Document Number: AFT05MS006N
Rev. 0, 2/2014

RoHS

RF Power LDMOS Transistor

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFET

Designed for handheld two-way radio applications with frequencies from 136 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.

Narrowband Performance (7.5 Vdc, I_{DQ} = 100 mA, T_A = 25°C, CW)

Frequency (MHz)	G_{ps} (dB)	η_D (%)	P_{out} (W)
520 (1)	18.3	73.0	6.0

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

Frequency (MHz)	P_{in} (W)	G_{ps} (dB)	η_D (%)	P_{out} (W)
136–174	0.19	15.5	60.0	6.0
440–520 (2)	0.15	16.3	65.0	6.4
760–870 (3)	0.20	15.2	58.5	6.7

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
520 (1)	CW	> 65:1 at all Phase Angles	0.12 (3 dB Overdrive)	10.8	No Device Degradation

1. Measured in 520 MHz narrowband test circuit.
2. Measured in 440–520 MHz UHF broadband reference circuit.
3. Measured in 760–870 MHz UHF broadband reference circuit.

Features

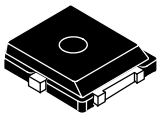
- Characterized for Operation from 136 to 941 MHz
- Unmatched Input and Output Allowing Wide Frequency Range Utilization
- Integrated ESD Protection
- Integrated Stability Enhancements
- Wideband — Full Power Across the Band
- Exceptional Thermal Performance
- Extreme Ruggedness
- High Linearity for: TETRA, SSB
- In Tape and Reel. T1 Suffix = 1,000 Units, 16 mm Tape Width, 7-inch Reel.

Typical Applications

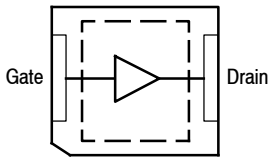
- Output Stage VHF Band Handheld Radio
- Output Stage UHF Band Handheld Radio
- Output Stage for 700–800 MHz Handheld Radio

AFT05MS006NT1

136–941 MHz, 6.0 W, 7.5 V
WIDEBAND
RF POWER LDMOS TRANSISTOR



PLD-1.5W



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

Figure 1. Pin Connections

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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	125 1.0	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 79° C, 6.0 W CW, 7.5 Vdc, I_{DQ} = 100 mA, 520 MHz	$R_{\theta JC}$	1.0	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2, passes 2500 V
Machine Model (per EIA/JESD22-A115)	A, passes 150 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	3	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}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 7.5 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	2	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	600	nAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 78 μAdc)	$V_{GS(th)}$	1.8	2.2	2.6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 0.78 Adc)	$V_{DS(on)}$	—	0.15	—	Vdc
Forward Transconductance (V_{DS} = 7.5 Vdc, I_D = 4.7 Adc)	g_{fs}	—	4.4	—	S

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.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 7.5 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.7	—	pF
Output Capacitance (V_{DS} = 7.5 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	47	—	pF
Input Capacitance (V_{DS} = 7.5 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	75	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 7.5 Vdc, I_{DQ} = 100 mA, P_{in} = 19.5 dBm, f = 520 MHz					
Common-Source Amplifier Output Power	P_{out}	—	6.0	—	W
Drain Efficiency	η_D	—	73.0	—	%

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

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
520	CW	> 65:1 at all Phase Angles	0.12 (3 dB Overdrive)	10.8	No Device Degradation

TYPICAL CHARACTERISTICS

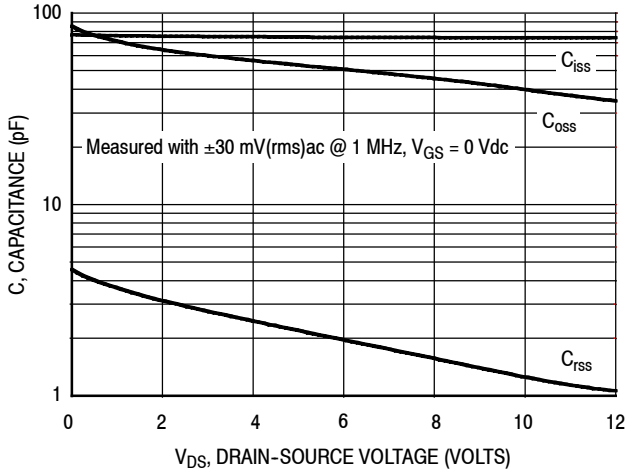
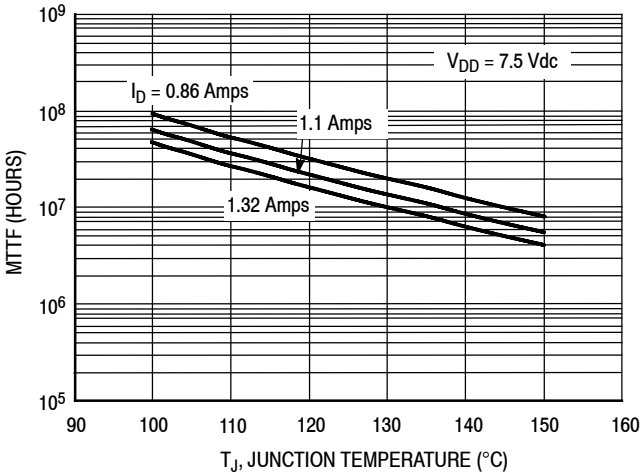


