Document Number: AFT05MS031N
Rev. 1, 4/2013

RF Power LDMOS Transistors

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFETs

Designed for mobile two-way radio applications with frequencies from 136 to 520 MHz. The high gain, ruggedness and broadband performance of these devices make them ideal for large-signal, common source amplifier applications in mobile radio equipment.

Typical Performance: (13.6 Vdc, T_A = 25°C, CW)

Frequency (MHz)	G_{ps} (dB)	η_D (%)	P1dB (W)
136-174 (1,4)	23.2	62.0	31
380-450 (2,4)	18.3	64.1	31
450-520 (3,4)	17.7	62.0	31
520 (5)	17.7	71.4	33

Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
155 (1)	CW	>65:1 at all Phase Angles	0.55 (3 dB Overdrive)	17	No Device Degradation
420 (2)			1.6 (3 dB Overdrive)		
490 (3)			2.0 (3 dB Overdrive)		
520 (5)			1.1 (3 dB Overdrive)		

1. Measured in 136-174 MHz VHF broadband reference circuit.
2. Measured in 380-450 MHz UHF broadband reference circuit.
3. Measured in 450-520 MHz UHF broadband reference circuit.
4. The values shown are the minimum measured performance numbers across the indicated frequency range.
5. Measured in 520 MHz narrowband test circuit.

Features

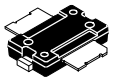
- Characterized for Operation from 136 to 520 MHz
- Unmatched Input and Output Allowing Wide Frequency Range Utilization
- Integrated ESD Protection
- Integrated Stability Enhancements
- Wideband — Full Power Across the Band:
  - 136-174 MHz
  - 380-450 MHz
  - 450-520 MHz
- 225°C Capable Plastic Package
- Exceptional Thermal Performance
- High Linearity for: TETRA, SSB, LTE
- Cost-effective Over-molded Plastic Packaging
- In Tape and Reel. R1 Suffix = 500 Units, 24 mm Tape Width, 13 inch Reel.

Typical Applications

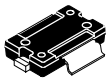
- Output Stage VHF Band Mobile Radio
- Output Stage UHF Band Mobile Radio

AFT05MS031NR1
AFT05MS031GNR1

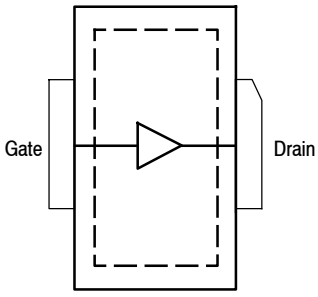
136-520 MHz, 31 W, 13.6 V
WIDEBAND
RF POWER LDMOS TRANSISTORS



TO-270-2
PLASTIC
AFT05MS031NR1



TO-270-2 GULL
PLASTIC
AFT05MS031GNR1



(Top View)

Note: 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, +40	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +12	Vdc
Operating Voltage	V_{DD}	17, +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 +225	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	294 1.47	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 79°C, 31 W CW, 13.6 Vdc, I_{DQ} = 10 mA, 520 MHz	$R_{\theta JC}$	0.67	°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 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	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} = 40 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	2	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 13.6 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	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 = 115 μAdc)	$V_{GS(th)}$	1.6	2.1	2.6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1.2 Adc)	$V_{DS(on)}$	—	0.13	—	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 7.5 Adc)	g_{fs}	—	5.8	—	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} = 13.6 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.6	—	pF
Output Capacitance (V_{DS} = 13.6 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	49.5	—	pF
Input Capacitance (V_{DS} = 13.6 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	109	—	pF
Functional Tests (1) (In Freescale Narrowband Test Fixture, 50 ohm system) V_{DD} = 13.6 Vdc, I_{DQ} = 10 mA, P_{out} = 31 W, f = 520 MHz					
Common-Source Amplifier Power Gain	G_{ps}	16.5	17.7	19.0	dB
Drain Efficiency	η_D	70.0	71.4	—	%

Load Mismatch/Ruggedness (In Freescale Test Fixture, 50 ohm system) I_{DQ} = 10 mA

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
520	CW	>65:1 at all Phase Angles	1.1 (3 dB Overdrive)	17	No Device Degradation

1. Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GN) parts.

TYPICAL CHARACTERISTICS

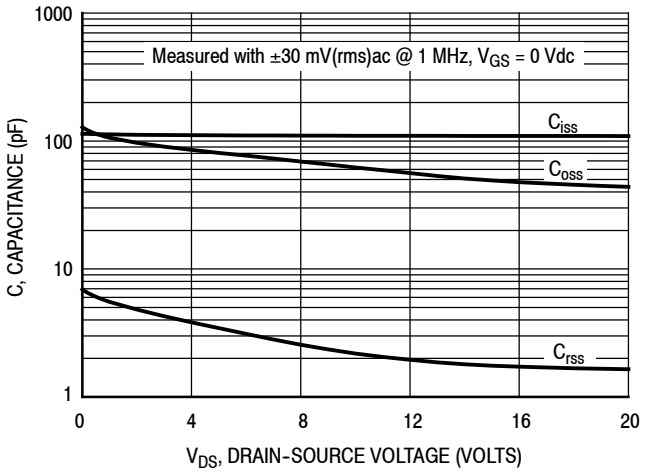


Figure 2. Capacitance versus Drain-Source Voltage

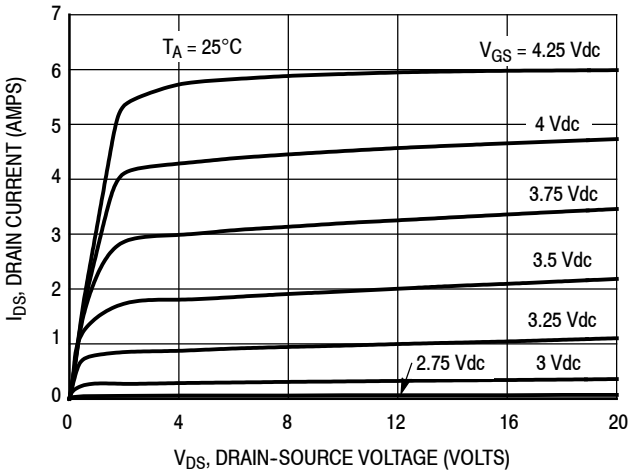
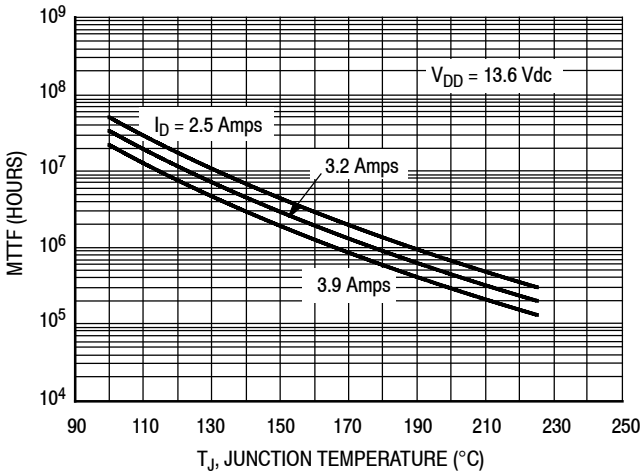


Figure 3. Drain Current versus Drain-Source Voltage



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 4. MTTF versus Junction Temperature - CW

520 MHz NARROWBAND PRODUCTION TEST FIXTURE

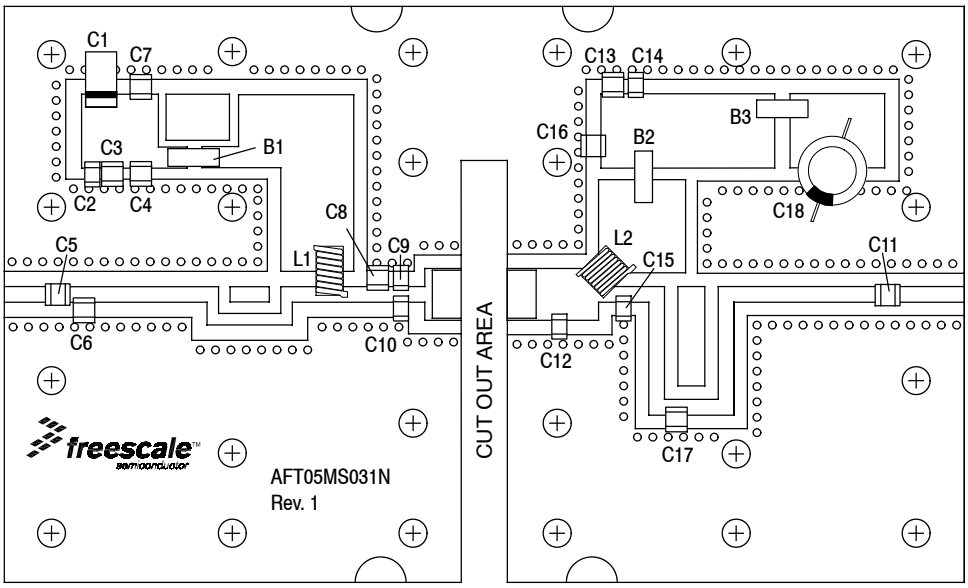


Figure 5. AFT05MS031NR1 Narrowband Test Circuit Component Layout — 520 MHz

Table 6. AFT05MS031NR1 Narrowband Test Circuit Component Designations and Values — 520 MHz

Part	Description	Part Number	Manufacturer
B1, B2, B3	RF Beads, Long	2743021447	Fair-Rite
C1	22 μF, 35 V Tantalum Capacitor	T491X226K035AT	Kemet
C2, C14	0.01 μF Chip Capacitors	C0805C103K5RAC	Kemet
C3, C13	0.1 μF Chip Capacitors	CDR33BX104AKWS	Kemet
C4	200 pF Chip Capacitor	ATC100B201JT300XT	ATC
C5	6.2 pF Chip Capacitor	ATC100B6R2JT500XT	ATC
C6	3.9 pF Chip Capacitor	ATC100B3R9JT500XT	ATC
C7, C16	180 pF Chip Capacitors	ATC100B181JT200XT	ATC
C8	10 pF Chip Capacitor	ATC100B100JT500XT	ATC
C9, C10, C11, C12	36 pF Chip Capacitors	ATC100B360JT500XT	ATC
C15	27 pF Chip Capacitor	ATC100B270JT500XT	ATC
C17	7.5 pF Chip Capacitor	ATC100B7R5JT500XT	ATC
C18	470 μF, 63 V Electrolytic Capacitor	SME63V471M12X25LL	United Chemi-Con
L1	43 nH, 10 Turn Inductor	B10TJLC	Coilcraft
L2	56 nH Inductor	1812SMS-56NJLC	Coilcraft
PCB	0.030″, ε_r = 2.55	AD255A	Arlon

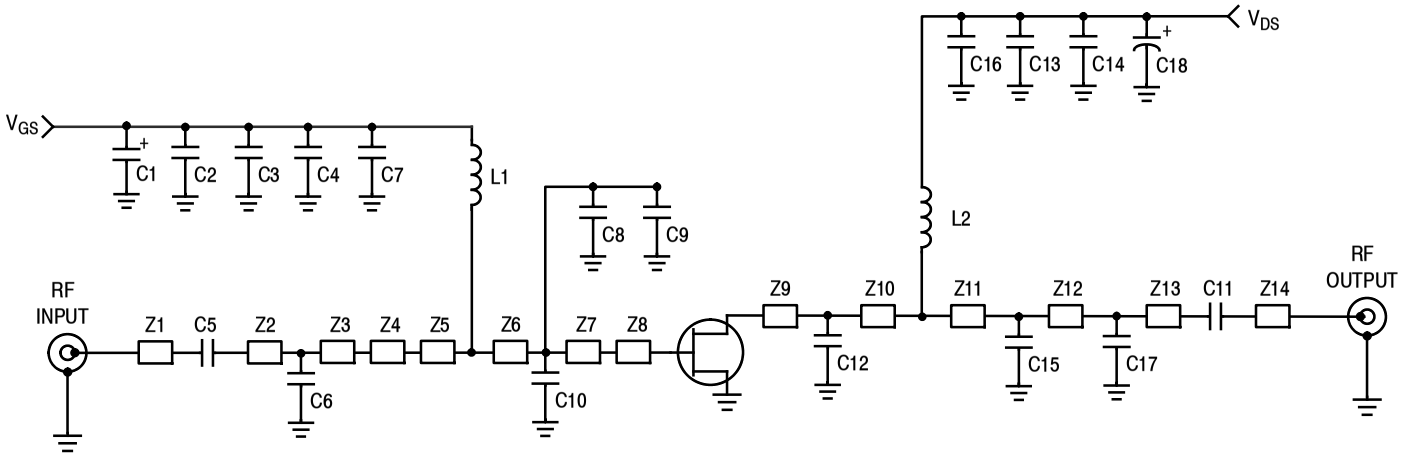


Figure 6. AFT05MS031NR1 Narrowband Test Circuit Schematic — 520 MHz

Table 7. AFT05MS031NR1 Narrowband Test Circuit Microstrips — 520 MHz

Microstrip	Description	Microstrip	Description
Z1	0.199″ × 0.082″ Microstrip	Z8	0.190″ × 0.270″ Microstrip
Z2	0.017″ × 0.082″ Microstrip	Z9	0.257″ × 0.275″ Microstrip
Z3*	0.670″ × 0.082″ Microstrip	Z10	0.145″ × 0.275″ Microstrip
Z4*	0.560″ × 0.060″ Microstrip	Z11	0.091″ × 0.082″ Microstrip
Z5*	0.370″ × 0.082″ Microstrip	Z12*	0.1322″ × 0.082″ Microstrip
Z6	0.079″ × 0.082″ Microstrip	Z13*	0.1420″ × 0.082″ Microstrip
Z7	0.352″ × 0.082″ Microstrip	Z14	0.315″ × 0.082″ Microstrip

