Document Number: MRFX035H
Rev. 0, 12/2018

RF Power LDMOS Transistor

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFET

This high ruggedness device is designed for use in high VSWR industrial, medical, broadcast, aerospace and mobile radio applications. Its unmatched input and output design supports frequency use from 1.8 to 512 MHz.

Typical Performance: V_{DD} = 65 Vdc

Frequency (MHz)	Signal Type	P_{out} (W)	G_{ps} (dB)	η_D (%)
1.8–54 (1,2)	CW	32 CW	24.1	58.1
30–400 (2)	CW	26 CW	15.1	42.3
230 (3)	CW	35 CW	24.8	75.8

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (dBm)	Test Voltage	Result
230 (3)	CW	> 65:1 at all Phase Angles	23.5 (3 dB Overdrive)	65	No Device Degradation

1. Measured in 1.8–54 MHz broadband reference circuit (page 5).
2. The values shown are the minimum measured performance numbers across the indicated frequency range.
3. Measured in 230 MHz production test fixture (page 10).

Features

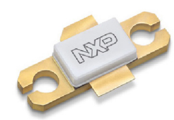
- Unmatched input and output allowing wide frequency range utilization
- 50 ohm native output impedance
- Qualified up to a maximum of 65 V_{DD} operation
- Characterized from 30 to 65 V for extended power range
- High breakdown voltage for enhanced reliability
- Suitable for linear application with appropriate biasing
- Integrated ESD protection with greater negative gate-source voltage range for improved Class C operation
- Included in NXP product longevity program with assured supply for a minimum of 15 years after launch

Typical Applications

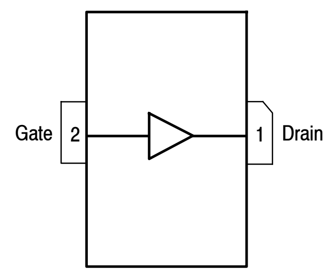
- Industrial, scientific, medical (ISM)
  – Laser generation
  – Plasma generation
  – Particle accelerators
  – MRI, RF ablation and skin treatment
  – Industrial heating, welding and drying systems
- Radio and VHF TV broadcast
- Aerospace
  – HF communications
  – Radar
- Mobile radio
  – HF and VHF communications
  – PMR base stations

MRFX035H

1.8–512 MHz, 35 W CW, 65 V WIDEBAND RF POWER LDMOS TRANSISTOR



NI-360H-2SB



(Top View)

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

Figure 1. Pin Connections

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	–0.5, +179	Vdc
Gate-Source Voltage	V_{GS}	–6.0, +10	Vdc
Storage Temperature Range	T_{stg}	–65 to +150	°C
Case Operating Temperature Range	T_C	–40 to +150	°C
Operating Junction Temperature Range (1,2)	T_J	–40 to +225	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	154 0.769	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case CW: Case Temperature 74.2°C, 35 W CW, 65 Vdc, I_{DQ} = 15 mA, 230 MHz	$R_{\theta JC}$	1.3	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JS-001-2017)	2, passes 2500 V
Charge Device Model (per JS-002-2014)	C3, passes 1200 V

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	400	nAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 250 μAdc)	$V_{(BR)DSS}$	179	193	—	Vdc
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} = 179 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	300	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 640 μAdc)	$V_{GS(th)}$	1.7	2.75	3.0	Vdc
Gate Quiescent Voltage (V_{DD} = 65 Vdc, I_D = 15 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2.5	3.0	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 100 mAdc)	$V_{DS(on)}$	—	0.17	—	Vdc
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 65 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.13	—	pF
Output Capacitance (V_{DS} = 65 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	13.7	—	pF
Input Capacitance (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	42.8	—	pF

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.nxp.com/RF/calculators.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.

(continued)

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (In NXP Production Test Fixture, 50 ohm system) V_{DD} = 65 Vdc, I_{DQ} = 15 mA, P_{out} = 35 W CW, f = 230 MHz					
Power Gain	G_{ps}	23.5	24.8	26.5	dB
Drain Efficiency	η_D	72.0	75.8	—	%
Input Return Loss	IRL	—	–16	–11	dB

Load Mismatch/Ruggedness (In NXP Production Test Fixture, 50 ohm system) I_{DQ} = 15 mA

Frequency (MHz)	Signal Type	VSWR	P_{in} (dBm)	Test Voltage, V_{DD}	Result
230	CW	> 65:1 at all Phase Angles	23.5 (3 dB Overdrive)	65	No Device Degradation

Table 5. Ordering Information

Device	Tape and Reel Information	Package
MRFX035HR5	R5 Suffix = 50 Units, 32 mm Tape Width, 13-inch Reel	NI-360H-2SB