Figure 2. Capacitance versus Drain-Source Voltage



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

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

Figure 3. MTTF versus Junction Temperature — CW

520 MHz NARROWBAND PRODUCTION TEST FIXTURE

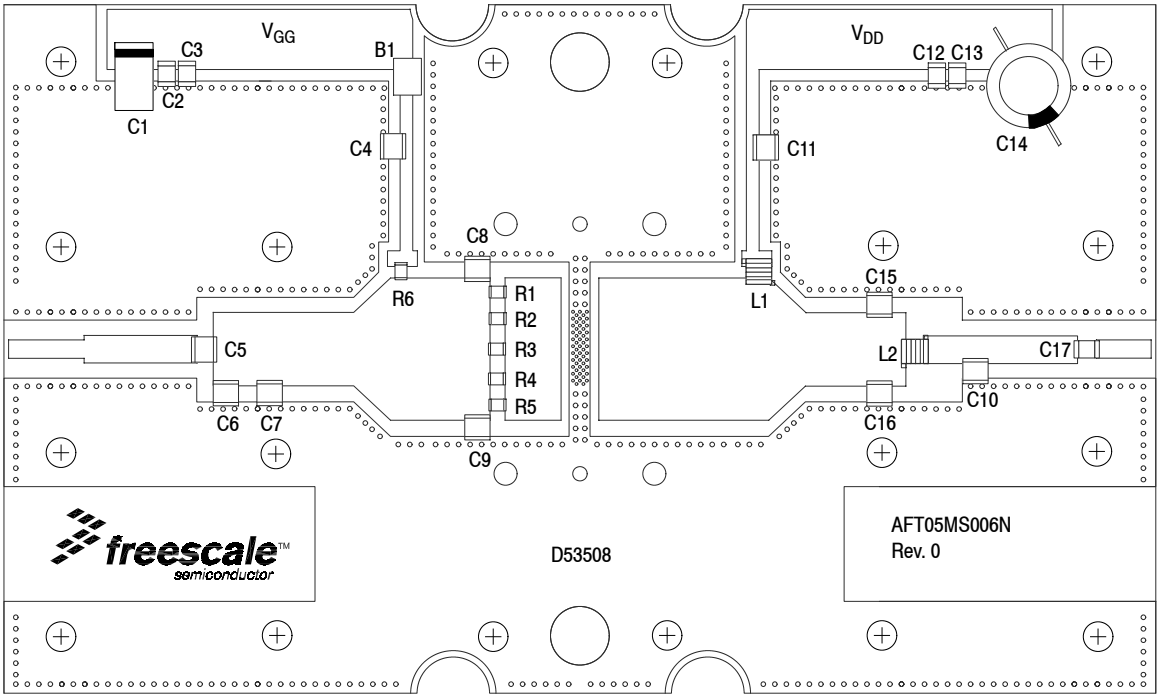


Figure 4. AFT05MS006NT1 Narrowband Test Circuit Component Layout — 520 MHz

Table 6. AFT05MS006NT1 Narrowband 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, C13	0.1 μF Chip Capacitors	CDR33BX104AKWS	AVX
C3, C12	0.01 μF Chip Capacitors	C0805C103K5RAC	Kemet
C4, C11	180 pF Chip Capacitors	ATC100B181JT300XT	ATC
C5	9.1 pF Chip Capacitor	ATC100B9R1CT500XT	ATC
C6, C7	15 pF Chip Capacitors	ATC100B150JT500XT	ATC
C8, C9	27 pF Chip Capacitors	ATC100B270JT500XT	ATC
C10	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C14	330 μF, 35 V Electrolytic Capacitor	MCGPR35V337M10X16-RH	Multicomp
C15, C16	20 pF Chip Capacitors	ATC100B200JT500XT	ATC
C17	16 pF Chip Capacitor	ATC100B160JT500XT	ATC
L1	8.0 nH, 3 Turn Inductor	A03TKLC	Coilcraft
L2	5 nH, 2 Turn Inductor	A02TKLC	Coilcraft
R1, R2, R3, R4, R5	1.5 Ω, 1/4 W Chip Resistors	RC1206FR-071R5L	Yageo
R6	27 Ω, 1/4 W Chip Resistor	CRCW120627R0FKEA	Vishay
PCB	Rogers RO4350B, 0.030″, ε_r = 3.66	D53508	MTL

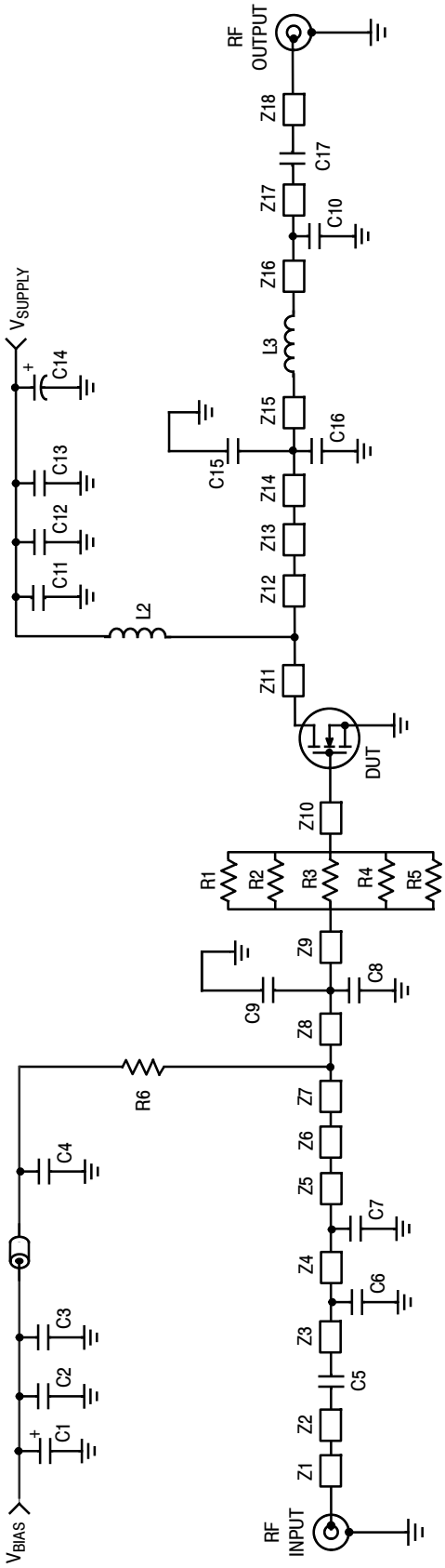


Figure 5. AFT05MS006NT1 Narrowband Test Circuit Schematic — 520 MHz

Table 7. AFT05MS006NT1 Narrowband Test Circuit Microstrips — 520 MHz

Microstrip	Description
Z1	0.328″ × 0.080″ Microstrip
Z2	0.490″ × 0.120″ Microstrip
Z3	0.055″ × 0.320″ Microstrip
Z4	0.190″ × 0.320″ Microstrip
Z5	0.365″ × 0.320″ Microstrip
Z6	0.160″ × 0.320″ × 0.620″ Taper Microstrip
Z7	0.045″ × 0.620″ Microstrip
Z8	0.332″ × 0.620″ Microstrip
Z9	0.055″ × 0.620″ Microstrip

Microstrip	Description
Z10	0.243″ × 0.620″ Microstrip
Z11	0.692″ × 0.620″ Microstrip
Z12	0.045″ × 0.620″ Microstrip
Z13	0.162″ × 0.320″ × 0.620″ Taper Microstrip
Z14	0.319″ × 0.320″ Microstrip
Z15	0.115″ × 0.320″ Microstrip
Z16	0.222″ × 0.120″ Microstrip
Z17	0.443″ × 0.120″ Microstrip
Z18	0.238″ × 0.080″ Microstrip

TYPICAL CHARACTERISTICS — 520 MHz NARROWBAND REFERENCE CIRCUIT

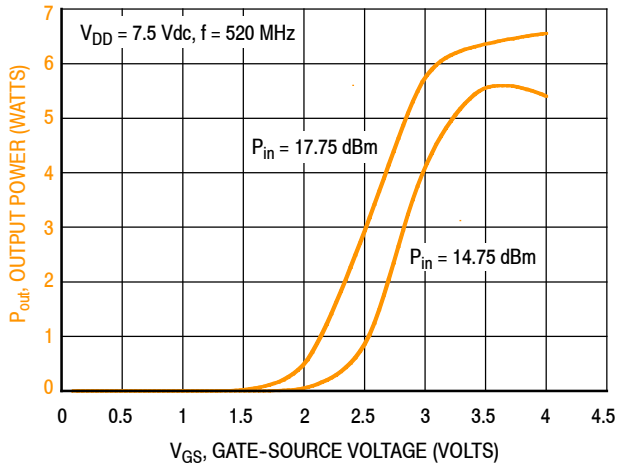


Figure 6. Output Power versus Gate-Source Voltage

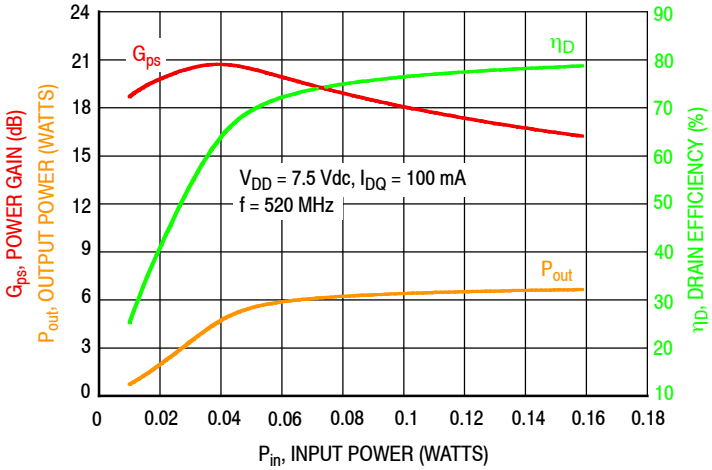


Figure 7. Power Gain, Drain Efficiency and Output Power versus Input Power

V_{DD} = 7.5 Vdc, I_{DQ} = 100 mA, P_{out} = 6.0 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
520	1.14 + j2.28	1.78 + j1.71

