Freescale Semiconductor
Technical Data

Document Number: MW6S010
Rev. 1, 5/2005

RF Power Field Effect Transistor

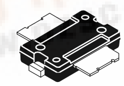
N-Channel Enhancement-Mode Lateral MOSFETs

Designed for Class A or Class AB base station applications with frequencies up to 1500 MHz. Suitable for analog and digital modulation and multicarrier amplifier applications.

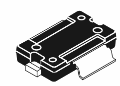
- Typical Two-Tone Performance @ 960 MHz, V_{DD} = 28 Volts, I_{DQ} = 125 mA, P_{out} = 10 Watts PEP
  - Power Gain — 18 dB
  - Drain Efficiency — 32%
  - IMD — -37 dBc
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 960 MHz, 10 Watts CW Output Power
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- On-Chip RF Feedback for Broadband Stability
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- N Suffix Indicates Lead-Free Terminations
- 200°C Capable Plastic Package
- In Tape and Reel. R1 Suffix = 500 Units per 24 mm, 13 inch Reel.

MW6S010NR1
MW6S010GNR1
MW6S010MR1
MW6S010GMR1

450-1500 MHz, 10 W, 28 V
LATERAL N-CHANNEL
BROADBAND RF POWER MOSFETs



CASE 1265-08, STYLE 1
TO-270-2
PLASTIC
MW6S010NR1(MR1)



CASE 1265A-02, STYLE 1
TO-270-2 GULL
PLASTIC
MW6S010GNR1(GMR1)

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +68	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +12	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	61.4 0.35	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +175	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 10 W PEP	$R_{\theta JC}$	2.85	°C/W

1. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

NOTE - **CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

Table 3. ESD Protection Characteristics

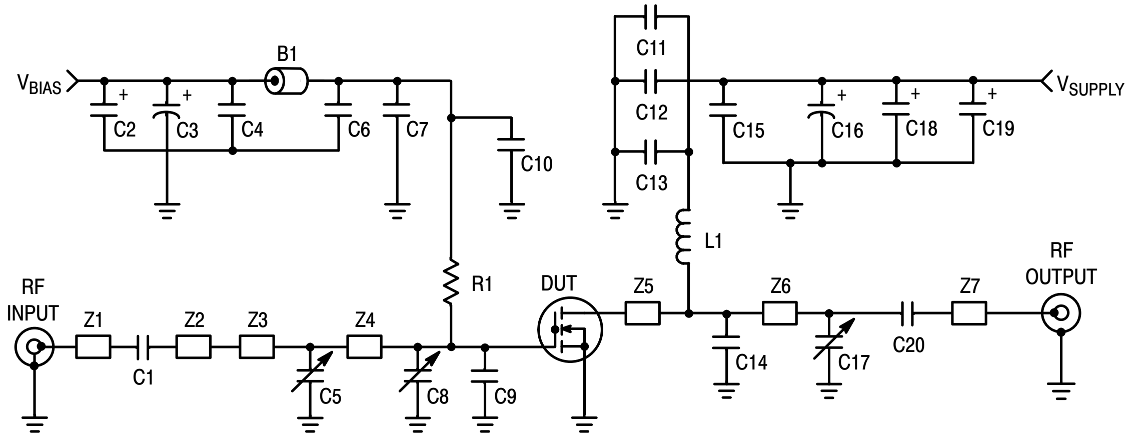
Test Methodology	Class
Human Body Model (per JESD22-A114)	1A
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	III

Table 4. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD 22-A113, IPC/JEDEC J-STD-020	1	260	°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 68 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 100 μAdc)	$V_{GS(th)}$	1.5	2.3	3	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 125 mAdc)	$V_{GS(Q)}$	—	3.1	—	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 0.3 Adc)	$V_{DS(on)}$	—	0.27	0.35	Vdc
Dynamic Characteristics					
Input Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{iss}	—	23	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	10	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.32	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 125 mA, P_{out} = 10 W PEP, f = 960 MHz, Two-Tone Test, 100 kHz Tone Spacing					
Power Gain	G_{ps}	17.5	18	20.5	dB
Drain Efficiency	η_D	31	32	—	%
Intermodulation Distortion	IMD	—	-37	-33	dBc
Input Return Loss	IRL	—	-18	-10	dB
Typical Performances (In Freescale 450 MHz Demo Board, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 150 mA, P_{out} = 10 W PEP, 420 MHz<Frequency<470 MHz, Two-Tone Test, 100 kHz Tone Spacing					
Power Gain	G_{ps}	—	20	—	dB
Drain Efficiency	η_D	—	33	—	%
Intermodulation Distortion	IMD	—	-40	—	dBc
Input Return Loss	IRL	—	-10	—	dB



Z1	0.073″ x 0.223″ Microstrip	Z5	0.313″ x 0.902″ Microstrip
Z2	0.112″ x 0.070″ Microstrip	Z6	0.073″ x 1.080″ Microstrip
Z3	0.213″ x 0.500″ Microstrip	Z7	0.073″ x 0.314″ Microstrip
Z4	0.313″ x 1.503″ Microstrip	PCB	Rogers ULTRALAM 2000, 0.031″, ε_r = 2.55

Figure 1. MW6S010NR1(GNR1/MR1/GMR1) Test Circuit Schematic — 900 MHz

Table 6. MW6S010NR1(GNR1/MR1/GMR1) Test Circuit Component Designations and Values — 900 MHz

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	2743019447	Fair-Rite
C1, C6, C11, C20	47 pF Chip Capacitors	100B470JP500X	ATC
C2, C18, C19	22 μF, 35 V Tantalum Capacitors	T491D226K035AS	Kemet
C3, C16	220 μF, 63 V Electrolytic Capacitors, Radial	13668221	Phillips
C4, C15	0.1 μF Chip Capacitors	CDR33BX104AKWS	Kemet
C5, C8, C17	0.8-8.0 pF Variable Capacitors, Gigatrim	272915L	Johanson
C7, C12	24 pF Chip Capacitors	100B240JP500X	ATC
C9, C10, C13	6.8 pF Chip Capacitors	100B6R8JP500X	ATC
C14	7.5 pF Chip Capacitor	100B7R5JP500X	ATC
L1	12.5 nH Inductor	A04T-5	Coilcraft
R1	1 kΩ Chip Resistor	CRCW12061001F100	Vishay-Dale

