

Gallium Arsenide PHEMT

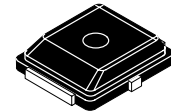
RF Power Field Effect Transistor

Designed for WLL/MMDS/BWA or UMTS driver applications. Characterized 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, $I_{DQ} = 130$ mA, $P_{out} = 1$ Watt Avg., 3550 MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
Power Gain — 10 dB
Efficiency — 25%
ACPR @ 5 MHz Offset — -43 dBc in 3.84 MHz Channel Bandwidth
- 9 Watts P1dB @ 3550 MHz, CW
- 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.

MRFG35010ANT1

**3.5 GHz, 9 W, 12 V
POWER FET
GaAs PHEMT**



**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}	33	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 Case Temperature 77°C, 1 W CW	$R_{\theta JC}$	6.5	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2 (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.freescal.com/rf>.
Select Documentation/Application Notes - AN1955.

Table 5. Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Saturated Drain Current ($V_{DS} = 3.5\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	2.9	—	A _{dc}
Off State Leakage Current ($V_{GS} = -0.4\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	< 1	100	μA_{dc}
Off State Drain Current ($V_{DS} = 12\text{ Vdc}$, $V_{GS} = -2.2\text{ Vdc}$)	I_{DSO}	—	0.1	1	mA _{dc}
Off State Current ($V_{DS} = 28.5\text{ Vdc}$, $V_{GS} = -2.5\text{ Vdc}$)	I_{DSX}	—	2	15	mA _{dc}
Gate-Source Cut-off Voltage ($V_{DS} = 3.5\text{ Vdc}$, $I_{DS} = 15\text{ mA}$)	$V_{GS(th)}$	-1.2	-1.0	-0.7	V _{dc}
Quiescent Gate Voltage ($V_{DS} = 12\text{ Vdc}$, $I_{DQ} = 180\text{ mA}$)	$V_{GS(Q)}$	-1.2	-0.95	-0.7	V _{dc}

Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 12\text{ Vdc}$, $I_{DQ} = 130\text{ mA}$, $P_{out} = 1\text{ W Avg.}$, $f = 3550\text{ MHz}$, Single-Carrier W-CDMA, 3.84 MHz Channel Bandwidth Carrier. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset.
 PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	9	10	—	dB
Drain Efficiency	η_D	23	25	—	%
Adjacent Channel Power Ratio	ACPR	—	-43	-40	dBc

Typical RF Performance (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 12\text{ Vdc}$, $I_{DQ} = 130\text{ mA}$, $f = 3550\text{ MHz}$

