Document Number: AFT05MS003N
Rev. 0, 8/2015

RoHS

RF Power LDMOS Transistor

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFET

Designed for handheld two-way radio applications with frequencies from 1.8 to 941 MHz. The high gain, ruggedness and wideband performance of this device make it ideal for large-signal, common-source amplifier applications in handheld radio equipment.

Wideband Performance (7.5 Vdc, T_A = 25°C, CW)

Frequency (MHz)	P_{in} (dBm)	G_{ps} (dB)	η_D (%)	P_{out} (W)
136–174 (1,4)	17.8	17.1	67.1	3.2
350–520 (2,4)	20.0	15.1	73.0	3.2

Narrowband Performance (7.5 Vdc, T_A = 25°C, CW)

Frequency (MHz)	G_{ps} (dB)	η_D (%)	P_{out} (W)
520 (3)	20.8	68.3	3.0

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (dBm)	Test Voltage	Result
520 (3)	CW	> 65:1 at all Phase Angles	21.1	9.0	No Device Degradation

1. Measured in 136–174 MHz VHF broadband reference circuit.
2. Measured in 350–520 MHz UHF broadband reference circuit.
3. Measured in 520 MHz narrowband production test circuit.
4. The values shown are the center band performance numbers across the indicated frequency range.

AFT05MS003N

1.8–941 MHz, 3 W, 7.5 V WIDEBAND AIRFAST RF POWER LDMOS TRANSISTOR

SOT-89

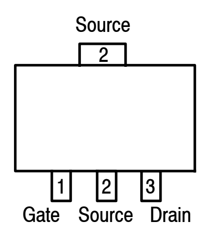


Figure 1. Pin Connections

Features

- Characterized for Operation from 1.8 to 941 MHz
- Unmatched Input and Output Allowing Wide Frequency Range Utilization
- Integrated ESD Protection
- Integrated Stability Enhancements
- Wideband — Full Power Across the Band
- Exceptional Thermal Performance
- Extreme Ruggedness

Typical Applications

- Output Stage VHF Band Handheld Radio
- Output Stage UHF Band Handheld Radio
- Output Stage for 700–900 MHz Handheld Radio
- Smart Metering
- Driver for 1.8–941 MHz Applications

freescale Airfast

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	–0.5, +30	Vdc
Gate-Source Voltage	V_{GS}	–6.0, +12	Vdc
Operating Voltage	V_{DD}	12.5, +0	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 +150	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	30.5 0.24	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value [2,3]	Unit
Thermal Resistance, Junction to Case Case Temperature 79°C, 3 W CW, 7.5 Vdc, I_{DQ} = 100 mA, 520 MHz	$R_{\theta JC}$	4.1	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1C, passes 1000 V
Machine Model (per EIA/JESD22-A115)	A, passes 100 V
Charge Device Model (per JESD22-C101)	IV, passes 2000 V

Table 4. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	1	260	°C

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 30 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	2	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 7.5 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	500	nAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 67 μAdc)	$V_{GS(th)}$	1.8	2.2	2.6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 700 mAdc)	$V_{DS(on)}$	—	0.25	—	Vdc
Forward Transconductance (V_{DS} = 7.5 Vdc, I_D = 2.6 Adc)	g_{fs}	—	3.1	—	S
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 7.5 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.1	—	pF
Output Capacitance (V_{DS} = 7.5 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	23.2	—	pF
Input Capacitance (V_{DS} = 7.5 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	38.5	—	pF

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

(continued)

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performance (In Freescale Narrowband Production Test Fixture, 50 ohm system) V_{DD} = 7.5 Vdc, I_{DQ} = 100 mA, P_{in} = 13.95 dBm, f = 520 MHz					
Common-Source Amplifier Output Power	P_{out}	—	3.0	—	W
Drain Efficiency	η_D	—	68.3	—	%

Load Mismatch/Ruggedness (In Freescale Narrowband Production Test Fixture, 50 ohm system) I_{DQ} = 100 mA

Frequency (MHz)	Signal Type	VSWR	P_{in} (dBm)	Test Voltage, V_{DD}	Result
520	CW	> 65:1 at all Phase Angles	21.1	9.0	No Device Degradation

Table 6. Ordering Information

Device	Tape and Reel Information	Package
AFT05MS003NT1	T1 Suffix = 1,000 Units, 12 mm Tape Width, 7-inch Reel	SOT-89

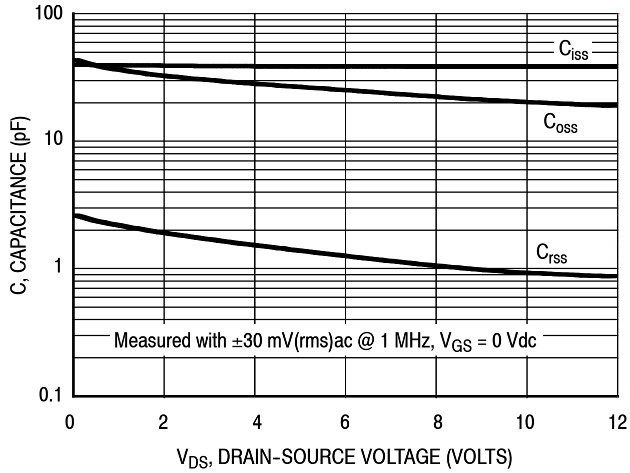
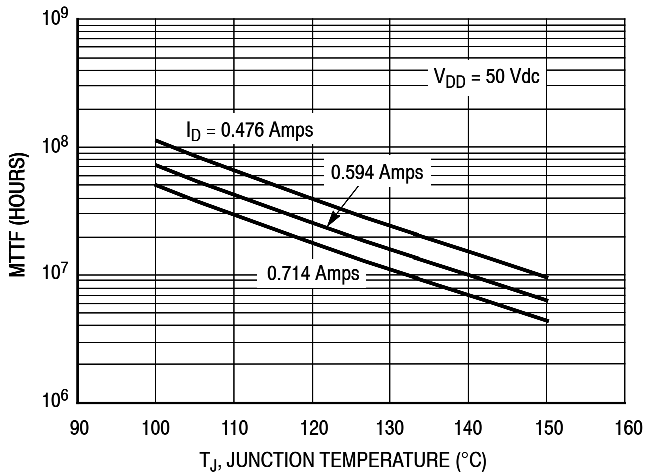


Figure 2. Capacitance versus Drain-Source Voltage



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

MTTF calculator available at http:/www.freescale.com/rf/calculators.