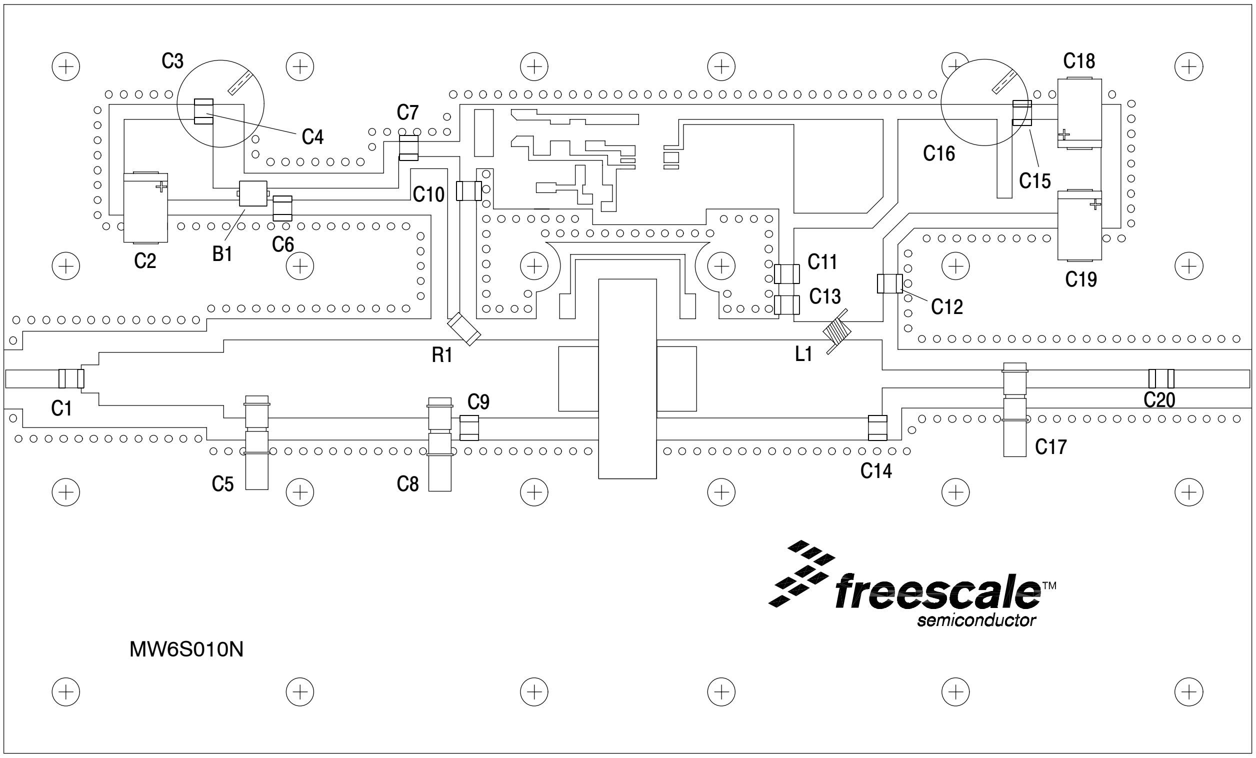


Figure 2. MW6S010NR1(GNR1/MR1/GMR1) Test Circuit Component Layout — 900 MHz

TYPICAL CHARACTERISTICS — 900 MHz

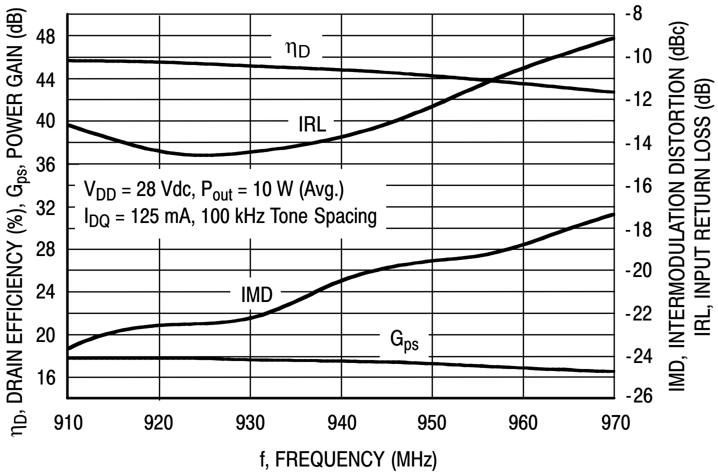


Figure 3. Two-Tone Wideband Performance @ P_{out} = 10 Watts

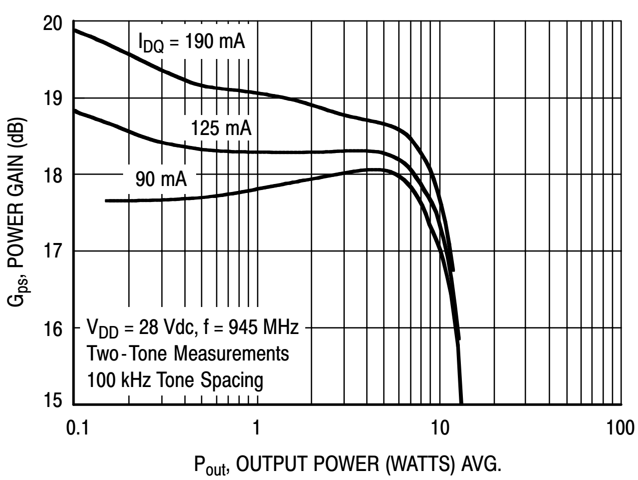


Figure 4. Two-Tone Power Gain versus Output Power

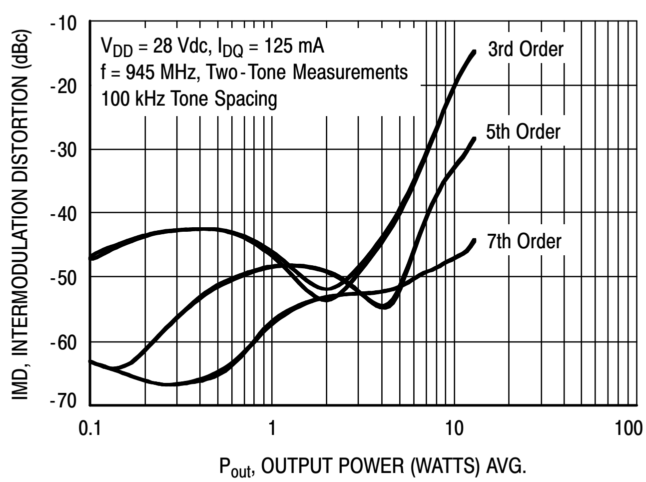