Output Power, 1 dB Compression Point, CW	P_{1dB}	—	9	—	W
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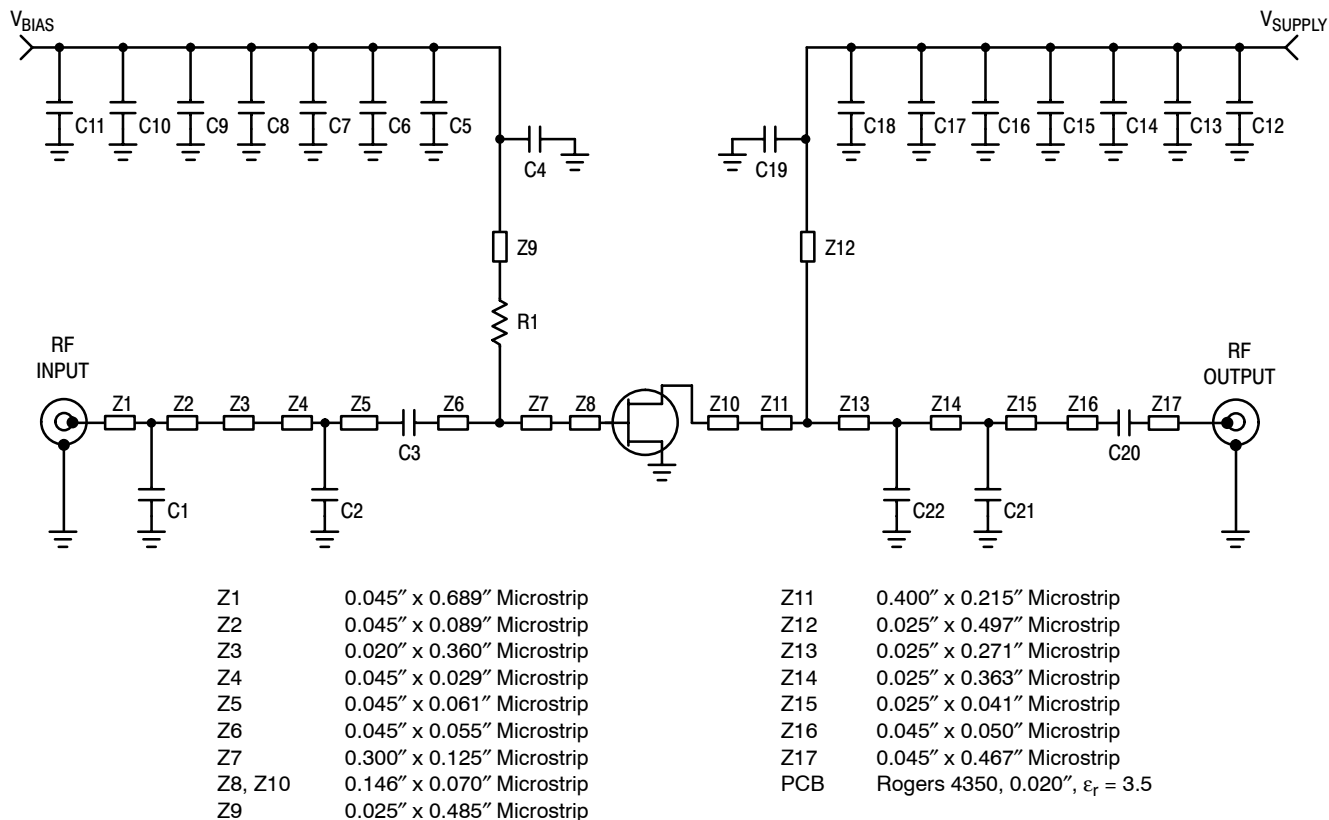


Figure 1. 3.5 GHz Test Circuit Schematic

Table 6. 3.5 GHz Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C21, C22	0.5 pF Chip Capacitors	08051J0R5BBT	AVX
C2	0.2 pF Chip Capacitor	06035J0R2BBT	AVX
C3	0.5 pF Chip Capacitor	06035J0R5BBT	AVX
C4, C19, C20	6.8 pF Chip Capacitors	08051J6R8BBT	AVX
C5, C18	10 pF Chip Capacitors	100A100JP150XT	ATC
C6, C17	100 pF Chip Capacitors	100A101JP150XT	ATC
C7, C16	100 pF Chip Capacitors	100B101JP500XT	ATC
C8, C15	1000 pF Chip Capacitors	100B102JP50XT	ATC
C9, C14	0.1 μ F Chip Capacitors	CDR33BX104AKWS	Kemet
C10, C13	39K pF Chip Capacitors	200B393KP50XT	ATC
C11, C12	10 μ F, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
R1	50 Ω Chip Resistor	P51ETR-ND	Newark