Figure 3. MTTF versus Junction Temperature — CW

136–174 MHz VHF BROADBAND REFERENCE CIRCUIT

Table 7. 136–174 MHz VHF Broadband Performance (In Freescale VHF Broadband Reference Circuit, 50 ohm system) V_{DD} = 7.5 Volts, I_{DQ} = 60 mA, T_A = 25°C, CW

Frequency (MHz)	P_{in} (dBm)	G_{ps} (dB)	η_D (%)	P_{out} (W)
135	17.8	17.5	68.1	3.5
155	17.8	17.1	67.1	3.2
175	17.8	17.2	65.6	3.3

Table 8. Load Mismatch/Ruggedness (In Freescale VHF Broadband Reference Circuit)

Frequency (MHz)	Signal Type	VSWR	P_{in} (dBm)	Test Voltage, V_{DD}	Result
155	CW	> 65:1 at all Phase Angles	20.0	9.0	No Device Degradation

136–174 MHz VHF BROADBAND REFERENCE CIRCUIT — 0.83″ × 1.86″ (2.1 cm × 4.7 cm)

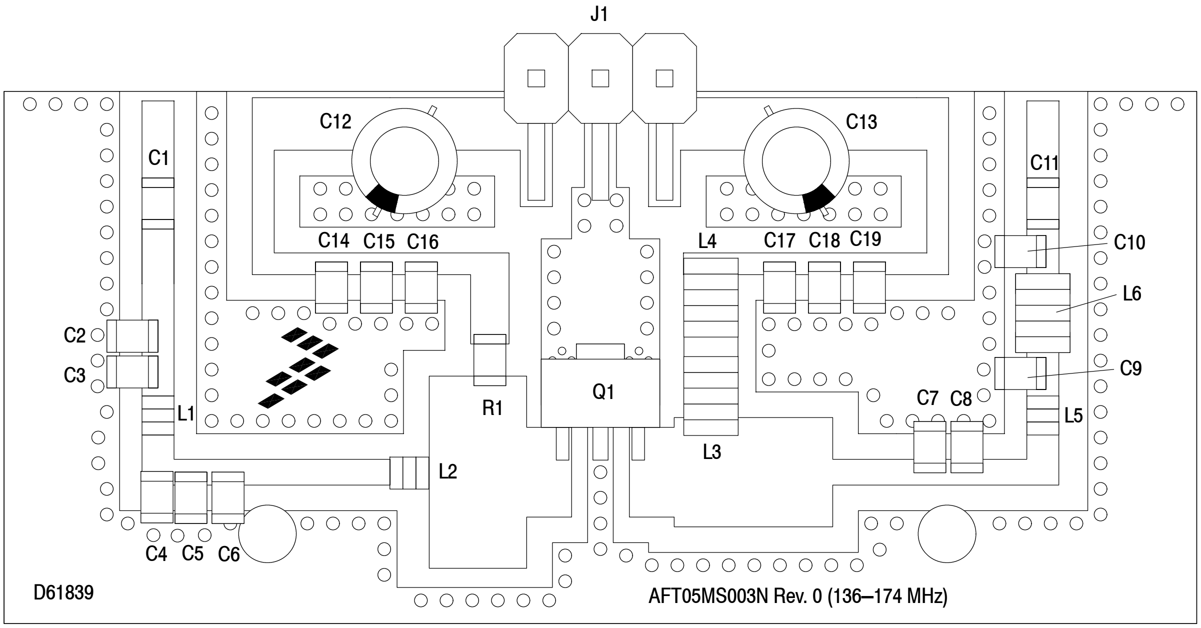


Figure 4. AFT05MS003N VHF Broadband Reference Circuit Component Layout — 136–174 MHz

Table 9. AFT05MS003N VHF Broadband Reference Circuit Component Designations and Values — 136–174 MHz

Part	Description	Part Number	Manufacturer
C1, C11	1500 pF Chip Capacitors	C2012X7R2A152K085AM	TDK
C2, C3, C4, C5, C8	56 pF Chip Capacitors	GQM2195C2E560GB12D	Murata
C6, C7	47 pF Chip Capacitors	GQM2195C2E470GB12D	Murata
C9	39 pF Chip Capacitor	GQM2195C2E390GB12D	Murata
C10	20 pF Chip Capacitor	GQM2195C2E200GB12D	Murata
C12, C13	10 μF, 50 V Electrolytic Capacitors	UVR1H100MDD	Nichicon
C14, C19	1 μF Chip Capacitors	GRM21BR71H105KA12L	Murata
C15, C18	1 nF Chip Capacitors	C2012X7R2E102M	TDK
C16, C17	100 pF Chip Capacitors	ATC600F101JT250XT	ATC
J1	Right-Angle Breakaway Headers (3 pins)	22-28-8360	Molex
L1	12.1 nH Inductor	0908SQ12N	Coilcraft
L2	11.2 nH Inductor	0807SQ11N	Coilcraft
L3, L4	25.0 nH Inductors	0908SQ25N	Coilcraft
L5	17.0 nH Inductor	0908SQ17N	Coilcraft
L6	23.0 nH Inductor	0908SQ23N	Coilcraft
Q1	RF Power LDMOS Transistor	AFT05MS003NT1	Freescale
R1	100 Ω, 1/4 W Chip Resistor	CRCW1206100RFKEA	Vishay
PCB	0.020″, ε_r = 4.8, FR4 (S-1000)	D61839	MTL

