MRF6V12500H

960—1215 MHz, 500 W, 50 V RF Power LDMOS Transistors

Rev. 6 — 2 December 2024 Product data sheet

1 General description

These RF power transistors are designed for applications operating at frequencies between 960 and 1215 MHz such as distance measuring equipment (DME), transponders and secondary radars for air traffic control. These devices are suitable for use in pulse applications, including Mode S ELM.

2 Features and benefits

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified up to a Maximum of 50 V_{DD} Operation
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation

3 Typical performance

Table 1. Typical Pulse Performance

V_{DD} = 50 Volts, I_{DQ} = 200 mA

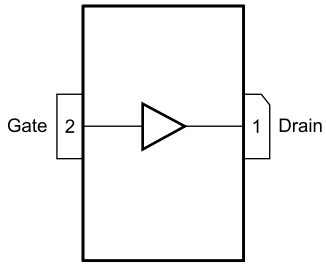
Application	Signal Type	P_{out}[1] (W)	Freq. (MHz)	G_{ps} (dB)	η_D (%)
Narrowband Short Pulse	Pulse (128 µsec, 10% Duty Cycle)	500 Peak	1030	19.7	62.0
Narrowband Mode S ELM	Pulse (48 × (32 µsec on, 18 µsec off), Period 2.4 msec, 6.4% Long-term Duty Cycle)	500 Peak	1030	19.7	62.0
Broadband	Pulse (128 µsec, 10% Duty Cycle)	500 Peak	960–1215	18.5	57.0

[1] Minimum output power for each specified pulse condition.

Table 2. Load Mismatch

Frequency (MHz)	Signal Type	VSWR	Peak Power (W)	Test Voltage	Result
1030	Pulse	10:1 at All Phase Angles	500	50	No Device Degradation

4 Pinning information



(Top View)

Note: The backside of the package is the source terminal for the transistor.

Figure 1. Pin Configuration

5 Ordering information

Table 3. Ordering Information

Device	Tape and Reel Information	Package
MRF6V12500HR5	R5 Suffix = 50 Units, 56 mm Tape Width, 13-inch Reel	NI-780H-2L
MRF6V12500HSR5		NI-780S-2L
MRF6V12500GSR5		NI-780GS-2L

6 Maximum ratings

Table 4. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	–0.5, +110	Vdc
Gate-Source Voltage	V_{GS}	–6.0, +10	Vdc
Storage Temperature Range	T_{stg}	–65 to +150	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature[1]	T_J	225	°C

[1] Continuous use at maximum temperature will affect MTTF.

7 Thermal characteristics

Table 5. Thermal Characteristics

Characteristic	Symbol	Value[1]	Unit
Thermal Impedance, Junction to Case Case Temperature 80°C, 500 W Peak, 128 µsec Pulse Width, 10% Duty Cycle	$Z_{\theta JC}$	0.044	°C/W

[1] Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to https://www.nxp.com/RF and search for AN1955.

8 ESD protection characteristics

Table 6. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2, passes 2600 V
Machine Model (per EIA/JESD22-A115)	B, passes 200 V
Charge Device Model (per JESD22-C101)	IV, passes 2000 V

9 Electrical characteristics

9.1 DC characteristics — off characteristics

Table 7. DC Characteristics — Off Characteristics

(T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	10	µAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 200 mA)	$V_{(BR)DSS}$	110	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	20	µAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 90 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	200	µAdc

9.2 DC characteristics — on characteristics

Table 8. DC Characteristics — On Characteristics

(T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 1.32 mA)	$V_{GS(th)}$	0.9	1.7	2.4	Vdc
Gate Quiescent Voltage (V_{DD} = 50 Vdc, I_D = 200 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.7	2.4	3.2	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.26 Adc)	$V_{DS(on)}$	—	0.25	—	Vdc

9.3 Dynamic characteristics

Table 9. Dynamic Characteristics

(T_A = 25°C unless otherwise noted)[1]

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.2	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	697	—	pF
Input Capacitance (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	1391	—	pF

[1] Part internally matched both on input and output.

9.4 Functional tests

Table 10. Functional Tests

(In NXP Narrowband Test Fixture, T_A = 25°C unless otherwise noted, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 200 mA, P_{out} = 500 W Peak (50 W Avg.), f = 1030 MHz, 128 µsec Pulse Width, 10% Duty Cycle

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	18.5	19.7	22.0	dB
Drain Efficiency	η_D	58.0	62.0	—	%
Input Return Loss	IRL	—	–18	–9	dB

9.5 Typical broadband performance

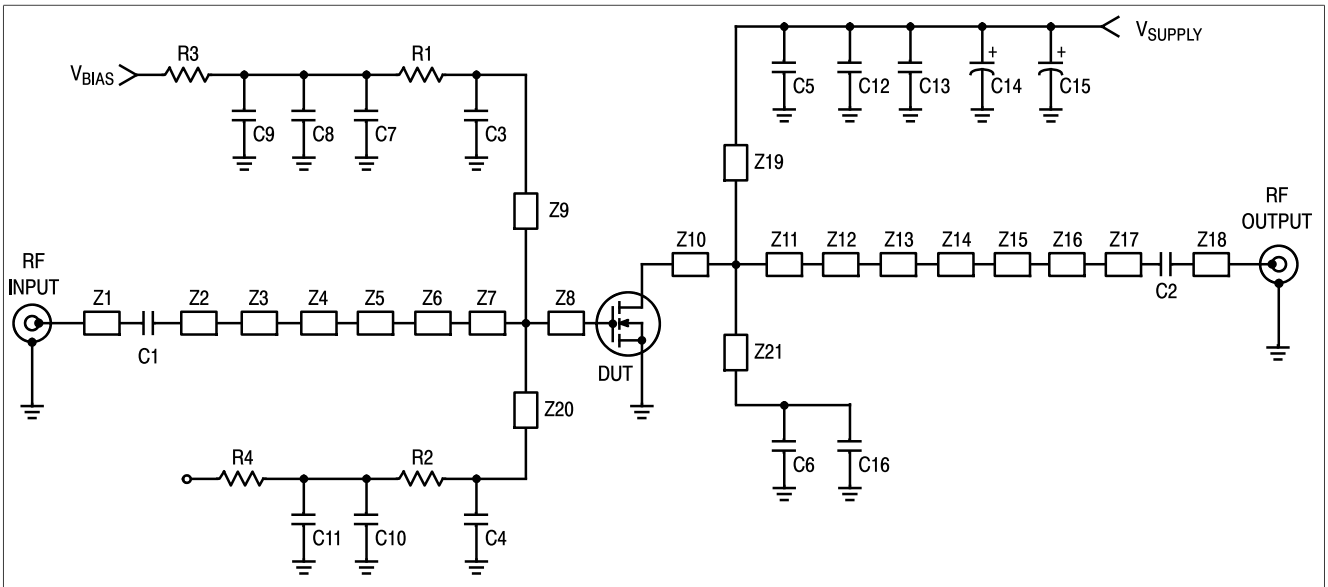
Table 11. Typical Broadband Performance — 960–1215 MHz