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

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

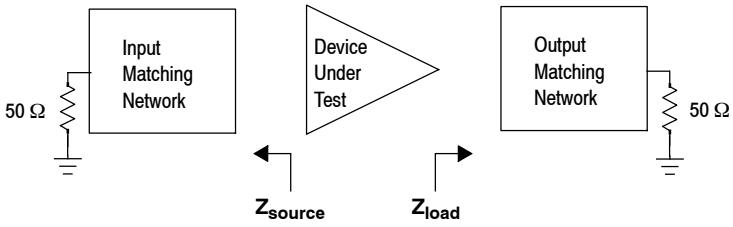


Figure 8. Narrowband Series Equivalent Source and Load Impedance — 520 MHz

Table 8. 440–520 MHz UHF Broadband Performance (In Freescale Reference Circuit, 50 ohm system)
V_{DD} = 7.5 Volts, I_{DQ} = 100 mA, T_A = 25°C, CW

Frequency (MHz)	P_{in} (W)	G_{ps} (dB)	η_D (%)	P_{out} (W)
440	0.13	16.7	63.7	5.9
480	0.08	18.6	68.5	6.1
520	0.11	17.5	73.1	6.0

Table 9. Load Mismatch/Ruggedness (In Freescale Reference Circuit)

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
480	CW	> 65:1 at all Phase Angles	0.19 (3 dB Overdrive)	10.8	No Device Degradation

440–520 MHz UHF BROADBAND REFERENCE CIRCUIT

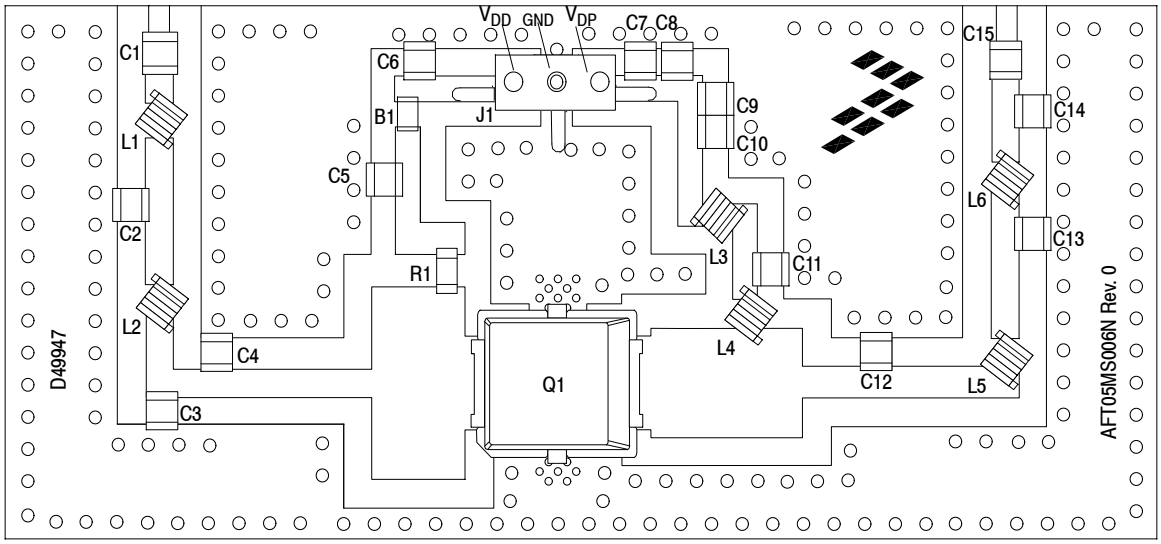


Figure 9. AFT05MS006NT1 UHF Broadband Reference Circuit Component Layout — 440–520 MHz

Table 10. AFT05MS006NT1 UHF Broadband Reference Circuit Component Designations and Values — 440–520 MHz

Part	Description	Part Number	Manufacturer
B1	30 Ω, 6 A Ferrite Bead	MPZ2012S300A	Fair-Rite
C1	18 pF Chip Capacitor	ATC600F180JT250XT	ATC
C2, C3, C11	15 pF Chip Capacitors	ATC600F150JT250XT	ATC
C4	56 pF Chip Capacitor	ATC600F560JT250XT	ATC
C5	100 pF Chip Capacitor	ATC600F100JT250XT	ATC
C6, C7	0.1 μF Chip Capacitors	GRM21BR71H104KA01B	Murata
C8	0.01 μF Chip Capacitor	GRM21BR72A103KA01B	Murata
C9	240 pF Chip Capacitor	ATC600F241JT250XT	ATC
C10	2.2 μF Chip Capacitor	GRM31CR71H225KA88L	Murata
C12	39 pF Chip Capacitor	ATC600F390JT250XT	ATC
C13	18 pF Chip Capacitor	ATC600F180JT250XT	ATC
C14	5.1 pF Chip Capacitor	ATC600F5R1BT250XT	ATC
C15	100 pF Chip Capacitor	ATC600F101JT250XT	ATC
J1	Right-Angle Breakaway Headers (3 pins)	22-28-8360	Molex
L1	5.5 nH Inductor	0806SQ5N5	Coilcraft
L2	6 nH Inductor	0806SQ6N0	Coilcraft
L3, L4	16.6 nH Inductors	0908SQ17N	Coilcraft
L5	1.65 nH Inductor	0906-2JLC	Coilcraft
L6	8.1 nH Inductor	0908SQ8N1	Coilcraft
Q1	RF Power LDMOS Transistor	AFT05MS006NT1	Freescale
R1	20 Ω, 1/4 W Chip Resistor	CRCW120620R0FKEA	Vishay
PCB	0.020″, ε_r = 4.8, Shengyi S1000-2	D49947	MTL

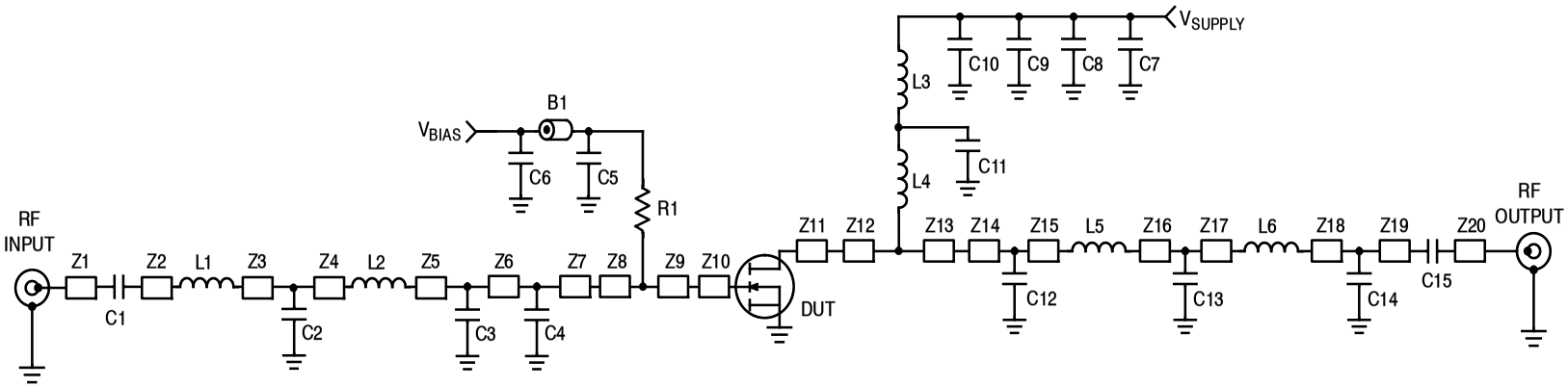


Figure 10. AFT05MS006NT1 UHF Broadband Reference Circuit Schematic — 440-520 MHz

Table 11. AFT05MS006NT1 UHF Broadband Reference Circuit Microstrips — 440-520 MHz