* Line length includes microstrip bends

TYPICAL CHARACTERISTICS — 520 MHz

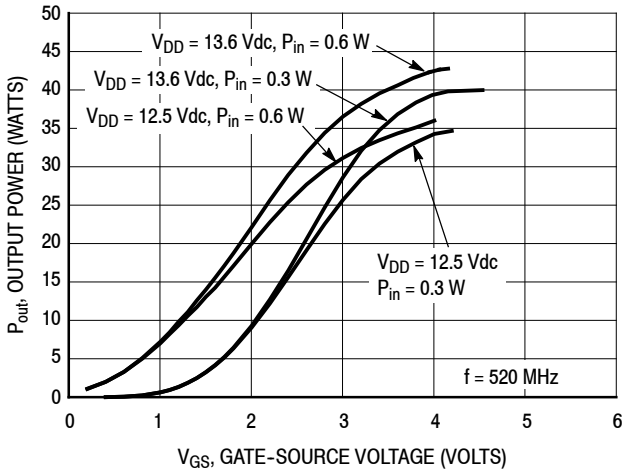


Figure 7. Output Power versus Gate-Source Voltage

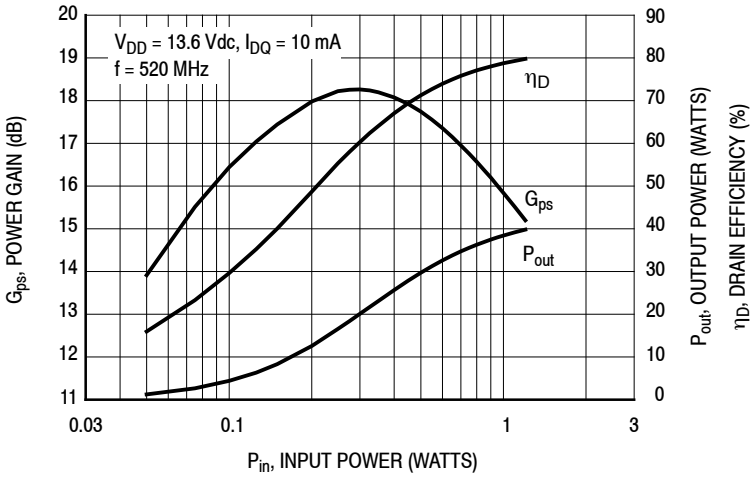


Figure 8. Power Gain, Output Power and Drain Efficiency versus Input Power

V_{DD} = 13.6 Vdc, I_{DQ} = 10 mA, P_{out} = 31 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
520	0.72 + j1.77	1.54 + j0.80

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

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

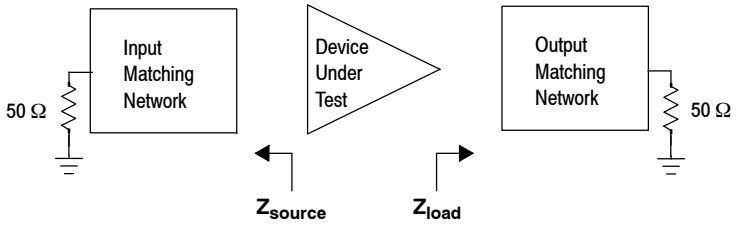


Figure 9. Narrowband Series Equivalent Source and Load Impedance — 520 MHz

Table 8. 136–174 MHz VHF Broadband Performance (In Freescale Reference Circuit, 50 ohm system)
V_{DD} = 13.6 Volts, I_{DQ} = 100 mA, T_A = 25°C, CW

Frequency (MHz)	G_{ps} (dB)	η_D (%)	P1dB (W)
136	25.0	64.0	31
155	23.2	63.0	31
174	23.2	62.0	31

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

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
155	CW	>65:1 at all Phase Angles	0.55 (3 dB Overdrive)	17	No Device Degradation

136–174 MHz VHF BROADBAND REFERENCE CIRCUIT

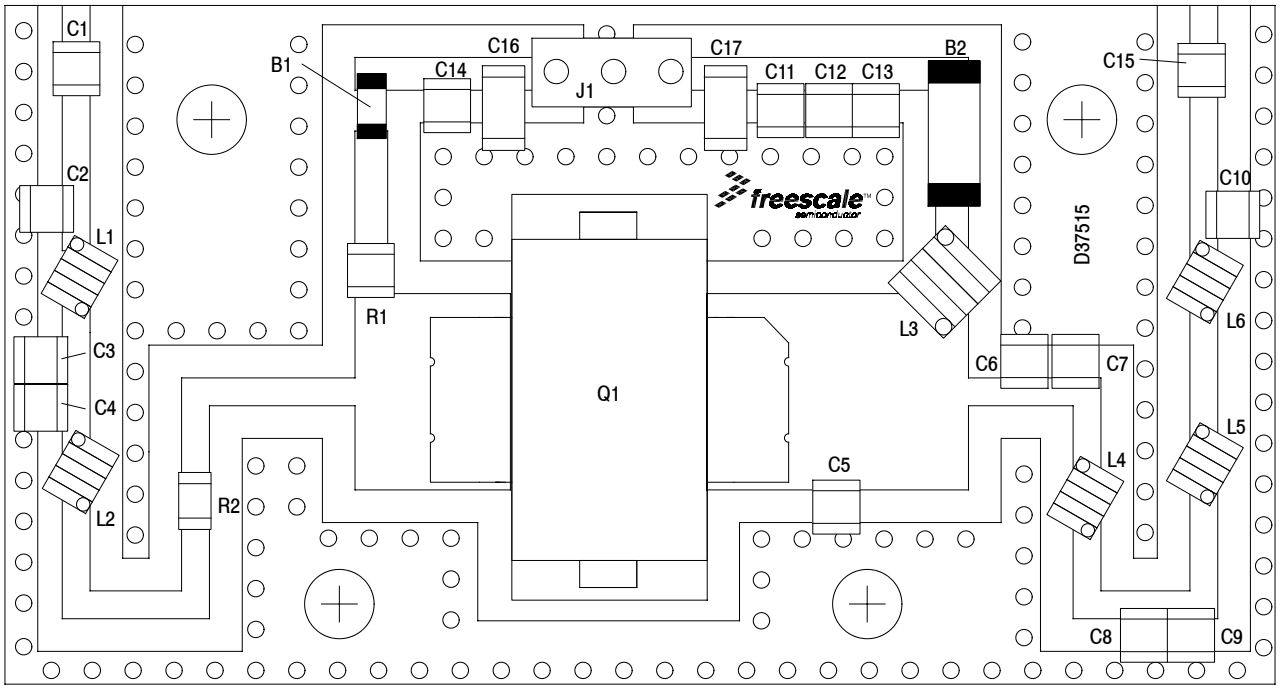


Figure 10. AFT05MS031NR1 VHF Broadband Reference Circuit Component Layout — 136–174 MHz

Table 10. AFT05MS031NR1 VHF Broadband Reference Circuit Component Designations and Values — 136–174 MHz

Part	Description	Part Number	Manufacturer
B1	Low Current Ferrite Bead	2508051107Y0	Fair-Rite
B2	High Current Ferrite Bead	2518065007Y6	Fair-Rite
C1	68 pF Chip Capacitor	ATC600F680JT250XT	ATC
C2	47 pF Chip Capacitor	ATC600F470BT250XT	ATC
C3, C4, C6, C7	100 pF Chip Capacitors	ATC600F101JT250XT	ATC
C5	20 pF Chip Capacitor	ATC600F200JT250XT	ATC
C8, C9	56 pF Chip Capacitors	ATC600F560JT250XT	ATC
C10	27 pF Chip Capacitor	ATC600F270JT250XT	ATC
C11	0.1 μF Chip Capacitor	GRM21BR71H104KA01B	Murata
C12	1 μF Chip Capacitor	GRM21BR71H105KA12L	Murata
C13, C14, C15	240 pF Chip Capacitors	ATC600F241JT250XT	ATC
C16, C17	10 μF Chip Capacitors	GRM31CR61H106KA12L	Murata
J1	3 Pin Connector	AMP-9-146305-0	TE Connectivity
L1	19 nH Inductor	0806SQ-19NGLC	Coilcraft
L2	6.9 nH Inductor	0807SQ-6N9GLC	Coilcraft
L3	27 nH Inductor	0908SQ-27NGLC	Coilcraft
L4	6 nH Inductor	0806SQ-6N0GLC	Coilcraft
L5	14 nH Inductor	0807SQ-14NGLC	Coilcraft
L6	10 nH Inductor	0807SQ-10NGLC	Coilcraft
Q1	RF Power LDMOS Transistor	AFT05MS031NR1	Freescale
R1	62 Ω, 1/4 W Chip Resistor	RG2012N-620-BT1	Susumu
R2	0 Ω, 1/4 W Chip Resistor	CWCR08050000Z0EA	Vishay
PCB	0.020″, ε_r = 4.9	S1000-2	Shengyi

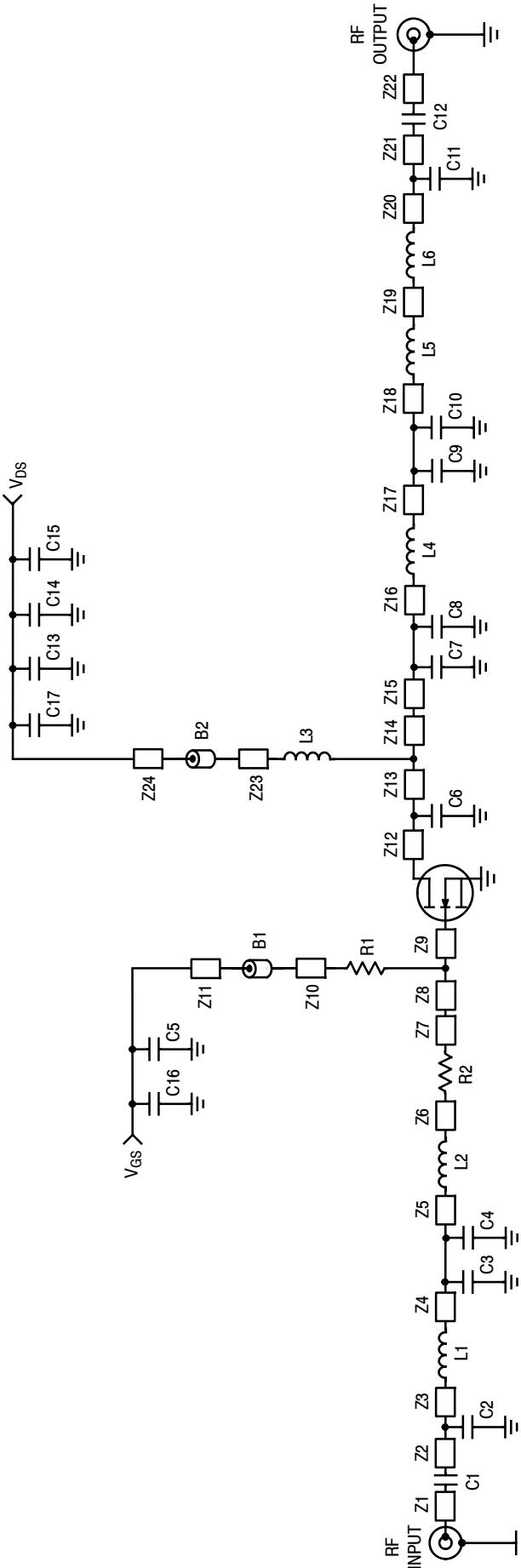


Figure 11. AFT05MS031NR1 VHF Broadband Reference Circuit Schematic — 136-174 MHz

Table 11. AFT05MS031NR1 VHF Broadband Reference Circuit Microstrips — 136-174 MHz