(In NXP 960–1215 MHz Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 200 mA, P_{out} = 500 W Peak (50 W Avg.), f = 960–1215 MHz, 128 µsec Pulse Width, 10% Duty Cycle

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	—	18.5	—	dB
Drain Efficiency	η_D	—	57.0	—	%

10 Test circuit schematic, parts list and component layout

10.1 Test circuit schematic



Z1	0.457" x 0.080" Microstrip	Z11	0.161" x 1.500" Microstrip
Z2	0.250" x 0.080" Microstrip	Z12	0.613" x 1.281" Microstrip
Z3	0.605" x 0.040" Microstrip	Z13	0.248" x 0.865" Microstrip
Z4	0.080" x 0.449" Microstrip	Z14	0.087" x 0.425" Microstrip
Z5	0.374" x 0.608" Microstrip	Z15	0.309" x 0.090" Microstrip
Z6	0.118" x 1.252" Microstrip	Z16	0.193" x 0.516" Microstrip
Z7	0.778" x 1.710" Microstrip	Z17	0.279" x 0.080" Microstrip
Z8	0.095" x 1.710" Microstrip	Z18	0.731" x 0.080" Microstrip
Z9, Z20	0.482" x 0.050" Microstrip	Z19, Z21	0.507" x 0.040" Microstrip
Z10	0.138" x 1.500" Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030", ε_r = 2.55

Figure 2. MRF6V12500H(HS) Test Circuit Schematic

10.2 Component designations and values

Table 12. MRF6V12500H(HS) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	5.1 pF Chip Capacitors	ATC100B5R1CT500XT	ATC
C3, C4, C5, C6	33 pF Chip Capacitors	ATC100B330JT500XT	ATC
C7, C10	10 µF, 50 V Chip Capacitors	GRM55DR61H106KA88L	Murata
C8, C11, C13, C16	2.2 µF, 100 V Chip Capacitors	2225X7R225KT3AB	ATC
C9	22 µF, 25 V Chip Capacitor	TPSD226M025R0200	AVX
C12	1 µF, 100 V Chip Capacitor	GRM31CR72A105KA01L	Murata
C14, C15	470 µF, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicomp
R1, R2	56 Ω, 1/4 W Chip Resistors	CRCW120656R0FKEA	Vishay
R3, R4	0 Ω, 3 A Chip Resistors	CRCW12060000Z0EA	Vishay