TYPICAL CHARACTERISTICS

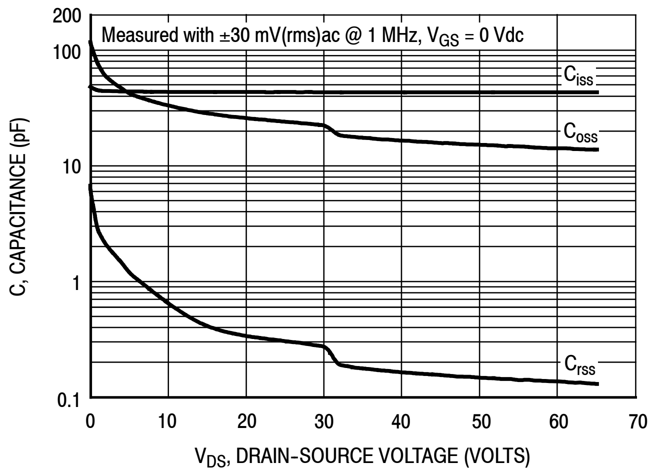
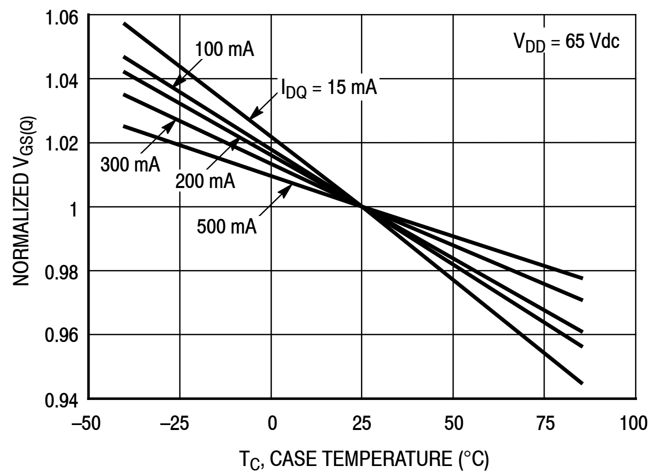
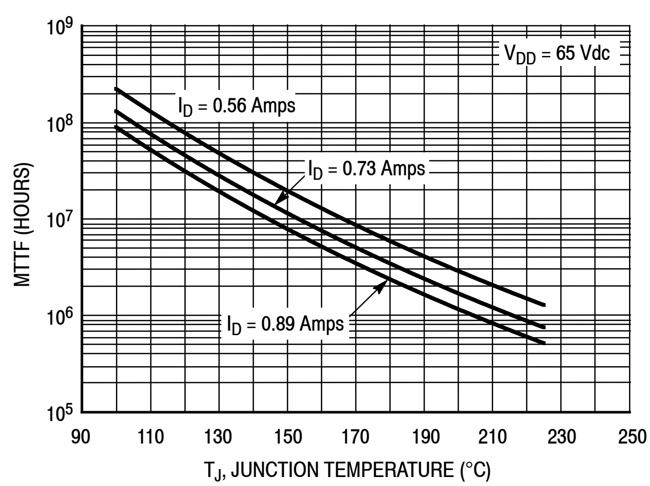


Figure 2. Capacitance versus Drain-Source Voltage



I_{DQ} (mA)	Slope (mV/°C)
15	–2.88
100	–2.32
200	–2.16
300	–1.76
500	–1.36

Figure 3. Normalized V_{GS} versus Quiescent Current and Case Temperature



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

MTTF calculator available at http://www.nxp.com/RF/calculators.

Figure 4. MTTF versus Junction Temperature — CW

1.8–54 MHz BROADBAND REFERENCE CIRCUIT — 2.0″ × 3.0″ (5.1 cm × 7.6 cm)

Table 6. 1.8–54 MHz HF Broadband Performance (In NXP Reference Circuit, 50 ohm system)
V_{DD} = 65 Vdc, I_{DQ} = 25 mA, P_{in} = 22 dBm, CW

Frequency (MHz)	P_{out} (W)	G_{ps} (dB)	η_D (%)
1.8	39	24.9	65.7
7.2	42	25.2	69.3
14.2	43	25.3	70.3
54	32	24.1	58.1

1.8–54 MHz BROADBAND REFERENCE CIRCUIT — 2.0″ × 3.0″ (5.1 cm × 7.6 cm)