Microstrip	Description
Z1	0.060″ × 0.034″ Microstrip
Z2	0.052″ × 0.046″ Microstrip
Z3	0.105″ × 0.046″ Microstrip
Z4	0.124″ × 0.046″ Microstrip
Z5	0.127″ × 0.044″ Microstrip
Z6	0.093″ × 0.044″ Microstrip
Z7	0.253″ × 0.044″ Microstrip

Microstrip	Description
Z8	0.123″ × 0.300″ Microstrip
Z9	0.029″ × 0.300″ Microstrip
Z10	0.070″ × 0.146″ Microstrip
Z11	0.070″ × 0.146″ Microstrip
Z12	0.153″ × 0.170″ Microstrip
Z13	0.094″ × 0.170″ Microstrip
Z14	0.120″ × 0.049″ Microstrip

Microstrip	Description
Z15	0.235″ × 0.049″ Microstrip
Z16	0.163″ × 0.046″ Microstrip
Z17	0.065″ × 0.046″ Microstrip
Z18	0.079″ × 0.044″ Microstrip
Z19	0.056″ × 0.044″ Microstrip
Z20	0.060″ × 0.034″ Microstrip

TYPICAL CHARACTERISTICS — 440–520 MHz UHF BROADBAND REFERENCE CIRCUIT

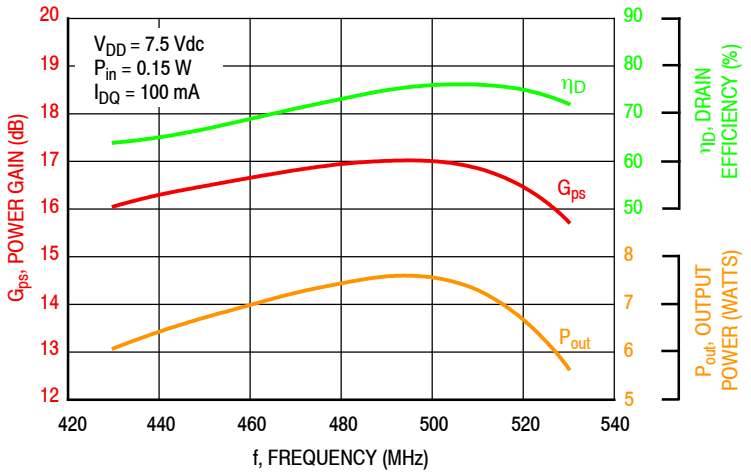


Figure 11. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power

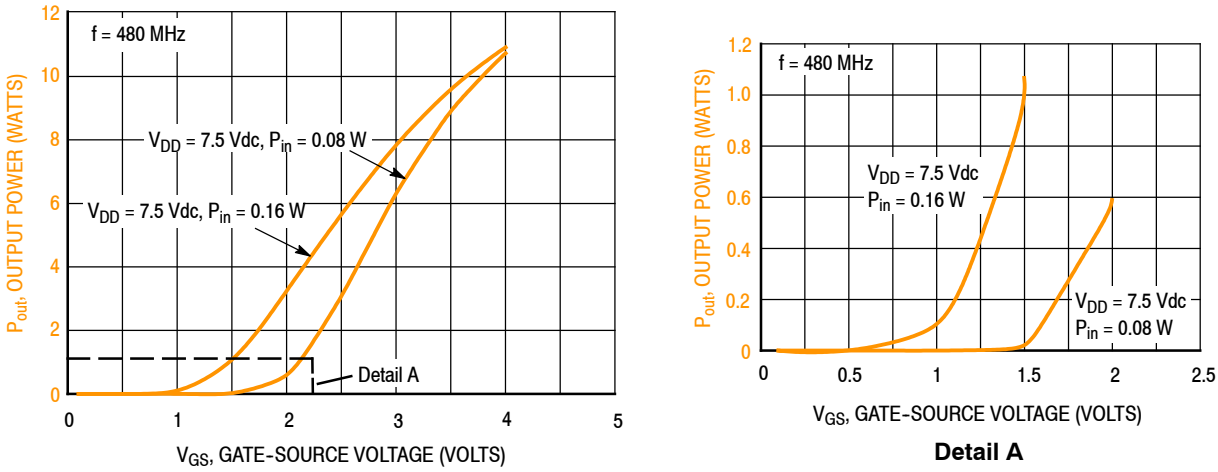


Figure 12. Output Power versus Gate-Source Voltage

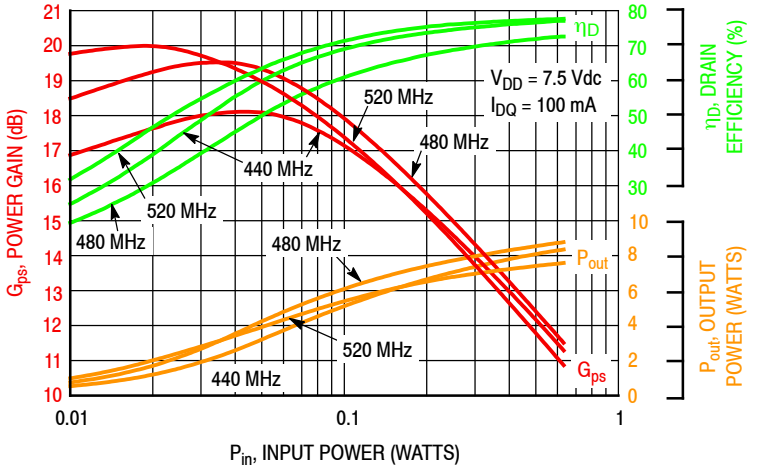
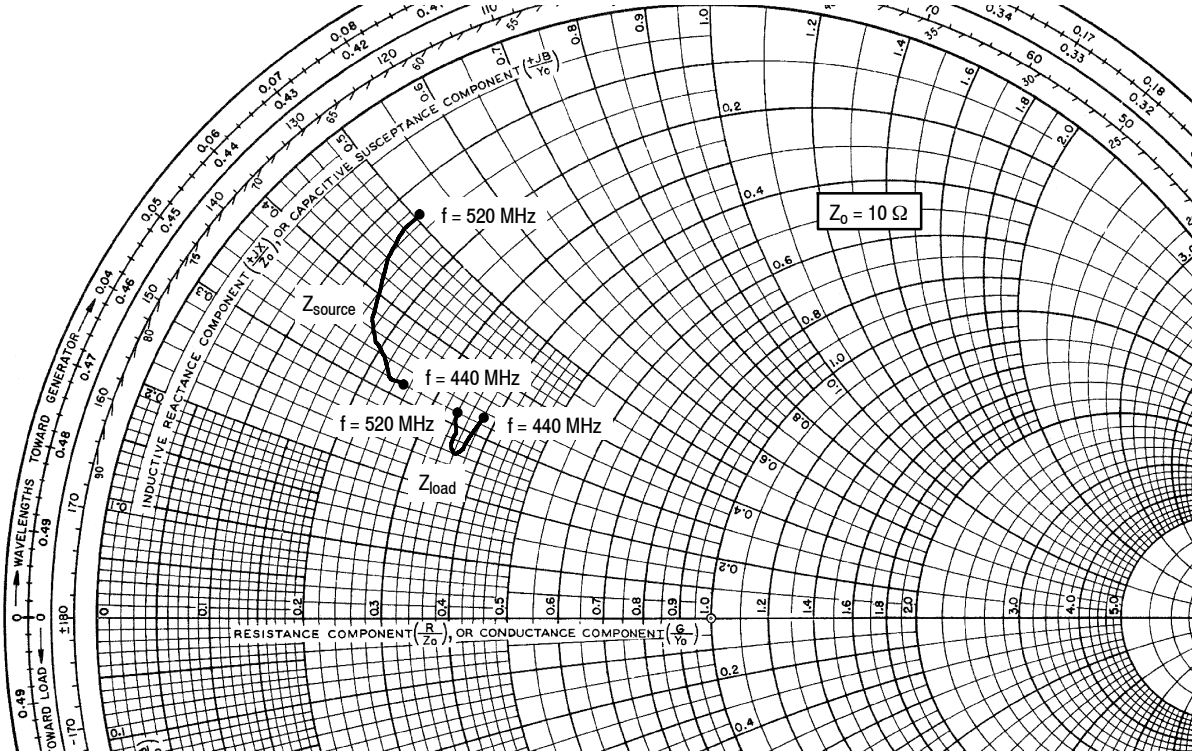