10.3 Component layout

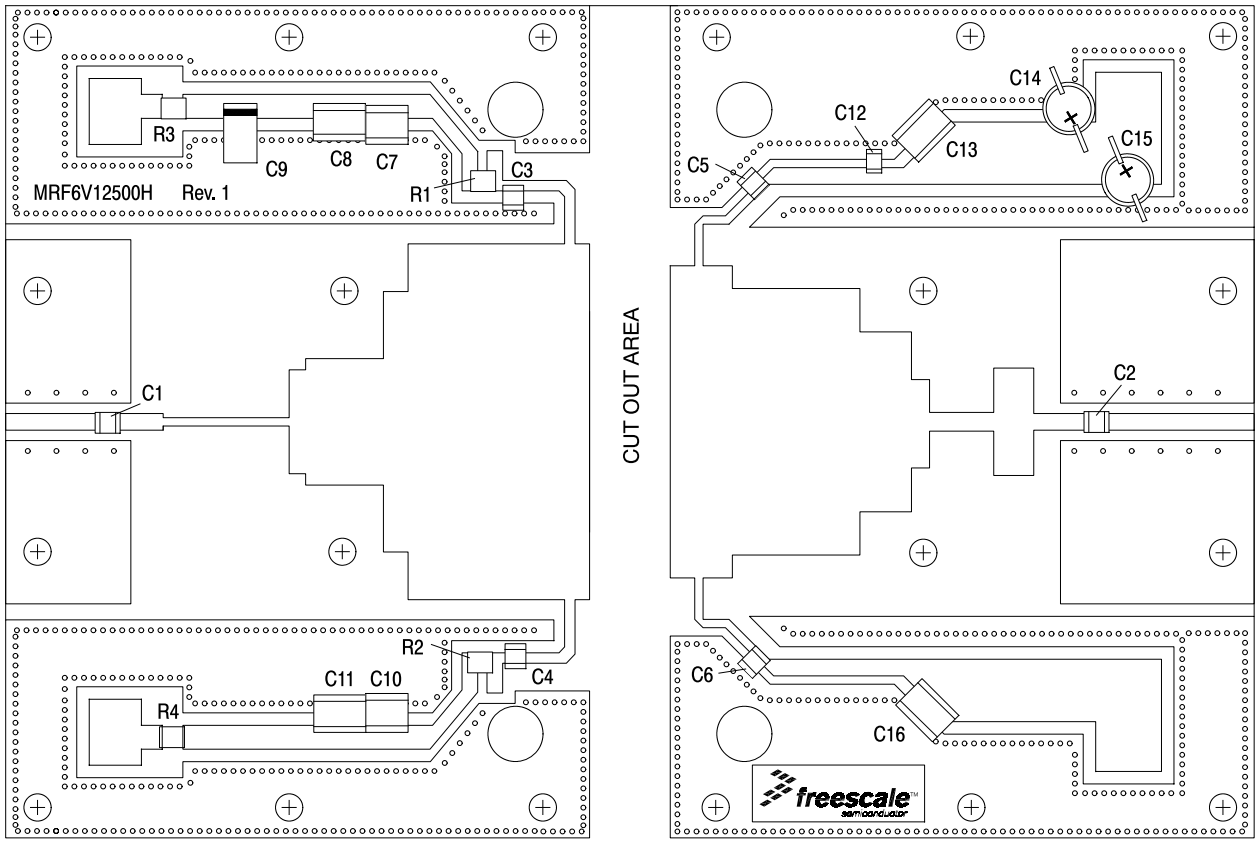


Figure 3. MRF6V12500H(HS) Test Circuit Component Layout

11 Typical characteristics performance graphs — 1030 MHz

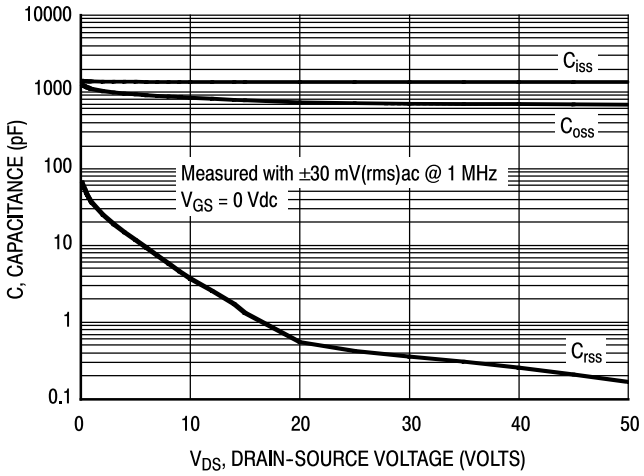


Figure 4. Capacitance versus Drain-Source Voltage

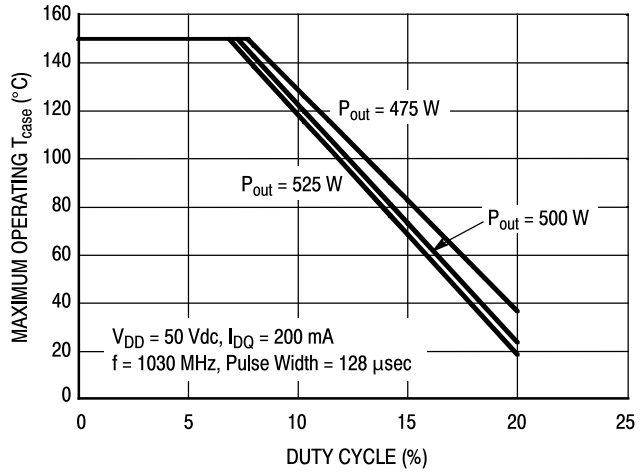


Figure 5. Safe Operating Area

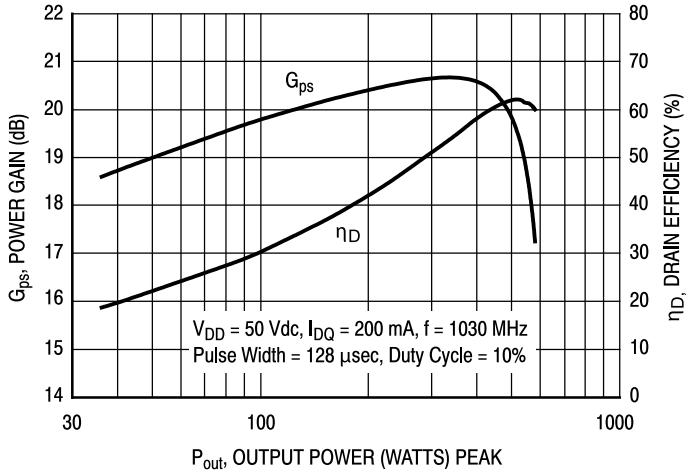


Figure 6. Power Gain and Drain Efficiency versus Output Power

11 Typical characteristics performance graphs — 1030 MHz...*continued*

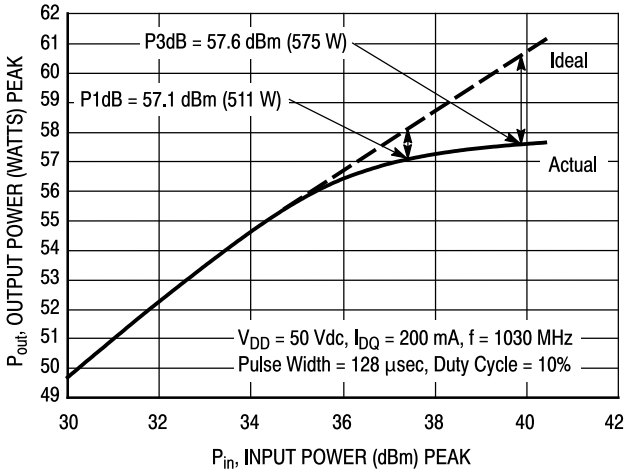


Figure 7. Output Power versus Input Power