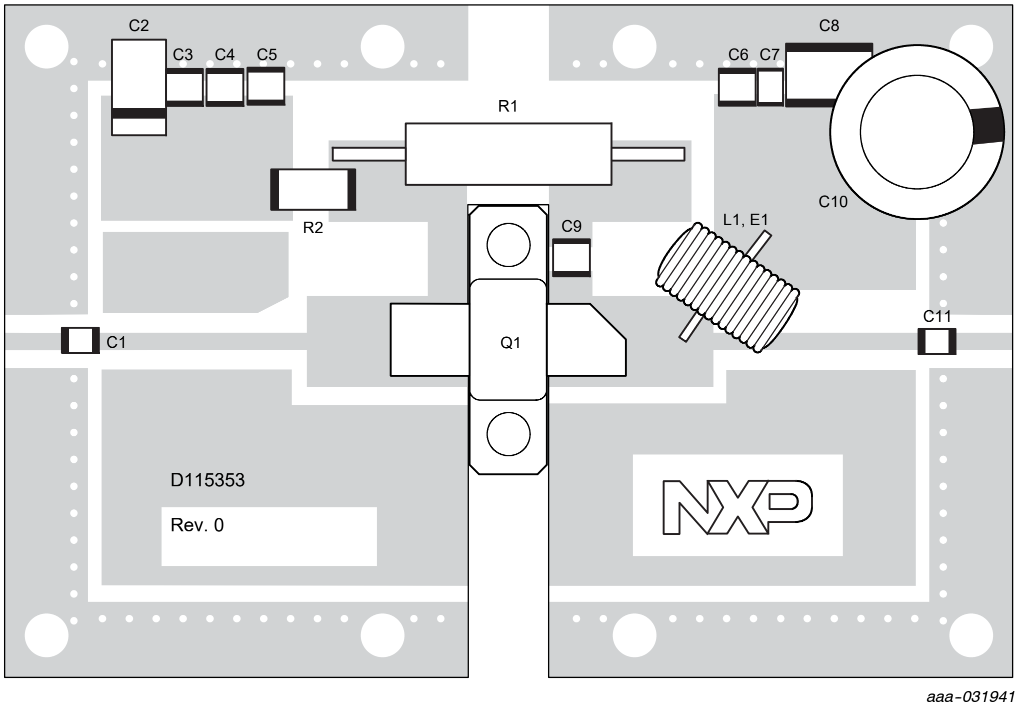


Figure 5. MRFX035H Broadband Reference Circuit Component Layout — 1.8–54 MHz

Table 7. MRFX035H Broadband Reference Circuit Component Designations and Values — 1.8–54 MHz

Part	Description	Part Number	Manufacturer
C1, C5, C6, C9, C11	22 nF Chip Capacitor	C3216NP02A223J160AA	TDK
C2	10 μF, 35 V Tantalum Capacitor	T491D106K035AT	Kemet
C3	0.1 μF Chip Capacitor	C1206C104K1RACTU	Kemet
C4	2.2 μF Chip Capacitor	C3225X7R1H225K	TDK
C7	0.1 μF Chip Capacitor	C3216C0G2A104J160AE	TDK
C8	2.2 μF Chip Capacitor	G2225X7R225KT3AB	ATC
C10	220 μF, 100 V Electrolytic Capacitor	MCGPR100V227M16X26	Multicomp
E1	61 Ferrite Toroid	5961001101	Fair-Rite
L1	26 Turns, 23 AWG, Toroid Transformer with Ferrite E1	MW0454 Copper Magnet Wire	Temco
Q1	RF Power LDMOS Transistor	MRFX035H	NXP
R1	1 kΩ, 3 W Axial Leaded Resistor	CPF31K0000FKE14	Vishay
R2	330 Ω, 1 W Chip Resistor	RMCF2512JT330R	Stackpole Electronics
PCB	FR4 0.30″, ε_r = 4.8, 1 oz. Copper	D115353	MTL

TYPICAL CHARACTERISTICS — 1.8–54 MHz BROADBAND REFERENCE CIRCUIT

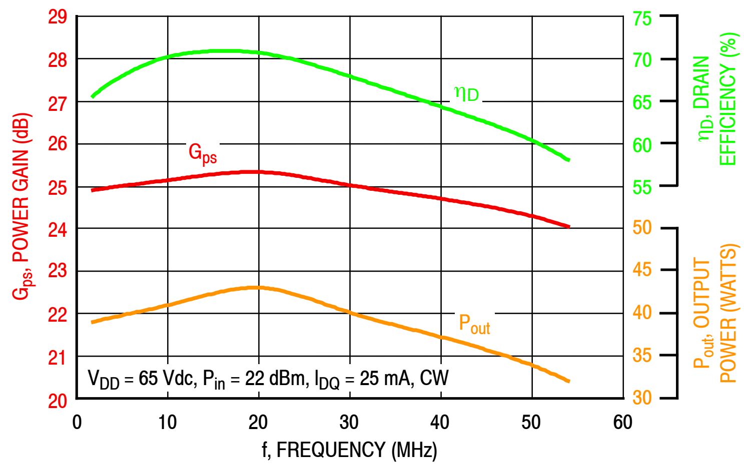


Figure 6. Power Gain, Drain Efficiency and CW Output Power versus Frequency at a Constant Input Power