Figure 5. Intermodulation Distortion Products versus Output Power

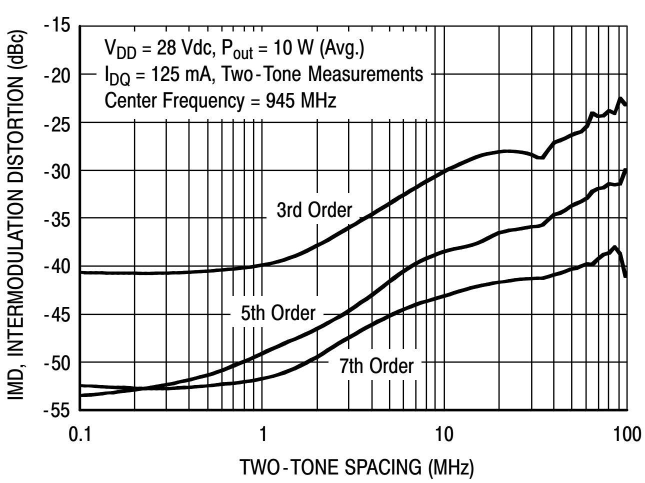


Figure 6. Intermodulation Distortion Products versus Tone Spacing

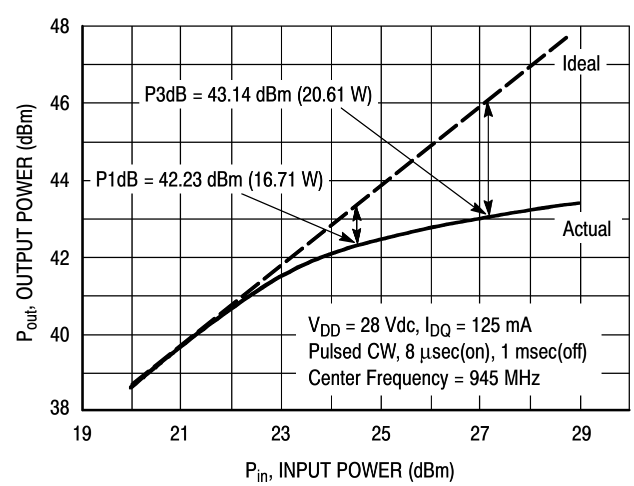


Figure 7. Pulse CW Output Power versus Input Power

TYPICAL CHARACTERISTICS — 900 MHz

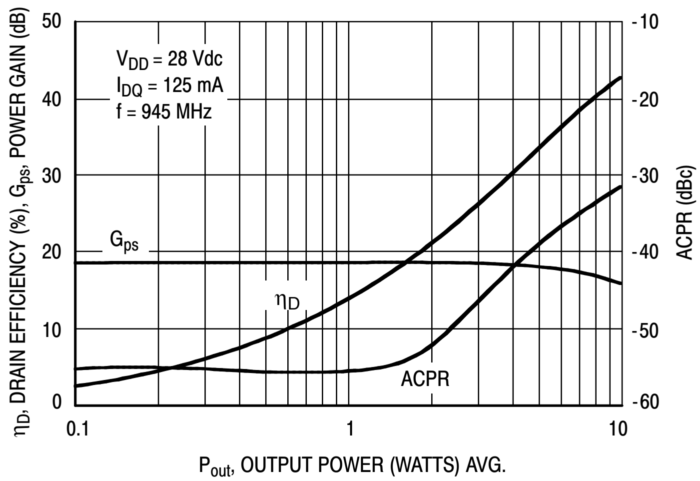


Figure 8. Single-Carrier CDMA ACPR, Power Gain and Power Added Efficiency versus Output Power