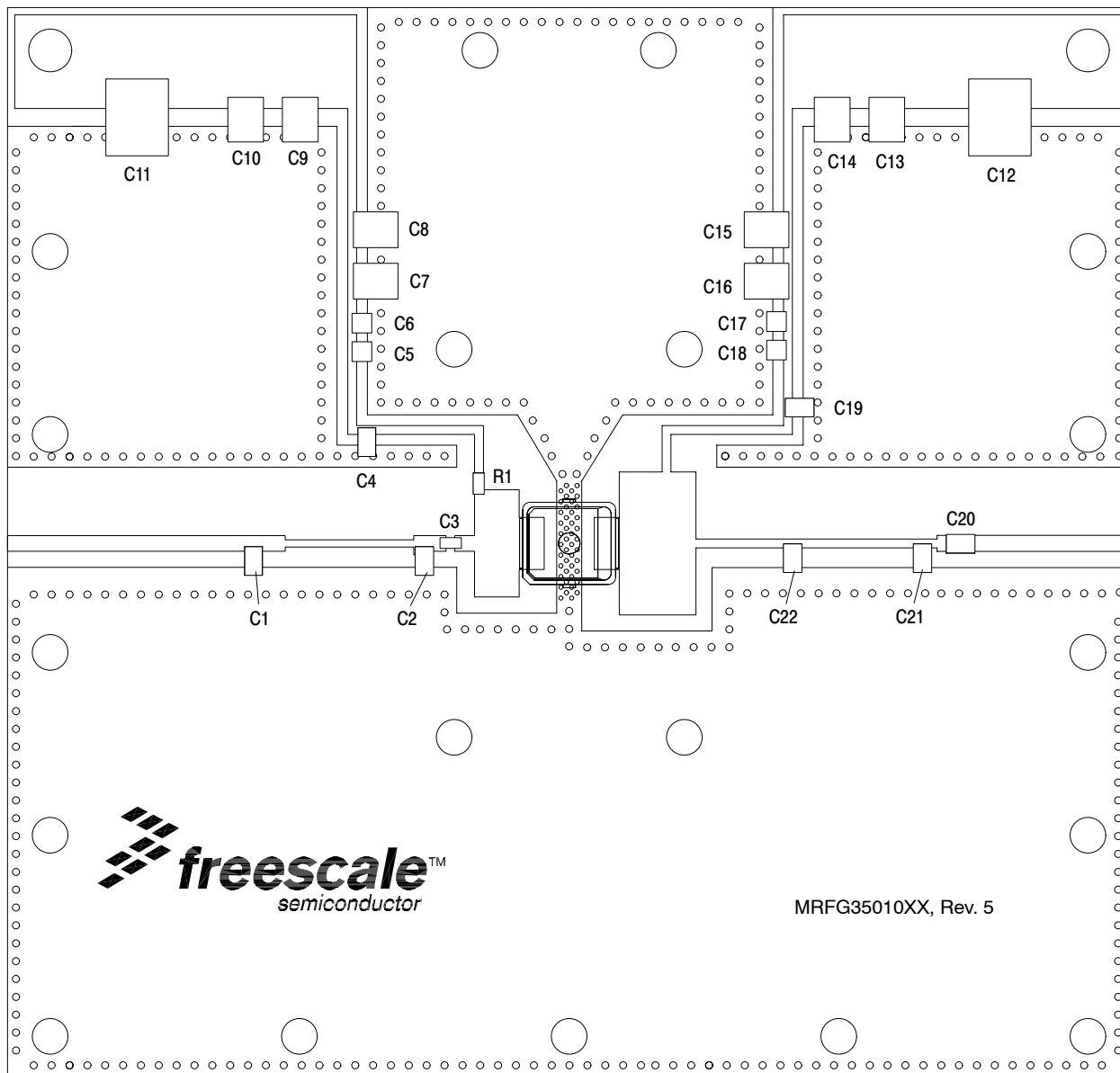


Figure 2. 3.5 GHz Test Circuit Component Layout

TYPICAL CHARACTERISTICS

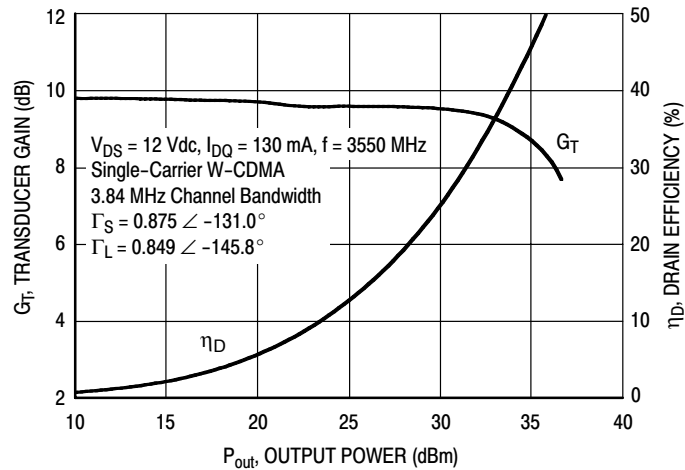


Figure 3. Single-Carrier W-CDMA Power Gain and Drain Efficiency versus Output Power