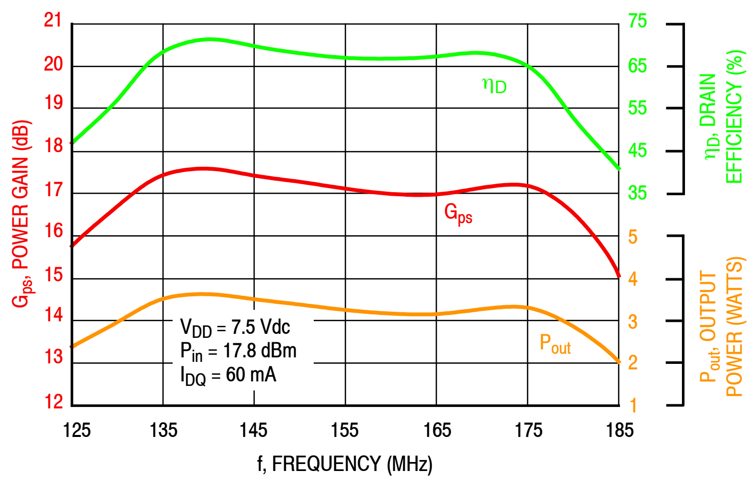
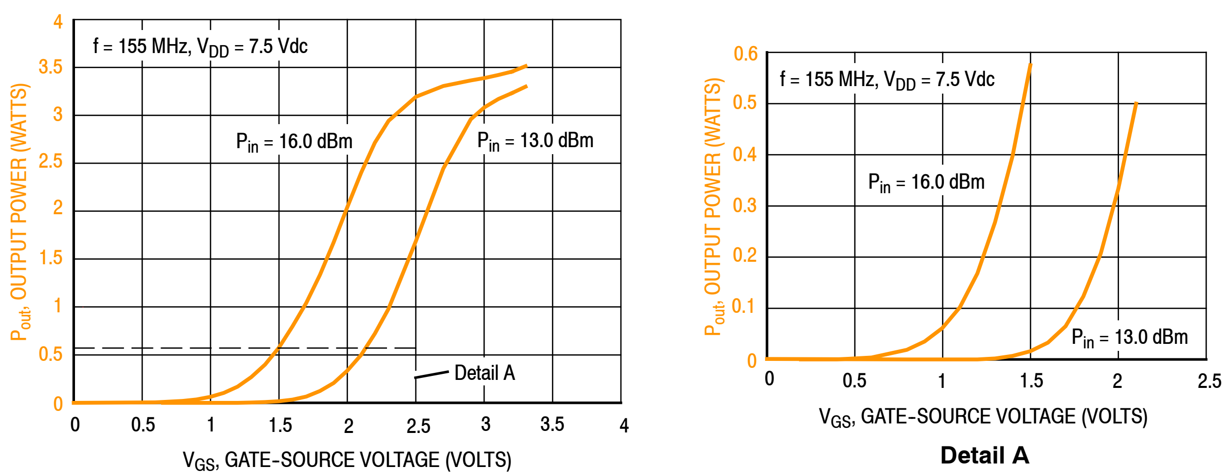


Figure 5. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant P_{in}



Detail A

Figure 6. Output Power versus Gate-Source Voltage

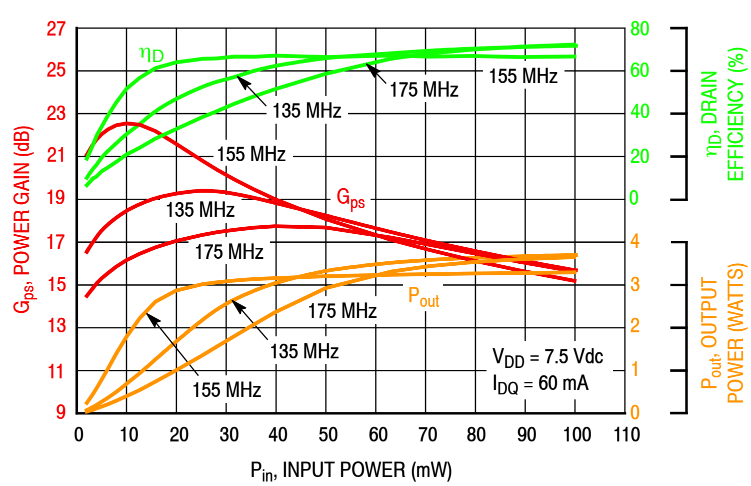
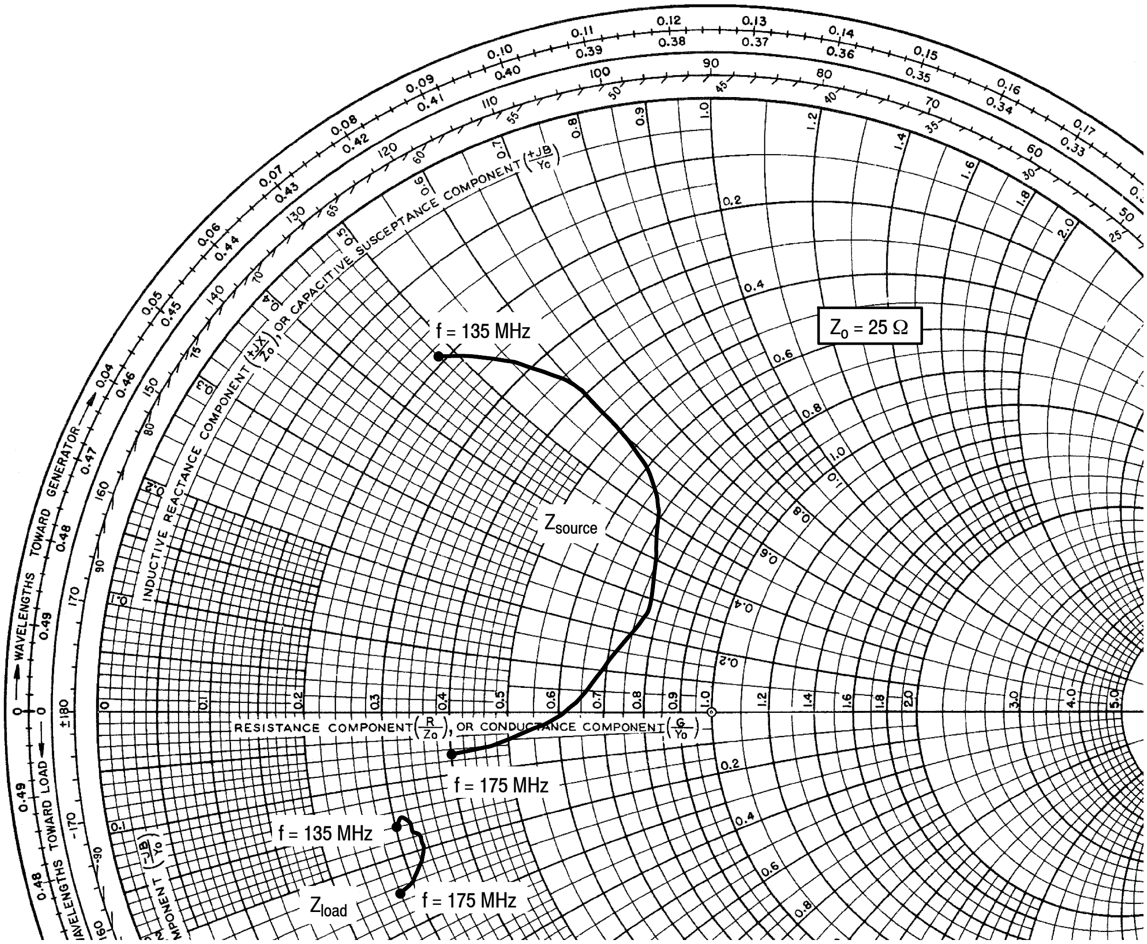