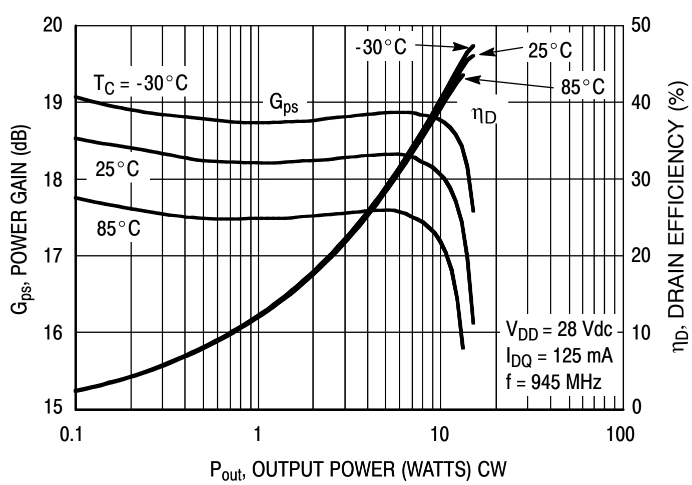


Figure 9. Power Gain and Power Added Efficiency versus Output Power

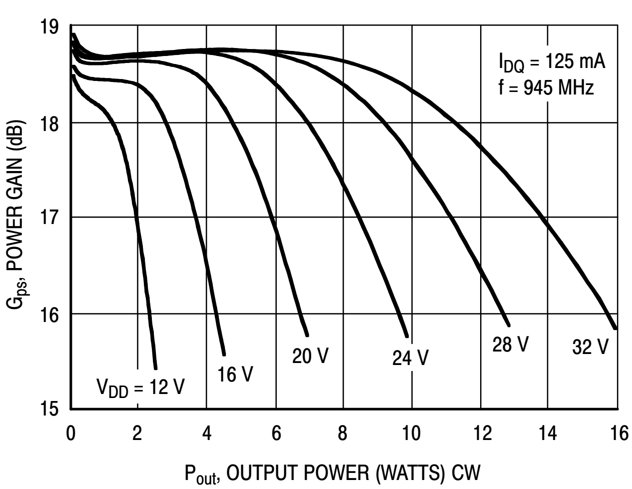


Figure 10. Power Gain versus Output Power

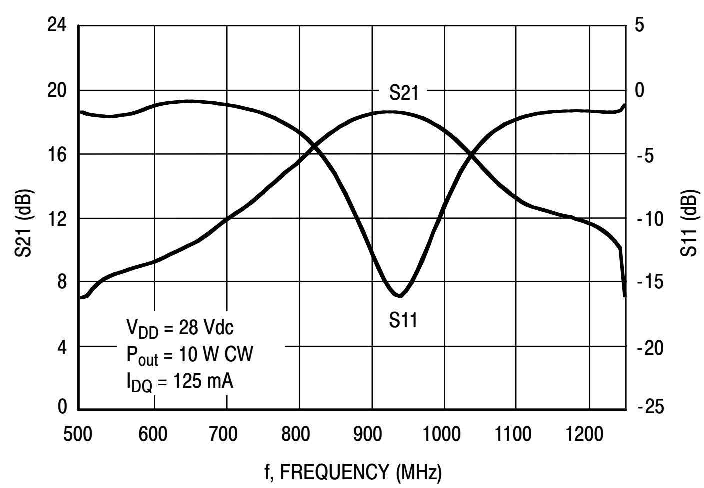
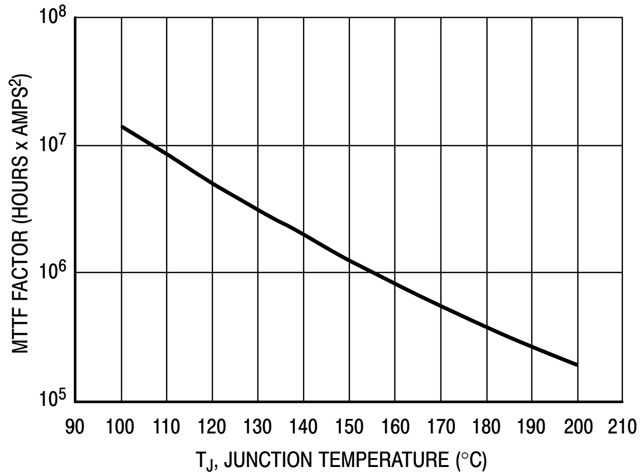


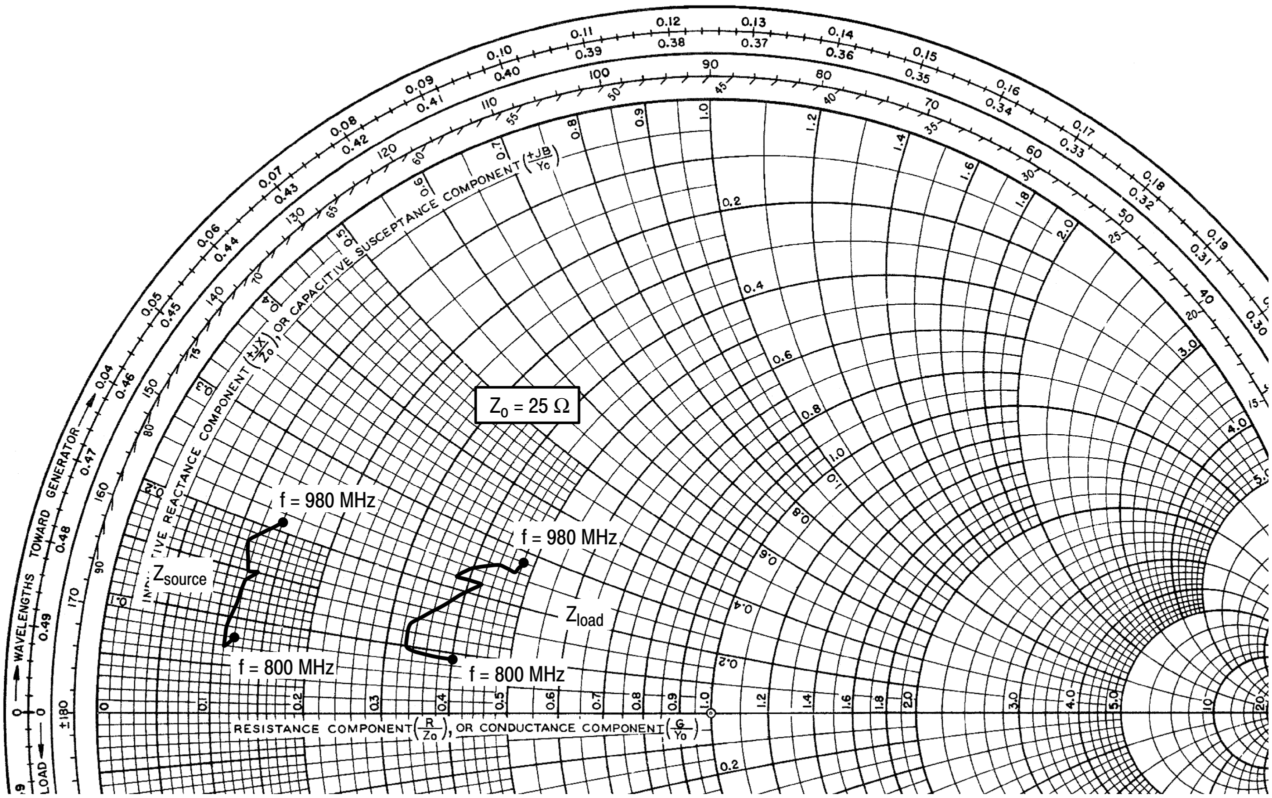
Figure 11. Broadband Frequency Response

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 12. MTTF Factor versus Junction Temperature



V_{DD} = 28 Vdc, I_{DQ} = 125 mA, P_{out} = 10 W PEP

f MHz	Z_{source} Ω	Z_{load} Ω
800	3.1 + j1.9	10.1 + j2.3
820	2.8 + j1.7	8.3 + j2.5
840	2.7 + j2.2	8.2 + j3.3
860	3.1 + j3.4	9.8 + j4.8
880	3.3 + j3.8	10.6 + j5.6
900	2.9 + j3.7	9.5 + j5.5
920	2.8 + j4.4	10.1 + j5.9
940	3.0 + j4.7	11.0 + j6.4
960	3.2 + j4.9	11.8 + j6.6
980	3.6 + j5.2	12.1 + j7.1