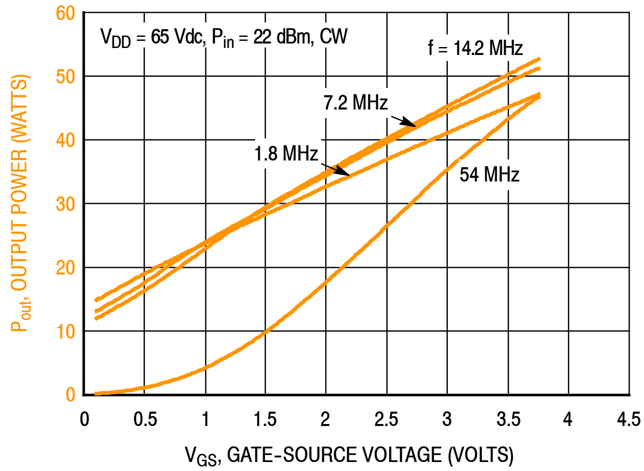
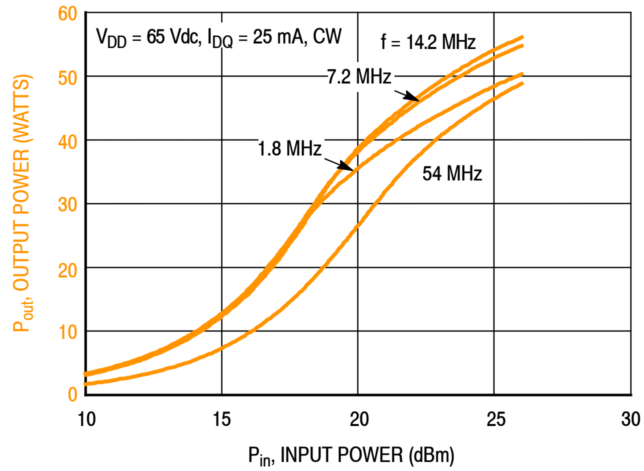


Figure 7. CW Output Power versus Gate-Source Voltage at a Constant Input Power



f (MHz)	P1dB (W)	P3dB (W)
1.8	36.4	44.6
7.2	43.7	51.3
14.2	44.5	52.4
54	38.7	47.7

Figure 8. CW Output Power versus Input Power

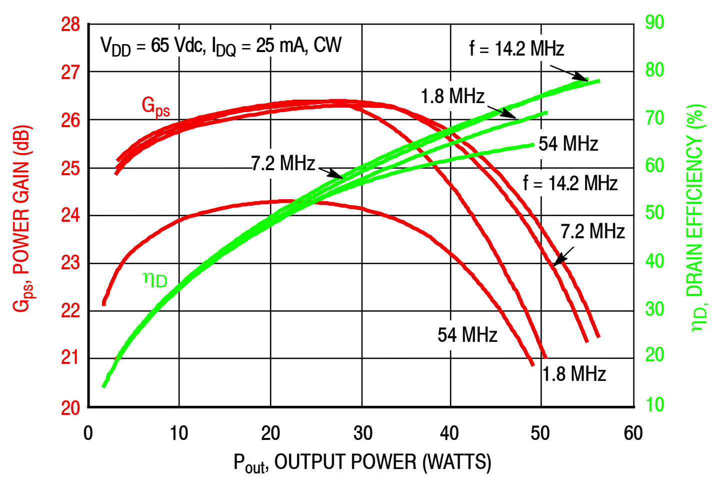


Figure 9. Power Gain and Drain Efficiency versus CW Output Power and Frequency

TYPICAL CHARACTERISTICS — 1.8–54 MHz BROADBAND REFERENCE CIRCUIT — TWO-TONE (1)

