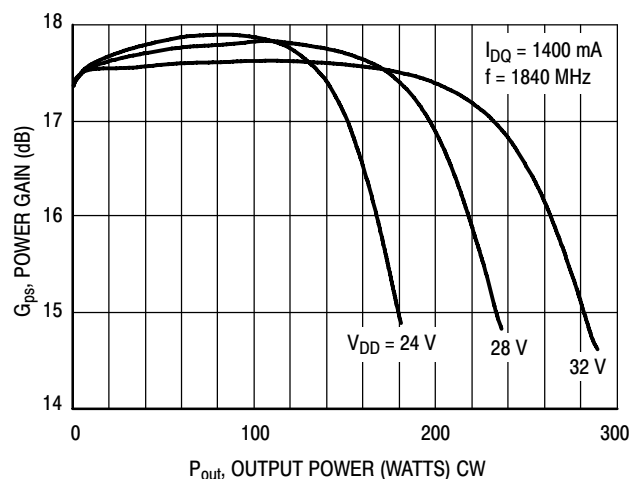
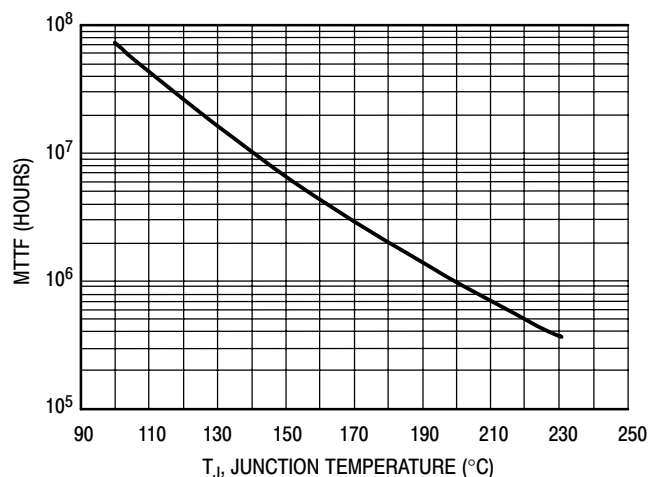


Figure 14. Power Gain versus Output Power



This above graph displays calculated MTT in hours when the device is operated at $V_{DD} = 28$ Vdc, $P_{out} = 50$ W Avg., and $\eta_D = 31\%$.

MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTT calculators by product.

Figure 15. MTT Factor versus Junction Temperature

W-CDMA TEST SIGNAL

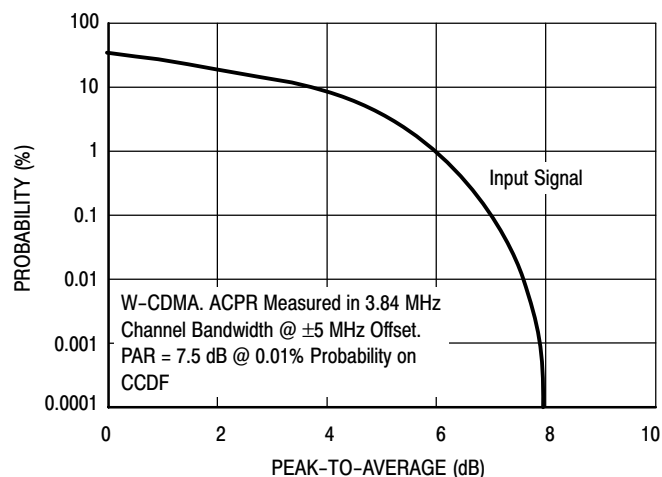


Figure 16. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 50% Clipping, Single-Carrier Test Signal