Microstrip	Description
Z1	0.034″ × 0.060″ Microstrip
Z2	0.034″ × 0.120″ Microstrip
Z3	0.034″ × 0.057″ Microstrip
Z4	0.034″ × 0.120″ Microstrip
Z5	0.034″ × 0.075″ Microstrip
Z6	0.034″ × 0.431″ Microstrip
Z7	0.034″ × 0.309″ Microstrip
Z8	0.240″ × 0.020″ Microstrip

Microstrip	Description
Z9	0.240″ × 0.170″ Microstrip
Z10	0.034″ × 0.130″ Microstrip
Z11	0.034″ × 0.080″ Microstrip
Z12	0.240″ × 0.155″ Microstrip
Z13	0.240″ × 0.115″ Microstrip
Z14	0.240″ × 0.050″ Microstrip
Z15	0.034″ × 0.065″ Microstrip
Z16	0.034″ × 0.140″ Microstrip

Microstrip	Description
Z17	0.034″ × 0.230″ Microstrip
Z18	0.034″ × 0.200″ Microstrip
Z19	0.034″ × 0.190″ Microstrip
Z20	0.034″ × 0.050″ Microstrip
Z21	0.034″ × 0.150″ Microstrip
Z22	0.034″ × 0.060″ Microstrip
Z23	0.034″ × 0.130″ Microstrip
Z24	0.034″ × 0.080″ Microstrip

TYPICAL CHARACTERISTICS — 136–174 MHz VHF BROADBAND REFERENCE CIRCUIT

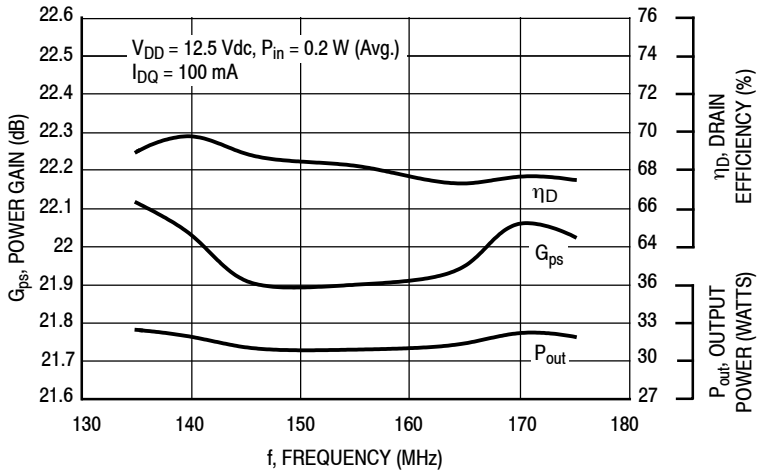


Figure 12. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 12.5 V

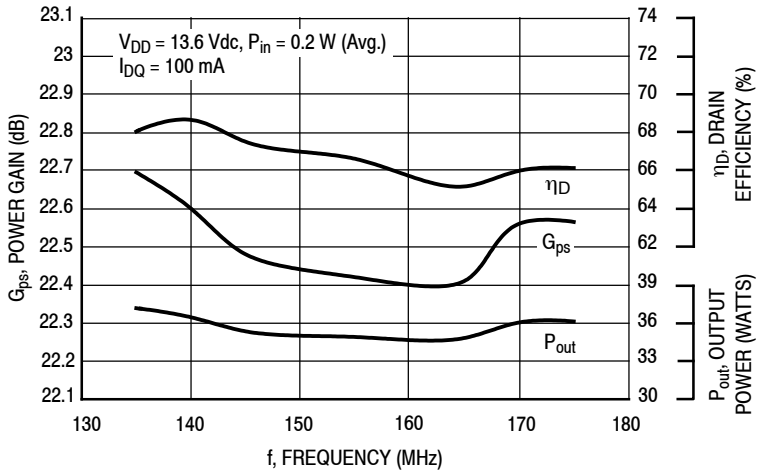


Figure 13. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 13.6 V

TYPICAL CHARACTERISTICS — 136–174 MHz VHF BROADBAND REFERENCE CIRCUIT

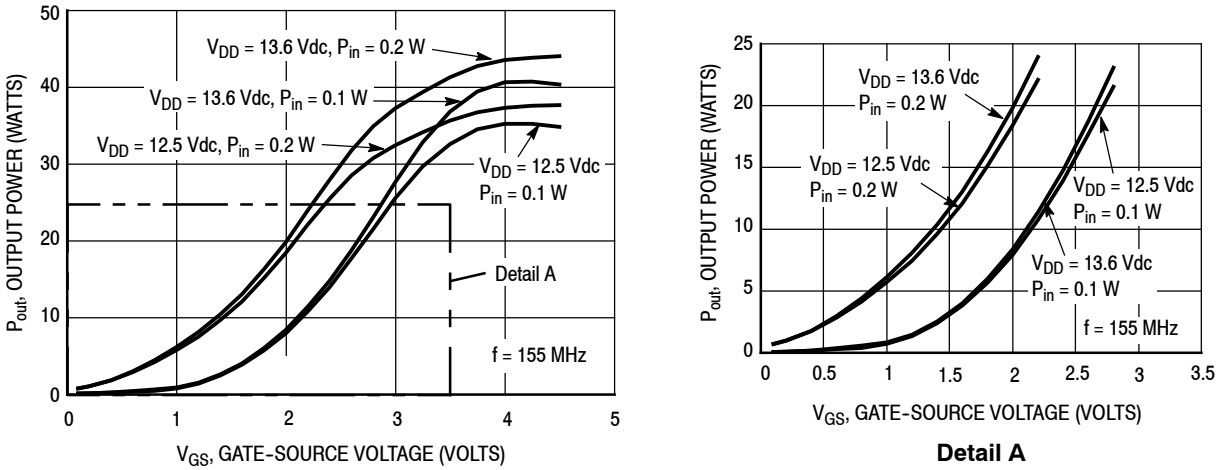


Figure 14. Output Power versus Gate-Source Voltage

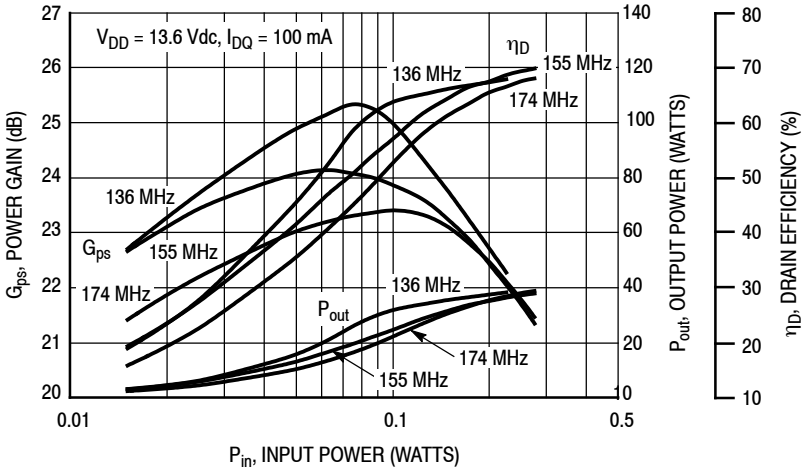
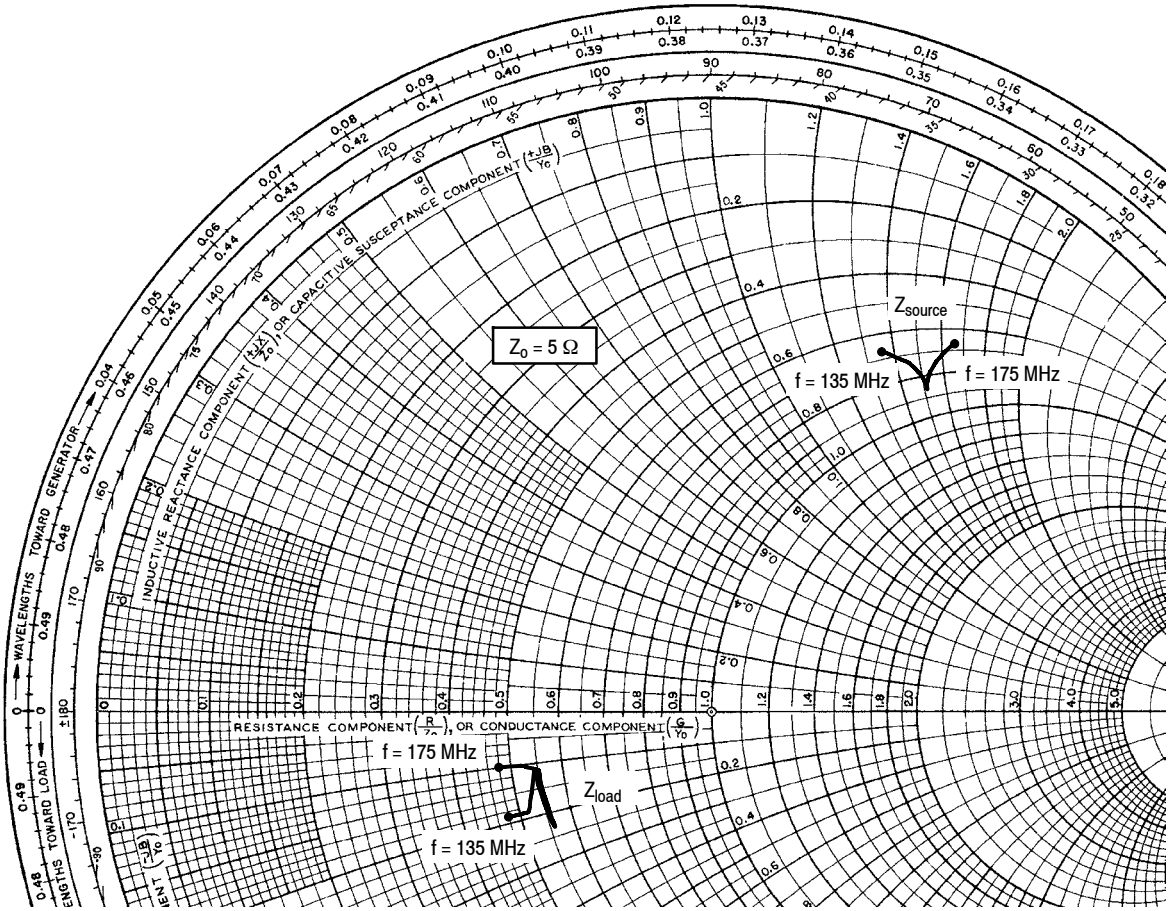


Figure 15. Power Gain, Output Power and Drain Efficiency versus Input Power and Frequency

136–174 MHz VHF BROADBAND REFERENCE CIRCUIT



V_{DD} = 13.6 Vdc, I_{DQ} = 100 mA, P_{out} = 31 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
135	3.33 + j6.92	2.42 - j0.95
140	3.66 + j7.23	2.59 - j0.96
145	3.97 + j7.44	2.71 - j1.03
150	4.21 + j7.53	2.78 - j1.13
155	4.31 + j7.54	2.77 - j1.23
160	4.21 + j7.54	2.71 - j1.31
165	3.94 + j7.65	2.61 - j1.34
170	3.58 + j7.94	2.50 - j1.32
175	3.24 + j8.42	2.41 - j1.24