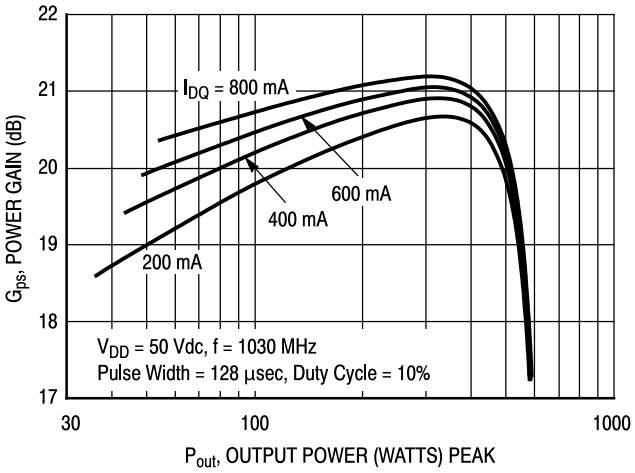


Figure 8. Power Gain versus Output Power

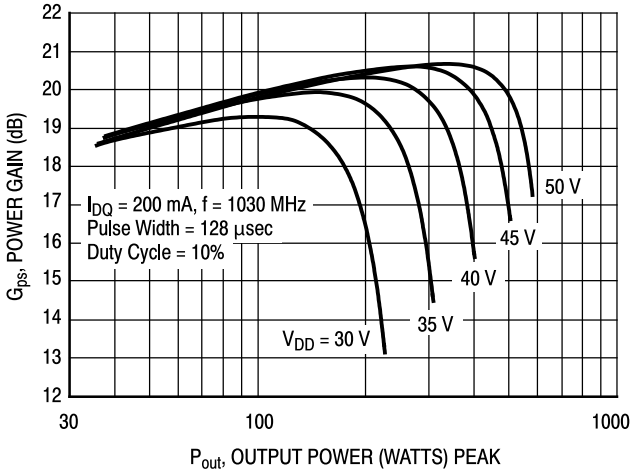


Figure 9. Power Gain versus Output Power

11 Typical characteristics performance graphs — 1030 MHz...*continued*

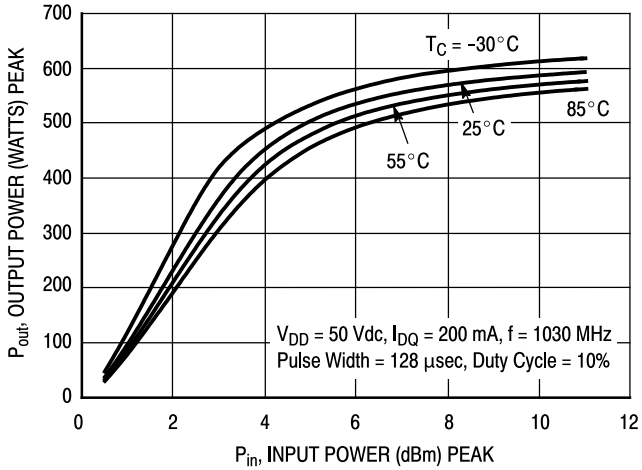


Figure 10. Output Power versus Input Power

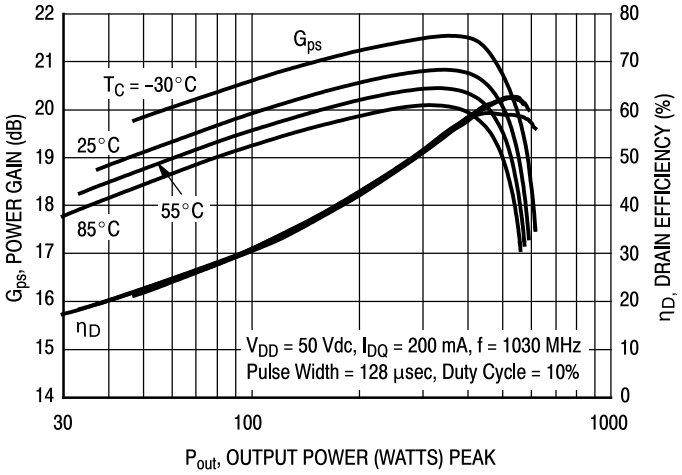
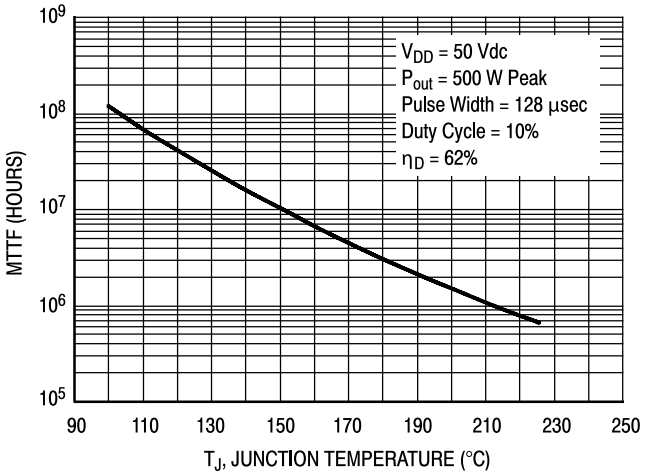


Figure 11. Power Gain and Drain Efficiency versus Output Power



Note: MTTF value represents the total cumulative operating time under indicated test conditions.