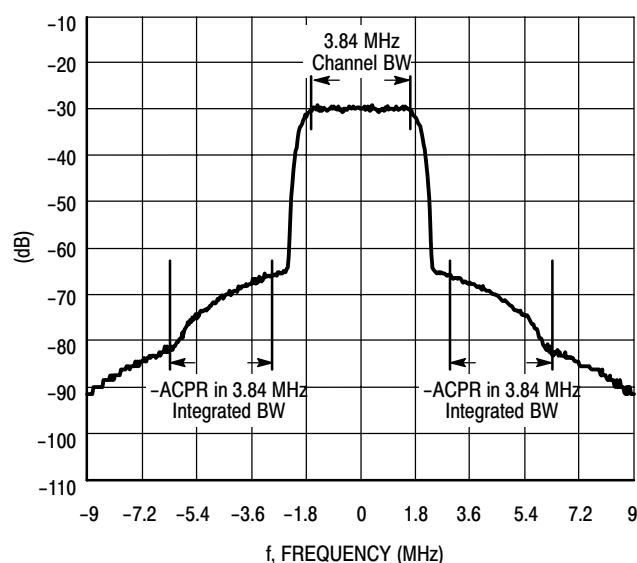
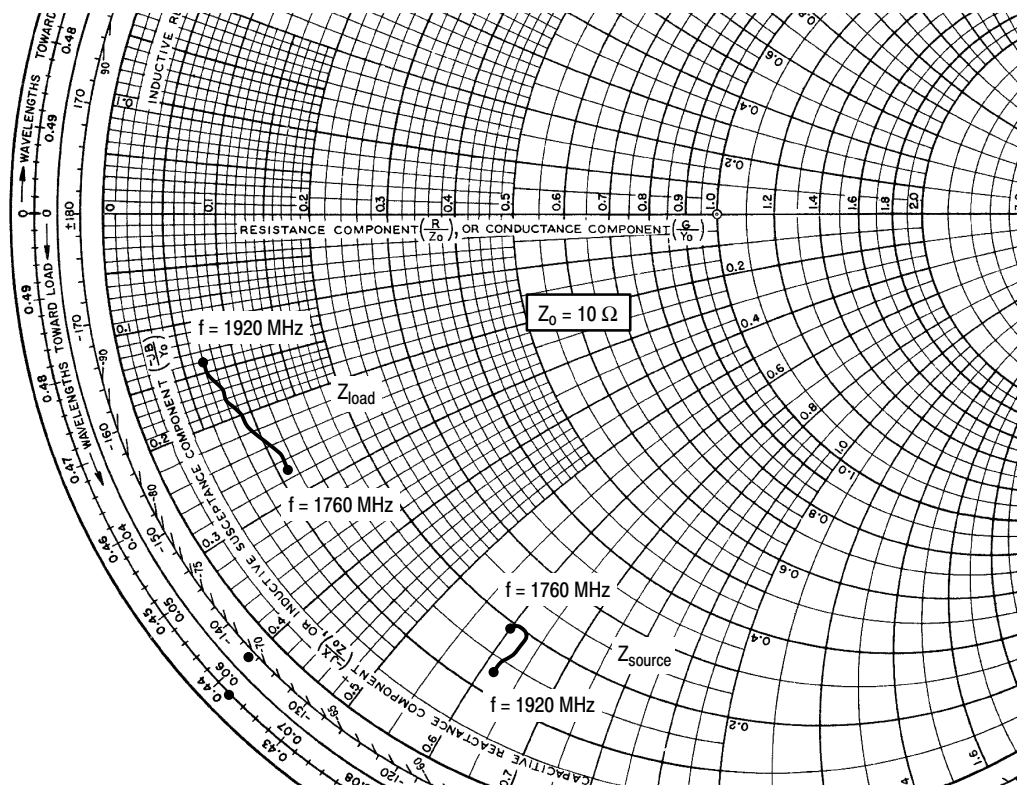