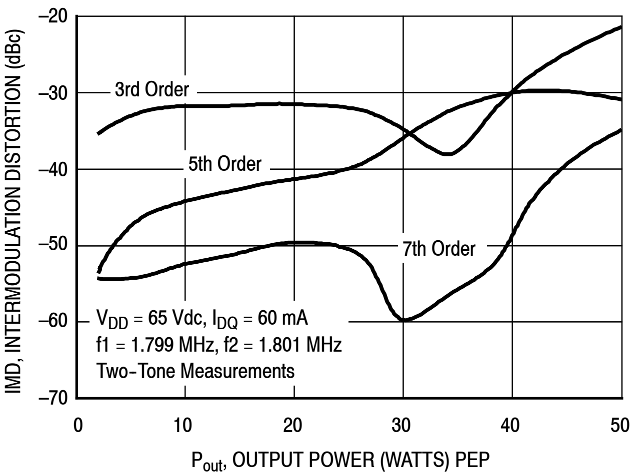


Figure 10. Intermodulation Distortion Products versus Output Power — 1.8 MHz

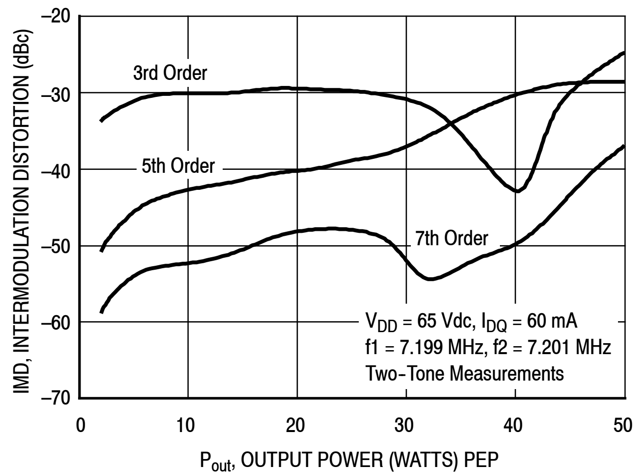


Figure 11. Intermodulation Distortion Products versus Output Power — 7.2 MHz

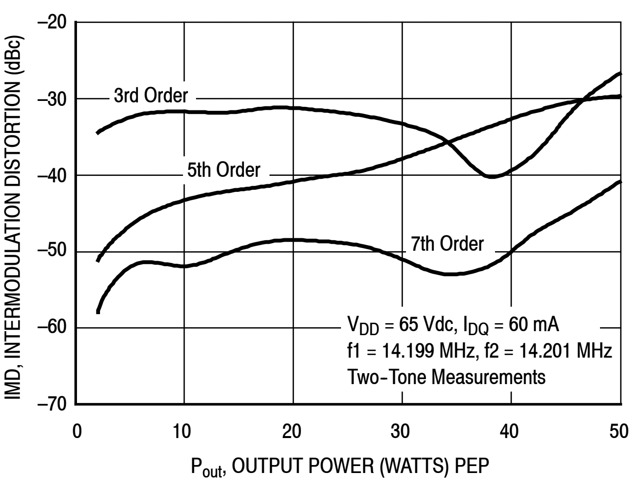


Figure 12. Intermodulation Distortion Products versus Output Power — 14.2 MHz

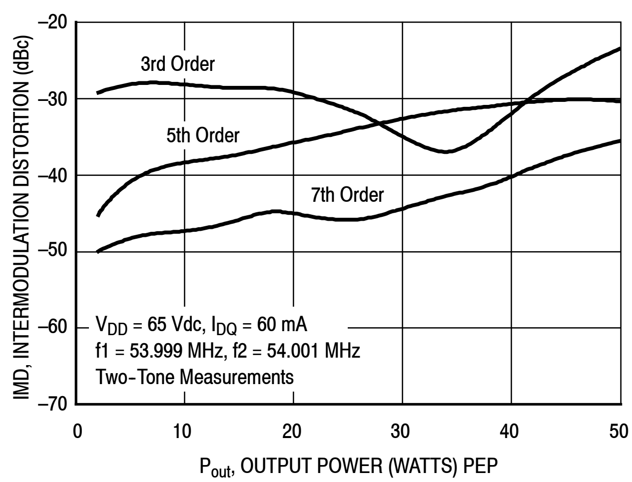


Figure 13. Intermodulation Distortion Products versus Output Power — 54 MHz

1. The distortion products are referenced to one of the two tones and the peak envelope power (PEP) is 6 dB above the power in a single tone.

1.8–54 MHz BROADBAND REFERENCE CIRCUIT

f MHz	Z_{source} Ω	Z_{load} Ω
1.8	42.6 – j2.98	48.8 + j0.18
7.2	42.5 – j1.78	48.5 – j1.37
14.2	42.4 – j2.46	48.3 – j2.80
54	41.3 – j8.14	46.5 – j10.59