Figure 7. Power Gain, Drain Efficiency and Output Power versus Input Power and Frequency



f MHz	Z_{source} Ω	Z_{load} Ω
135	4.81 + j11.90	7.48 – j3.90
140	5.82 + j13.00	7.70 – j3.87
145	7.20 + j14.00	7.90 – j3.96
150	9.40 + j14.99	8.12 – j4.18
155	12.60 + j15.10	8.21 – j4.53
160	16.80 + j13.17	8.17 – j4.98
165	19.37 + j7.27	7.95 – j5.45
170	16.05 + j0.81	7.56 – j5.90
175	10.05 – j0.70	7.03 – j6.25

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

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

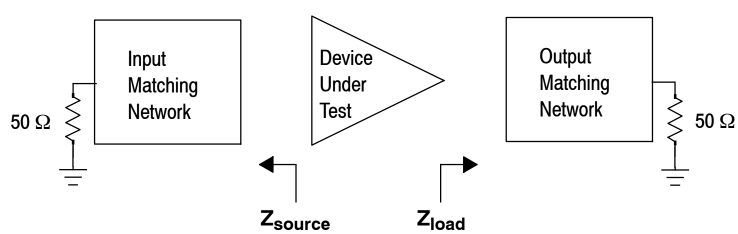


Figure 8. VHF Broadband Series Equivalent Source and Load Impedance — 136–174 MHz

Table 10. 350–520 MHz UHF Broadband Performance (In Freescale UHF Broadband Reference Circuit, 50 ohm system) V_{DD} = 7.5 Volts, I_{DQ} = 50 mA, T_A = 25°C, CW

Frequency (MHz)	P_{in} (dBm)	G_{ps} (dB)	η_D (%)	P_{out} (W)
350	20.0	15.5	59.0	3.8
435	20.0	15.1	73.0	3.2
520	20.0	15.2	69.6	3.3

Table 11. Load Mismatch/Ruggedness (In Freescale UHF Broadband Reference Circuit)

Frequency (MHz)	Signal Type	VSWR	P_{in} (dBm)	Test Voltage, V_{DD}	Result
435	CW	> 65:1 at all Phase Angles	23.0	9.0	No Device Degradation

350–520 MHz UHF BROADBAND REFERENCE CIRCUIT — 0.83″ × 1.86″ (2.1 cm × 4.7 cm)

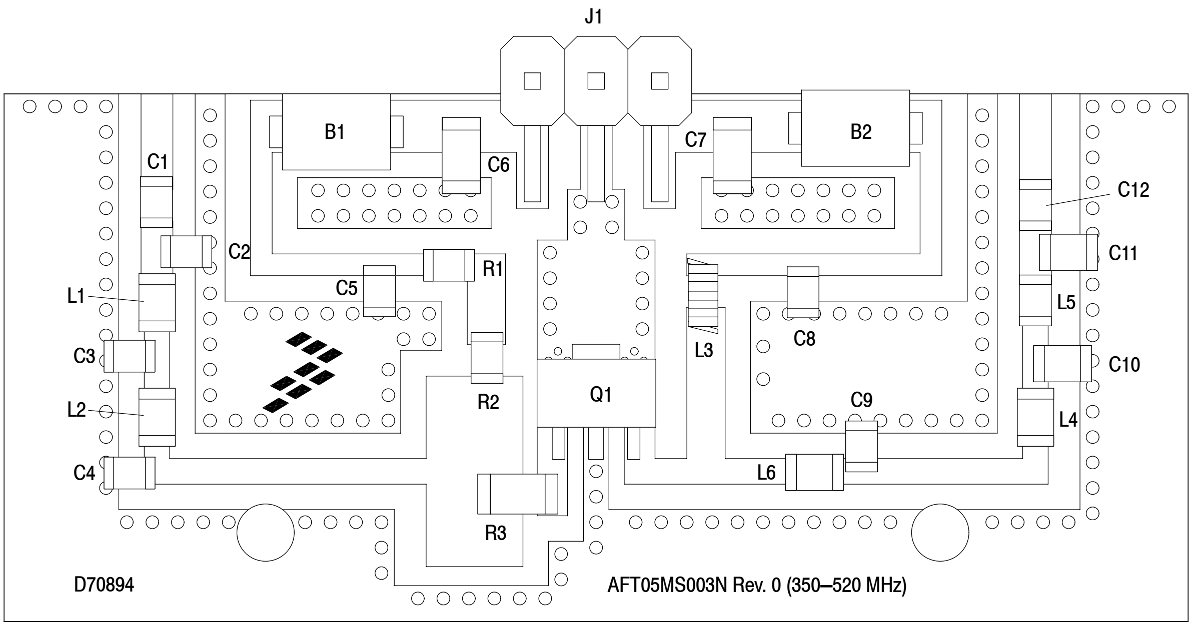


Figure 9. AFT05MS003N UHF Broadband Reference Circuit Component Layout — 350–520 MHz

Table 12. AFT05MS003N UHF Broadband Reference Circuit Component Designations and Values — 350–520 MHz