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

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

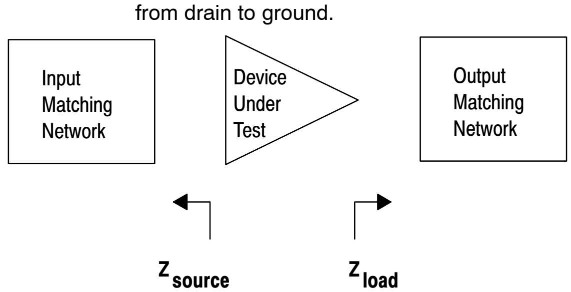
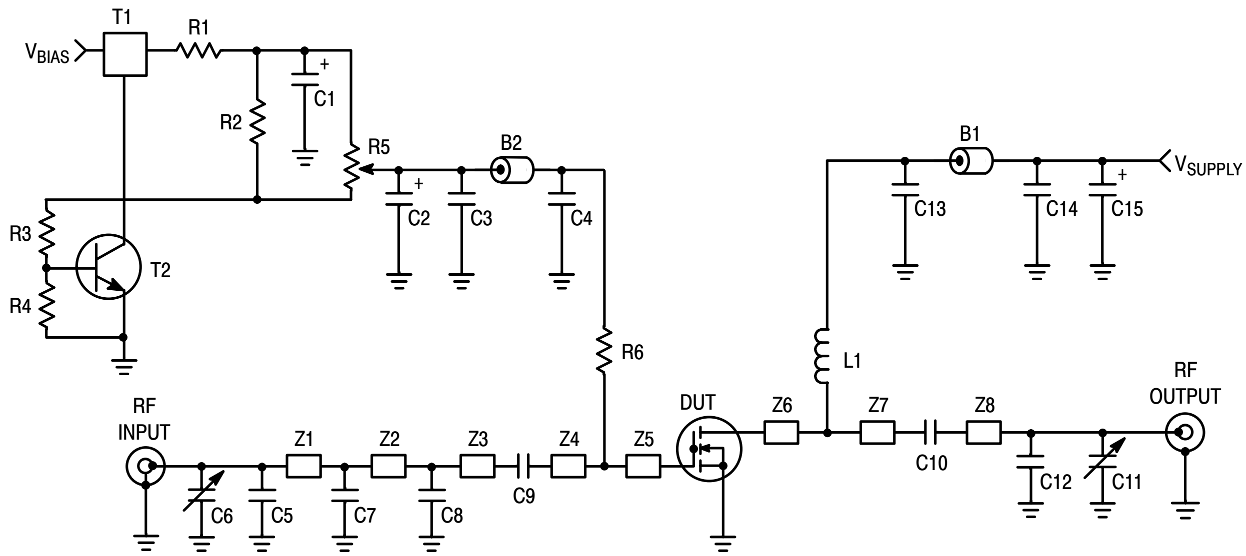


Figure 13. Series Equivalent Source and Load Impedance — 900 MHz



Z1	0.540″ x 0.080″ Microstrip	Z5	0.475″ x 0.330″ Microstrip
Z2	0.365″ x 0.080″ Microstrip	Z6	0.475″ x 0.325″ Microstrip
Z3	0.225″ x 0.080″ Microstrip	Z8	1.250″ x 0.080″ Microstrip
Z4, Z7	0.440″ x 0.080″ Microstrip	PCB	Rogers ULTRALAM 2000, 0.030″, ε_r = 2.55

Figure 14. MW6S010NR1(GNR1/MR1/GMR1) Test Circuit Schematic — 450 MHz

Table 7. MW6S010NR1(GNR1/MR1/GMR1) Test Circuit Component Designations and Values — 450 MHz

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Bead	2743019447	Fair-Rite
C1	1 μF, 35 V Tantalum Capacitor	T491C105K050AS	Kemet
C2, C15	22 μF, 35 V Tantalum Capacitors	T491X226K035AS	Kemet
C3, C14	0.1 μF Chip Capacitors	C1210C104K5RACTR	Kemet
C4, C9, C10, C13	330 pF Chip Capacitors	700A331JP150X	ATC
C5	4.3 pF Chip Capacitor	100B4R3JP500X	ATC
C6, C11	0.6-8.0 pF Variable Capacitors	27291SL	Johanson
C7, C8, C12	4.7 pF Chip Capacitors	100B4R7JP500X	ATC
L1	39 μH Chip Inductor	ISC-1210	Vishay-Dale
R1	10 Ω Chip Resistor (0805)	CRCW080510R0F100	Vishay-Dale
R2	1 kΩ Chip Resistor (0805)	CRCW08051001F100	Vishay-Dale
R3	1.2 kΩ Chip Resistor (0805)	CRCW08051201F100	Vishay-Dale
R4	2.2 kΩ Chip Resistor (0805)	CRCW08052201F100	Vishay-Dale
R5	5 kΩ Potentiometer	1224W	Bourns
R6	1 kΩ Chip Resistor (1206)	CRCW12061001F100	Vishay-Dale
T1	5 Volt Regulator, Micro 8	LP2951	On Semiconductor
T2	NPN Transistor	BC847ALT1	On Semiconductor