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

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

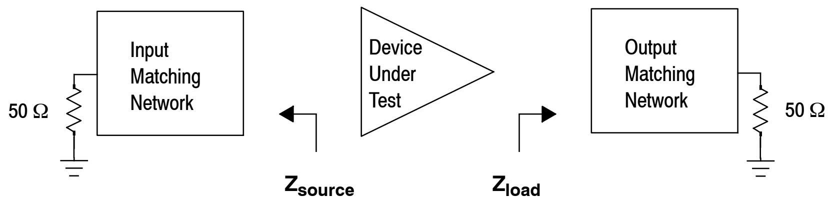


Figure 14. Broadband Series Equivalent Source and Load Impedance — 1.8–54 MHz

230 MHz PRODUCTION TEST FIXTURE — 3.0″ × 5.0″ (7.6 cm × 12.7 cm)

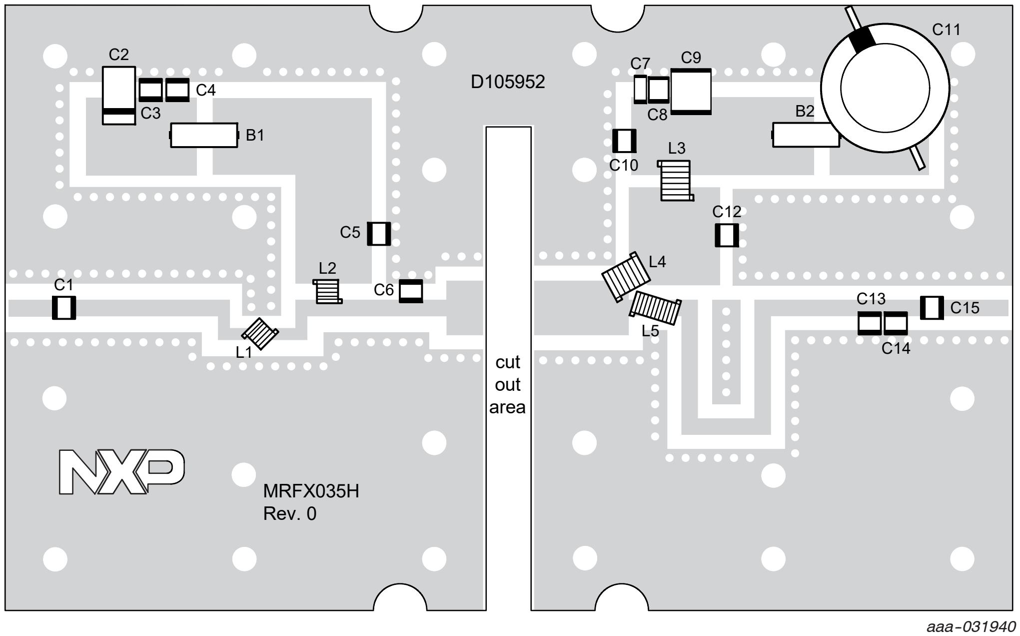


Figure 15. MRFX035H Production Test Fixture Component Layout — 230 MHz

Table 8. MRFX035H Production Test Fixture Component Designations and Values — 230 MHz

Part	Description	Part Number	Manufacturer
B1, B2	Long RF Bead	2743021447	Fair-Rite
C1	15 pF Chip Capacitor	ATC100B150JT500XT	ATC
C2	22 μF, 35 V Tantalum Capacitor	T491X226K035AT	Kemet
C3	2.2 μF Chip Capacitor	C3225X7R1H225K250AB	TDK
C4	0.1 μF Chip Capacitor	CDR33BX104AKWS	AVX
C5, C10, C12, C15	1000 pF Chip Capacitor	ATC100B102JT50XT	ATC
C6	5.1 pF Chip Capacitor	ATC100B5R1CT500XT	ATC
C7	0.1 μF Chip Capacitor	C1206C104K1RACTU	Kemet
C8	1 μF Chip Capacitor	C3225JB2A105K200AA	TDK
C9	15 μF Chip Capacitor	C5750X7S2A156M230KB	TDK
C11	470 μF, 100 V Electrolytic Capacitor	MCGPR100V477M16X32	Multicomp
C13, C14	5.6 pF Chip Capacitor	ATC100B5R6C500XT	ATC
L1	5.0 nH, 2 Turn Inductor	A02TJLC	Coilcraft
L2	8.0 nH, 3 Turn Inductor	A03TJLC	Coilcraft
L3	120 nH Inductor	1812SMS-R12JLC	Coilcraft
L4	100 nH Inductor	1812SMS-R10JLC	Coilcraft
L5	28 nH, 8 Turn Inductor	B08TJLC	Coilcraft
PCB	Rogers AD255C, 0.030″, ε_r = 2.55, 1 oz. Copper	D105952	MTL

TYPICAL CHARACTERISTICS — 230 MHz, T_C = 25°C
PRODUCTION TEST FIXTURE

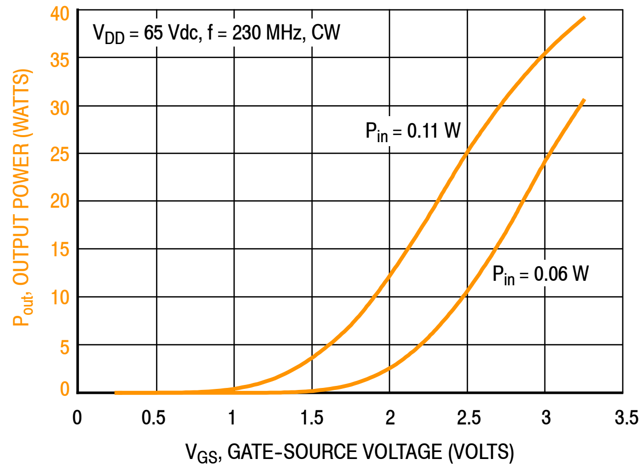
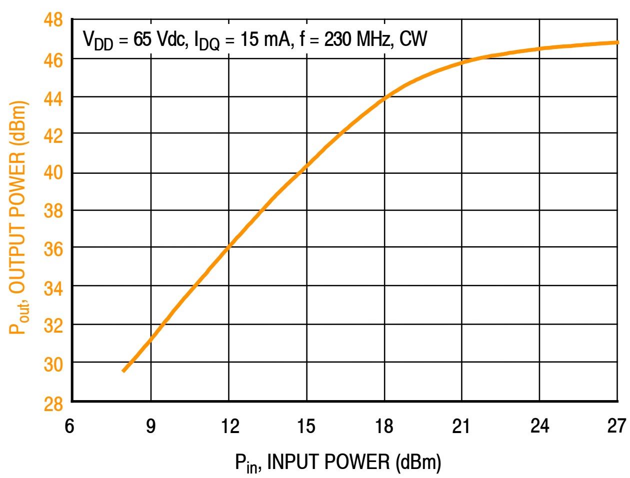