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

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

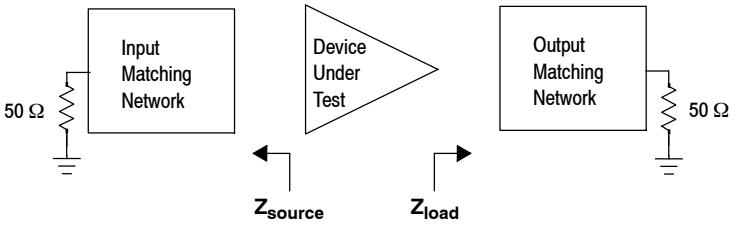


Figure 16. VHF Broadband Series Equivalent Source and Load Impedance — 136–174 MHz

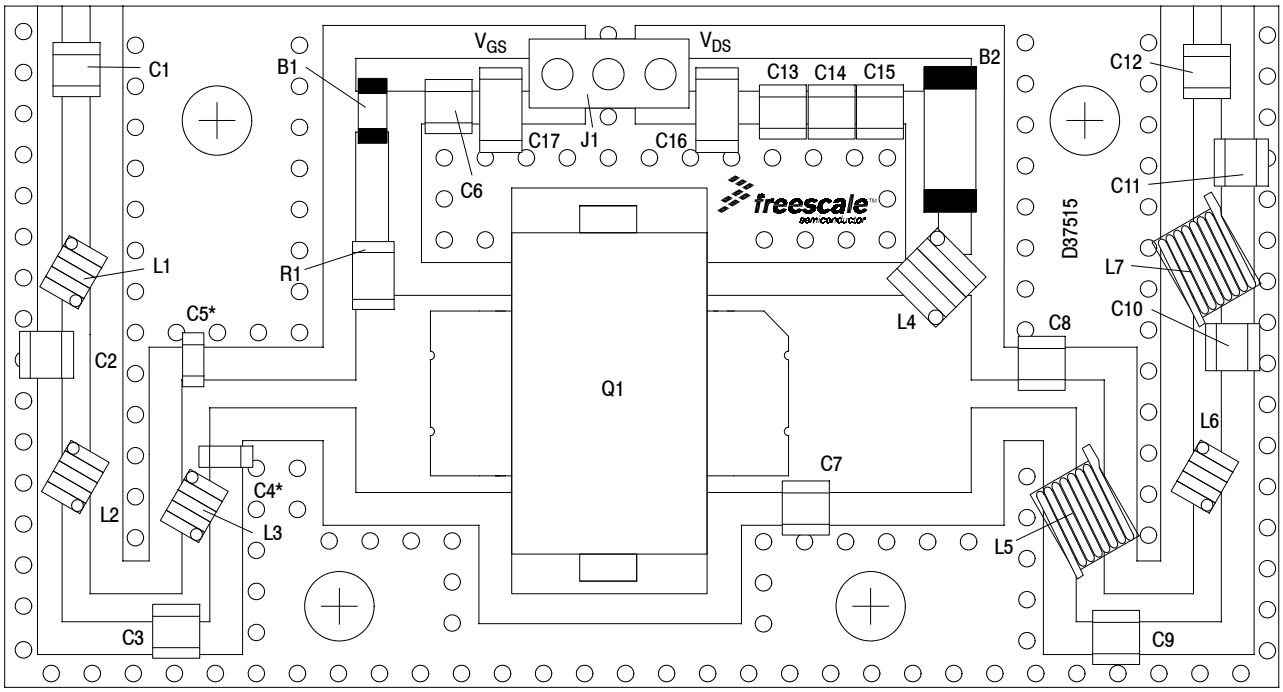
Table 12. 380–450 MHz UHF Broadband Performance (In Freescale Reference Circuit, 50 ohm system)
V_{DD} = 13.6 Volts, I_{DQ} = 100 mA, T_A = 25°C, CW

Frequency (MHz)	G_{ps} (dB)	η_D (%)	P1dB (W)
380	18.7	64.1	31
420	18.6	67.0	31
450	18.3	68.1	31

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

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
420	CW	>65:1 at all Phase Angles	1.6 (3 dB Overdrive)	17	No Device Degradation

380–450 MHz UHF BROADBAND REFERENCE CIRCUIT



* C4 and C5 are mounted vertically.

Figure 17. AFT05MS031NR1 UHF Broadband Reference Circuit Component Layout — 380–450 MHz

Table 14. AFT05MS031NR1 UHF Broadband Reference Circuit Component Designations and Values — 380–450 MHz

Part	Description	Part Number	Manufacturer
B1	Low Current Ferrite Bead	2508051107Y0	Fair-Rite
B2	High Current Ferrite Bead	2518065007Y6	Fair-Rite
C1, C5	56 pF Chip Capacitors	ATC600F560JT250XT	ATC
C2	3.9 pF Chip Capacitor	ATC600F3R9BT250XT	ATC
C3	18 pF Chip Capacitor	ATC600F180JT250XT	ATC
C4	47 pF Chip Capacitor	ATC600F470JT250XT	ATC
C6, C12, C15	240 pF Chip Capacitors	ATC600F241JT250XT	ATC
C7	24 pF Chip Capacitor	ATC600F240JT250XT	ATC
C8	68 pF Chip Capacitor	ATC600F680JT250XT	ATC
C9	27 pF Chip Capacitor	ATC600F270JT250XT	ATC
C10	8.2 pF Chip Capacitor	ATC600F8R2BT250XT	ATC
C11	3.0 pF Chip Capacitor	ATC600F3R0BT250XT	ATC
C13	0.1 μF Chip Capacitor	GRM21BR71H104KA01B	Murata
C14	1 μF Chip Capacitor	GRM21BR71H105KA12L	Murata
C16, C17	10 μF Chip Capacitors	GRM31CR61H106KA12L	Murata
J1	3 Pin Connector	AMP-9-146305-0	TE Connectivity
L1, L2, L3, L6	5.5 nH Inductors	0806SQ-5N5GLC	Coilcraft
L4	17 nH Inductor	0908SQ-17NGLC	Coilcraft
L5	1.65 nH Inductor	0906-2KLC	Coilcraft
L7	2.55 nH Inductor	0906-3JLC	Coilcraft
Q1	RF Power LDMOS Transistor	AFT05MS031NR1	Freescale
R1	62 Ω, 1/4 W Chip Resistor	RG2012N-620-BT1	Susumu
PCB	0.020″, ε_r = 4.9	S1000-2	Shengyi

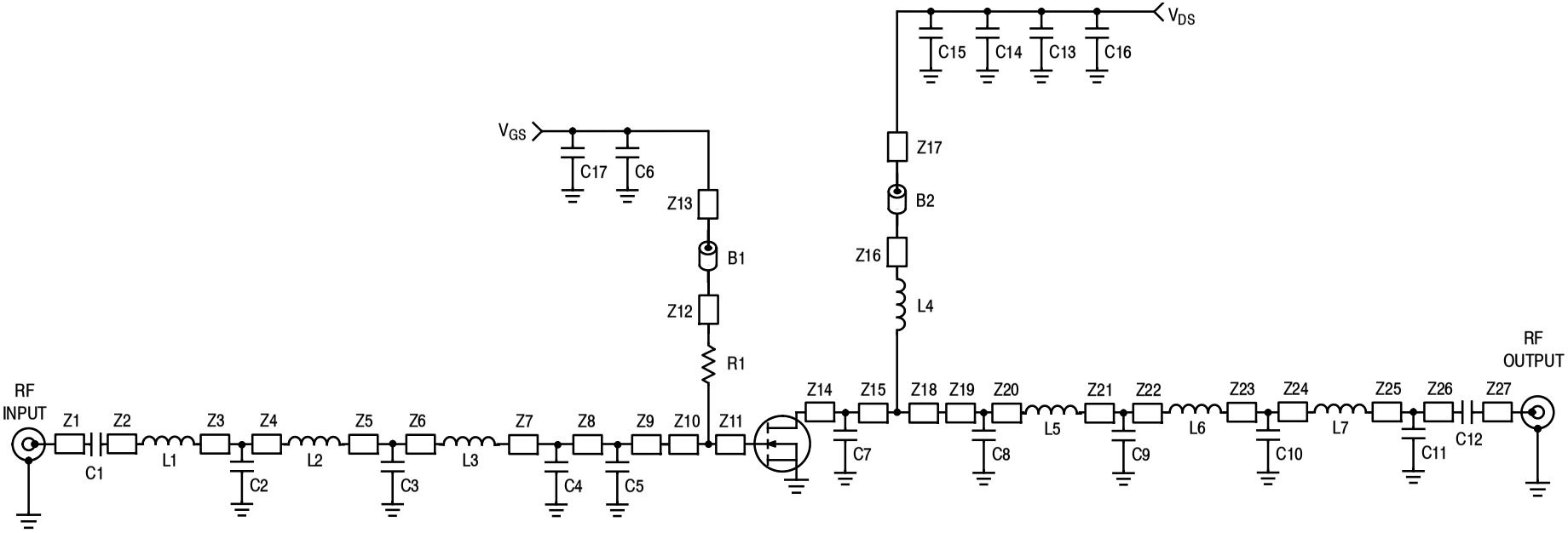


Figure 18. AFT05MS031NR1 UHF Broadband Reference Circuit Schematic — 380–450 MHz

Table 15. AFT05MS031NR1 UHF Broadband Reference Circuit Microstrips — 380–450 MHz

Microstrip	Description
Z1	0.034″ × 0.060″ Microstrip
Z2	0.034″ × 0.200″ Microstrip
Z3	0.034″ × 0.056″ Microstrip
Z4	0.034″ × 0.154″ Microstrip
Z5*	0.034″ × 0.237″ Microstrip
Z6*	0.034″ × 0.234″ Microstrip
Z7	0.034″ × 0.010″ Microstrip
Z8	0.034″ × 0.083″ Microstrip
Z9	0.034″ × 0.178″ Microstrip

Microstrip	Description
Z10	0.240″ × 0.048″ Microstrip
Z11	0.240″ × 0.142″ Microstrip
Z12	0.034″ × 0.149″ Microstrip
Z13*	0.034″ × 0.085″ Microstrip
Z14	0.240″ × 0.090″ Microstrip
Z15	0.240″ × 0.186″ Microstrip
Z16	0.034″ × 0.149″ Microstrip
Z17*	0.034″ × 0.085″ Microstrip
Z18	0.240″ × 0.044″ Microstrip

Microstrip	Description
Z19	0.034″ × 0.057″ Microstrip
Z20*	0.034″ × 0.201″ Microstrip
Z21*	0.034″ × 0.110″ Microstrip
Z22*	0.034″ × 0.361″ Microstrip
Z23	0.034″ × 0.112″ Microstrip
Z24	0.034″ × 0.083″ Microstrip
Z25	0.034″ × 0.073″ Microstrip
Z26	0.034″ × 0.077″ Microstrip
Z27	0.034″ × 0.060″ Microstrip

* Line length includes microstrip bends

TYPICAL CHARACTERISTICS — 380–450 MHz UHF BROADBAND REFERENCE CIRCUIT

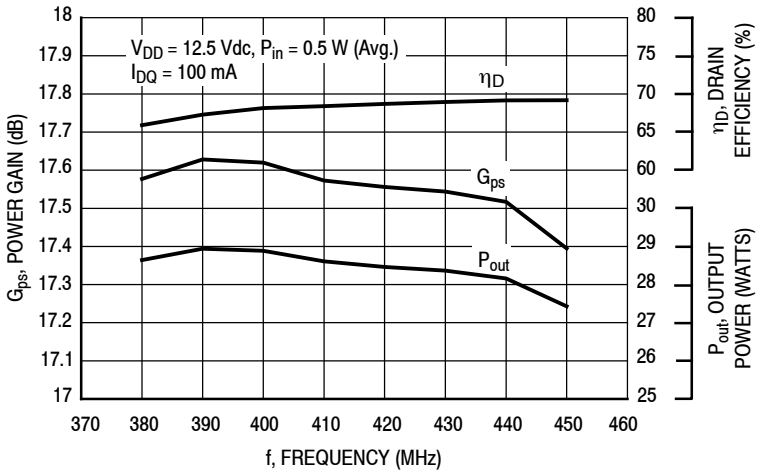


Figure 19. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 12.5 V

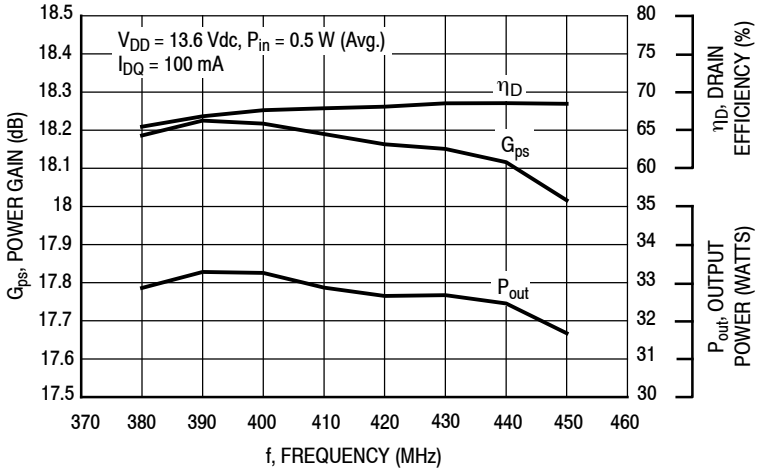


Figure 20. Power Gain, Drain Effiency and Output Power versus Frequency at a Constant Input Power — 13.6 V