Figure 12. MTTF versus Junction Temperature

11 Typical characteristics performance graphs — 1030 MHz...*continued*

V_{DD} = 50 Vdc, I_{DQ} = 200 mA, P_{out} = 500 W Peak

f MHz	Z_{source} Ω	Z_{load} Ω
1030	1.36 – j1.27	2.50 – j0.17

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

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

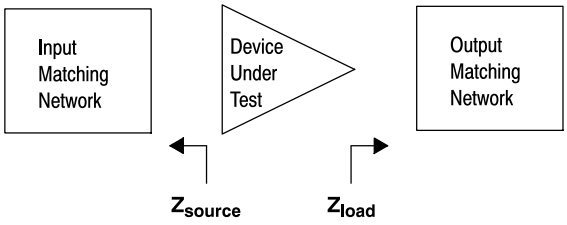


Figure 13. Series Equivalent Source and Load Impedance

12 Component layout and parts list — 960–1215 MHz

12.1 Component layout — 960–1215 MHz

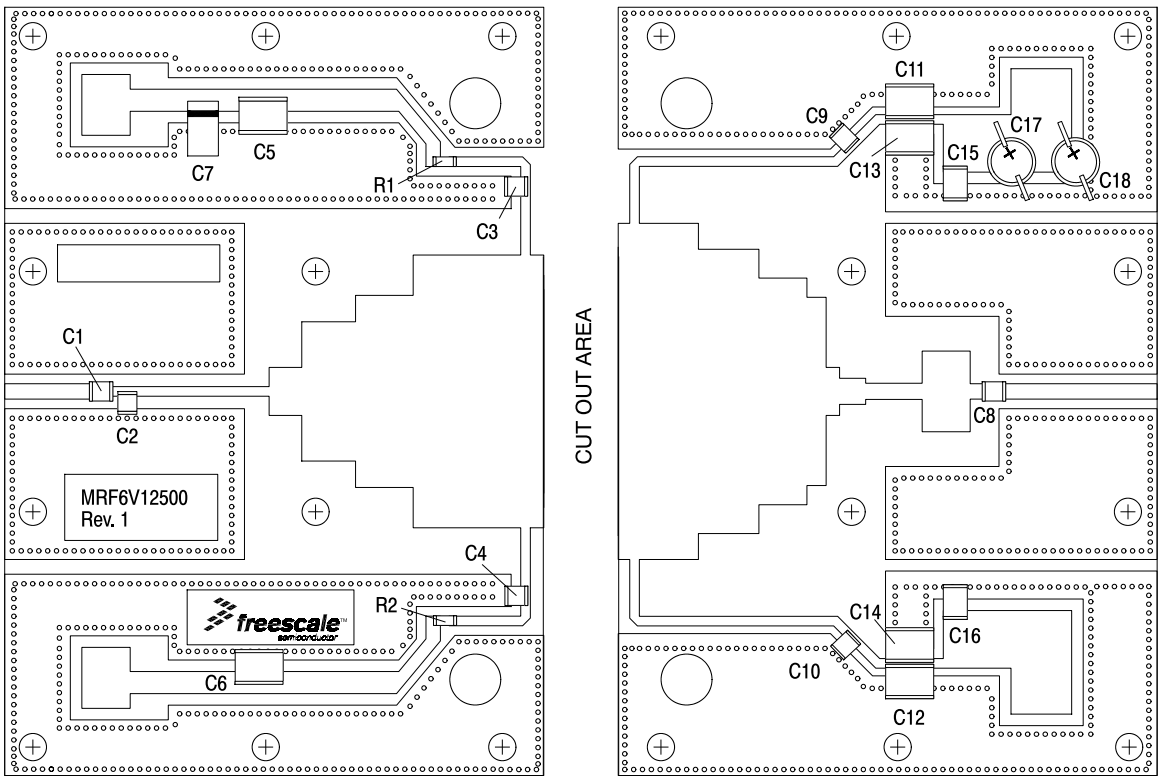


Figure 14. MRF6V12500H(HS) Test Circuit Component Layout — 960–1215 MHz

12.2 Component designations and values — 960–1215 MHz

Table 13. MRF6V12500H(HS) Test Circuit Component Designations and Values — 960–1215 MHz

Part	Description	Part Number	Manufacturer
C1	2.2 pF Chip Capacitor	ATC100B2R2JT500XT	ATC
C2	0.2 pF Chip Capacitor	ATC100B0R2BT500XT	ATC
C3, C4	33 pF Chip Capacitors	ATC100B330JT500XT	ATC
C5, C6, C11, C12	2.2 µF, 100 V Chip Capacitors	G2225X7R225KT3AB	ATC
C7	22 µF, 35 V Tantalum Capacitor	T491X226K035AT	Kemet
C8	8.2 pF Chip Capacitor	ATC100B8R2CT500XT	ATC
C9, C10	39 pF Chip Capacitors	ATC100B390JT500XT	ATC
C13, C14	0.022 µF, 100 V Chip Capacitors	C1825C223K1GAC	Kemet
C15, C16	0.10 µF, 100 V Chip Capacitors	C1812F104K1RAC	Kemet
C17, C18	470 µF, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicomp
R1, R2	22 Ω, 1/4 W Chip Resistors	CRCW120622R0FKEA	Vishay
PCB	0.030″, ε_r = 2.55	AD255A	Arlon

13 Typical characteristics performance graphs — 960–1215 MHz

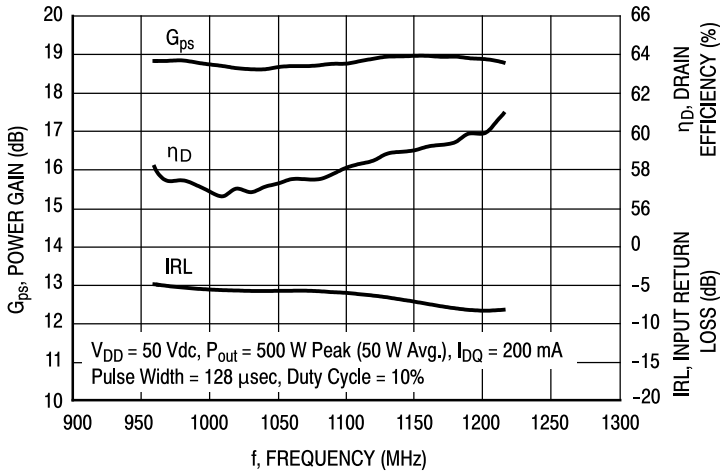


Figure 15. Power Gain, Drain Efficiency and IRL versus Frequency

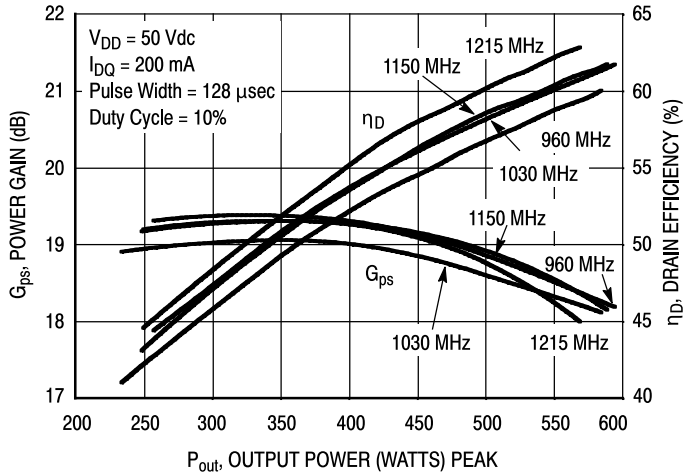
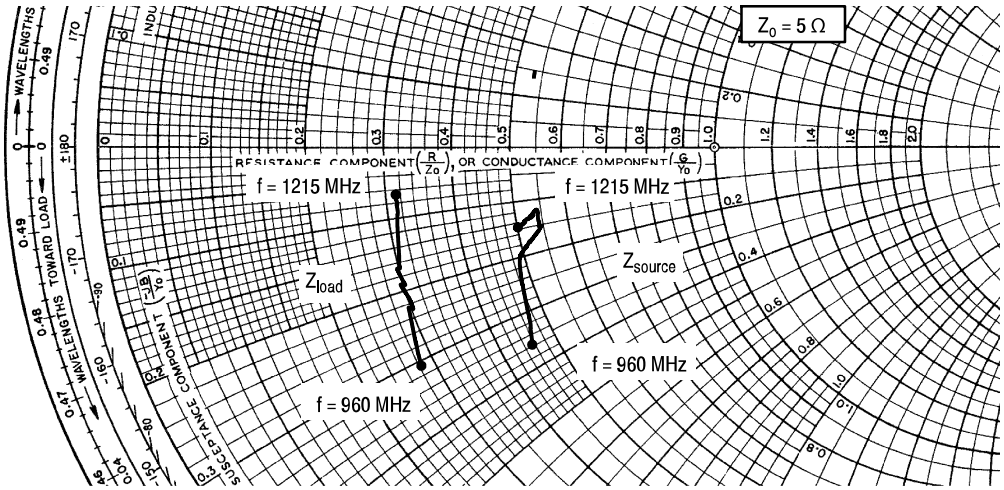