Figure 16. Output Power versus Gate-Source Voltage at a Constant Input Power



f (MHz)	P1dB (W)	P3dB (W)
230	37	43

Figure 17. Output Power versus Input Power

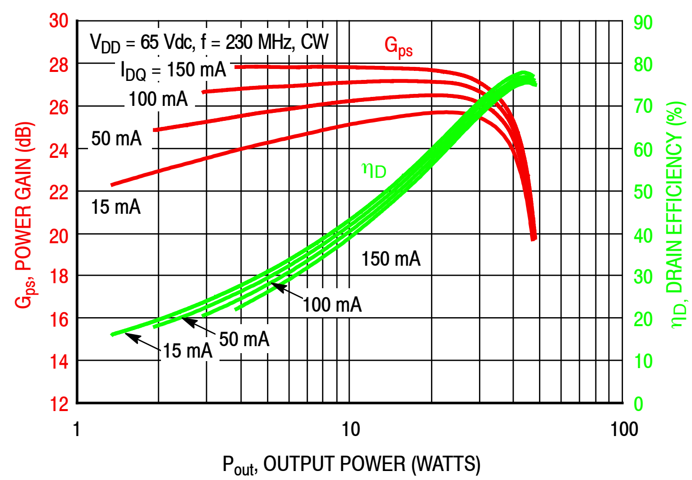


Figure 18. Power Gain and Drain Efficiency versus Output Power and Quiescent Current

