Document Number: MRFG35005AN
Rev. 2, 6/2009

RoHS

Gallium Arsenide PHEMT

RF Power Field Effect Transistor

MRFG35005ANT1

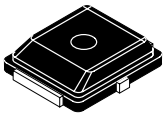
3.5 GHz, 4.5 W, 12 V
POWER FET
GaAs PHEMT

Designed for WLL/MMDS/BWA or UMTS driver applications with frequencies from 500 to 5000 MHz. Device is unmatched and is suitable for use in Class AB Customer Premise Equipment (CPE) applications.

- Typical Single-Carrier W-CDMA Performance: V_{DD} = 12 Volts, I_{DQ} = 80 mA, P_{out} = 450 mWatts Avg., 3550 MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 11 dB
  Drain Efficiency — 26%
  ACPR @ 5 MHz Offset — -44 dBc in 3.84 MHz Channel Bandwidth
- 4.5 Watts P1dB @ 3550 MHz, CW

Features

- Excellent Phase Linearity and Group Delay Characteristics
- High Gain, High Efficiency and High Linearity
- RoHS Compliant
- In Tape and Reel. T1 Suffix = 1000 Units per 12 mm, 7 inch Reel.



CASE 466-03, STYLE 1
PLD-1.5
PLASTIC

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	15	Vdc
Gate-Source Voltage	V_{GS}	-5	Vdc
RF Input Power	P_{in}	30	dBm
Storage Temperature Range	T_{stg}	-65 to +150	°C
Channel Temperature (1)	T_{ch}	175	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.7	°C/W

Table 3. ESD Protection Characteristics

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

Table 4. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	3	260	°C

1. For reliable operation, the operating channel temperature should not exceed 150°C.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

freescale semiconductor

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

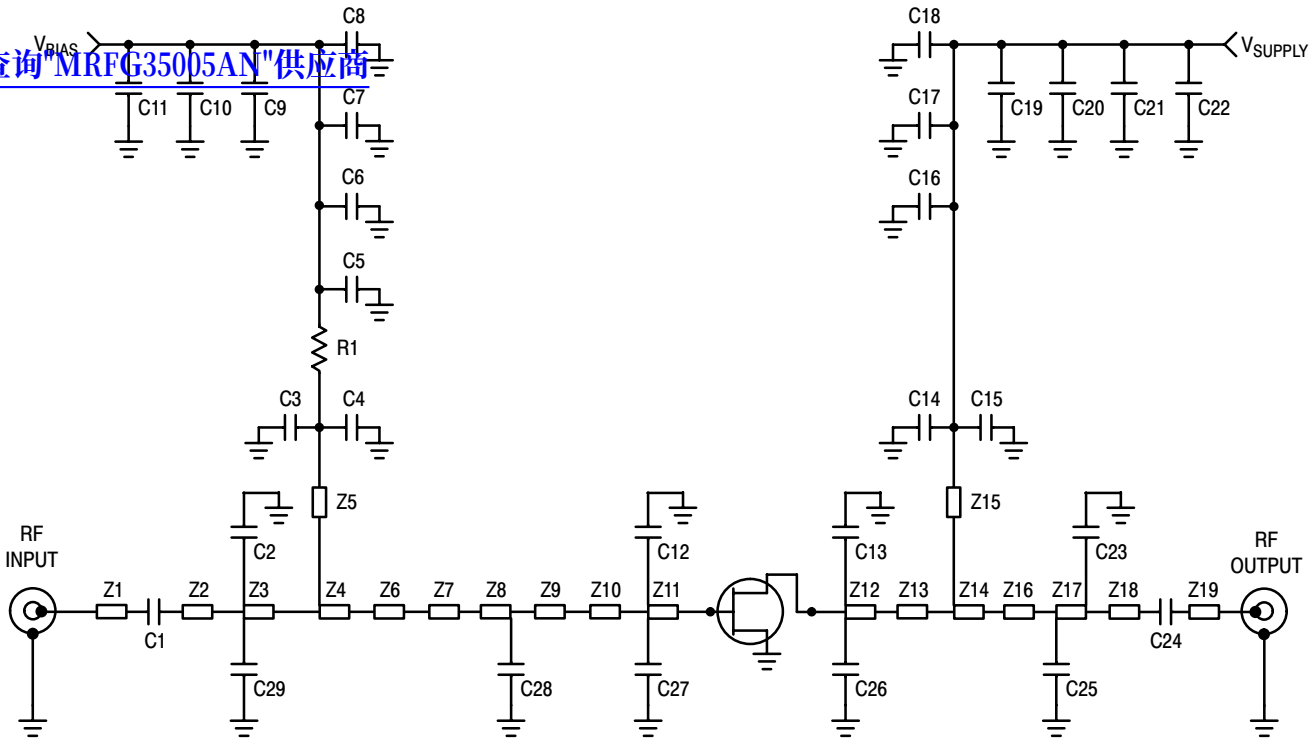
Characteristic	Symbol	Min	Typ	Max	Unit
Saturated Drain Current (V_{DS} = 3.5 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	1.7	—	Adc
Off State Leakage Current (V_{GS} = -0.4 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	< 1	100	μAdc
Off State Drain Current (V_{DS} = 12 Vdc, V_{GS} = -2.5 Vdc)	I_{DSO}	—	1	600	μAdc
Off State Current (V_{DS} = 28.5 Vdc, V_{GS} = -2.5 Vdc)	I_{DSX}	—	< 1	9	mAdc
Gate-Source Cut-off Voltage (V_{DS} = 3.5 Vdc, I_{DS} = 8.7 mA)	$V_{GS(th)}$	-1.2	-0.95	-0.7	Vdc
Quiescent Gate Voltage (V_{DS} = 12 Vdc, I_D = 105 mA)	$V_{GS(Q)}$	-1.1	-0.85	-0.6	Vdc

Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 12 Vdc, I_{DQ} = 80 mA, P_{out} = 450 mWatts Avg., f = 3550 MHz, Single-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carrier. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	10	11	—	dB
Drain Efficiency	η_D	22	26	—	%
Adjacent Channel Power Ratio	ACPR	—	-44	-39	dBc

Typical RF Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 12 Vdc, I_{DQ} = 80 mA, f = 3550 MHz

Output Power, 1 db Compression Point, CW	P_{1dB}	—	4.5	—	W



Z1, Z19	0.044″ x 0.125″ Microstrip	Z12	0.408″ x 0.120″ Microstrip
Z2	0.044″ x 0.435″ Microstrip	Z13	0.174″ x 0.259″ Microstrip
Z3	0.254″ x 0.298″ Microstrip	Z14	0.348″ x 0.269″ Microstrip
Z4	0.590″ x 0.336″ Microstrip	Z16	0.110″ x 0.075″ Microstrip
Z5, Z15	0.015″ x 0.527″ Microstrip	Z17	0.110″ x 0.240″ Microstrip
Z6, Z8, Z10	0.025″ x 0.050″ Microstrip	Z18	0.044″ x 0.387″ Microstrip
Z7, Z9	0.025″ x 0.125″ Microstrip	PCB	Rogers 4350, 0.020″, ε_r = 3.5
Z11	0.081″ x 0.400″ Microstrip		

Figure 1. MRFG35005AN Test Circuit Schematic

Table 6. MRFG35005AN Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C24	7.5 pF Chip Capacitors	ATC100A7R5JT150XT	ATC
C2	0.4 pF Chip Capacitor	08051J0R4BBS	AVX
C3, C4, C14, C15	3.9 pF Chip Capacitors	08051J3R9BBS	AVX
C5, C16	10 pF Chip Capacitors	ATC100A100JT150XT	ATC
C6, C17	100 pF Chip Capacitors	ATC100A101JT150XT	ATC
C7, C18	100 pF Chip Capacitors	ATC100B101JT500XT	ATC
C8, C19	1000 pF Chip Capacitors	ATC100B102JT50XT	ATC
C9, C20	39K pF Chip Capacitors	ATC200B393KT50XT	ATC
C10, C21	0.01 μF Chip Capacitors	ATC200B103KT50XT	ATC
C11, C22	10 μF Chip Capacitors	GRM55DR61H106KA88B	Murata
C12, C28	0.1 pF Chip Capacitors	08051J0R1BBS	AVX
C13, C26	0.3 pF Chip Capacitors	08051J0R3BBS	AVX
C23	1.0 pF Chip Capacitor	08051J1R0BBS	AVX
C25	1.2 pF Chip Capacitor	08051J1R2BBS	AVX
C27	0.2 pF Chip Capacitor	08051J0R2BBS	AVX
C29	0.8 pF Chip Capacitor	08051J0R8BBS	AVX
R1	100 Ω, 1/4 W Chip Resistor	CRCW12061000FKTA	Vishay

