

# LDMOS 射频功率晶体管

## 1. 产品特性

- 静电保护
- 高效率
- 高增益
- 高耐用性
- 优异的热稳定性

## 2. 产品应用

- CDMA
- W-CDMA
- GSM EDGE
- MC-GSM
- LTE
- WiMAX

## 3. 典型性能

HTN7G27S010P 10W 射频功率晶体管是基站用 700-2700 MHz 频率范围内。

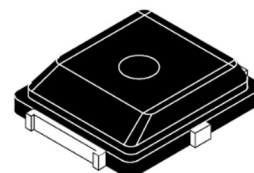
表 1. 测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , CW Signal, 基于华太 Demo PA 测试板。

频率(MHz)	增益(dB)	P1dB(dBm)	P3dB(dBm)	效率(%)
2110	18.8	41.8	42.7	58.0
2140	19.1	41.4	42.4	59.0
2170	19.0	40.9	41.9	57.7

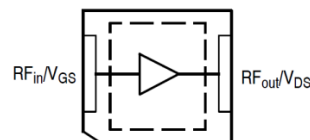
表 2. 测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ ,  $P_{out}=31.0dBm$  (1.26W) Avg., Single Carrier W-CDMA, Input Signal PAR=9.9 dB @0.01%Probability on CCDF, 基于华太 Demo PA 测试板。

频率(MHz)	增益(dB)	效率(%)	ACPR(dBc)	IRL(dB)
2110	18.8	17.3	-47.0	-13.6
2140	19.1	18.1	-48.0	-14.7
2170	19.0	18.8	-48.0	-15.6

HTN7G27S010P



封装: PQFN6\*5



(Top View)

引脚连接

**表 3. 测试条件: 增益和效率:  $V_{DD}=12V_{dc}$ ,  $IDQ=145mA$ , CW; ACPR:  $P_{out}=27dBm$  (0.5W) Avg., Single Carrier W-CDMA, Input Signal PAR=9.9 dB @0.01%Probability on CCDF, 基于华太 Demo PA 测试板。**

频率(MHz)	增益(dB)	P1dB(dBm)	效率 P1dB(%)	ACPR (dBc)
2320	12.8	36.6	40.8	-46.5
2345	12.8	36.5	41.6	-46.5
2370	12.5	36.5	43.1	-46.5

#### 4. 极限参数

**表 4. 极限参数**

参数	符号	值	单位
漏源电压	$V_{DSS}$	-0.5, +65	Vdc
栅源电压	$V_{GS}$	-5.0, +10	Vdc
工作电压	$V_{DD}$	28, +0	Vdc
温度存储	$T_{stg}$	-55 to +150	°C
工作封装温度	$T_c$	-40 to +150	°C
工作结温	$T_J$	-40 to +225	°C

#### 5. 热性能

**表 5 热性能**

参数	符号	条件	典型值	单位
热阻 (管芯至封装管脚)	$R_{\theta JC}$	封装管脚温度: 50°C CW 输出功率: 10W	3.5	°C/W

## 6. 电学特性

表 6. 直流特性

参数	符号	测试条件	最小值	典型值	最大值	单位
击穿电压	$V_{(BR)DSS}$	$V_{GS}=0V$ ; $I_D=33.6\mu A$	65	-	-	V
开启电压	$V_{GS(th)}$	$V_{DS}=V_{GS}$ ; $I_D=33.6\mu A$	-	1.4	-	V
漏极漏电流	$I_{DSS}$	$V_{DS}=65V$ ; $V_{GS}=0V$	-	-	1.4	$\mu A$
栅极漏电流	$I_{GSS}$	$V_{DS}=0V$ ; $V_{GS}=5V$	-	-	140	nA
导通电阻	$R_{DS(on)}$	$V_{GS}=6V$ ; $I_D=900mA$	-	1.1	-	$\Omega$

表 7. ESD 特性

测试方法	等级
HBM (参考 JESD22--A114)	1B
MM (参考 EIA/JESD22--A115)	A
CDM (参考 JESD22--C101)	III

表 8. 负载失配测试 (基于华太 Demo PA 测试板)