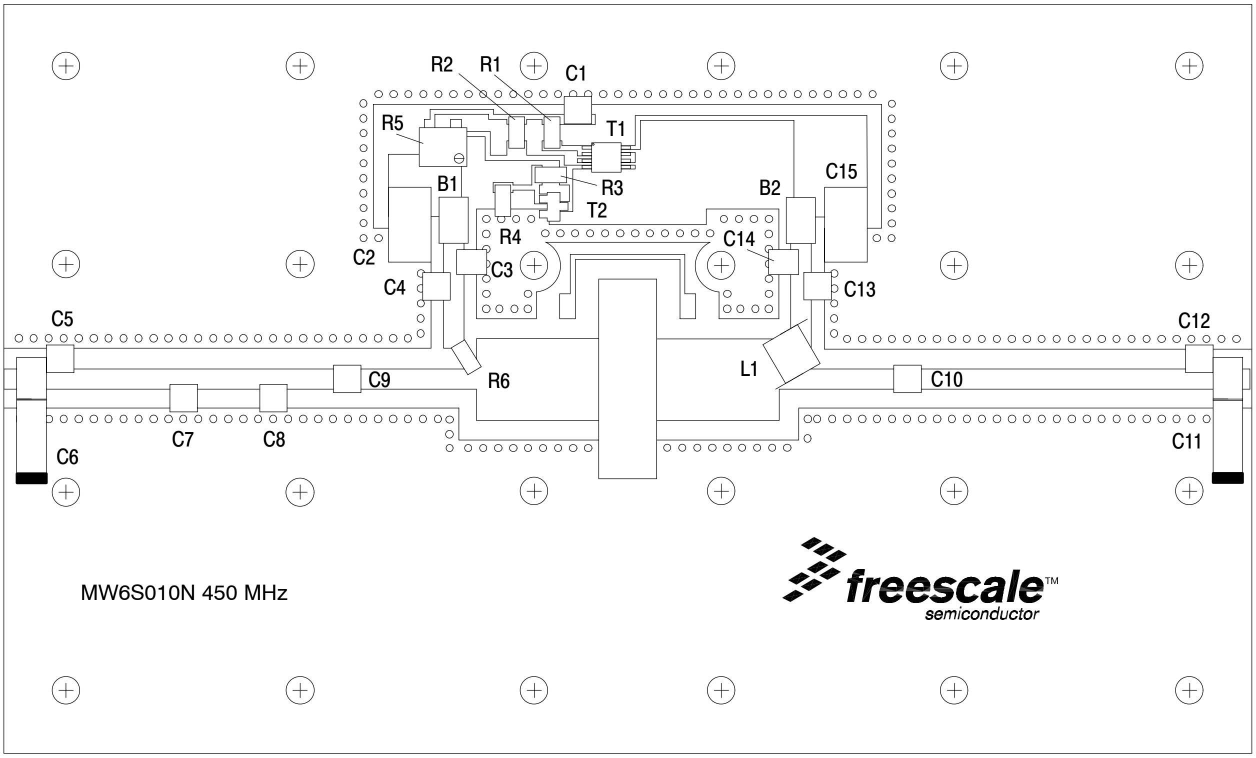


Figure 15. MW6S010NR1(GNR1/MR1/GMR1) Test Circuit Component Layout — 450 MHz

TYPICAL CHARACTERISTICS — 450 MHz

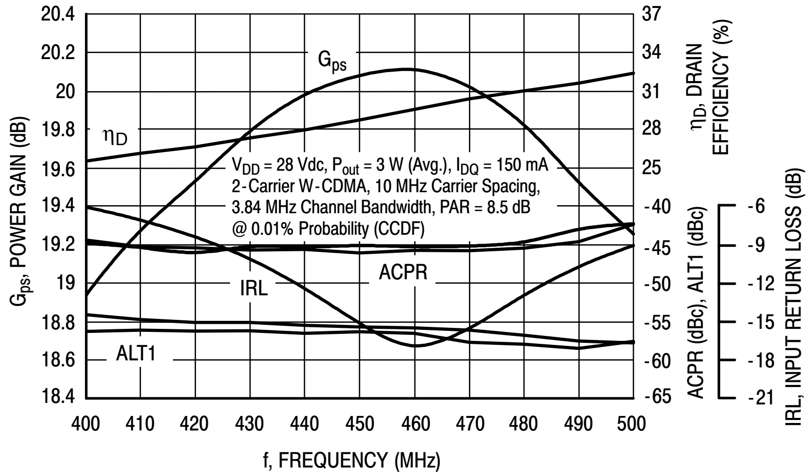


Figure 16. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 3 Watts Avg.

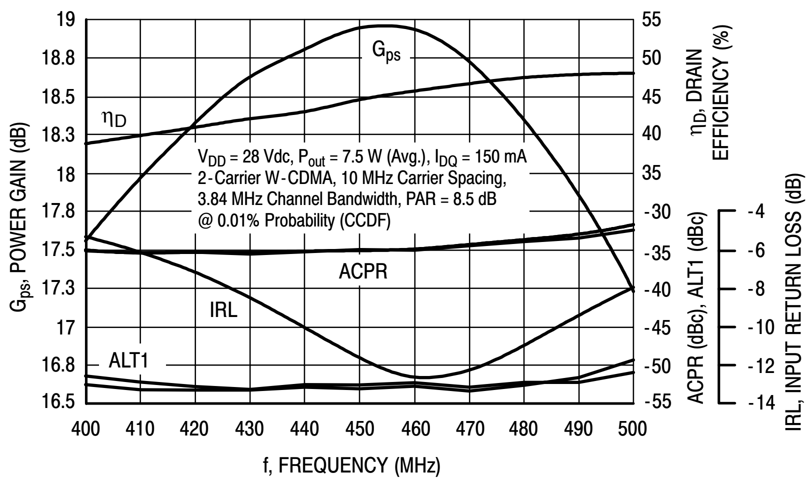


Figure 17. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 7.5 Watts Avg.