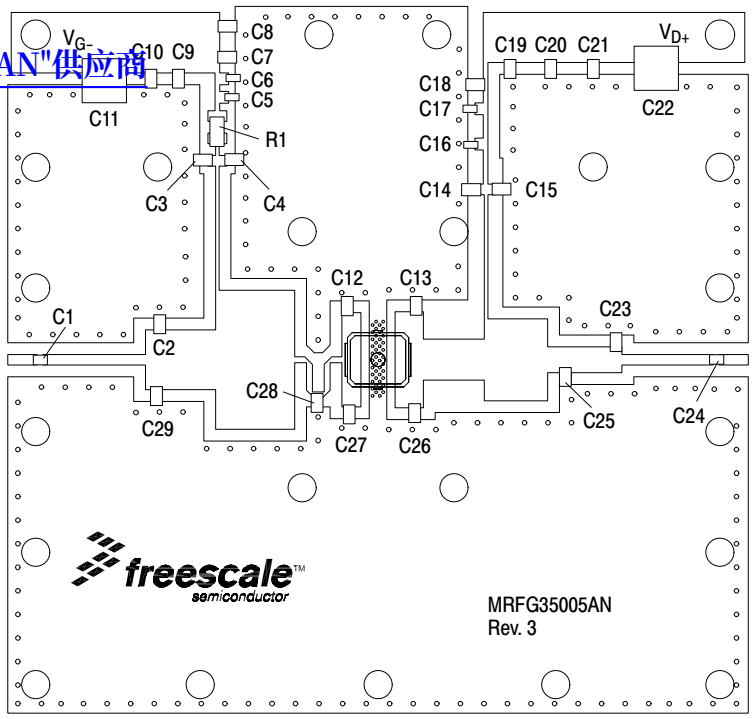


Figure 2. MRFG35005AN Test Circuit Component Layout

TYPICAL CHARACTERISTICS

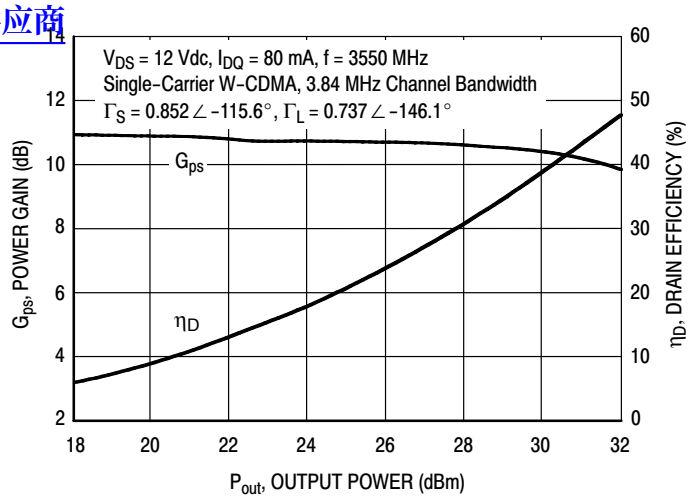


Figure 3. Single-Channel W-CDMA Power Gain and Drain Efficiency versus Output Power

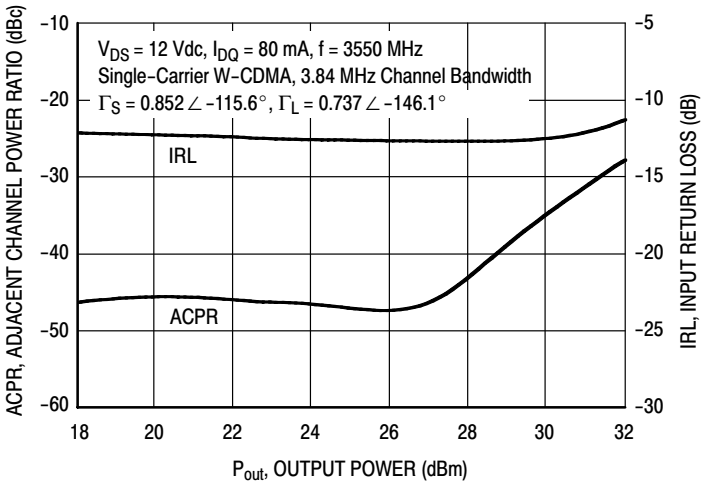


Figure 4. Single-Channel W-CDMA Adjacent Channel Power Ratio and IRL versus Output Power

NOTE: All data is referenced to package lead interface. Γ_S and Γ_L are the impedances presented to the DUT. All data is generated from load pull, not from the test circuit shown.