TYPICAL CHARACTERISTICS — 380–450 MHz UHF BROADBAND REFERENCE CIRCUIT

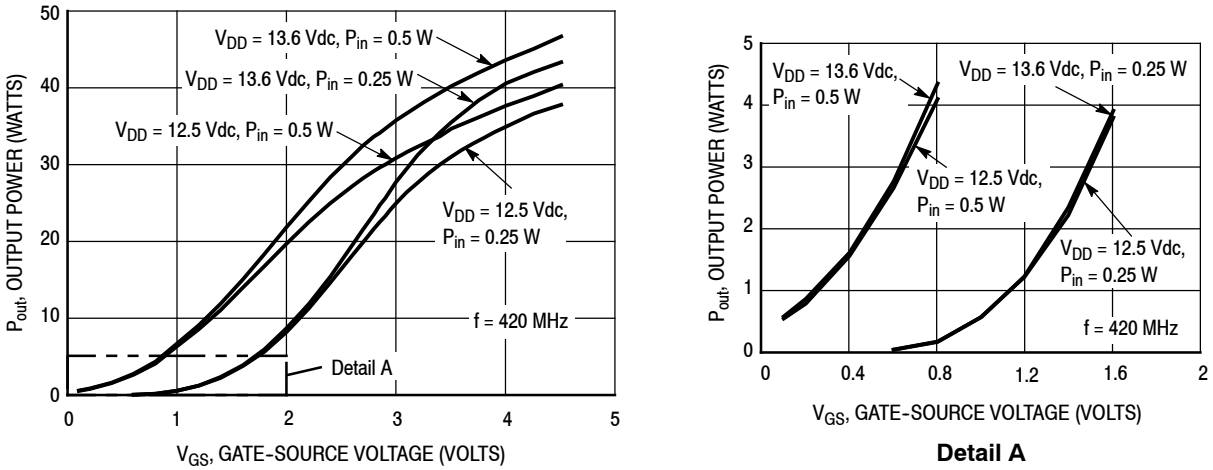


Figure 21. Output Power versus Gate-Source Voltage

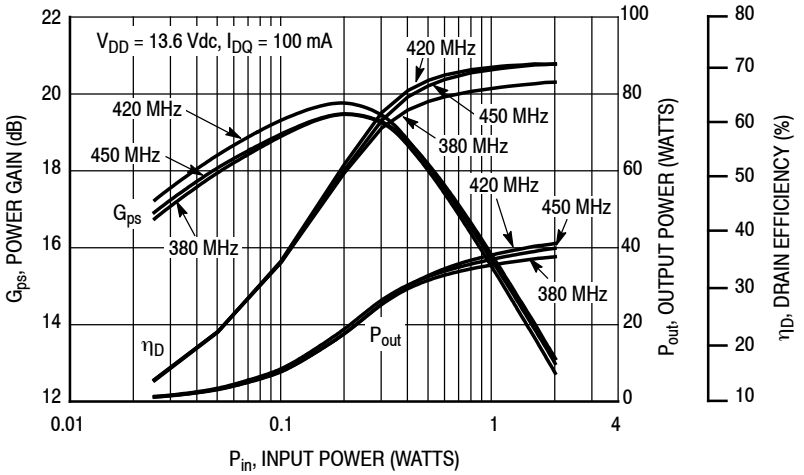
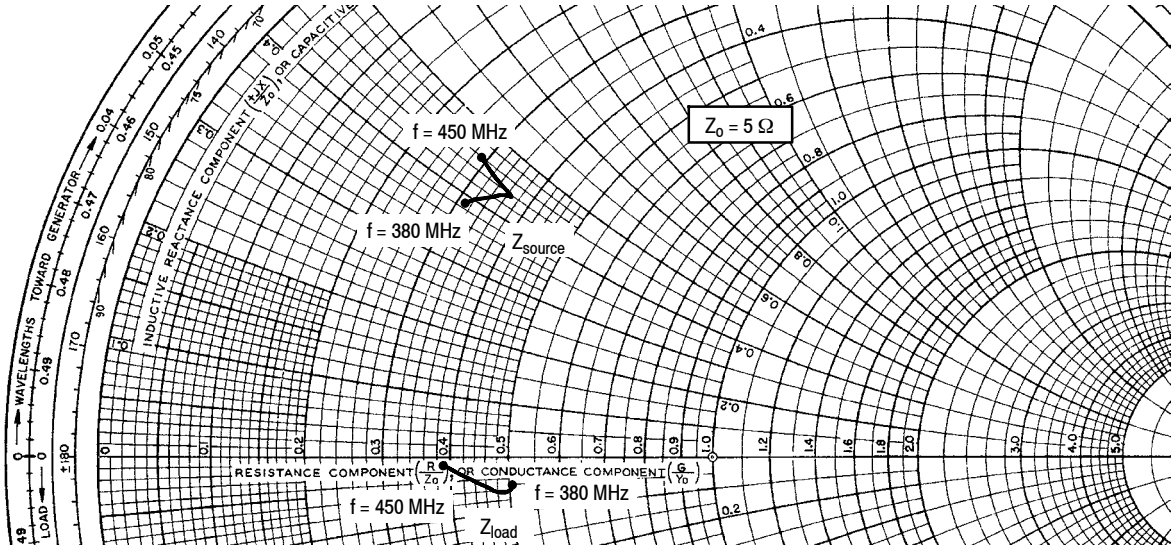


Figure 22. Power Gain, Output Power and Drain Efficiency versus Input Power and Frequency



V_{DD} = 13.6 Vdc, I_{DQ} = 100 mA, P_{out} = 31 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
380	1.57 + j1.94	2.53 – j0.27
390	1.66 + j2.07	2.53 – j0.26
400	1.74 + j2.16	2.56 – j0.27
410	1.79 + j2.20	2.49 – j0.29
420	1.79 + j2.21	2.38 – j0.28
430	1.74 + j2.21	2.26 – j0.24
440	1.62 + j2.23	2.11 – j0.16
450	1.45 + j2.29	1.95 – j0.05

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

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

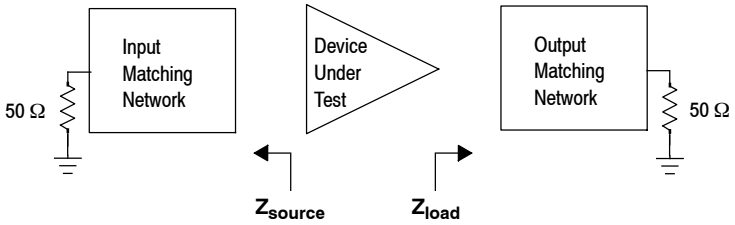


Figure 23. UHF Broadband Series Equivalent Source and Load Impedance — 380–450 MHz

Table 16. 450–520 MHz UHF Broadband Performance (In Freescale Reference Circuit, 50 ohm system)
V_{DD} = 13.6 Volts, I_{DQ} = 100 mA, T_A = 25°C, CW

Frequency (MHz)	G_{ps} (dB)	η_D (%)	P1dB (W)
450	17.7	62.0	31
490	18.7	63.8	31
520	17.9	67.0	31

Table 17. Load Mismatch/Ruggedness (In Freescale Reference Circuit)

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
490	CW	>65:1 at all Phase Angles	2.0 (3 dB Overdrive)	17	No Device Degradation

450–520 MHz UHF BROADBAND REFERENCE CIRCUIT

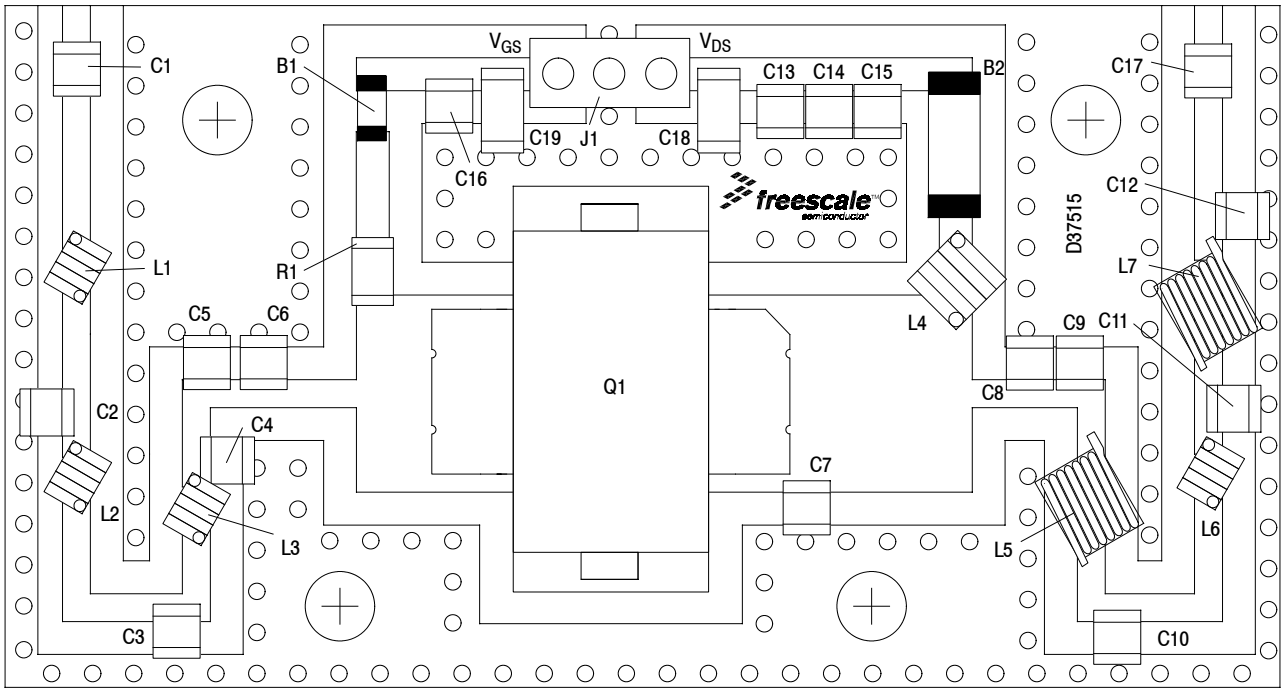


Figure 24. AFT05MS031NR1 UHF Broadband Reference Circuit Component Layout — 450–520 MHz

Table 18. AFT05MS031NR1 UHF Broadband Reference Circuit Component Designations and Values — 450–520 MHz