Part	Description	Part Number	Manufacturer
B1, B2	RF Beads	2743019447	Fair-Rite
C1, C8, C12	100 pF Chip Capacitors	ATC100A101JT150XT	ATC
C2	9.0 pF Chip Capacitor	GQM2195C2E9R0BB12D	Murata
C3	10 pF Chip Capacitor	GQM2195C2E100FB12D	Murata
C4, C9	39 pF Chip Capacitors	GQM2195C2E390GB12D	Murata
C5	100 pF Chip Capacitor	GQM2195C2E101GB12D	Murata
C6	1.0 μF Chip Capacitor	GRM31CR72A105KA01L	Murata
C7	10 μF Chip Capacitor	GRM31CR61H106KA12L	Murata
C10	15 pF Chip Capacitor	GQM2195C2E150FB12D	Murata
C11	3.9 pF Chip Capacitor	GQM2195C2E3R9BB12D	Murata
J1	Right-Angle Breakaway Headers (3 pins)	22-28-8360	Molex
L1	2.2 nH Inductor	L06032E2CGS	AVX
L2, L5	6.8 nH Inductors	ATC0805WL6R8	ATC
L3	19 nH Inductor	0806SQ19N	Coilcraft
L4	5.6 nH Inductor	L08055R6CEW	AVX
L6	1.8 nH Inductor	L08051E8CGS	AVX
Q1	RF Power LDMOS Transistor	AFT05MS003NT1	Freescale
R1, R2	22 Ω, 1/10 W Chip Resistor	RR1220Q-220-D	Susumu
R3	1.5 Ω, 1/10 W Chip Resistor	RC1206FR-071R5L	Yageo
PCB	0.020″, ε_r = 4.8, FR4 (S–1000)	D70894	MTL

TYPICAL CHARACTERISTICS — 350–520 MHz UHF BROADBAND REFERENCE CIRCUIT

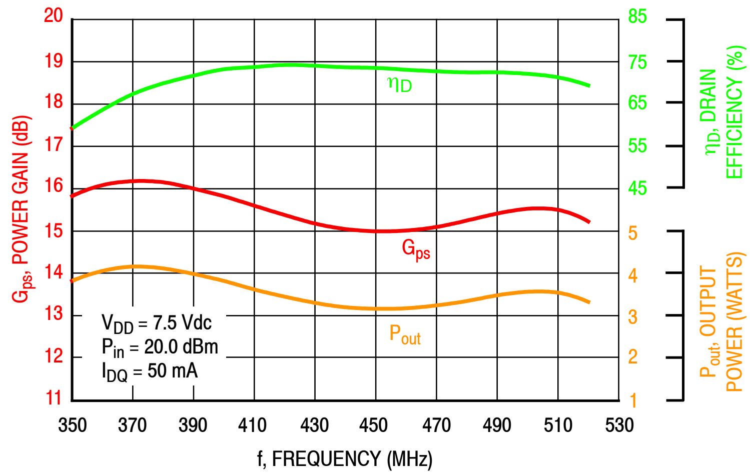


Figure 10. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant P_{in}

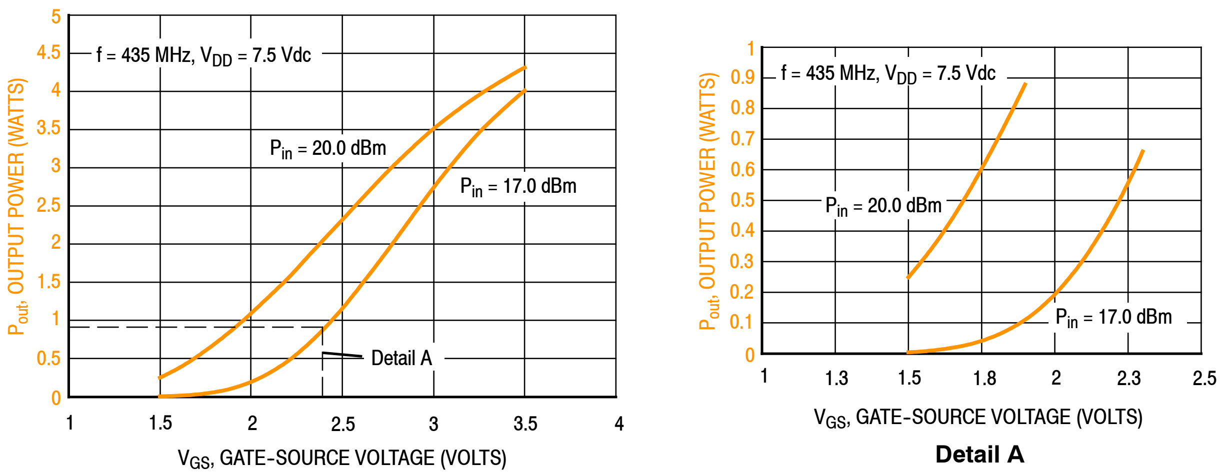


Figure 11. Output Power versus Gate-Source Voltage

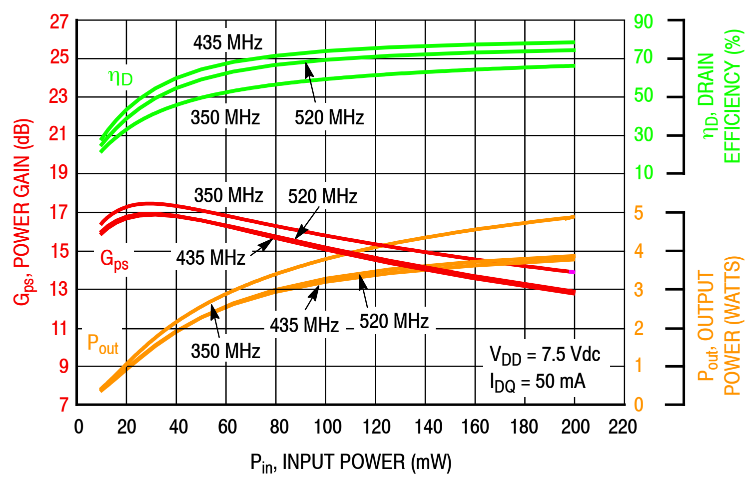
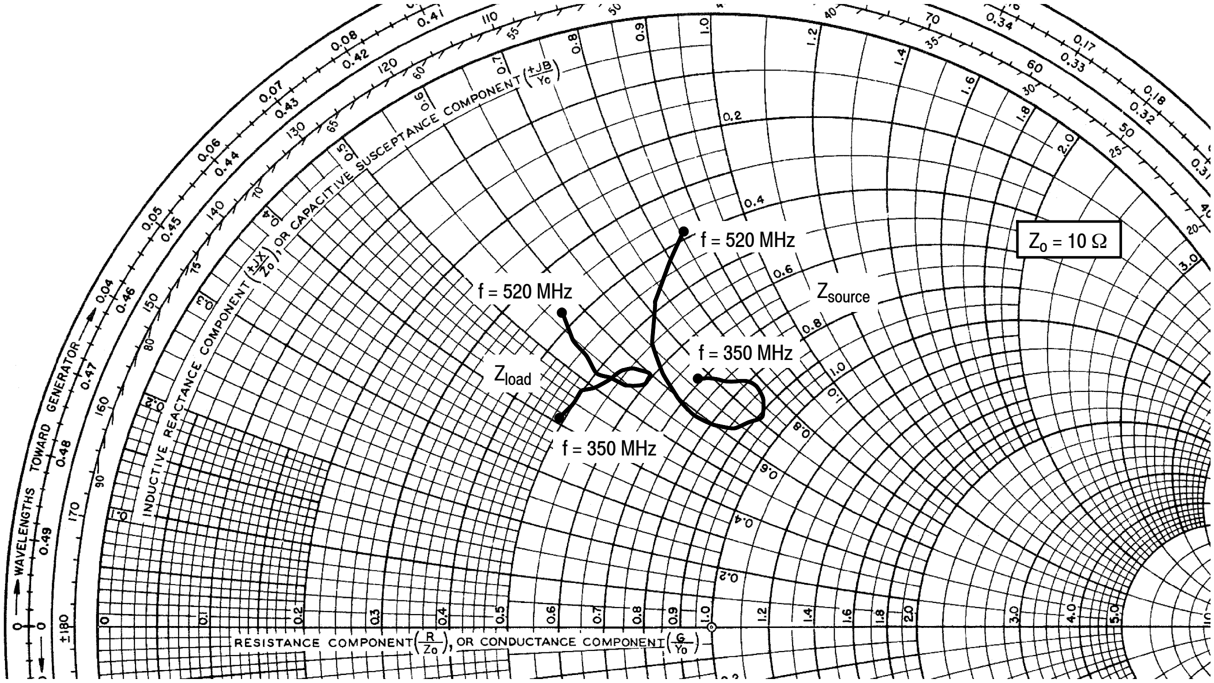