TYPICAL CHARACTERISTICS

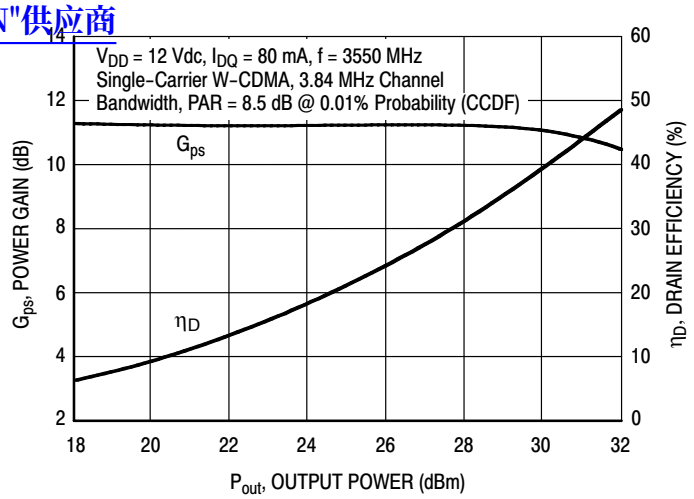


Figure 5. Single-Channel W-CDMA Power Gain and Drain Efficiency versus Output Power

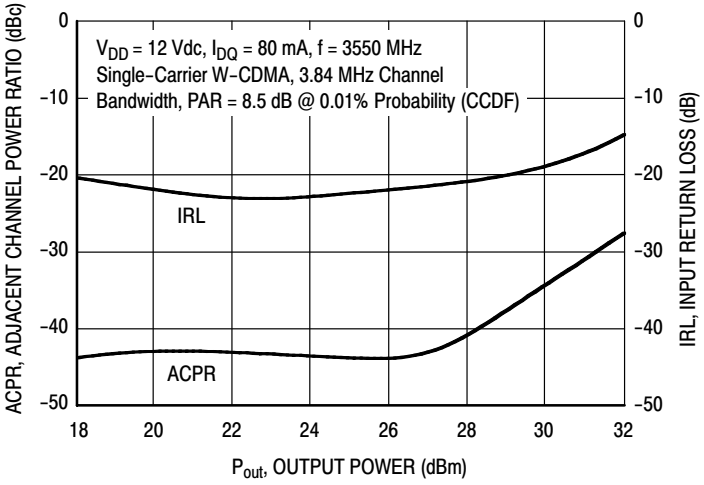


Figure 6. Single-Channel W-CDMA Adjacent Channel Power Ratio and IRL versus Output Power

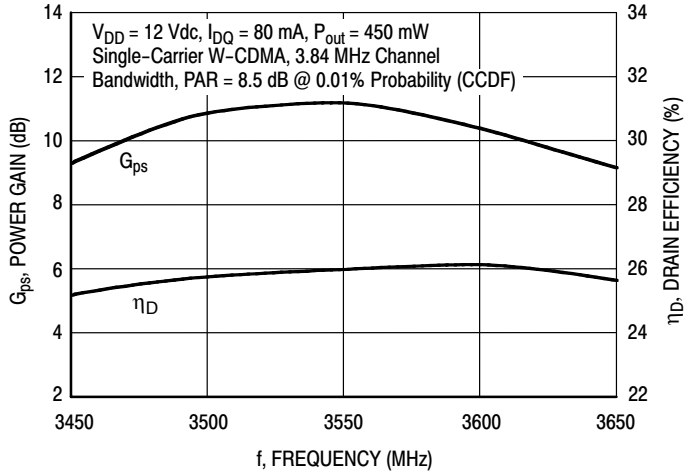


Figure 7. Single-Channel W-CDMA Power Gain and Drain Efficiency versus Frequency

NOTE: Data is generated from the test circuit shown.

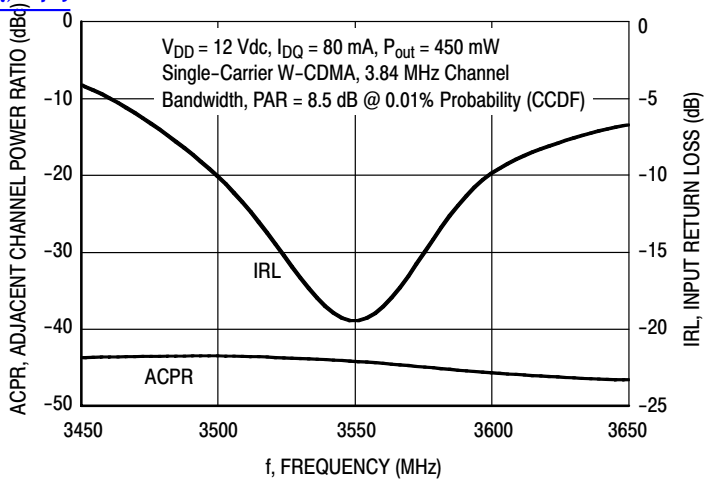


Figure 8. Single-Channel W-CDMA Adjacent Channel Power Ratio and IRL versus Frequency