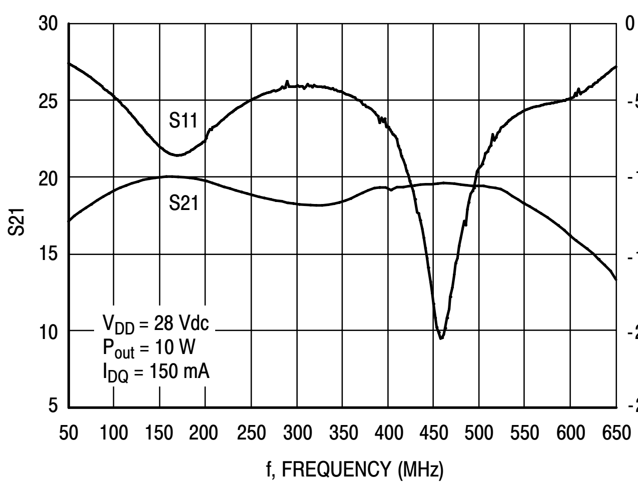


Figure 18. Broadband Frequency Response

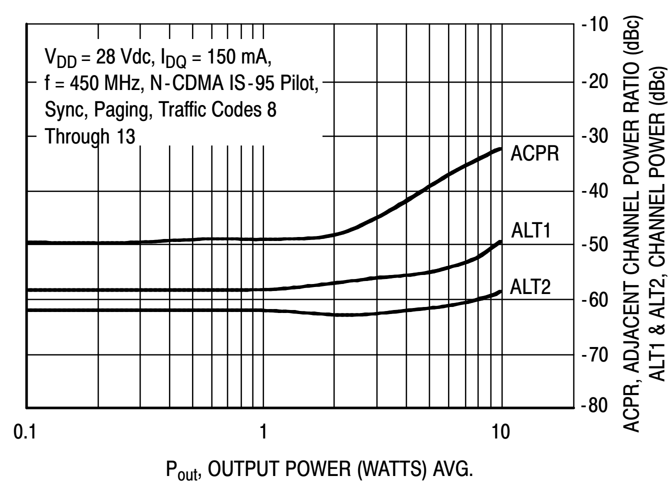
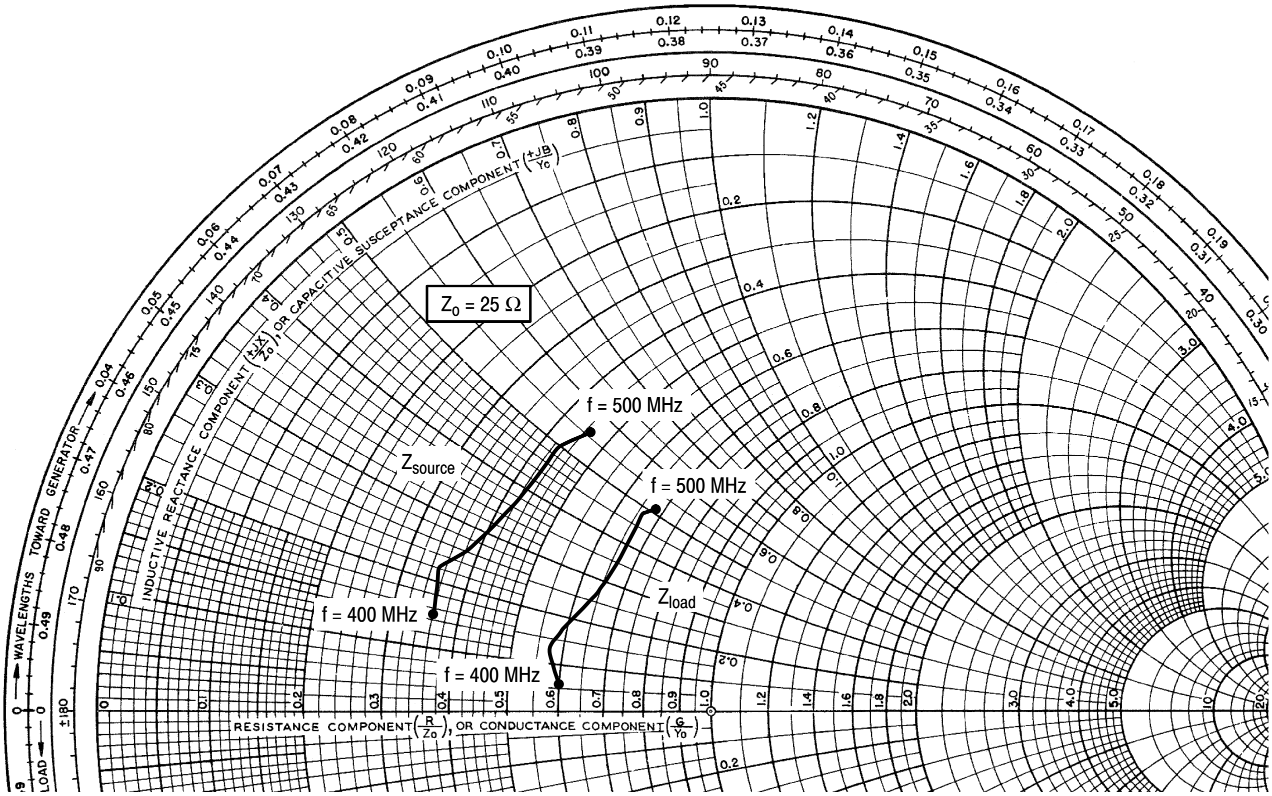


Figure 19. Single-Carrier N-CDMA ACPR, ALT1 and ALT2 versus Output Power



V_{DD} = 28 Vdc, I_{DQ} = 150 mA, P_{out} = 10 W PEP

f MHz	Z_{source} Ω	Z_{load} Ω
400	9.0 + j3.8	15.0 + j1.4
420	8.8 + j5.4	14.3 + j3.3
440	9.6 + j6.6	15.0 + j4.7
460	10.6 + j9.5	16.3 + j7.3
480	10.7 + j12.6	16.4 + j11.1
500	11.5 + j13.9	16.9 + j12.7