Figure 12. Power Gain, Drain Efficiency and Output Power versus Input Power and Frequency



f MHz	Z_{source} Ω	Z_{load} Ω
350	6.90 + j6.70	4.89 + j4.10
360	7.22 + j6.96	4.95 + j4.48
370	7.60 + j7.15	5.04 + j4.83
380	7.94 + j7.62	5.15 + j5.14
390	8.34 + j7.66	5.28 + j5.42
400	8.65 + j7.61	5.44 + j5.65
410	8.97 + j7.37	5.58 + j5.82
420	9.08 + j7.06	5.73 + j5.90
430	8.91 + j6.73	5.86 + j5.95
440	8.63 + j6.34	5.94 + j5.90
450	8.14 + j6.04	5.95 + j5.81
460	7.49 + j5.89	5.87 + j5.66
470	6.77 + j5.95	5.68 + j5.51
480	6.05 + j6.21	5.39 + j5.39
490	5.38 + j6.64	5.03 + j5.33
500	4.80 + j7.20	4.60 + j5.35
510	4.30 + j7.86	4.16 + j5.47
520	3.94 + j8.57	3.68 + j5.71

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

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

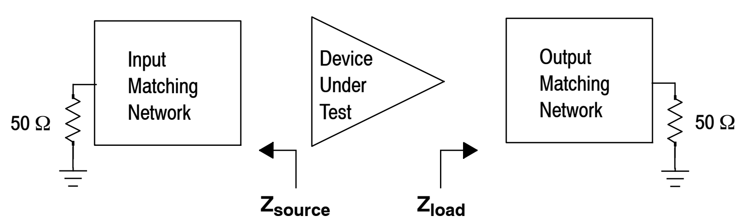


Figure 13. UHF Broadband Series Equivalent Source and Load Impedance — 350–520 MHz

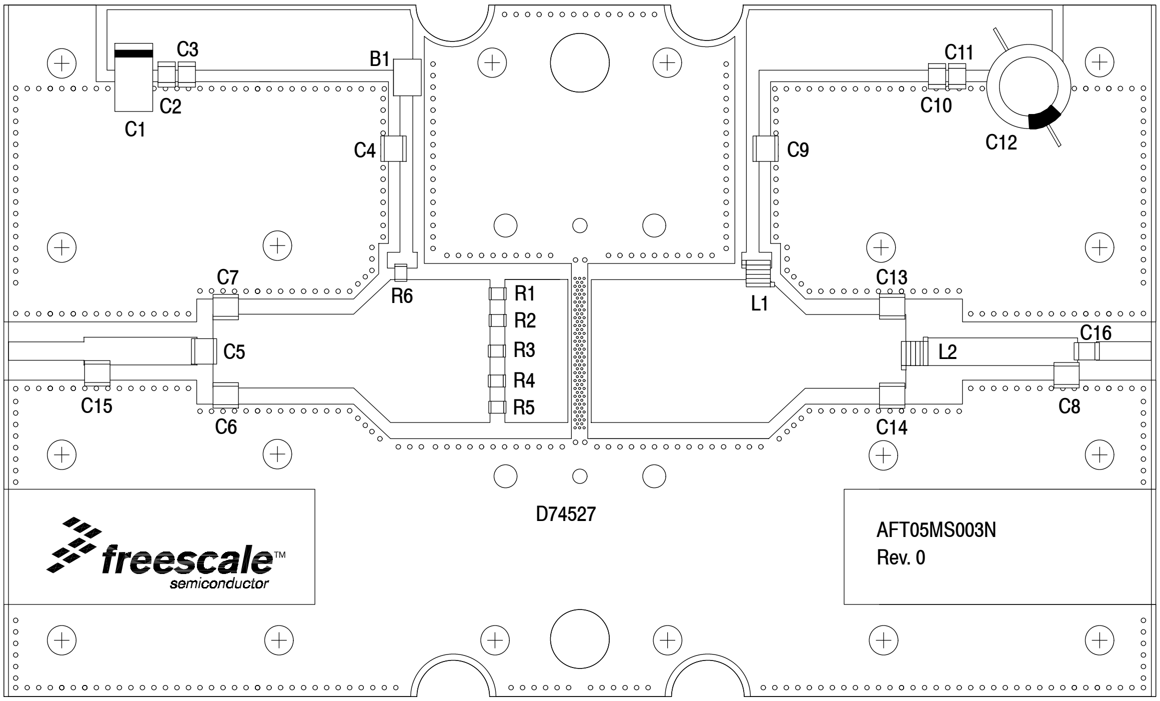


Figure 14. AFT05MS003N Narrowband Production Test Circuit Component Layout — 520 MHz