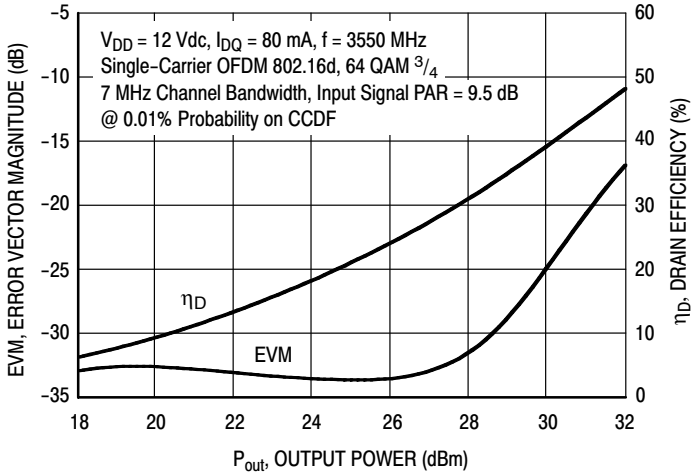
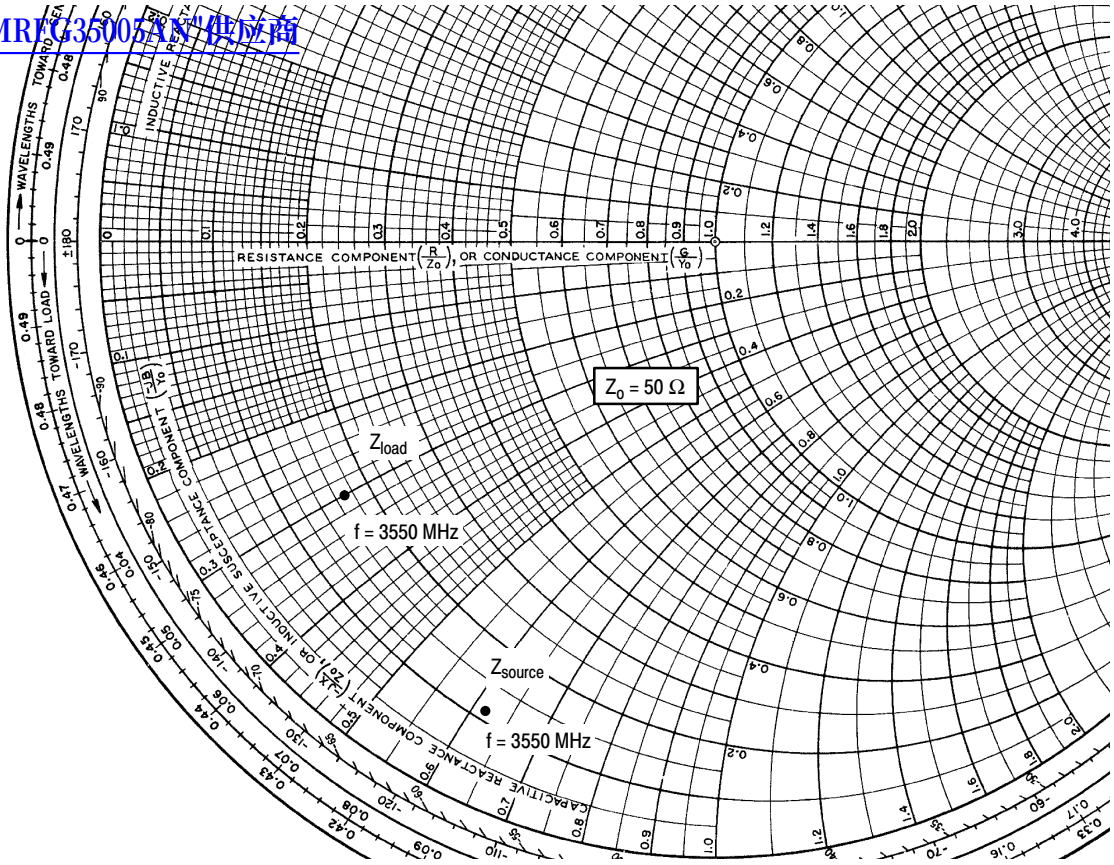


Figure 9. Single-Channel OFDM Error Vector Magnitude and Drain Efficiency versus Output Power

NOTE: Data is generated from the test circuit shown.