Part	Description	Part Number	Manufacturer
B1	Low Current Ferrite Bead	2508051107Y0	Fair-Rite
B2	High Current Ferrite Bead	2518065007Y6	Fair-Rite
C1	56 pF Chip Capacitor	ATC600F560JT250XT	ATC
C2	2.7 pF Chip Capacitor	ATC600F2R7BT250XT	ATC
C3	12 pF Chip Capacitor	ATC600F120JT250XT	ATC
C4, C9	27 pF Chip Capacitors	ATC600F270JT250XT	ATC
C5, C8	33 pF Chip Capacitors	ATC600F330JT250XT	ATC
C6	39 pF Chip Capacitor	ATC600F390JT250XT	ATC
C7, C10	18 pF Chip Capacitors	ATC600F180JT250XT	ATC
C11	8.2 pF Chip Capacitor	ATC600F8R2BT250XT	ATC
C12	1.8 pF Chip Capacitor	ATC600F1R8BT250XT	ATC
C13	0.1 μF Chip Capacitor	GRM21BR71H104KA01B	Murata
C14	1 μF Chip Capacitor	GRM21BR71H105KA12L	Murata
C15, C16, C17	240 pF Chip Capacitors	ATC600F241JT250XT	ATC
C18, C19	10 μF Chip Capacitors	GRM31CR61H106KA12L	Murata
J1	3 Pin Connector	AMP-9-146305-0	TE Connectivity
L1, L3	6.0 nH Inductors	0806SQ-6N0GLC	Coilcraft
L2, L6	5.5 nH Inductors	0806SQ5N5GLC	Coilcraft
L4	17 nH Inductor	0908SQ-17NGLC	Coilcraft
L5, L7	1.65 nH Inductors	0906-2KLC	Coilcraft
Q1	RF Power LDMOS Transistor	AFT05MS031NR1	Freescale
R1	62 Ω, 1/4 W Chip Resistor	RG2012N-620-BT1	Susumu
PCB	0.020″, ε_r = 4.9	S1000-2	Shengyi

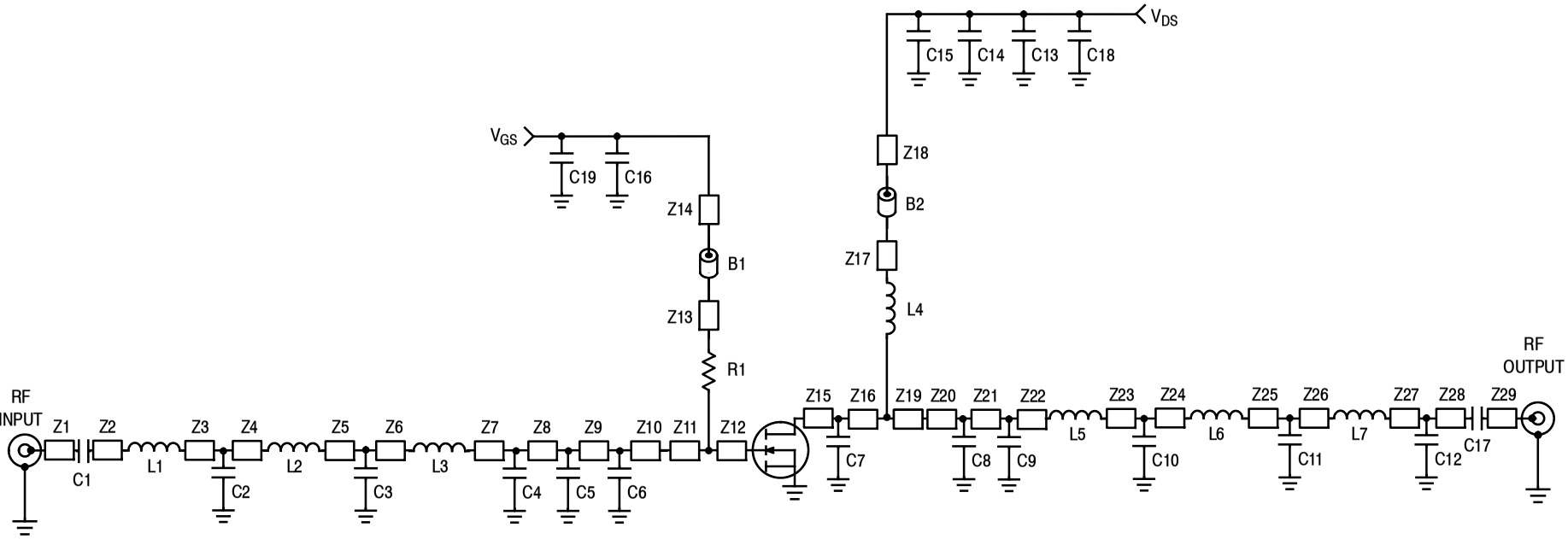


Figure 25. AFT05MS031NR1 UHF Broadband Reference Circuit Schematic — 450-520 MHz

Table 19. AFT05MS031NR1 UHF Broadband Reference Circuit Microstrips — 450-520 MHz

Microstrip	Description
Z1	0.034″ × 0.060″ Microstrip
Z2	0.034″ × 0.200″ Microstrip
Z3	0.034″ × 0.128″ Microstrip
Z4	0.034″ × 0.054″ Microstrip
Z5*	0.034″ × 0.202″ Microstrip
Z6*	0.034″ × 0.160″ Microstrip
Z7	0.034″ × 0.010″ Microstrip
Z8	0.034″ × 0.115″ Microstrip
Z9	0.034″ × 0.060″ Microstrip
Z10	0.034″ × 0.150″ Microstrip

Microstrip	Description
Z11	0.240″ × 0.010″ Microstrip
Z12	0.240″ × 0.180″ Microstrip
Z13	0.034″ × 0.149″ Microstrip
Z14	0.034″ × 0.084″ Microstrip
Z15	0.240″ × 0.054″ Microstrip
Z16	0.240″ × 0.170″ Microstrip
Z17	0.034″ × 0.149″ Microstrip
Z18	0.034″ × 0.184″ Microstrip
Z19	0.240″ × 0.044″ Microstrip
Z20	0.034″ × 0.057″ Microstrip

Microstrip	Description
Z21	0.034″ × 0.010″ Microstrip
Z22	0.034″ × 0.176″ Microstrip
Z23*	0.034″ × 0.118″ Microstrip*
Z24*	0.034″ × 0.295″ Microstrip*
Z25	0.034″ × 0.018″ Microstrip
Z26	0.034″ × 0.177″ Microstrip
Z27	0.034″ × 0.022″ Microstrip
Z28	0.034″ × 0.188″ Microstrip
Z29	0.034″ × 0.060″ Microstrip

* Line length includes microstrip bends

TYPICAL CHARACTERISTICS — 450–520 MHz UHF BROADBAND REFERENCE CIRCUIT

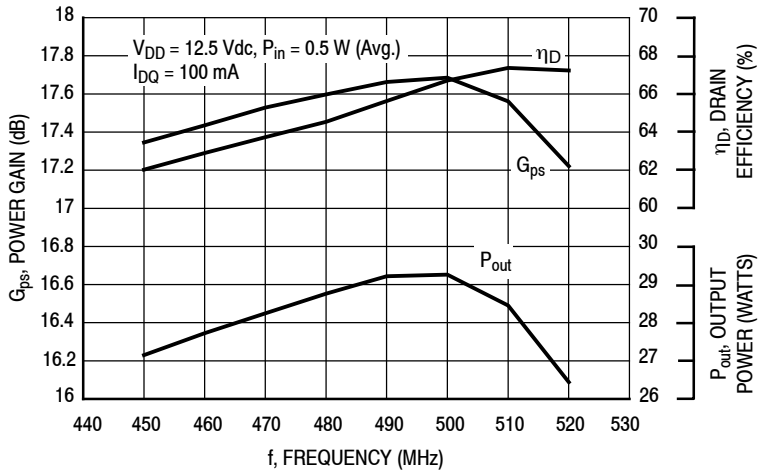


Figure 26. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 12.5 V

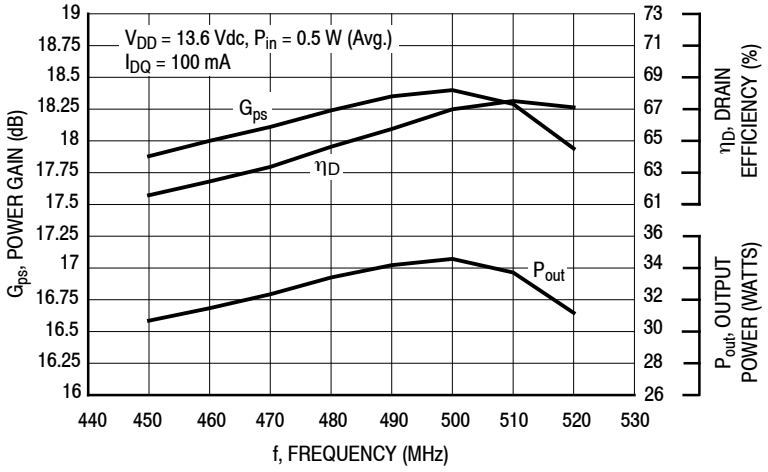


Figure 27. Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power — 13.6 V

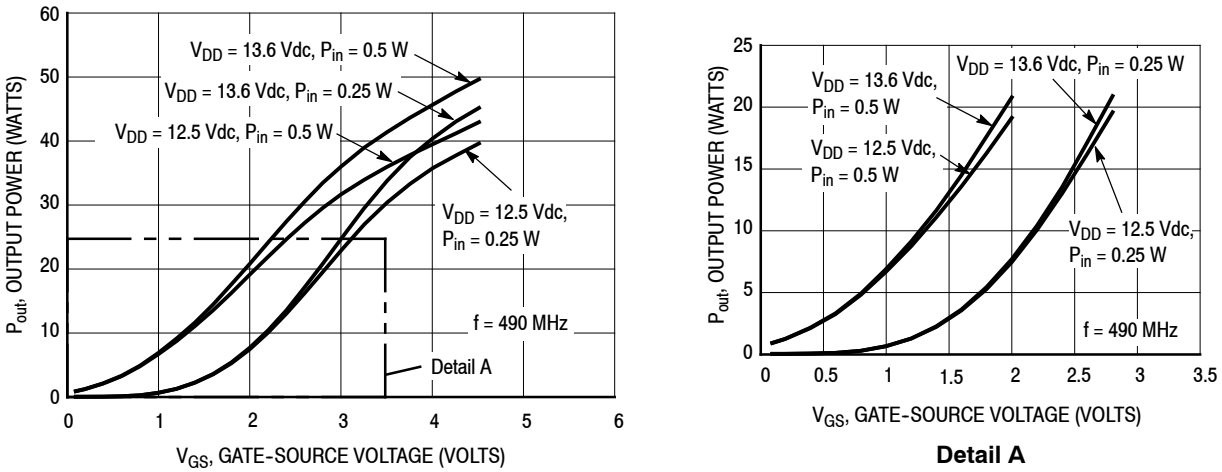


Figure 28. Output Power versus Gate–Source Voltage

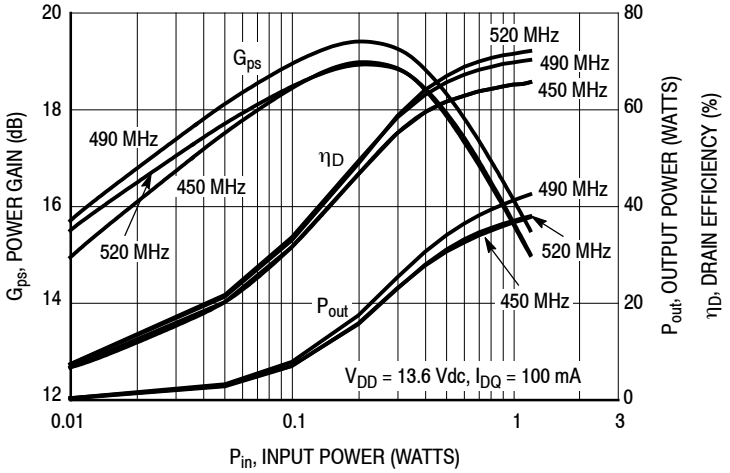
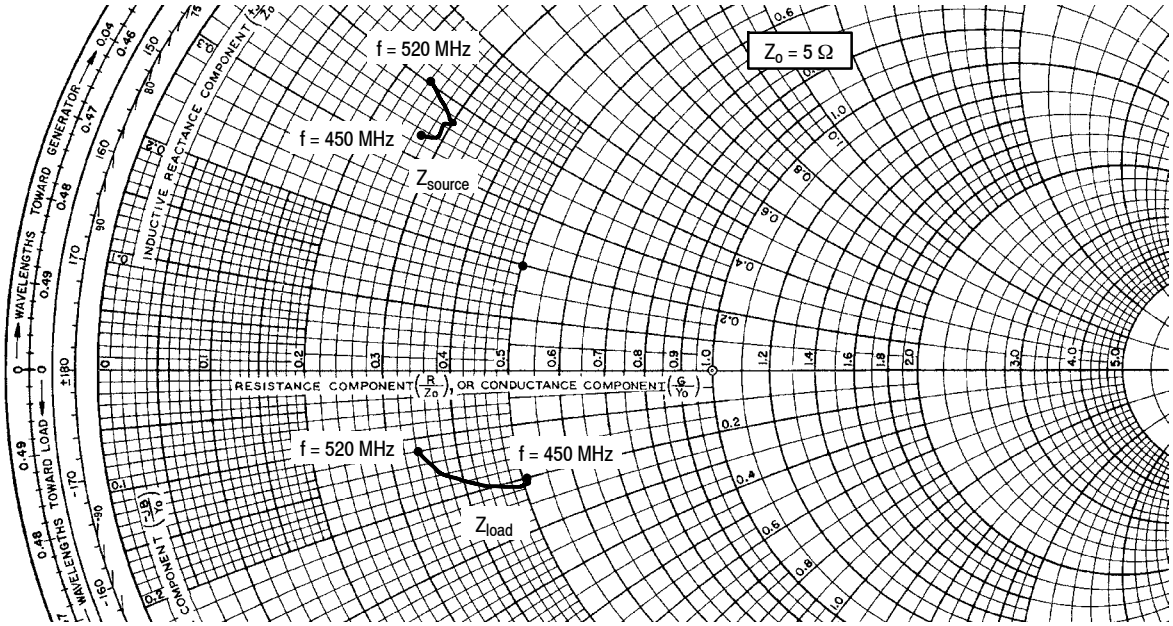