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

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

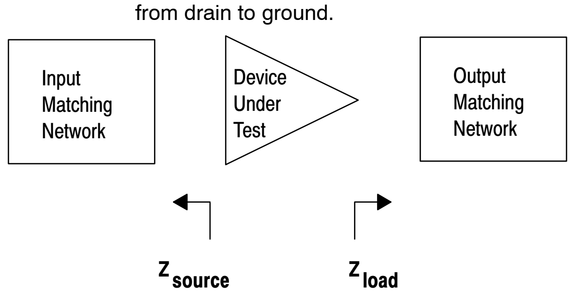
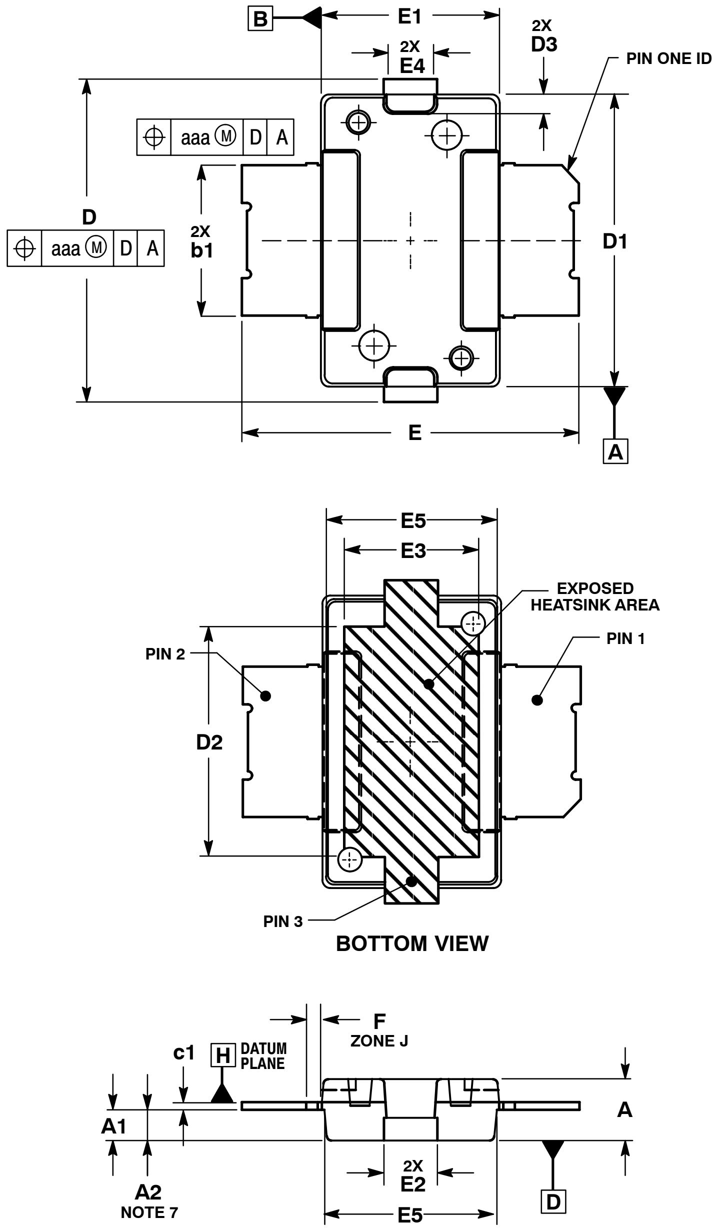


Figure 20. Series Equivalent Source and Load Impedance — 450 MHz

NOTES

PACKAGE DIMENSIONS

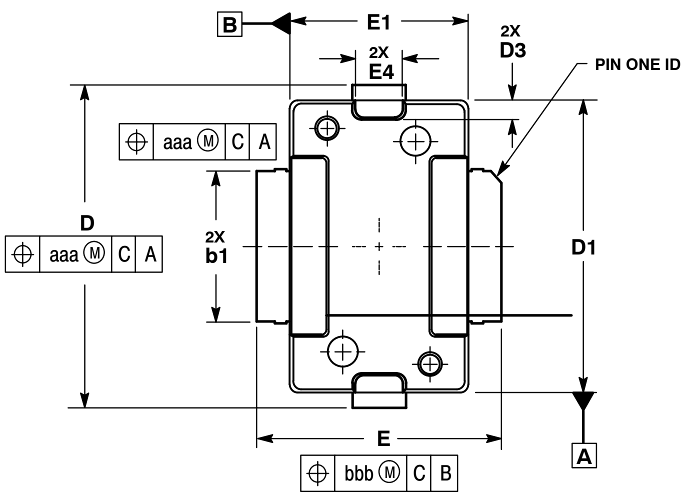


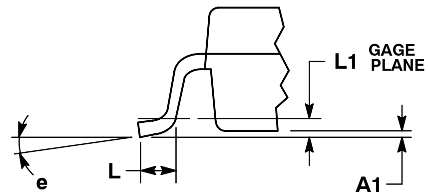
NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DATUM PLANE -H- IS LOCATED AT TOP OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE TOP OF THE PARTING LINE.
4. DIMENSIONS “D1” AND “E1” DO NOT INCLUDE MOLD PROTRUSION. 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. ALLOWABLE PROTRUSION IS .003 PER SIDE. DIMENSIONS “D” AND “E2” DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -D-.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.078	.082	1.98	2.08
A1	.039	.043	0.99	1.09
A2	.040	.042	1.02	1.07
D	.416	.424	10.57	10.77
D1	.378	.382	9.60	9.70
D2	.290	.320	7.37	8.13
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	.180	3.81	4.57
E4	.058	.066	1.47	1.68
E5	.231	.235	5.87	5.97
F	.025 BSC		0.64 BSC	
b1	.193	.199	4.90	5.06
c1	.007	.011	0.18	0.28
aaa	.004		0.10	

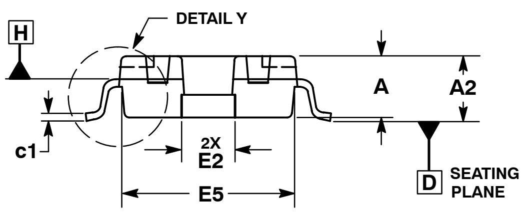
STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

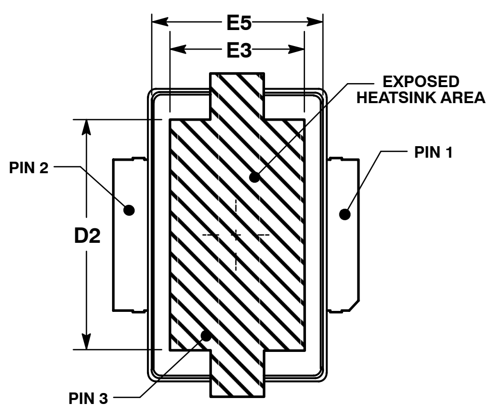
CASE 1265-08
ISSUE G
TO-270-2
PLASTIC
MW6S010NR1(MR1)





DETAIL Y





BOTTOM VIEW

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-.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.078	.082	1.98	2.08
A1	.001	.004	0.02	0.10
A2	.077	.088	1.96	2.24
D	.416	.424	10.57	10.77
D1	.378	.382	9.60	9.70
D2	.290	.320	7.37	8.13
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	.180	3.81	4.57
E4	.058	.066	1.47	1.68
E5	.231	.235	5.87	5.97
L	.018	.024	4.90	5.06
L1	.01 BSC		0.25 BSC	
b1	.193	.199	4.90	5.06
c1	.007	.011	0.18	0.28
e	2°	8°	2°	8°
aaa	.004		0.10	

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

CASE 1265A-02
ISSUE A
TO-270-2 GULL
PLASTIC
MW6S010GNR1(GMR1)

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Europe, Middle East, and Africa:
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Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
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Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
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