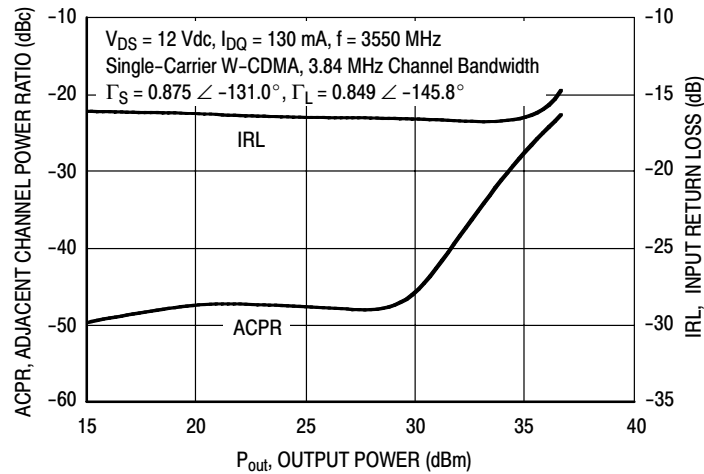


Figure 4. Single-Carrier W-CDMA ACPR and Input Return Loss versus Output Power

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

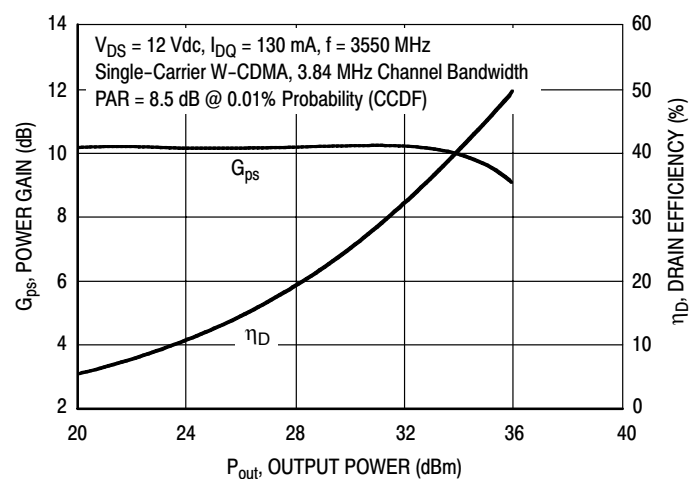


Figure 5. Single-Carrier W-CDMA Power Gain and Drain Efficiency versus Output Power