V_{DD} = 12 Vdc, I_{DQ} = 80 mA, P_{out} = 450 mW Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
3550	5.6 - j31.2	8.3 - j14.8

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

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

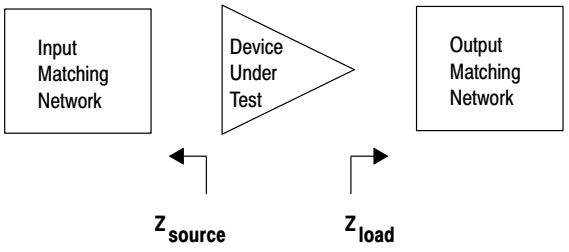


Figure 10. Series Equivalent Source and Load Impedance

Table 7. Common Source S-Parameters (V_{DD} = 12 Vdc, I_{DQ} = 80 mA, T_A = 25°C, 50 Ohm System)

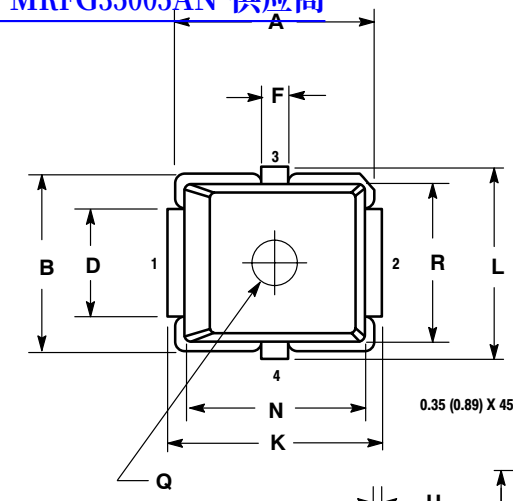
	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ ϕ	$\|S_{21}\|$	∠ ϕ	$\|S_{12}\|$	∠ ϕ	$\|S_{22}\|$	∠ ϕ
500	0.916	-175.6	6.446	82.2	0.029	0.7	0.653	-175.5
550	0.916	-177.4	5.893	80.3	0.029	0.1	0.652	-176.7
600	0.916	-178.9	5.422	78.4	0.029	-1.2	0.651	-177.9
650	0.916	179.7	5.028	76.7	0.029	-2.2	0.649	-179.1
700	0.916	178.5	4.693	75.0	0.029	-3.0	0.648	179.7
750	0.916	177.4	4.405	73.3	0.029	-4.0	0.646	178.6
800	0.916	176.4	4.153	71.7	0.029	-4.7	0.645	177.5
850	0.915	175.5	3.931	70.1	0.029	-5.4	0.644	176.4
900	0.916	174.7	3.729	68.5	0.029	-6.1	0.643	175.3
950	0.916	174.0	3.548	67.0	0.029	-6.8	0.642	174.2
1000	0.914	173.3	3.381	65.4	0.030	-7.3	0.640	173.1
1050	0.915	172.6	3.236	64.0	0.030	-8.0	0.640	171.9
1100	0.915	172.0	3.097	62.5	0.030	-8.7	0.640	170.8
1150	0.915	171.4	2.974	61.1	0.030	-9.3	0.639	169.8
1200	0.915	170.8	2.861	59.6	0.030	-9.9	0.639	168.8
1250	0.914	170.1	2.757	58.2	0.030	-10.7	0.639	167.7
1300	0.913	169.6	2.661	56.7	0.030	-11.2	0.638	166.8
1350	0.913	168.9	2.572	55.3	0.030	-11.8	0.638	166.0
1400	0.913	168.1	2.488	53.8	0.030	-12.4	0.639	165.1
1450	0.913	167.3	2.412	52.4	0.030	-13.1	0.639	164.2
1500	0.911	166.4	2.341	50.9	0.030	-13.8	0.639	163.5
1550	0.910	163.1	2.292	49.2	0.031	-14.7	0.636	164.9
1600	0.909	162.3	2.229	47.8	0.031	-15.3	0.635	164.2
1650	0.909	161.5	2.170	46.3	0.031	-16.1	0.635	163.4
1700	0.909	160.7	2.113	44.9	0.031	-16.5	0.636	162.6
1750	0.908	159.9	2.060	43.4	0.031	-17.2	0.636	161.8
1800	0.908	159.1	2.009	42.0	0.031	-17.7	0.636	161.0
1850	0.907	158.3	1.960	40.5	0.031	-18.3	0.636	160.2
1900	0.908	157.6	1.915	39.1	0.031	-19.0	0.637	159.4
1950	0.908	156.8	1.871	37.7	0.031	-19.8	0.638	158.6
2000	0.907	156.1	1.829	36.2	0.031	-20.3	0.638	157.8
2050	0.908	155.3	1.791	34.8	0.031	-21.1	0.638	157.0
2100	0.907	154.5	1.754	33.4	0.031	-21.7	0.638	156.2
2150	0.912	153.6	1.721	31.9	0.031	-22.3	0.642	155.3
2200	0.907	153.1	1.688	30.5	0.032	-22.8	0.639	154.8
2250	0.907	152.2	1.657	29.0	0.032	-23.6	0.638	154.0
2300	0.906	151.3	1.629	27.6	0.032	-24.2	0.638	153.1
2350	0.905	150.5	1.603	26.1	0.032	-24.8	0.637	152.3
2400	0.906	149.6	1.579	24.6	0.032	-25.7	0.637	151.6
2450	0.904	148.7	1.557	23.1	0.032	-26.6	0.635	150.7
2500	0.903	147.8	1.536	21.6	0.032	-27.4	0.634	149.9
2550	0.903	146.8	1.518	20.1	0.033	-27.9	0.633	149.2
2600	0.900	145.8	1.500	18.5	0.033	-28.5	0.630	148.3
2650	0.901	144.8	1.483	17.0	0.033	-29.3	0.629	147.5
2700	0.899	143.8	1.469	15.4	0.033	-30.1	0.627	146.6
2750	0.898	142.7	1.455	13.8	0.034	-31.0	0.625	145.8