Figure 13. Power Gain, Drain Efficiency and Output Power versus Input Power and Frequency

440–520 MHz UHF BROADBAND REFERENCE CIRCUIT



V_{DD} = 7.5 Vdc, I_{DQ} = 100 mA, P_{out} = 6 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
440	2.46 + j3.15	3.80 + j3.27
450	2.30 + j3.23	3.70 + j2.77
460	2.11 + j3.35	3.69 + j2.66
470	1.90 + j3.48	3.60 + j2.61
480	1.71 + j3.72	3.54 + j2.68
490	1.56 + j4.01	3.50 + j2.78
500	1.43 + j4.37	3.46 + j2.92
510	1.33 + j4.75	3.42 + j3.09
520	1.28 + j5.10	3.37 + j3.22

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

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

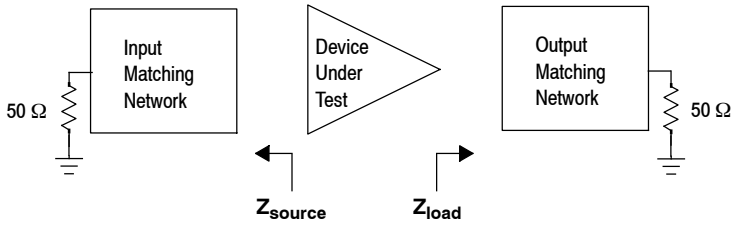


Figure 14. UHF Broadband Series Equivalent Source and Load Impedance — 440–520 MHz

Table 12. 760–870 MHz UHF Broadband Performance (In Freescale Reference Circuit, 50 ohm system)
V_{DD} = 7.5 Volts, I_{DQ} = 100 mA, T_A = 25°C, CW

Frequency (MHz)	P_{in} (W)	G_{ps} (dB)	η_D (%)	P_{out} (W)
760	0.12	16.6	50.4	6.0
815	0.13	16.1	58.1	6.0
870	0.16	15.0	60.0	6.0

Table 13. Load Mismatch/Ruggedness (In Freescale Reference Circuit)

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
815	CW	> 65:1 at all Phase Angles	0.4 (3 dB Overdrive)	9.0	No Device Degradation

760–870 MHz UHF BROADBAND REFERENCE CIRCUIT

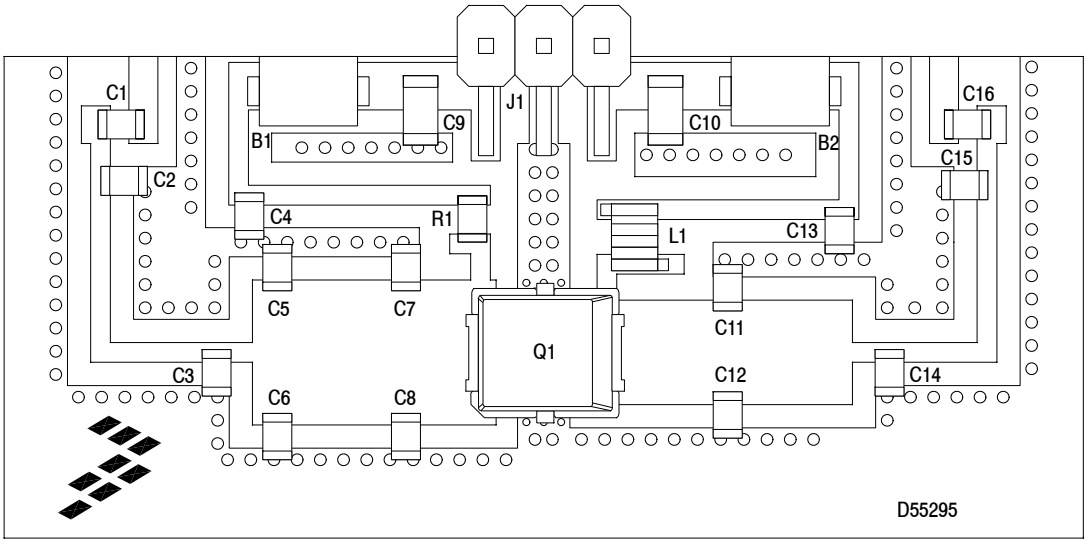


Figure 15. AFT05MS006NT1 UHF Broadband Reference Circuit Component Layout — 760–870 MHz

Table 14. AFT05MS006NT1 UHF Broadband Reference Circuit Component Designations and Values — 760–870 MHz

Part	Description	Part Number	Manufacturer
B1, B2	RF Beads	2743019447	Fair–Rite
C1, C5, C6, C7, C8	20 pF Chip Capacitors	GQM2195C2E200GB12D	Murata
C2	8.2 pF Chip Capacitor	GQM2195C2E8R2BB12D	Murata
C3	10 pF Chip Capacitor	GQM2195C2E100FB12D	Murata
C4, C13	56 pF Chip Capacitors	GQM2195C2E560GB12D	Murata
C9	1 μF Chip Capacitor	GRM31MR71H105KA88L	Murata
C10	10 μF Chip Capacitor	GRM31CR61H106KA12L	Murata
C11, C12	15 pF Chip Capacitors	GQM2195C2E150FB12D	Murata
C14, C15	5.6 pF Chip Capacitors	GQM2195C2E5R6BB12D	Murata
C16	100 pF Chip Capacitor	GQM2195C2E101GB12D	Murata
J1	Right–Angle Breakaway Headers (3 pins)	22–28–8360	Molex
L1	22 nH Air Core Inductor	0908SQ–22NJL	Coilcraft
Q1	RF Power LDMOS Transistor	AFT05MS006NT1	Freescale
R1	200 Ω, 1/8 W Chip Resistor	CRCW0805200RJNEA	Vishay
PCB	0.020″, ε_r = 4.8, FR4	D55295	MTL