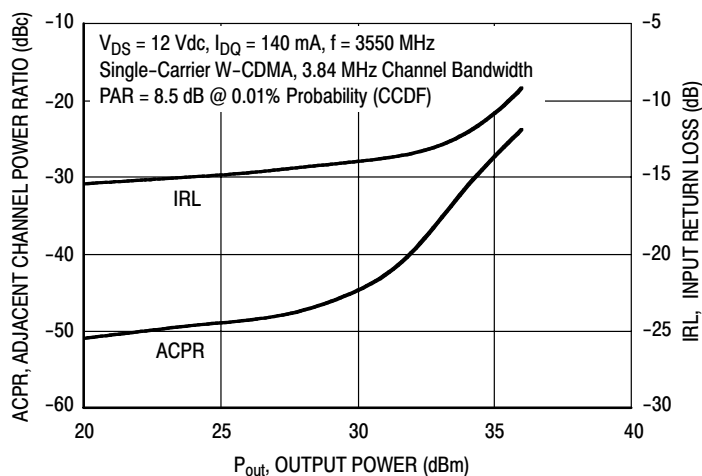
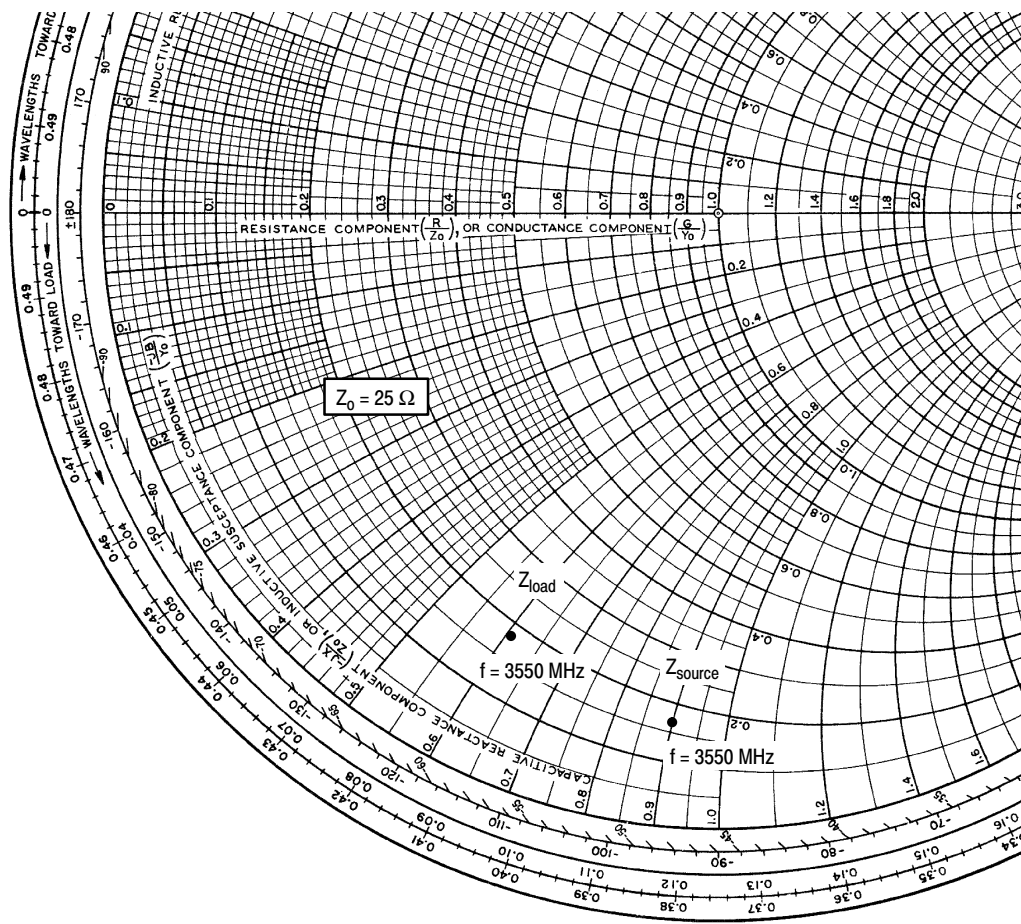


Figure 6. Single-Carrier W-CDMA ACPR and Input Return Loss versus Output Power

NOTE: Data is generated from the test circuit shown.



$V_{DD} = 12 \text{ Vdc}$, $I_{DQ} = 130 \text{ mA}$, $P_{out} = 1 \text{ W Avg.}$

f MHz	Z_{source} Ω	Z_{load} Ω
3550	4.0 - j22.6	4.5 - j15.3

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

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

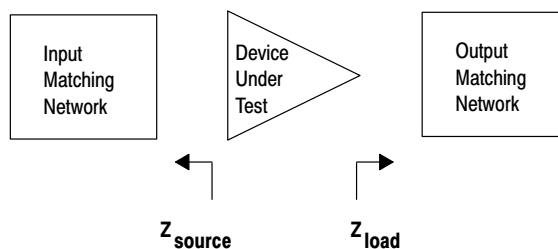


Figure 7. Series Equivalent Source and Load Impedance

Table 7. Class AB Common Source S-Parameters ($V_{DD} = 12$ Vdc, $I_{DQ} = 130$ mA, $T_A = 25^\circ\text{C}$, 50 ohm system)