Table 13. AFT05MS003N Narrowband Production Test Circuit Component Designations and Values — 520 MHz

Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1	22 μF, 35 V Tantalum Capacitor	T491X226K035AT	Kemet
C2, C11	0.1 μF Chip Capacitors	CDR33BX104AKWS	Kemet
C3, C10	0.01 μF Chip Capacitors	C0805C103K5RAC	Kemet
C4, C9	180 pF Chip Capacitors	ATC100B181JT300XT	ATC
C5	68 pF Chip Capacitor	ATC100B680JT500XT	ATC
C6, C7	18 pF Chip Capacitors	ATC100B180JT500XT	ATC
C8	4.7 pF Chip Capacitor	ATC100B4R7JT500XT	ATC
C12	330 μF, 35 V Electrolytic Capacitor	MCGPR35V337M10X16-RH	Multicomp
C13	13 pF Chip Capacitor	ATC100B130JT500XT	ATC
C14	16 pF Chip Capacitor	ATC100B160JT500XT	ATC
C15	3.3 pF Chip Capacitor	ATC100B3R3JT500XT	ATC
C16	6.8 pF Chip Capacitor	ATC100B6R8CT500XT	ATC
L1	8 nH, 3 Turn Inductor	A03TKLC	Coilcraft
L2	5 nH, 2 Turn Inductor	A02TKLC	Coilcraft
R1, R2, R3, R4, R5, R6	3.9 Ω, 1/4 W Chip Resistors	RC1206FR-073R9L	Yageo
PCB	Rogers RO4350, 0.030″, ε_r = 3.66	D74527	MTL