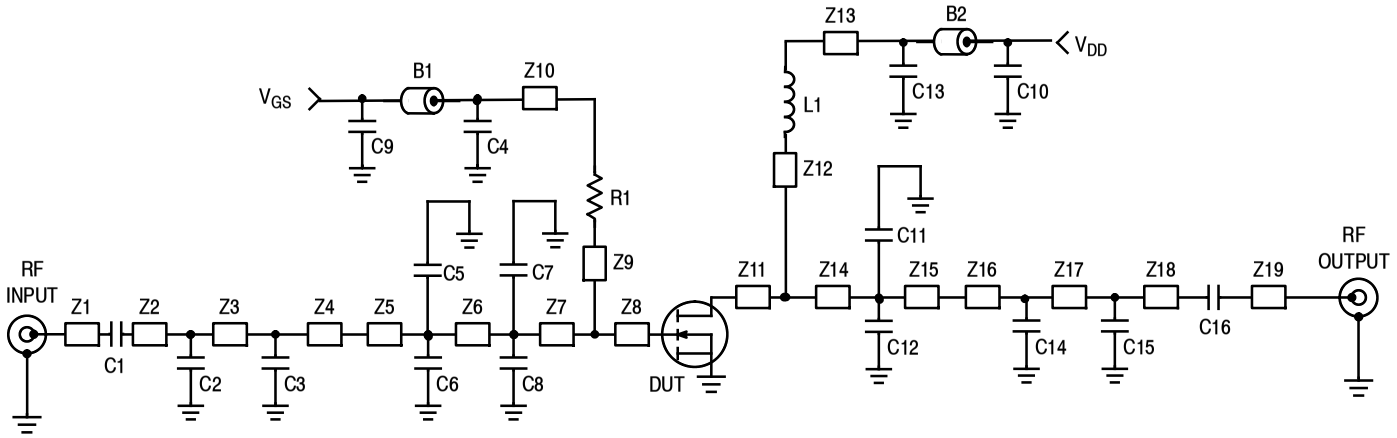


Figure 16. AFT05MS006NT1 UHF Broadband Reference Circuit Schematic — 760-870 MHz

Table 15. AFT05MS006NT1 UHF Broadband Reference Circuit Microstrips — 760-870 MHz

Microstrip	Description
Z1	0.150″ × 0.050″ Microstrip
Z2	0.155″ × 0.034″ Microstrip
Z3	0.430″ × 0.034″ Microstrip
Z4	0.065″ × 0.034″ Microstrip
Z5	0.040″ × 0.250″ Microstrip
Z6	0.222″ × 0.250″ Microstrip
Z7	0.130″ × 0.250″ Microstrip

Microstrip	Description
Z8	0.027″ × 0.250″ Microstrip
Z9	0.066″ × 0.034″ Microstrip
Z10	0.386″ × 0.034″ Microstrip
Z11	0.027″ × 0.180″ Microstrip
Z12	0.160″ × 0.034″ Microstrip
Z13	0.350″ × 0.034″ Microstrip
Z14	0.210″ × 0.180″ Microstrip

Microstrip	Description
Z15	0.215″ × 0.180″ Microstrip
Z16	0.065″ × 0.034″ Microstrip
Z17	0.430″ × 0.034″ Microstrip
Z18	0.120″ × 0.034″ Microstrip
Z19	0.150″ × 0.050″ Microstrip

TYPICAL CHARACTERISTICS — 760–870 MHz UHF BROADBAND REFERENCE CIRCUIT

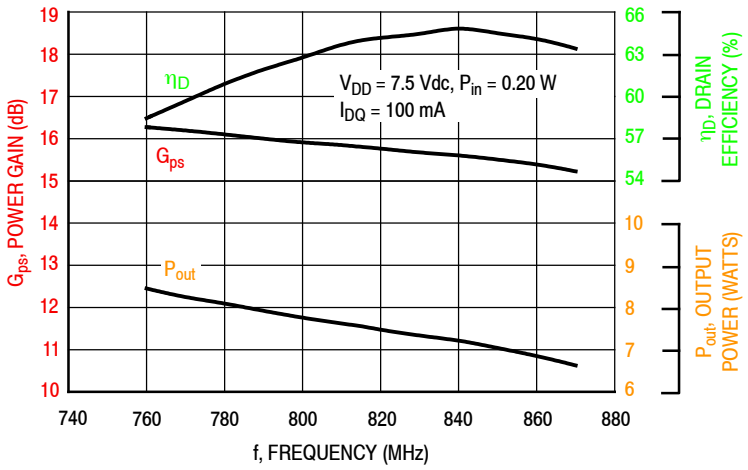


Figure 17. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power

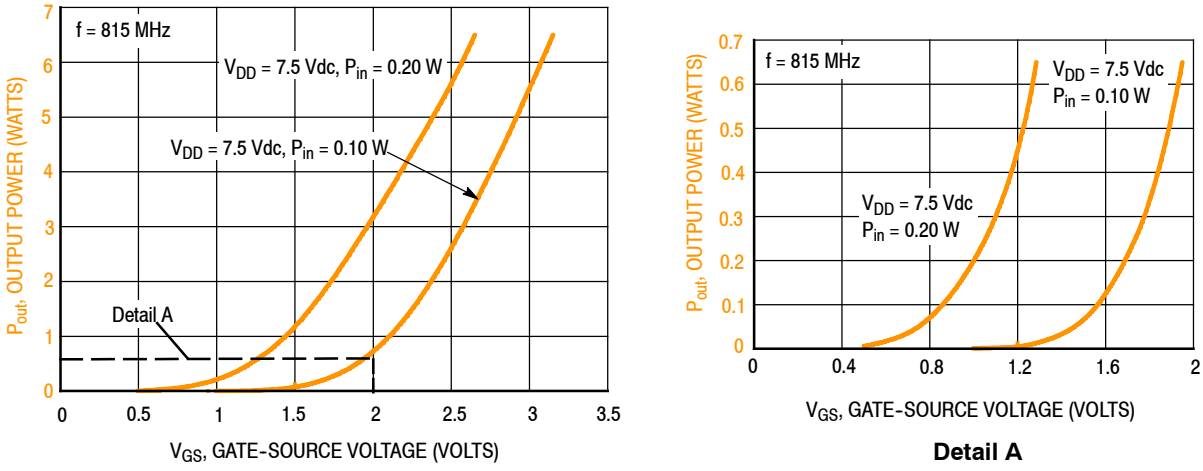


Figure 18. Output Power versus Gate-Source Voltage

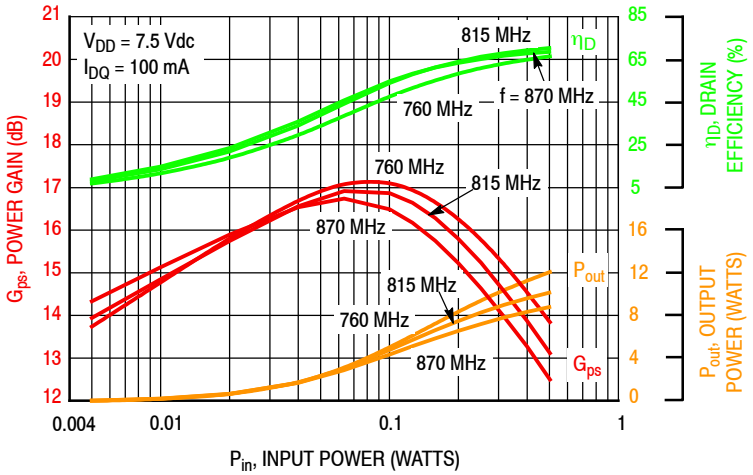
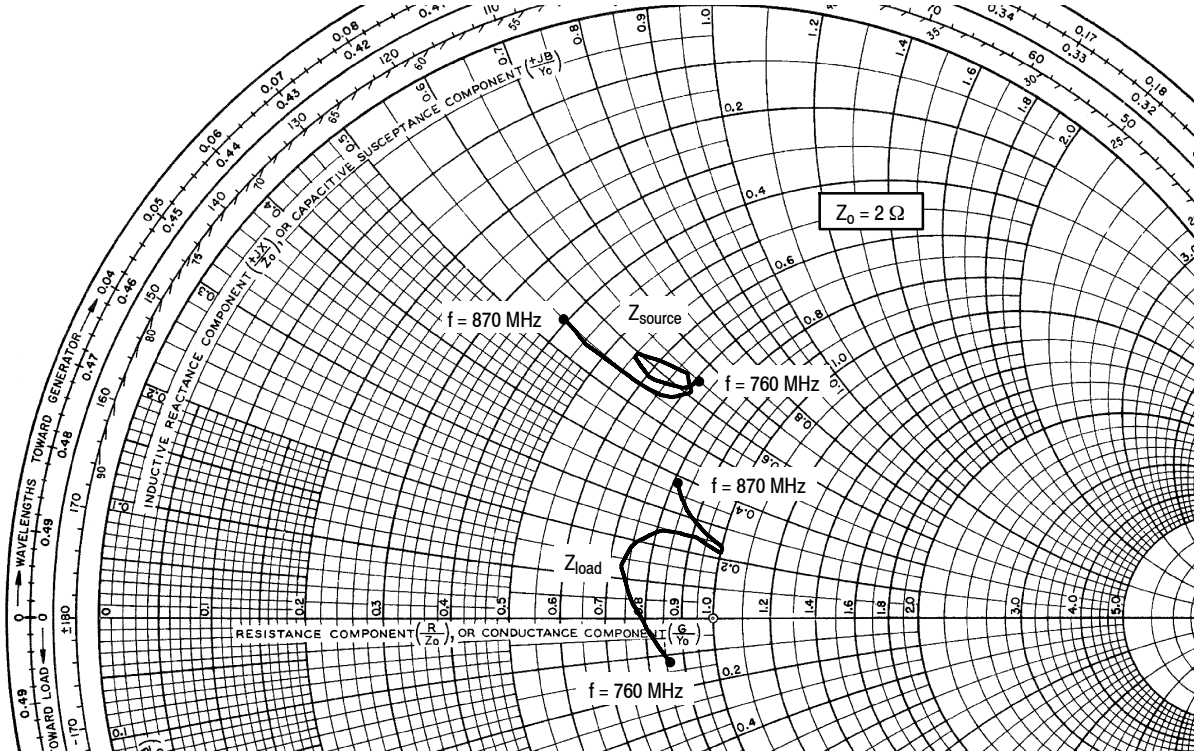