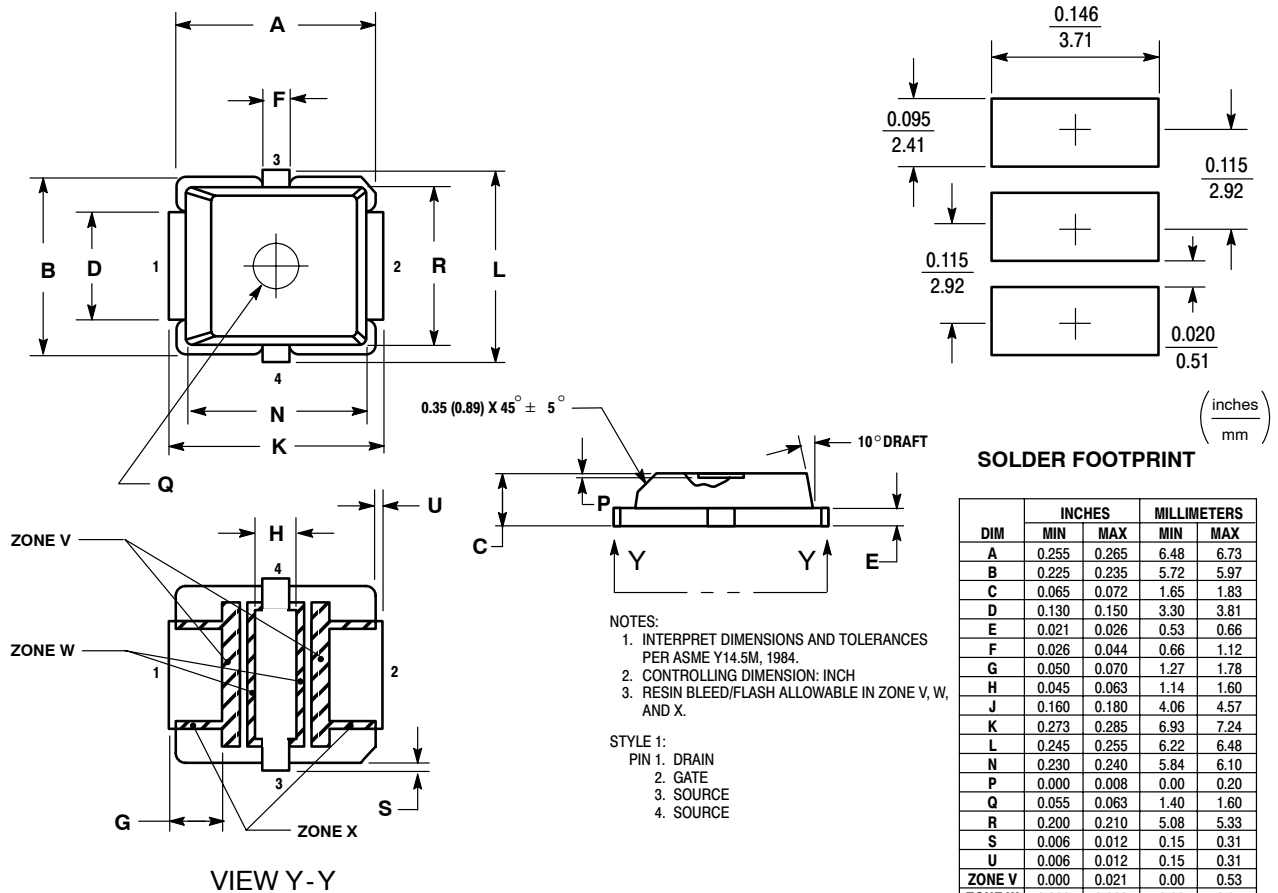
f GHz	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	S ₁₁	$\angle \phi$	S ₂₁	$\angle \phi$	S ₁₂	$\angle \phi$	S ₂₂	$\angle \phi$
0.5	0.945	-174.56	4.019	84.19	0.020	3.30	0.780	-179.31
0.55	0.946	-176.04	3.663	82.53	0.020	2.54	0.781	179.94
0.6	0.947	-177.32	3.366	80.98	0.020	2.19	0.781	179.35
0.65	0.947	-178.45	3.112	79.47	0.020	1.57	0.781	178.72
0.7	0.948	-179.56	2.895	77.97	0.020	0.87	0.781	178.05
0.75	0.948	179.46	2.706	76.52	0.020	0.62	0.781	177.37
0.8	0.948	178.47	2.540	75.04	0.020	-0.13	0.780	176.66
0.85	0.948	177.54	2.393	73.57	0.020	-0.49	0.780	175.92
0.9	0.949	176.67	2.262	72.11	0.020	-0.94	0.781	175.15
0.95	0.950	175.80	2.144	70.67	0.020	-1.83	0.781	174.36
1	0.949	174.99	2.036	69.21	0.020	-2.42	0.780	173.56
1.05	0.950	174.21	1.944	67.79	0.020	-2.91	0.781	172.68
1.1	0.950	173.45	1.855	66.34	0.020	-3.44	0.781	171.84
1.15	0.950	172.67	1.775	64.92	0.020	-4.10	0.781	171.00
1.2	0.949	171.97	1.701	63.52	0.020	-4.38	0.781	170.10
1.25	0.950	171.32	1.634	62.09	0.020	-4.91	0.781	169.21
1.3	0.950	170.63	1.571	60.69	0.020	-5.31	0.782	168.37
1.35	0.950	169.95	1.513	59.26	0.020	-6.04	0.783	167.37
1.4	0.949	169.34	1.459	57.88	0.020	-6.58	0.783	166.48
1.45	0.949	168.69	1.409	56.49	0.020	-7.02	0.784	165.70
1.5	0.949	168.05	1.365	55.14	0.020	-7.32	0.785	164.78
1.55	0.948	168.83	1.317	53.93	0.020	-7.26	0.787	162.67