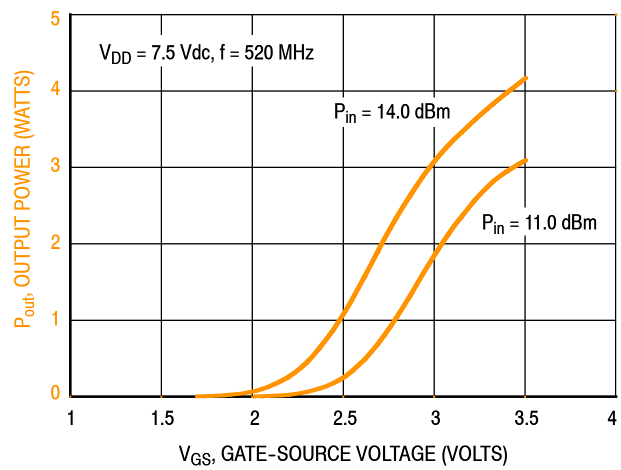


Figure 15. Output Power versus Gate-Source Voltage

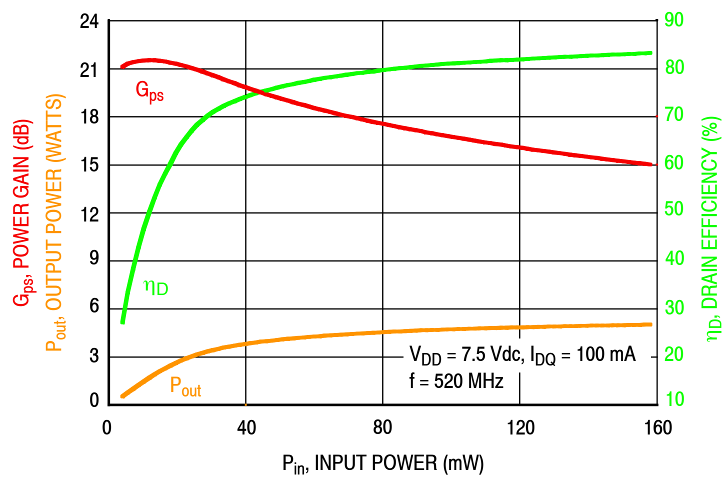


Figure 16. Power Gain, Output Power and Drain Efficiency versus Input Power

f MHz	Z_{source} Ω	Z_{load} Ω
520	1.86 + j4.46	4.30 + j3.43

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

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

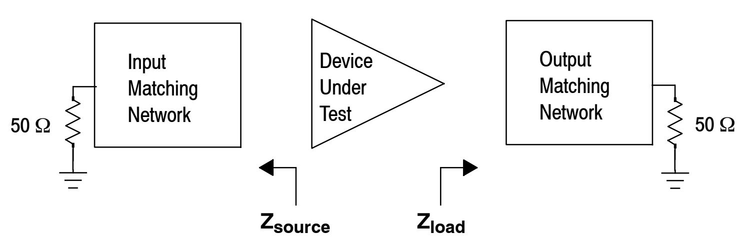


Figure 17. Narrowband Series Equivalent Source and Load Impedance — 520 MHz

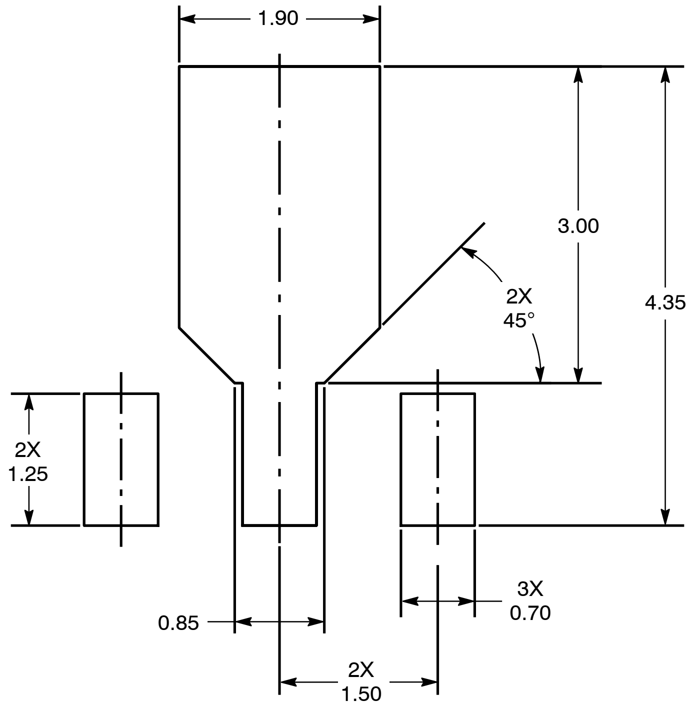


Figure 18. PCB Pad Layout for SOT-89A

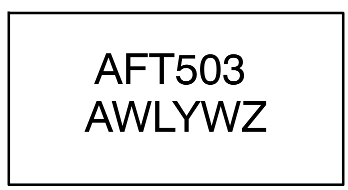
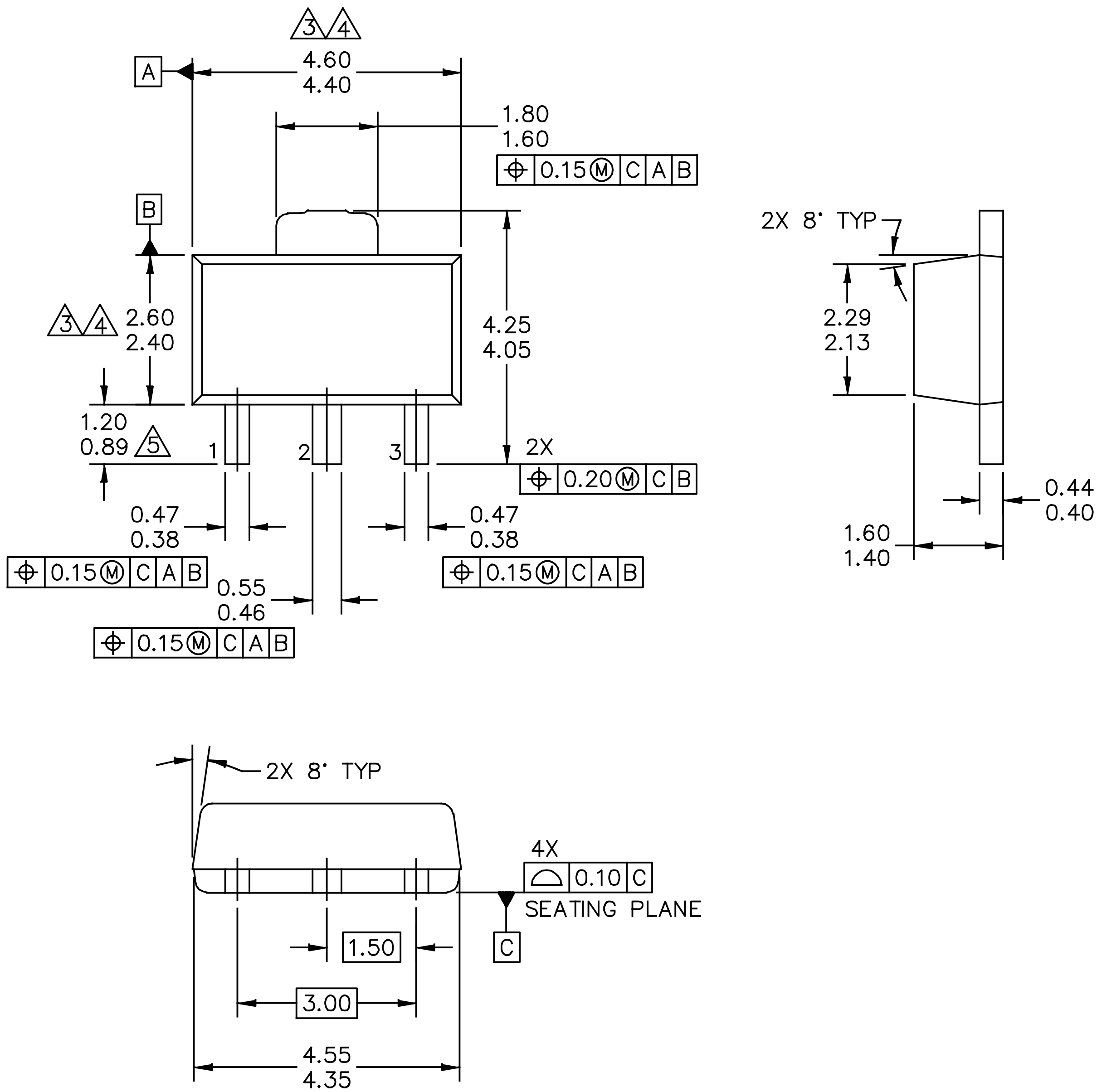


Figure 19. Product Marking

PACKAGE DIMENSIONS

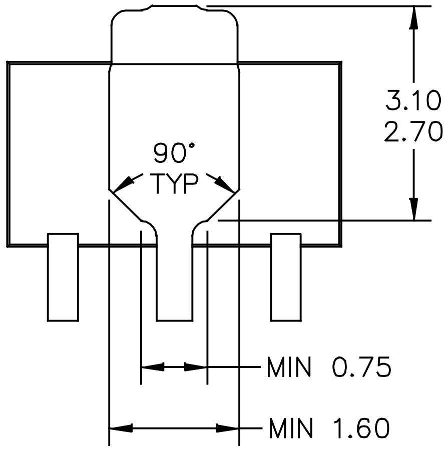


© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: SOT–89A, 3 LEAD, 4.5 X 2.5 PKG, 1.5 MM PITCH	DOCUMENT NO: 98ASA00241D	REV: 0
	CASE NUMBER: 2142–01	15 JUL 2010
	STANDARD: NON–JEDEC	

Pin 1. Drain

2. Gate

3. Source



BOTTOM VIEW

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: SOT–89A, 3 LEAD, 4.5 X 2.5 PKG, 1.5 MM PITCH	DOCUMENT NO: 98ASA00241D	REV: 0
	CASE NUMBER: 2142–01	15 JUL 2010
	STANDARD: NON–JEDEC	

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M — 1994.

2. ALL DIMENSIONS ARE IN MILLIMETERS.

3. DIMENSIONS DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.5 MM PER END. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.5 MM PER SIDE.

4. DIMENSION ARE DETERMINED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTERLEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.

5. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
TITLE: SOT–89A, 3 LEAD, 4.5 X 2.5 PKG, 1.5 MM PITCH	DOCUMENT NO: 98ASA00241D		REV: 0
	CASE NUMBER: 2142–01		15 JUL 2010
	STANDARD: NON–JEDEC		

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources 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

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.freescale.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	Aug. 2015	• Initial Release of Data Sheet

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