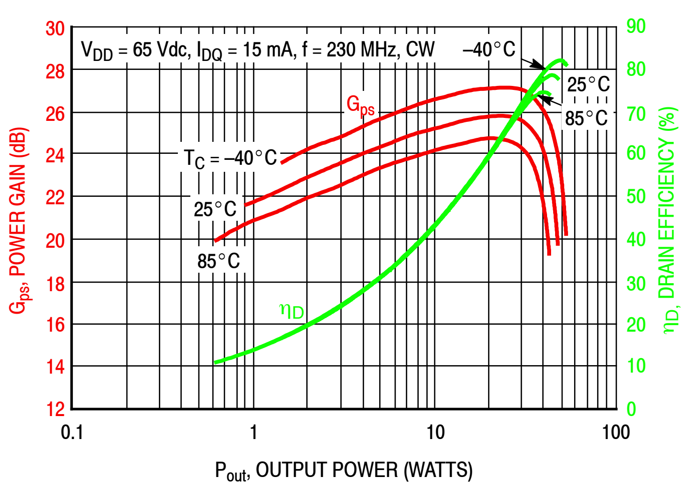


Figure 19. Power Gain and Drain Efficiency versus Output Power

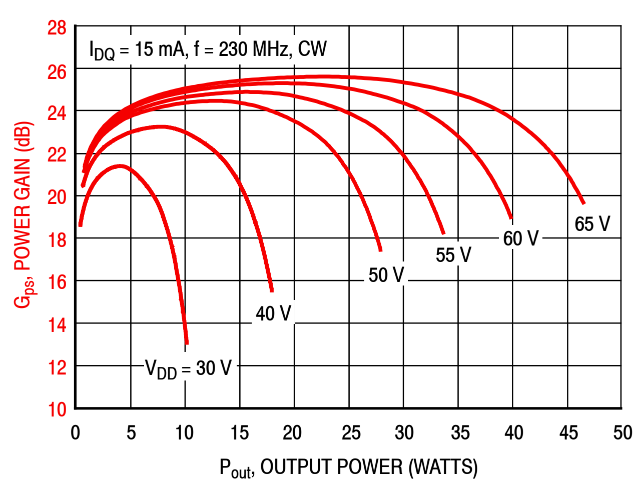


Figure 20. Power Gain versus Output Power and Drain-Source Voltage

230 MHz PRODUCTION TEST FIXTURE

f MHz	Z_{source} Ω	Z_{load} Ω
230	3.1 + j27.0	16.2 + j39.5

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

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

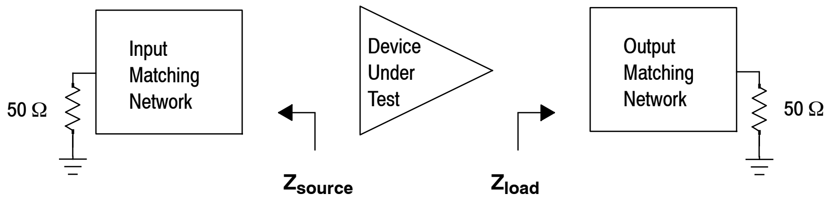
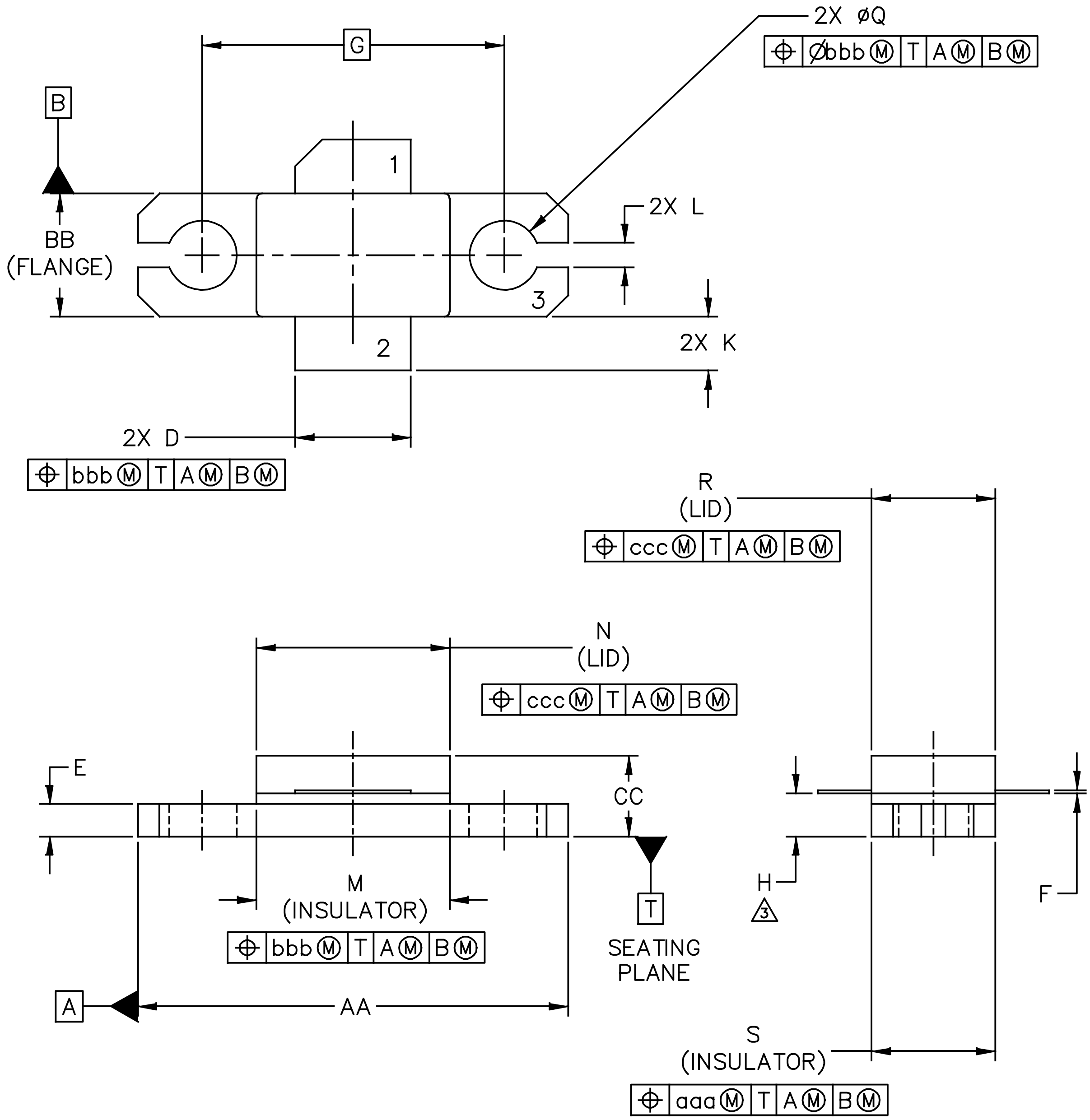


Figure 21. Series Equivalent Source and Load Impedance — 230 MHz

PACKAGE DIMENSIONS



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	STANDARD: NON−JEDEC	
	SOT1791−1	17 FEB 2016

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH

3. (△) DIMENSION H IS MEASURED .030 INCH (0.762 MM) AWAY FROM THE FLANGE TO CLEAR THE EPOXY FLOW OUT REGION PARALLEL TO DATUM B.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
AA	.795	.805	20.19	20.45	N	.357	.363	9.07	9.22
BB	.225	.235	5.72	5.97	Q	.125	.135	3.18	3.43
CC	.125	.175	3.18	4.45	R	.227	.233	5.77	5.92
D	.210	.220	5.33	5.59	S	.225	.235	5.72	5.97
E	.055	.065	1.40	1.65					
F	.004	.006	0.10	0.15	aaa	.005		0.13	
G	.562 BSC		14.28 BSC		bbb	.010		0.25	
H	.077	.087	1.96	2.21	ccc	.015		0.38	
K	.085	.115	2.16	2.92					
L	.040	.050	1.02	1.27					
M	.355	.365	9.02	9.27					

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	STANDARD: NON–JEDEC	
	SOT1791–1	17 FEB 2016

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

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

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

Development Tools

- Printed Circuit Boards

To Download Resources Specific to a Given Part Number:

1. Go to http://www.nxp.com/RF
2. Search by part number
3. Click part number link
4. Choose the desired resource from the drop down menu

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Dec. 2018	• Initial release of data sheet