Figure 17. Single-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1400 \text{ mA}$, $P_{out} = 50 \text{ W Avg.}$

f MHz	Z_{source} Ω	Z_{load} Ω
1760	$1.93 - j6.00$	$1.13 - j2.65$
1780	$1.95 - j6.10$	$1.05 - j2.45$
1800	$1.99 - j6.18$	$0.97 - j2.29$
1820	$1.95 - j6.22$	$0.90 - j2.12$
1840	$1.85 - j6.30$	$0.85 - j2.00$
1860	$1.71 - j6.26$	$0.81 - j1.84$
1880	$1.55 - j6.25$	$0.75 - j1.70$
1900	$1.39 - j6.20$	$0.70 - j1.54$
1920	$1.23 - j6.15$	$0.67 - j1.38$

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

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

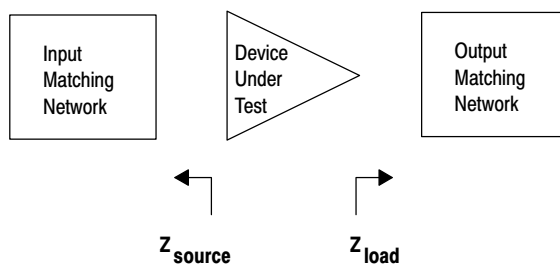
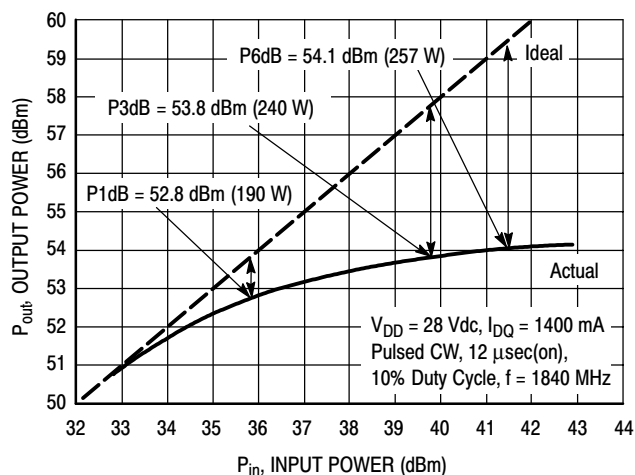


Figure 18. Series Equivalent Source and Load Impedance

ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS

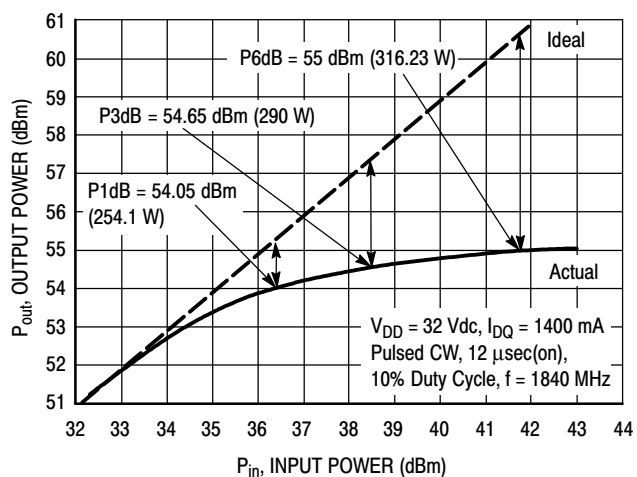


NOTE: Measured in a Peak Tuned Load Pull Fixture

Test Impedances per Compression Level

	Z_{source} Ω	Z_{load} Ω
3dB	1.23 - j7.91	0.88 - j2.81

Figure 19. Pulsed CW Output Power versus Input Power



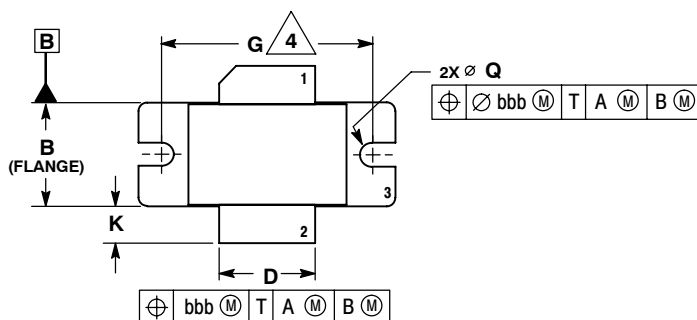
NOTE: Measured in a Peak Tuned Load Pull Fixture