Figure 19. Power Gain, Drain Efficiency and Output Power versus Input Power and Frequency

760–870 MHz UHF BROADBAND REFERENCE CIRCUIT



V_{DD} = 7.5 Vdc, I_{DQ} = 100 mA, P_{out} = 6 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
760	1.42 + j1.30	1.72 - j0.24
770	1.37 + j1.21	1.65 - j0.11
780	1.21 + j1.16	1.53 + j0.08
790	1.10 + j1.17	1.46 + j0.25
800	1.09 + j1.19	1.49 + j0.38
810	1.17 + j1.24	1.61 + j0.47
820	1.33 + j1.27	1.82 + j0.50
830	1.42 + j1.22	1.99 + j0.46
840	1.35 + j1.14	1.99 + j0.48
850	1.12 + j1.10	1.84 + j0.56
860	0.90 + j1.08	1.69 + j0.66
870	0.77 + j1.10	1.62 + j0.73

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

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

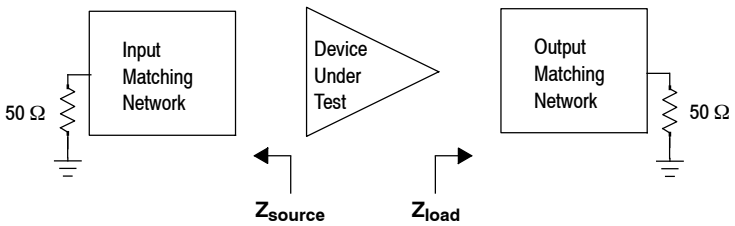


Figure 20. UHF Broadband Series Equivalent Source and Load Impedance — 760–870 MHz