1.6	0.948	168.16	1.278	52.65	0.020	-7.55	0.788	162.09
1.65	0.948	167.46	1.238	51.29	0.020	-7.83	0.789	161.44
1.7	0.948	166.80	1.203	50.05	0.020	-8.50	0.790	160.84
1.75	0.949	166.20	1.168	48.79	0.020	-9.20	0.790	160.36
1.8	0.950	165.51	1.137	47.59	0.020	-9.26	0.791	159.76
1.85	0.950	164.95	1.108	46.33	0.020	-9.47	0.791	159.37
1.9	0.950	164.28	1.080	45.15	0.020	-9.71	0.792	158.91
1.95	0.950	163.65	1.053	43.95	0.020	-9.95	0.793	158.40
2	0.951	162.95	1.029	42.80	0.020	-10.45	0.793	158.00
2.05	0.950	162.45	1.004	41.72	0.020	-10.68	0.794	157.80
2.1	0.950	161.82	0.983	40.60	0.020	-11.15	0.794	157.42
2.15	0.950	161.22	0.962	39.44	0.020	-11.31	0.794	157.19
2.2	0.949	160.64	0.944	38.45	0.020	-11.94	0.796	157.03
2.25	0.949	160.02	0.926	37.33	0.020	-12.19	0.797	156.78
2.3	0.949	159.39	0.910	36.28	0.020	-12.28	0.796	156.48
2.35	0.951	158.85	0.894	35.26	0.020	-12.28	0.797	156.47
2.4	0.949	158.25	0.880	34.21	0.020	-12.08	0.797	156.16
2.45	0.948	157.61	0.867	33.14	0.020	-12.46	0.796	155.87
2.5	0.949	157.00	0.855	32.09	0.021	-12.24	0.797	155.85
2.55	0.948	156.38	0.843	31.01	0.021	-12.56	0.796	155.53
2.6	0.948	155.73	0.833	29.90	0.021	-12.08	0.796	155.28
2.65	0.946	155.07	0.823	28.86	0.021	-12.64	0.796	155.24
2.7	0.945	154.41	0.813	27.71	0.021	-12.48	0.796	154.81
2.75	0.944	153.70	0.805	26.55	0.022	-13.14	0.794	154.51