Test Impedances per Compression Level

	Z_{source} Ω	Z_{load} Ω
P3dB	1.23 - j7.91	1.03 - j2.65

Figure 20. Pulsed CW Output Power versus Input Power

PACKAGE DIMENSIONS

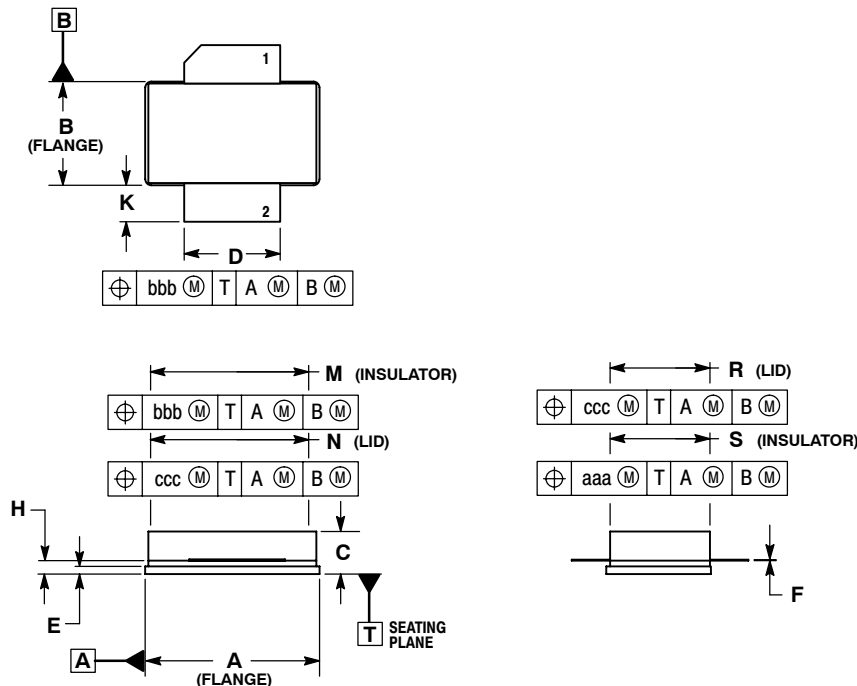


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
 4. RECOMMENDED BOLT CENTER DIMENSION OF 1.16 (29.57) BASED ON M3 SCREW.

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	0.175	0.205	4.44	5.21
M	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
Q	Ø 1.18	Ø 1.38	Ø 3.00	Ø 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

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

CASE 465B-03
ISSUE D
NI-880
MRF7S18170HR3



- 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

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

CASE 465C-02
ISSUE D
NI-880S
MRF7S18170HSR3

MRF7S18170HR3 MRF7S18170HSR3

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	Oct. 2006	• Initial Release of Data Sheet
1	Dec. 2008	• Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, On Characteristics table, p. 2 • Updated Typical Performance table to provide better definition of characterization attributes, p. 3 • Corrected Z7 from 1.110" to 0.120" in Z list, Fig. 1, Test Circuit Schematic – NI-880, p. 4 • Updated Part Numbers in Tables 5, 6, Component Designations and Values, to latest RoHS compliant part numbers, p. 4, 6 • Corrected Z7 from 1.110" to 0.117" in Z list, Fig. 3, Test Circuit Schematic – NI-880S, p. 6 • Adjusted scale for Fig. 10, Intermodulation Distortion Products versus Tone Spacing, to show wider dynamic range, p. 9 • Replaced Fig. 15, MTTF versus Junction Temperature, with updated graph; removed Amps² and listed operating characteristics and location of MTTF calculator for device, p. 10 • Updated Fig. 16, CCDF W-CDMA 3GPP, Test Model 1, 64 PDCH, 50% Clipping, Single-Carrier Test Signal, to show input signal only, p. 10

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