Figure 29. Power Gain, Output Power and Drain Efficiency versus Input Power and Frequency



V_{DD} = 13.6 Vdc, I_{DQ} = 100 mA, P_{out} = 31 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
450	1.37 + j1.64	2.57 – j1.01
460	1.43 + j1.72	2.49 – j1.03
470	1.47 + j1.79	2.38 – j1.03
480	1.49 + j1.83	2.26 – j1.01
490	1.47 + j1.86	2.11 – j0.95
500	1.41 + j1.89	1.97 – j0.87
510	1.32 + j1.93	1.82 – j0.76
520	1.20 + j1.99	1.68 – j0.62

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

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

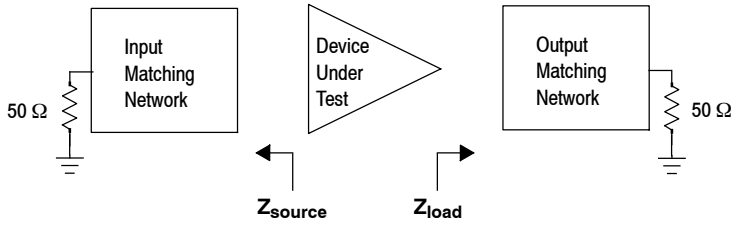
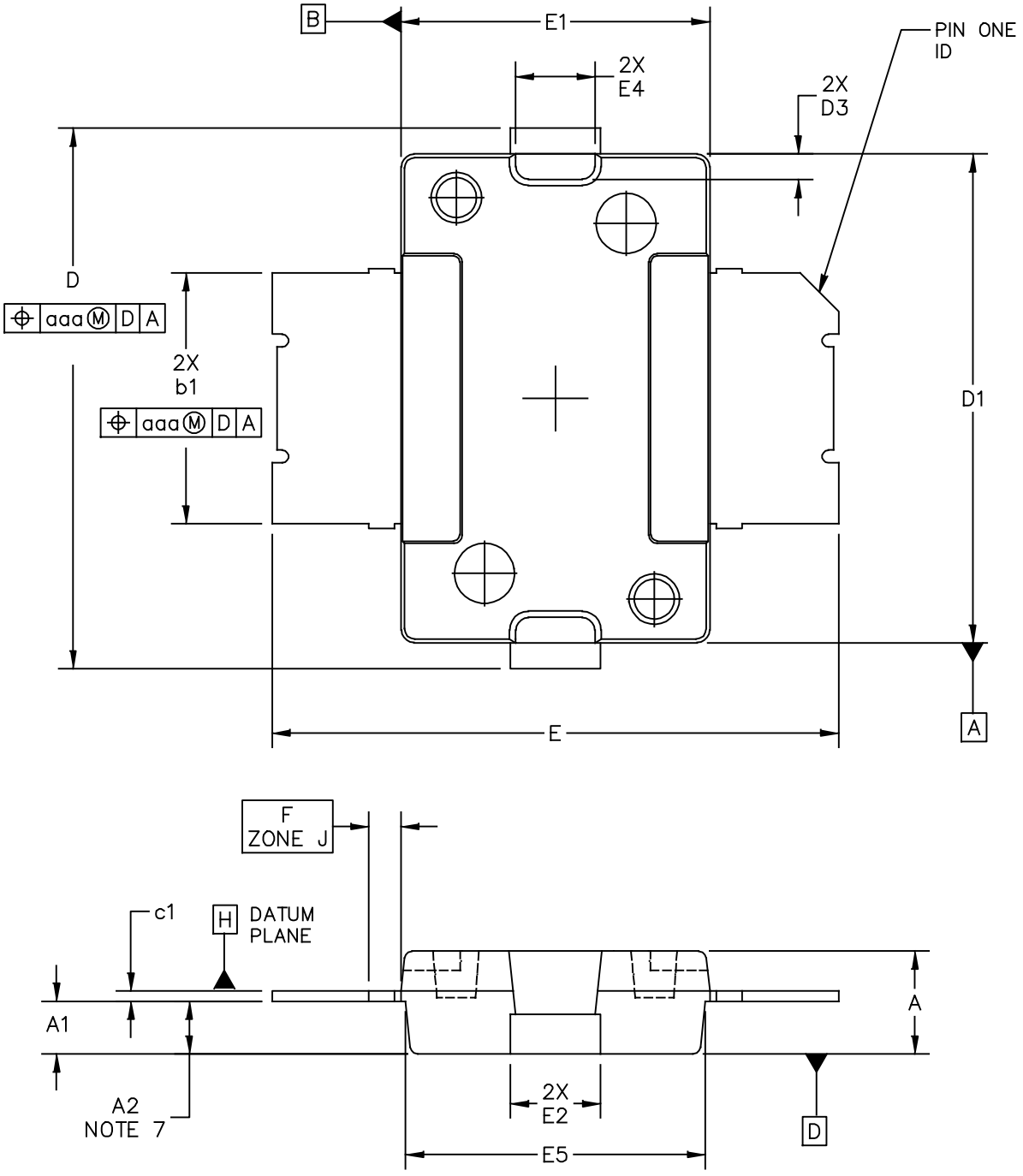
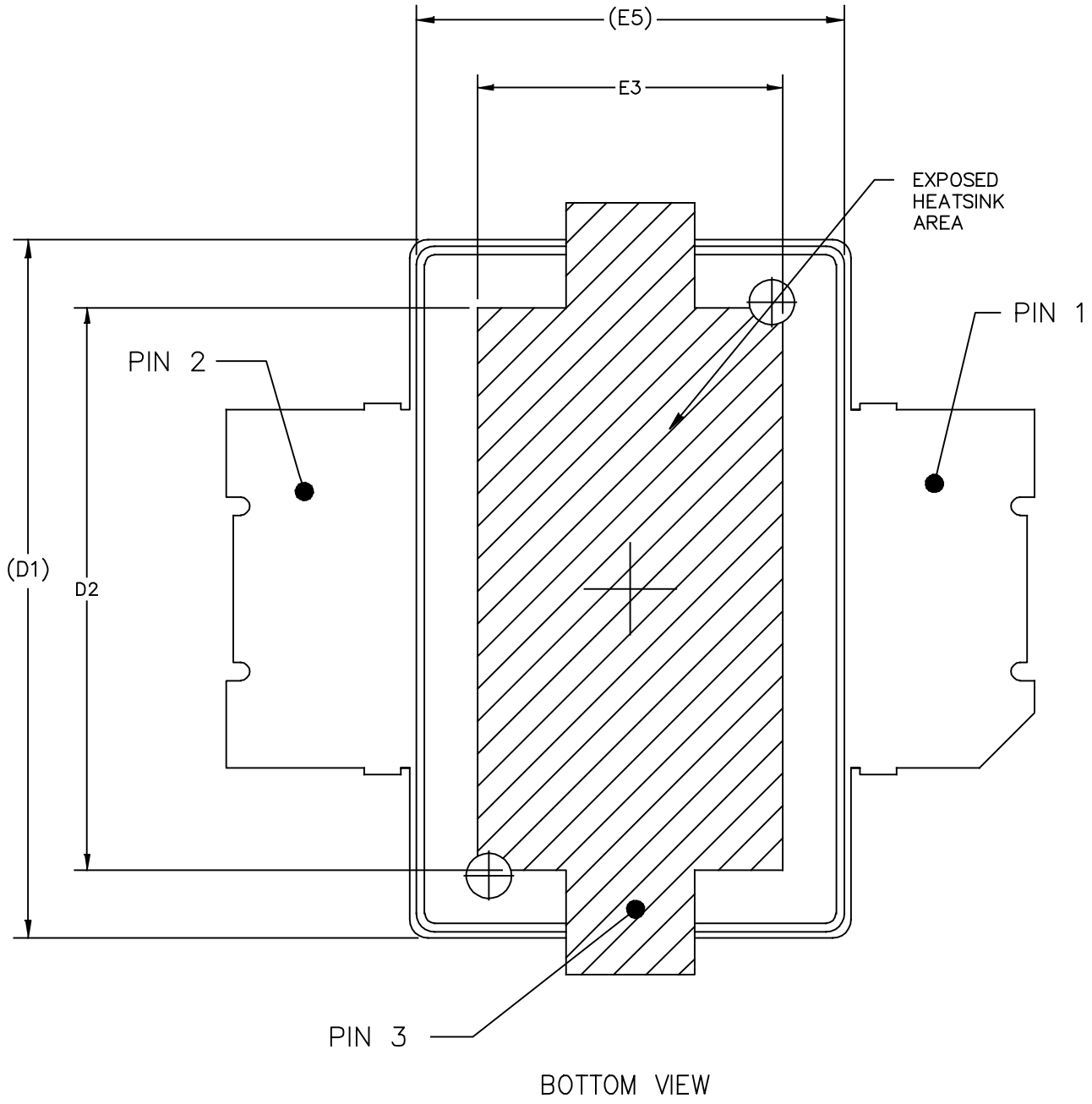


Figure 30. UHF Broadband Series Equivalent Source and Load Impedance — 450–520 MHz

PACKAGE DIMENSIONS



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TITLE: TO−270 SURFACE MOUNT	DOCUMENT NO: 98ASH98117A	REV: K
	CASE NUMBER: 1265−09	29 JUN 2007
	STANDARD: JEDEC TO−270 AA	



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	CASE NUMBER: 1265−09	29 JUN 2007
	STANDARD: JEDEC TO−270 AA	

NOTES:
1. CONTROLLING DIMENSION: INCH

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

3. DATUM PLANE –H– IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.

4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D1 AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –H–.

5. DIMENSION "b1" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE "b1" DIMENSION AT MAXIMUM MATERIAL CONDITION.

6. DATUMS –A– AND –B– TO BE DETERMINED AT DATUM PLANE –H–.

7. DIMENSION "A2" APPLIES WITHIN ZONE "J" ONLY.

8. DIMENSIONS "D" AND "E2" DO NOT INCLUDE MOLD PROTRUSION. OVERALL LENGTH INCLUDING MOLD PROTRUSION SHOULD NOT EXCEED 0.430 INCH FOR DIMENSION "D" AND 0.080 INCH FOR DIMENSION "E2". DIMENSIONS "D" AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –D–.