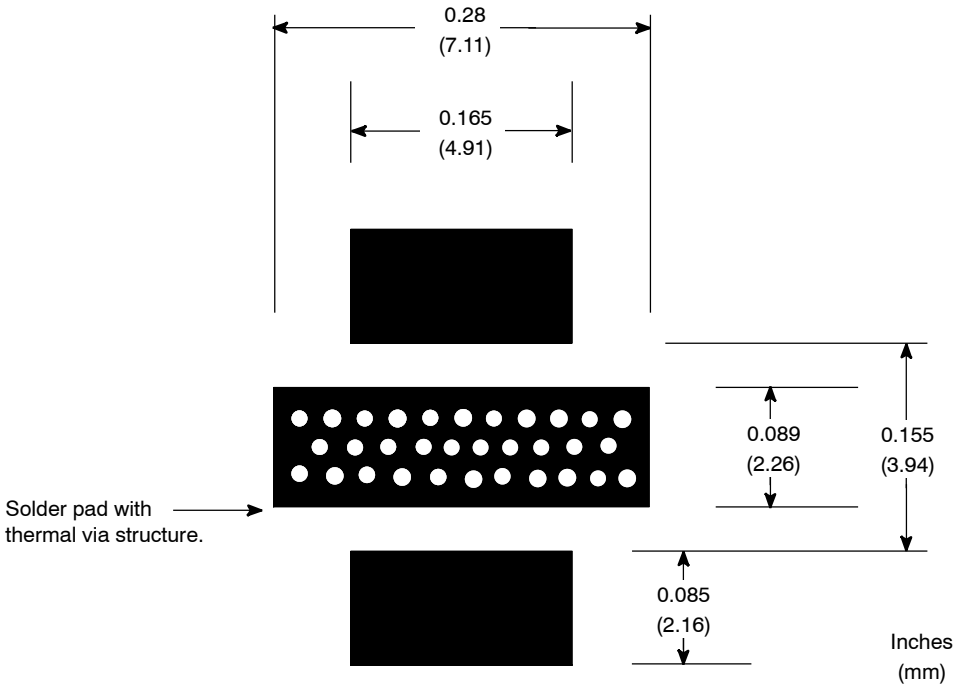


Figure 21. PCB Pad Layout for PLD-1.5W

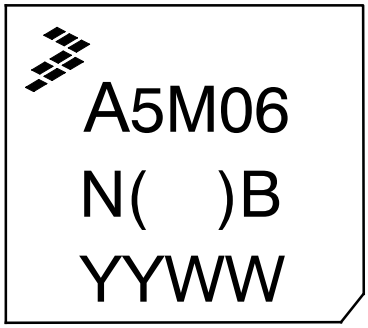
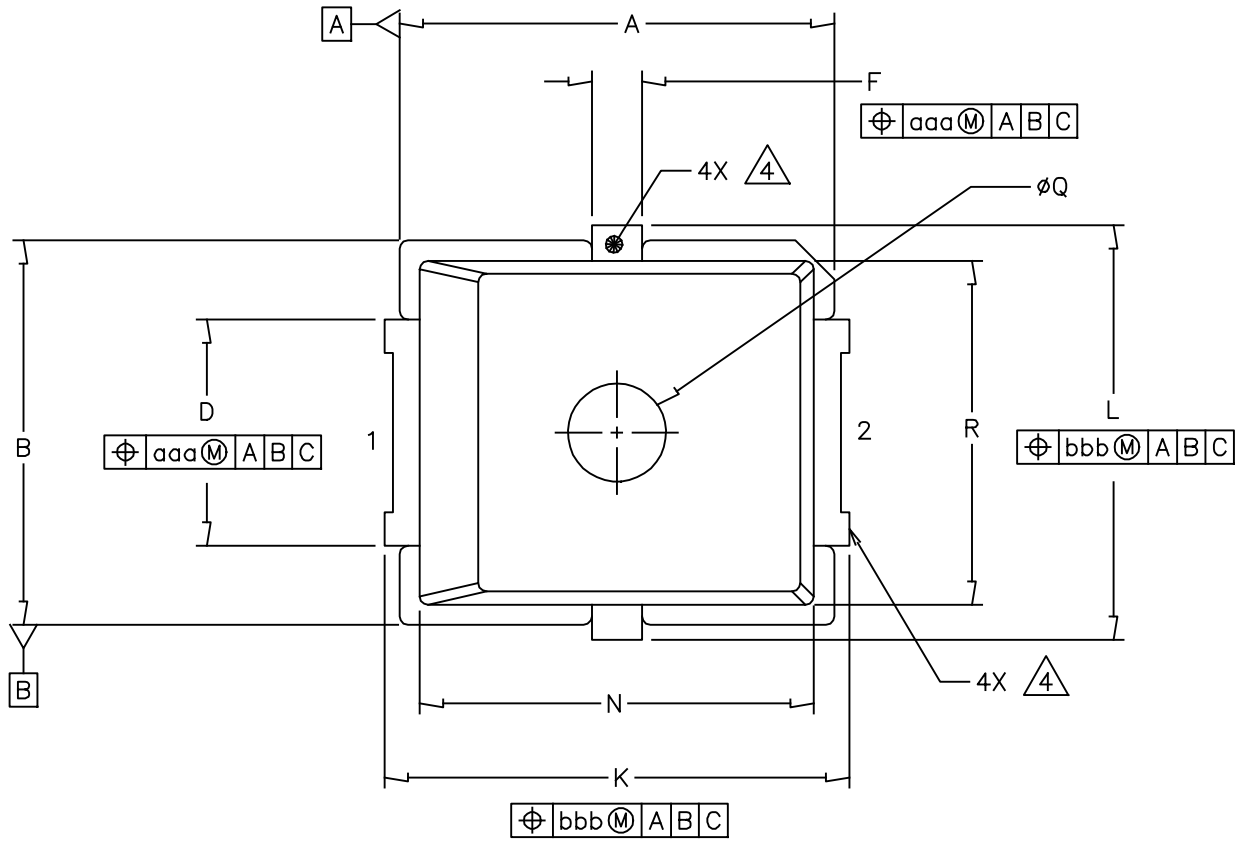
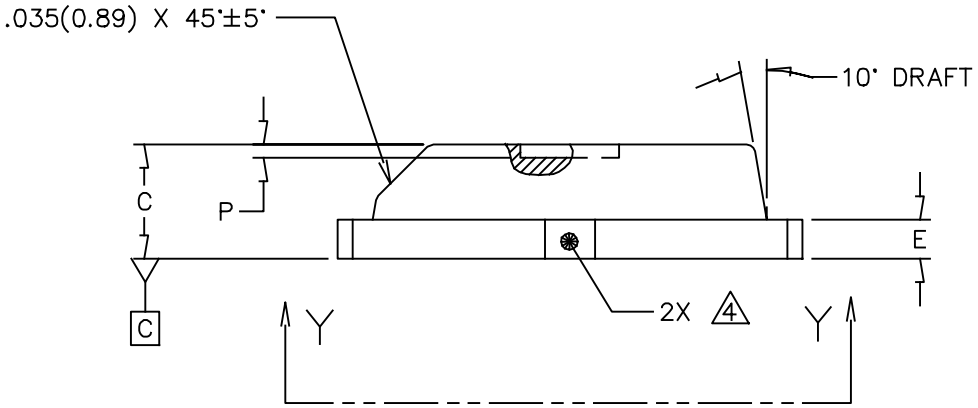


Figure 22. Product Marking

PACKAGE DIMENSIONS





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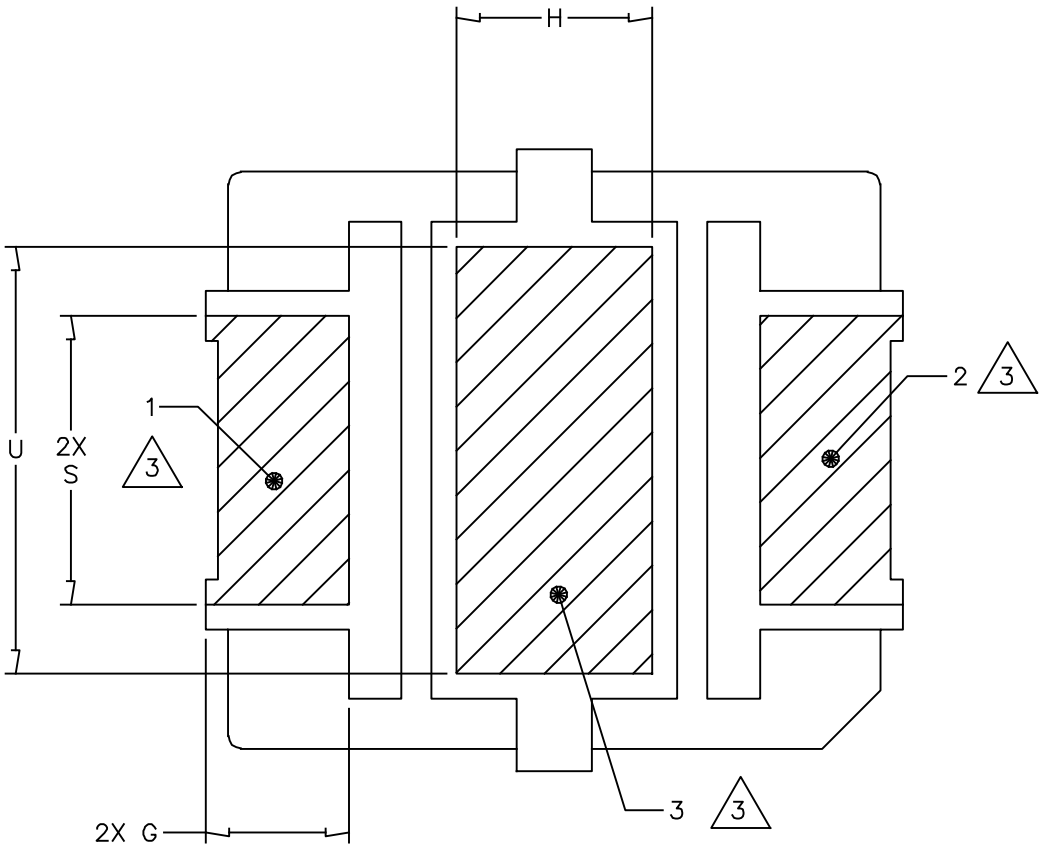
	CASE NUMBER: 2297–01	14 JUN 2012
	STANDARD: NON–JEDEC	



VIEW Y–Y

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	CASE NUMBER: 2297–01	14 JUN 2012
	STANDARD: NON–JEDEC	

NOTES:

1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
3. HATCHING REPRESENTS THE EXPOSED AND SOLDERABLE AREA. DIMENSIONS G, S, H AND U REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF EXPOSED AREA.
4. THESE SURFACES ARE NOT PART OF THE SOLDERABLE SURFACES AND MAY REMAIN UNPLATED.

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.255	.265	6.48	6.73	Q	.055	.063	1.40	1.60
B	.225	.235	5.72	5.97	R	.200	.210	5.08	5.33
C	.065	.072	1.65	1.83	S	.110	–	2.79	–
D	.130	.150	3.30	3.81	U	.156	–	3.96	–
E	.021	.026	0.53	0.66	aaa		.004		0.10
F	.026	.044	0.66	1.12	bbb		.005		0.13
G	.038	–	0.97	–					
H	.069	–	1.75	–					
J	.160	.180	4.06	4.57					
K	.273	.285	6.93	7.24					
L	.245	.255	6.22	6.48					
N	.230	.240	5.84	6.10					
P	.000	.008	0.00	0.20					

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PLD–1.5W	CASE NUMBER: 2297–01	14 JUN 2012
	STANDARD: NON–JEDEC	

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following documents, software and tools to aid your design process.

Application Notes

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Over-Molded Plastic 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

For Software and Tools, do a Part Number search at http://www.freescale.com, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Feb. 2014	• Initial Release of Data Sheet

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