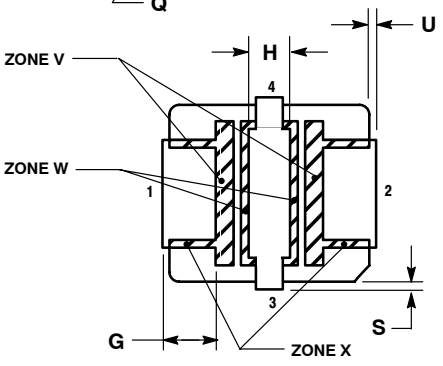
(continued)

Table 7. Common Source S-Parameters (V_{DD} = 12 Vdc, I_{DQ} = 80 mA, T_A = 25°C, 50 Ohm System) **(continued)**

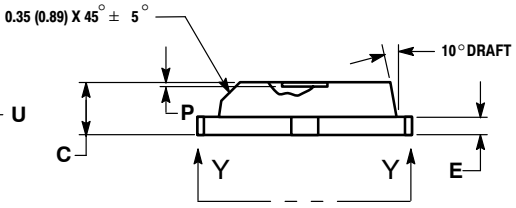
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\|S_{11}\|$	∠ ϕ	$\|S_{21}\|$	∠ ϕ	$\|S_{12}\|$	∠ ϕ	$\|S_{22}\|$	∠ ϕ
2800	0.897	141.6	1.444	12.3	0.034	-31.8	0.623	145.0
2850	0.895	140.5	1.433	10.6	0.034	-32.6	0.619	144.2
2900	0.895	139.3	1.424	9.0	0.034	-33.4	0.617	143.3
2950	0.893	138.0	1.415	7.4	0.035	-34.3	0.614	142.4
3000	0.894	136.8	1.407	5.7	0.035	-35.1	0.612	141.5
3050	0.892	135.5	1.398	4.1	0.036	-36.1	0.608	140.7
3100	0.890	134.3	1.393	2.4	0.036	-36.8	0.604	139.7
3150	0.889	133.0	1.386	0.7	0.036	-37.8	0.601	138.9
3200	0.887	131.6	1.381	-1.0	0.037	-38.6	0.598	137.9
3250	0.885	130.3	1.376	-2.7	0.037	-39.7	0.594	136.9
3300	0.884	128.9	1.372	-4.5	0.038	-40.7	0.590	135.9
3350	0.883	127.5	1.368	-6.2	0.038	-41.7	0.586	134.9
3400	0.882	126.1	1.365	-7.9	0.039	-42.8	0.583	133.9
3450	0.881	124.6	1.361	-9.7	0.039	-43.8	0.580	132.9
3500	0.878	123.1	1.358	-11.5	0.040	-45.0	0.576	131.9
3550	0.877	121.7	1.354	-13.2	0.040	-46.0	0.572	130.9
3600	0.876	120.2	1.351	-15.0	0.040	-47.2	0.568	129.8
3650	0.875	118.6	1.349	-16.8	0.041	-48.1	0.565	128.7
3700	0.873	117.2	1.346	-18.6	0.041	-48.9	0.561	127.6
3750	0.871	115.6	1.343	-20.4	0.042	-50.0	0.558	126.4
3800	0.870	114.1	1.341	-22.3	0.042	-51.0	0.555	125.3
3850	0.868	112.5	1.339	-24.1	0.042	-52.2	0.551	124.1
3900	0.867	110.9	1.337	-26.0	0.043	-53.2	0.548	122.9
3950	0.865	109.3	1.335	-27.9	0.043	-54.3	0.545	121.6
4000	0.863	107.7	1.332	-29.8	0.044	-55.4	0.541	120.3
4050	0.862	106.0	1.331	-31.7	0.044	-56.5	0.538	119.0
4100	0.860	104.2	1.331	-33.6	0.045	-57.6	0.535	117.7
4150	0.858	102.4	1.329	-35.7	0.045	-58.7	0.532	116.3
4200	0.856	100.6	1.327	-37.7	0.046	-60.0	0.528	114.9
4250	0.854	98.7	1.326	-39.8	0.046	-61.3	0.526	113.5
4300	0.852	96.8	1.325	-41.9	0.047	-62.5	0.523	112.0
4350	0.850	94.9	1.324	-44.0	0.047	-63.7	0.519	110.4
4400	0.847	92.8	1.323	-46.1	0.048	-65.0	0.516	108.8
4450	0.845	90.7	1.323	-48.4	0.048	-66.5	0.513	107.0
4500	0.845	88.5	1.322	-50.6	0.049	-67.9	0.509	105.2
4550	0.842	86.1	1.320	-53.0	0.049	-69.4	0.506	103.4
4600	0.838	84.2	1.317	-55.3	0.050	-70.9	0.502	101.4
4650	0.840	81.6	1.317	-57.7	0.050	-72.6	0.498	99.4
4700	0.836	79.3	1.316	-60.0	0.051	-73.9	0.494	97.4
4750	0.840	76.9	1.313	-62.6	0.052	-75.8	0.490	95.1
4800	0.837	73.9	1.311	-65.1	0.052	-77.6	0.486	92.9
4850	0.837	71.4	1.309	-67.7	0.053	-79.5	0.482	90.5
4900	0.838	68.5	1.305	-70.3	0.053	-81.2	0.478	88.1
4950	0.834	65.9	1.300	-73.0	0.054	-83.0	0.474	85.7
5000	0.834	62.9	1.295	-75.7	0.054	-85.0	0.470	82.9