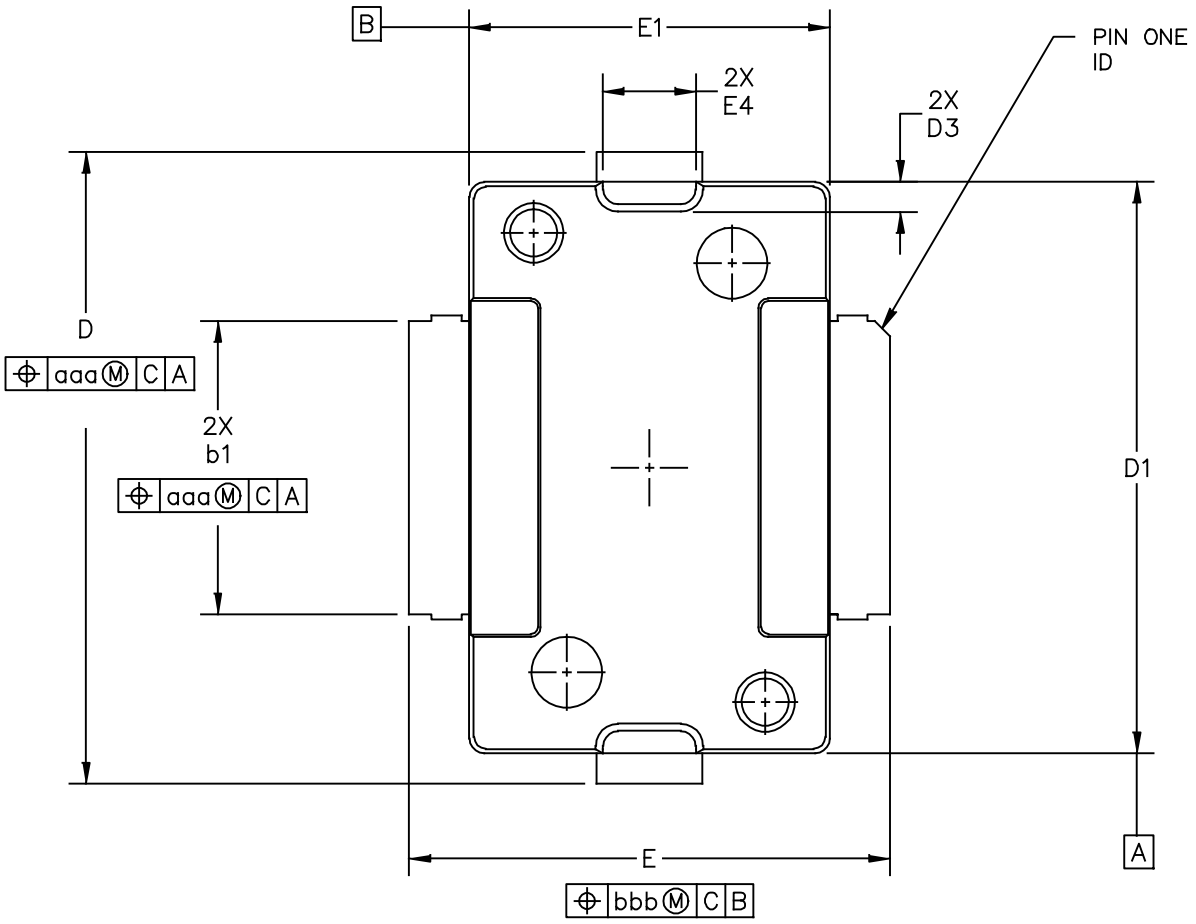
STYLE 1:
PIN 1 – DRAIN
PIN 2 – GATE
PIN 3 – SOURCE

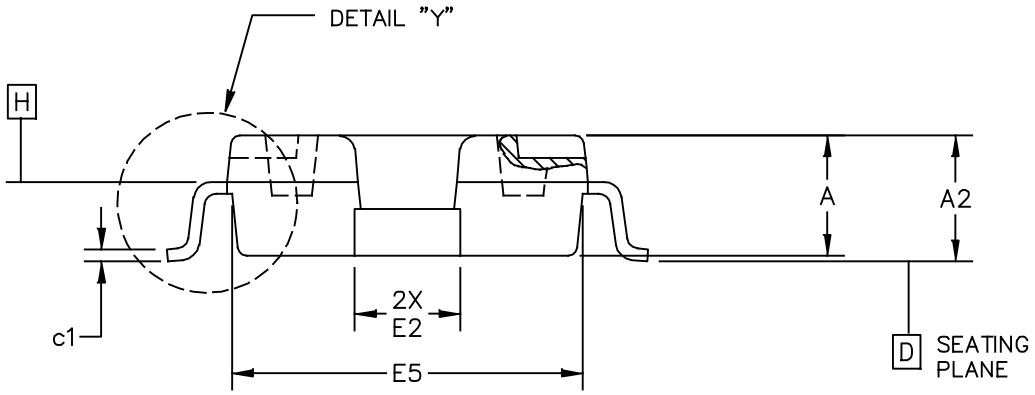
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A	.078	.082	1.98	2.08	F	.025 BSC		0.64 BSC	
A1	.039	.043	0.99	1.09	b1	.193	.199	4.90	5.06
A2	.040	.042	1.02	1.07	c1	.007	.011	0.18	0.28
D	.416	.424	10.57	10.77	aaa	.004		0.10	
D1	.378	.382	9.60	9.70					
D2	.290	----	7.37	----					
D3	.016	.024	0.41	0.61					
E	.436	.444	11.07	11.28					
E1	.238	.242	6.04	6.15					
E2	.066	.074	1.68	1.88					
E3	.150	----	3.81	----					
E4	.058	.066	1.47	1.68					
E5	.231	.235	5.87	5.97					

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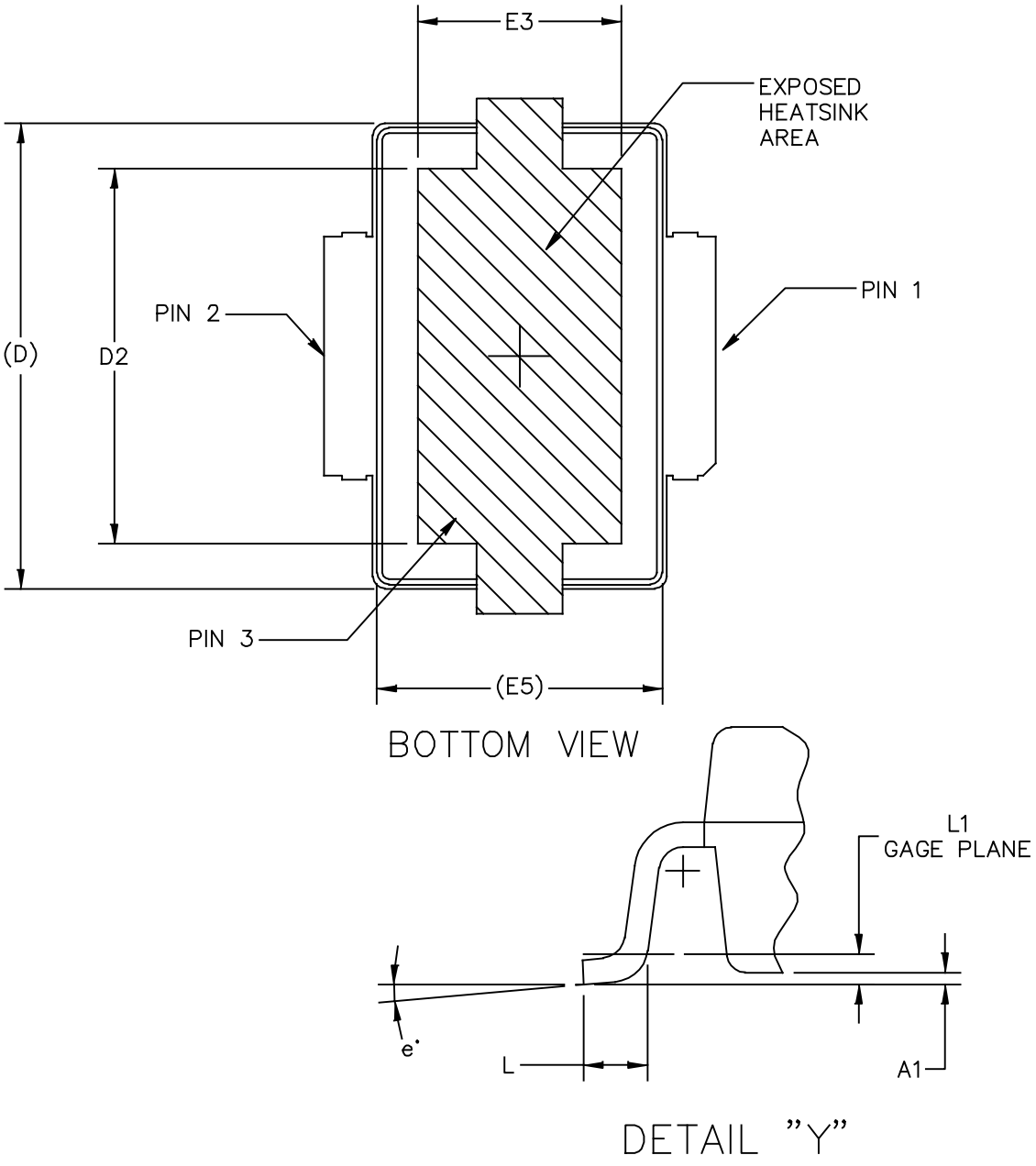
MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE

TITLE:	DOCUMENT NO: 98ASH98117A	REV: K
TO–270 SURFACE MOUNT	CASE NUMBER: 1265–09	29 JUN 2007
	STANDARD: JEDEC TO–270 AA	





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	CASE NUMBER: 1265A–03	02 JUL 2007
	STANDARD: JEDEC TO–270 BA	



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TITLE: TO−270 GULL WING	DOCUMENT NO: 98ASA99301D	REV: C
	CASE NUMBER: 1265A−03	02 JUL 2007
	STANDARD: JEDEC TO−270 BA	

NOTES:
1. CONTROLLING DIMENSION: INCH

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

3. DATUM PLANE –H– IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.

4. DIMENSIONS "D1" AND "E1" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .006 PER SIDE. DIMENSIONS "D1 AND "E1" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –H–.

5. DIMENSION b1 DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .005 TOTAL IN EXCESS OF THE b1 DIMENSION AT MAXIMUM MATERIAL CONDITION.

6. DATUMS –A– AND –B– TO BE DETERMINED AT DATUM PLANE –H–.

7. DIMENSIONS "D" AND "E2" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .003 PER SIDE. DIMENSIONS "D AND "E2" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –D–.

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.078	.082	1.98	2.08	L	.018	.024	0.46	0.61
A1	.001	.004	0.02	0.10	L1	.01 BSC		0.25 BSC	
A2	.077	.088	1.96	2.24	b1	.193	.199	4.90	5.06
D	.416	.424	10.57	10.77	c1	.007	.011	0.18	0.28
D1	.378	.382	9.60	9.70	e	2°	8°	2°	8°
D2	.290	–	7.37	–	aaa	.004		0.10	
D3	.016	.024	0.41	0.61					
E	.316	.324	8.03	8.23					
E1	.238	.242	6.04	6.15					
E2	.066	.074	1.68	1.88					
E3	.150	–	3.81	–					
E4	.058	.066	1.47	1.68					
E5	.231	.235	5.87	5.97					

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MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE

TITLE:	DOCUMENT NO: 98ASA99301D	REV: C
TO–270 GULL WING	CASE NUMBER: 1265A–03	02 JUL 2007
	STANDARD: JEDEC TO–270 BA	

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
- AN3789: Clamping of High Power RF Transistors and RFICs in Over-Molded Plastic Packages

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	June 2012	• Initial Release of Data Sheet
1	Apr. 2013	• Load Mismatch/Ruggedness tables: changed output power to input power to clarify the conditions used during test, p. 1, 3, 14, 20 • Added 136-174 MHz VHF Broadband Reference Circuit as follows: - Typical Performance table, p. 1 - Table 8, VHF Broadband Performance, p. 8 - Table 9, Load Mismatch/Ruggedness, p. 8 - Fig. 10, VHF Broadband Reference Circuit Component Layout, p. 9 - Table 10, VHF Broadband Reference Circuit Component Designations and Values, p. 9 - Fig. 11, VHF Broadband Reference Circuit Schematic, p. 10 - Table 11, VHF Broadband Reference Circuit Microstrips, p. 10 - Fig. 12, Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power - 12.5 V, p. 11 - Fig. 13, Power Gain, Drain Efficiency and Output Power versus Frequency at a Constant Input Power - 13.6 V, p. 11 - Fig. 14, Output Power versus Gate-Source Voltage, p. 12 - Fig. 15, Power Gain, Output Power and Drain Efficiency versus Input Power and Frequency, p. 12 - Fig. 16, VHF Broadband Series Equivalent Source and Load Impedance, p. 13 • Figs. 10, 17 and 24, Reference Circuit Component Layouts: added manufacturer part number, p. 9, 15, 21 • Fig. 23, UHF Broadband Series Equivalent Source and Load Impedance — 380-450 MHz: corrected bias measurement from 10 mA to 100 mA, p. 19

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