(continued)

Table 7. Class AB Common Source S-Parameters ($V_{DD} = 12\text{ Vdc}$, $I_{DQ} = 130\text{ mA}$, $T_A = 25^\circ\text{C}$, 50 ohm system) (continued)

f GHz	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	S ₁₁	∠φ	S ₂₁	∠φ	S ₁₂	∠φ	S ₂₂	∠φ
2.8	0.943	153.02	0.796	25.46	0.022	-13.75	0.794	154.30
2.85	0.943	152.31	0.788	24.29	0.022	-14.19	0.794	153.85
2.9	0.942	151.61	0.781	23.11	0.022	-14.81	0.792	153.42
2.95	0.939	150.84	0.775	22.01	0.022	-15.38	0.791	153.00
3	0.942	150.15	0.768	20.75	0.022	-15.83	0.792	152.55
3.05	0.941	149.40	0.761	19.55	0.023	-16.06	0.787	152.10
3.1	0.939	148.59	0.757	18.31	0.023	-16.58	0.789	151.47
3.15	0.939	147.75	0.751	17.03	0.023	-17.33	0.788	150.69
3.2	0.938	146.97	0.747	15.68	0.023	-17.60	0.786	149.89
3.25	0.941	145.84	0.743	14.42	0.023	-18.35	0.789	149.10
3.3	0.937	145.28	0.736	12.96	0.023	-18.68	0.785	148.30
3.35	0.936	144.36	0.733	11.56	0.023	-19.36	0.780	147.36
3.4	0.935	143.56	0.728	10.18	0.024	-19.65	0.780	146.56
3.45	0.937	142.81	0.724	8.84	0.024	-19.96	0.781	145.50
3.5	0.934	141.86	0.719	7.37	0.024	-19.70	0.775	144.38
3.55	0.934	140.99	0.716	6.03	0.024	-19.69	0.776	143.47
3.6	0.933	140.12	0.711	4.58	0.025	-20.44	0.773	142.22
3.65	0.931	139.20	0.708	3.03	0.025	-21.24	0.768	141.01
3.7	0.933	138.37	0.704	1.61	0.025	-22.19	0.769	140.17
3.75	0.933	137.48	0.700	0.20	0.025	-22.67	0.767	138.91
3.8	0.933	136.55	0.696	-1.33	0.026	-23.74	0.763	137.79
3.85	0.931	135.57	0.693	-2.73	0.026	-24.10	0.765	136.96
3.9	0.928	134.64	0.689	-4.11	0.026	-24.28	0.767	135.76
3.95	0.925	133.78	0.685	-5.62	0.026	-24.60	0.765	134.55
4	0.921	133.05	0.682	-7.05	0.026	-25.13	0.769	133.67
4.05	0.920	132.39	0.678	-8.42	0.027	-25.07	0.772	132.19
4.1	0.918	131.72	0.675	-9.92	0.027	-25.69	0.767	130.73
4.15	0.923	130.82	0.673	-11.37	0.027	-26.05	0.766	129.70
4.2	0.919	129.91	0.669	-12.78	0.028	-26.99	0.768	128.51
4.25	0.922	129.26	0.666	-14.22	0.028	-27.58	0.762	127.29
4.3	0.924	128.37	0.664	-15.61	0.028	-28.51	0.764	126.49
4.35	0.926	127.34	0.662	-16.92	0.029	-28.82	0.761	125.41
4.4	0.926	126.32	0.658	-18.36	0.029	-29.48	0.756	124.59
4.45	0.926	125.27	0.658	-19.76	0.029	-29.54	0.759	123.86
4.5	0.926	124.13	0.657	-21.11	0.030	-30.12	0.758	122.97
4.55	0.925	123.09	0.654	-22.50	0.030	-30.82	0.753	122.26
4.6	0.924	122.08	0.654	-23.83	0.030	-31.17	0.755	121.74
4.65	0.924	120.81	0.654	-25.14	0.031	-31.73	0.754	120.88
4.7	0.922	119.61	0.653	-26.55	0.031	-32.31	0.750	120.35
4.75	0.921	118.44	0.654	-27.97	0.032	-33.11	0.752	119.79
4.8	0.919	117.22	0.654	-29.30	0.032	-33.53	0.751	119.03
4.85	0.917	115.94	0.653	-30.70	0.032	-34.28	0.747	118.53
4.9	0.916	114.60	0.655	-32.19	0.033	-34.59	0.748	118.03
4.95	0.914	113.24	0.657	-33.61	0.033	-34.92	0.748	117.16
5	0.912	111.82	0.657	-35.10	0.034	-35.27	0.743	116.59

PACKAGE DIMENSIONS



CASE 466-03
ISSUE D
PLD-1.5
PLASTIC

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	May 2006	• 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 • Added Table 3, ESD Protection Characteristics, p. 1; renumbered subsequent tables
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

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Technical Information Center
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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

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