PACKAGE DIMENSIONS





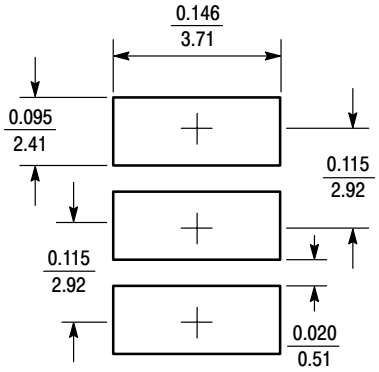
VIEW Y-Y



NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1984.
2. CONTROLLING DIMENSION: INCH
3. RESIN BLEED/FLASH ALLOWABLE IN ZONE V, W, AND X.

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

CASE 466-03
ISSUE D
PLD-1.5
PLASTIC



(inches / mm)

SOLDER FOOTPRINT

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.255	0.265	6.48	6.73
B	0.225	0.235	5.72	5.97
C	0.065	0.072	1.65	1.83
D	0.130	0.150	3.30	3.81
E	0.021	0.026	0.53	0.66
F	0.026	0.044	0.66	1.12
G	0.050	0.070	1.27	1.78
H	0.045	0.063	1.14	1.60
J	0.160	0.180	4.06	4.57
K	0.273	0.285	6.93	7.24
L	0.245	0.255	6.22	6.48
N	0.230	0.240	5.84	6.10
P	0.000	0.008	0.00	0.20
Q	0.055	0.063	1.40	1.60
R	0.200	0.210	5.08	5.33
S	0.006	0.012	0.15	0.31
U	0.006	0.012	0.15	0.31
ZONE V	0.000	0.021	0.00	0.53
ZONE W	0.000	0.010	0.00	0.25
ZONE X	0.000	0.010	0.00	0.25

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	July 2007	• Initial Release of Data Sheet
1	Dec. 2008	• Removed ”Operating Case Temperature Range” from Maximum Ratings table so that the maximum channel temperature rating is the limiting thermal design criteria and not the case temperature range, p. 1
2	June 2009	• Modified data sheet to reflect MSL rating change from 1 to 3 as a result of the standardization of packing process as described in Product and Process Change Notification number, PCN13516, p. 1

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
http://www.freescale.com/support

USA/Europe or Locations Not Listed:
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

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
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
1-800-441-2447 or +1-303-675-2140
Fax: +1-303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Document Number: MRFG35005AN
Rev. 2, 6/2009