Figure 16. Power Gain and Drain Efficiency versus Output Power

13 Typical characteristics performance graphs — 960–1215 MHz...*continued*



V_{DD} = 50 Vdc, I_{DQ} = 200 mA, P_{out} = 500 W Peak

f MHz	Z_{source} Ω	Z_{load} Ω
960	2.25 – j1.78	1.38 – j1.53
1030	2.51 – j1.02	1.48 – j1.11
1090	2.69 – j0.73	1.51 – j0.78
1150	2.71 – j0.65	1.53 – j0.49
1215	2.48 – j0.76	1.53 – j0.33

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

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

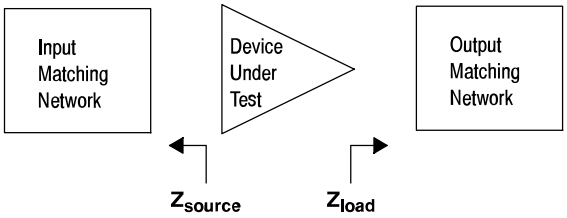
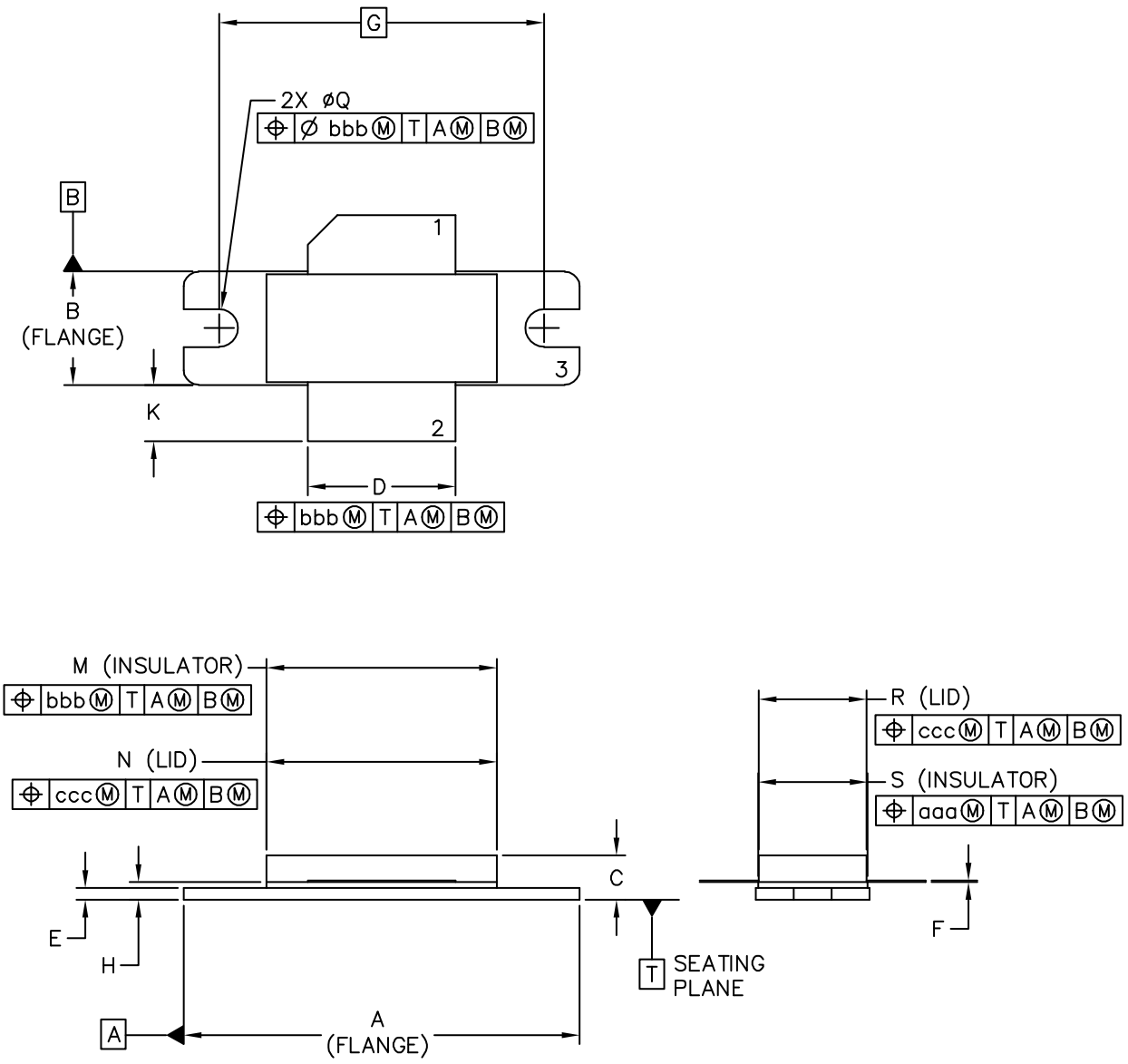


Figure 17. Series Equivalent Source and Load Impedance — 960–1215 MHz

14 Package information



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TITLE: NI–780	DOCUMENT NO: 98ASB15607C	REV: H
	STANDARD: NON–JEDEC	
	SOT1792–1	14 MAR 2016

Figure 18. Package Outline (NI-780H-2L)

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M—1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.762) AWAY FROM PACKAGE BODY.

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	1.335	1.345	33.91	34.16	R	.365	.375	9.27	9.53
B	.380	.390	9.65	9.91	S	.365	.375	9.27	9.52
C	.125	.170	3.18	4.32	aaa	—	.005	—	0.127
D	.495	.505	12.57	12.83	bbb	—	.010	—	0.254
E	.035	.045	0.89	1.14	ccc	—	.015	—	0.381
F	.003	.006	0.08	0.15	—	—	—	—	—
G	1.100 BSC		27.94 BSC		—	—	—	—	—
H	.057	.067	1.45	1.7	—	—	—	—	—
K	.170	.210	4.32	5.33	—	—	—	—	—
M	.774	.786	19.66	19.96	—	—	—	—	—
N	.772	.788	19.6	20	—	—	—	—	—
Q	ø.118	ø.138	ø3	ø3.51	—	—	—	—	—

MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

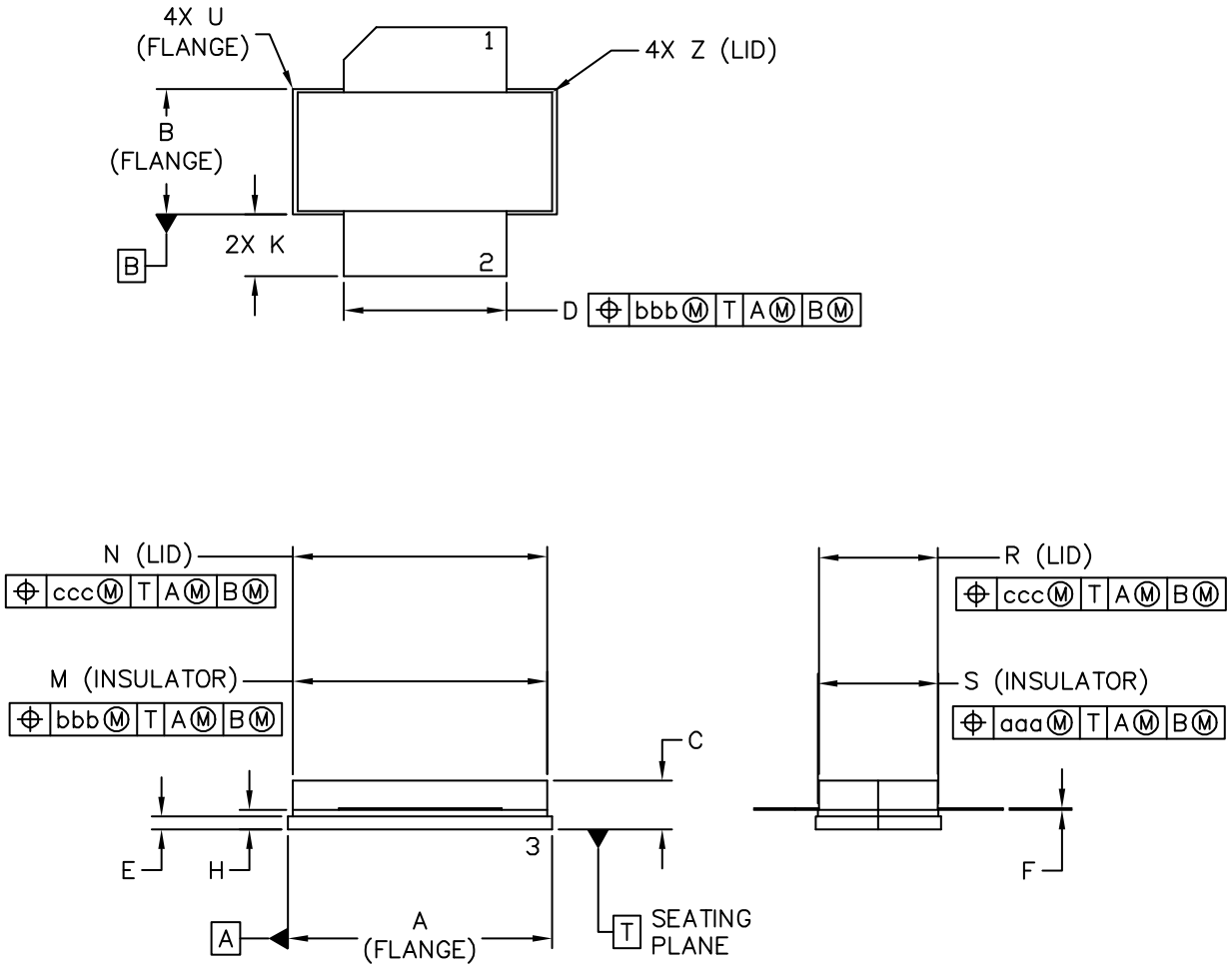
TITLE: NI—780

DOCUMENT NO: 98ASB15607C REV: H

STANDARD: NON—JEDEC

SOT1792—1 14 MAR 2016

Figure 19. Package Outline (NI-780H-2L) — Notes, Dimensions



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TITLE: NI–780S	DOCUMENT NO: 98ASB16718C	REV: J
	STANDARD: NON–JEDEC	
	SOT1793–1	15 MAR 2016

Figure 20. Package Outline (NI-780S-2L)

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M—1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.805	.815	20.45	20.7	U	—	.040	—	1.02
B	.380	.390	9.65	9.91	Z	—	.030	—	0.76
C	.125	.170	3.18	4.32	aaa	.005	—	0.127	—
D	.495	.505	12.57	12.83	bbb	.010	—	0.254	—
E	.035	.045	0.89	1.14	ccc	.015	—	0.381	—
F	.003	.006	0.08	0.15	—	—	—	—	—
H	.057	.067	1.45	1.7	—	—	—	—	—
K	.170	.210	4.32	5.33	—	—	—	—	—
M	.774	.786	19.61	20.02	—	—	—	—	—
N	.772	.788	19.61	20.02	—	—	—	—	—
R	.365	.375	9.27	9.53	—	—	—	—	—
S	.365	.375	9.27	9.52	—	—	—	—	—

MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

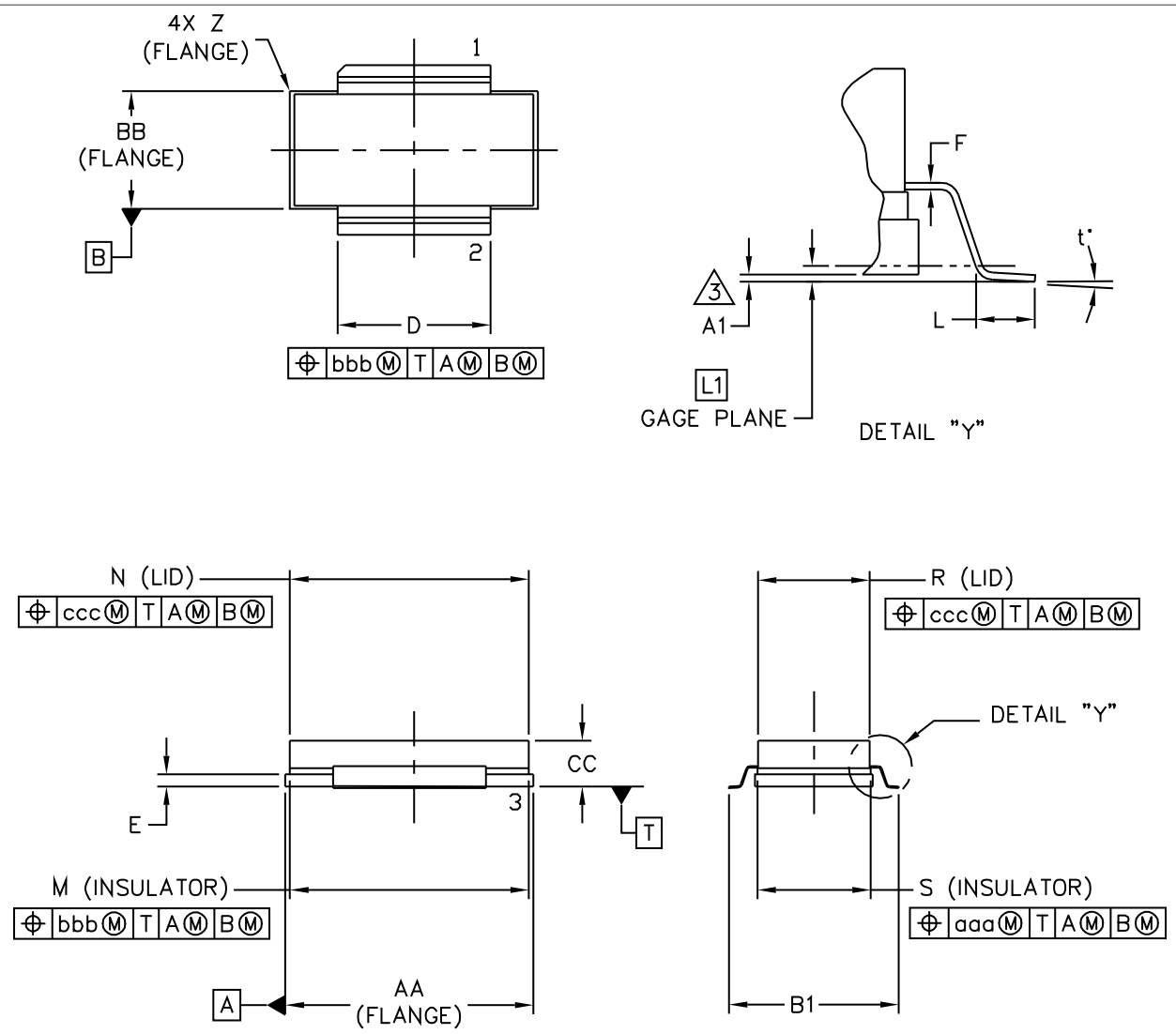
TITLE: NI—780S

DOCUMENT NO: 98ASB16718C REV: J

STANDARD: NON—JEDEC

SOT1793—1 15 MAR 2016

Figure 21. Package Outline (NI-780S-2L) — Notes, Dimensions



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TITLE: NI-780GS-2L	DOCUMENT NO: 98ASA00193D	REV: C
	STANDARD: NON-JEDEC	
	SOT1802-1	22 FEB 2016

Figure 22. Package Outline (NI-780GS-2L)

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH.

3. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM T. THE POSITIVE VALUE IMPLIES THAT THE PACKAGE BOTTOM IS HIGHER THAN THE LEAD BOTTOM.

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
AA	.805	.815	20.45	20.70	Z	R.000	R.040	R0.00	R1.02
A1	.002	.008	0.05	0.20	t°	0°	8°	0°	8°
BB	.380	.390	9.65	9.91					
B1	.546	.562	13.87	14.27					
CC	.125	.170	3.18	4.32	aaa		.005		0.13
D	.495	.505	12.57	12.83	bbb		.010		0.25
E	.035	.045	0.89	1.14	ccc		.015		0.38
F	.003	.006	0.08	0.15					
L	.038	.046	0.97	1.17					
L1	.010 BSC		0.25 BSC						
M	.774	.786	19.66	19.96					
N	.772	.788	19.61	20.02					
R	.365	.375	9.27	9.53					
S	.365	.375	9.27	9.53					

MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

TITLE: NI–780GS–2L

DOCUMENT NO: 98ASA00193D REV: C

STANDARD: NON–JEDEC

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Figure 23. Package Outline (NI-780GS-2L) — Notes, Dimensions

15 Product documentation and software

Refer to the following resources to aid your design process.

Application Notes

- AN1908: Solder Reflow Attach Method for High Power RF Devices in Air Cavity Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

Software

- RF High Power Model

16 Revision history

The following table summarizes revisions to this document.

Table 14. Revision History

Document ID	Release date	Description
MRF6V12500H Rev. 6	25 November 2024	• Table 2, Ordering information: updated the Device column to reflect the correct orderable part numbers, p. 2
MRF6V12500H Rev. 5	13 July 2016	• Added part number MRF6V12500GS, pp. 1, 3 • Added NI-780GS-2L package isometric, p. 1, and Mechanical Outline, pp. 15–16
MRF6V12500H Rev. 4	10 March 2015	• MRF6V12500HR3 tape and reel option replaced with MRF6V12500HR5 and MRF6V12500HSR3 tape and reel option replaced with MRF6V12500HSR5 per PCN15551 • Modified figure titles and/or graph axes labels to clarify application use, pp. 6, 7, 9 • Typical performance table: added Narrowband Mode S ELM application data, p. 1
MRF6V12500H Rev. 3	13 June 2012	• Table 3, ESD Protection Characteristics: added the device's ESD passing level as applicable to each ESD class, p. 2 • Modified figure titles and/or graph axes labels to clarify application use, pp. 5, 6, 9 • Fig. 6, Output Power versus Input Power: corrected P_{out}, Output Power unit of measure to watts, p. 5 • Fig. 9, Output Power versus Input Power: corrected P_{out}, Output Power unit of measure to watts, p. 6 • Fig. 11, MTTF versus Junction Temperature: MTTF end temperature on graph changed to match maximum operating junction temperature, p. 6

Table 14. Revision History*...continued*

Document ID	Release date	Description
MRF6V12500H Rev. 2	15 September 2010	• Maximum Ratings table: corrected V_{DSS} from –0.5, +100 to –0.5, +110 Vdc, p. 2 • Added 960–1215 MHz Broadband application as follows: – Typical Performance, pp. 1, 2 – Fig. 13, Test Circuit Component Layout and Table 6, Test Circuit Component Designations and Values, p. 8 – Fig. 14, Pulsed Power Gain, Drain Efficiency and IRL versus Frequency, p. 9 – Fig. 15, Power Gain and Drain Efficiency versus Output Power, p. 9 – Fig. 16, Series Equivalent Source and Load Impedance, p. 10
MRF6V12500H Rev. 1	28 April 2010	• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and related “Continuous use at maximum temperature will affect MTTF” footnote added, p. 1 • Added RF High Power Model availability to Product Software, p. 9
MRF6V12500H Rev. 0	14 September 2009	• Initial Release of Data Sheet

Legal information

Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL https://www.nxp.com.

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