测试条件	测试结果
$V_{DD}=28V$ , $I_{DQ}=140mA$ , $f=2140MHz$ , $V_{SWR}=10:1$ , $P_{out}=43.0dBm$ , CW Signal (输入在 P3dB 基础再过推 3dB)	晶体管性能不变

表 9. 参考设计电路板典型性能

参数	符号	最小值	典型值	最大值	单位
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*测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ ,  $P_{out}=31.0dBm$  (1.26W),  $Avg.$ ,  $f=2140MHz$ , Single-Carrier W-CDMA, Input Signal  $PAR=9.9dB$  @0.01% Probability on CCDF. ACPR measured in 3.84MHz Channel Bandwidth @  $\pm 5MHz$  Offset.*

增益	$G_{ps}$	-	19.1	-	dB
漏极效率	$\eta_D$	-	18.1	-	%
临信道功率比	ACPR	-	-48.0	-	dBc

*测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , CW Signal.*

1dB 压缩输出功率	P1dB	-	41.4	-	dBm
AM/PM (2110-2170MHz 频段 P3dB 最大值)	$\Phi$	-	18.1	-	°
VBW (三阶交调转折点)	$VBW_{res}$	-	90	-	MHz
2110-2170MHz 60MHz 带宽内增益平坦度 @ P1dB	$G_F$	-	0.3	-	dB

## 7. Load-Pull 测试数据

### Load-Pull 最大功率点特性

测试条件: 28V 漏极电压, 140mA 静态电流, 脉冲连续波信号, 40us 脉宽, 4% 占空比

f (MHz)	$Z_{source}$ ( $\Omega$ )	Max Output Power				
		P1dB				
		$Z_{load}$ ( $\Omega$ )	Gain (dB)	(dBm)	(W)	$\eta_D$ (%)
940	0.79+j3.77	14.13+j1.11	25.63	43.48	22.28	64.90
1400	0.88+j0.15	12.08+j2.86	22.36	42.75	18.84	58.91
1840	0.88+j0.45	8.53+j2.50	19.32	42.56	18.03	54.47
2170	1.44-j2.25	4.73+j0.43	19.41	42.45	17.58	56.25
2300	1.26-j2.34	4.54+j0.34	19.10	42.51	17.82	56.90
2450	1.28-j5.38	4.49+j0.56	17.56	42.52	17.86	57.56
2600	1.04-j3.53	3.99+j1.00	17.38	42.22	16.67	55.88

f (MHz)	$Z_{source}$ ( $\Omega$ )	Max Output Power				
		P3dB				
		$Z_{load}$ ( $\Omega$ )	Gain (dB)	(dBm)	(W)	$\eta_D$ (%)
940	0.79+j3.77	13.97+j1.29	25.70	44.42	27.67	71.25
1400	0.88+j0.15	13.00+j3.20	22.23	43.63	23.07	64.04
1840	0.88+j0.45	12.42+j2.69	22.29	43.67	23.28	62.81
2170	1.44-j2.25	8.63+j2.51	19.29	43.44	22.08	57.68
2300	1.26-j2.34	6.15+j0.12	19.17	43.31	21.43	56.92
2450	1.28-j5.38	5.79+j0.45	17.32	43.32	21.48	56.96
2600	1.04-j3.53	5.61+j0.13	17.11	43.32	21.48	57.17

**测试条件: 12V 漏极电压, 140mA 静态电流, 脉冲连续波信号, 40us 脉宽, 4% 占空比**

f (MHz)	Z <sub>source</sub> (Ω)	Max Output Power				
		P1dB				
		Z <sub>load</sub> (Ω)	Gain (dB)	(dBm)	(W)	η <sub>D</sub> (%)
2110	1.12-4.12j	3.00-j3.33	16.1	37.89	6.15	49.79

f (MHz)	Z <sub>source</sub> (Ω)	Max Output Power				
		P3dB				
		Z <sub>load</sub> (Ω)	Gain (dB)	(dBm)	(W)	η <sub>D</sub> (%)
2110	1.12-4.12j	3.32-j3.51	16.1	39.05	8.04	54.47

### Load-Pull 最大效率点特性

**测试条件: 28V 漏极电压, 140mA 静态电流, 脉冲连续波信号, 40us 脉宽, 4% 占空比**

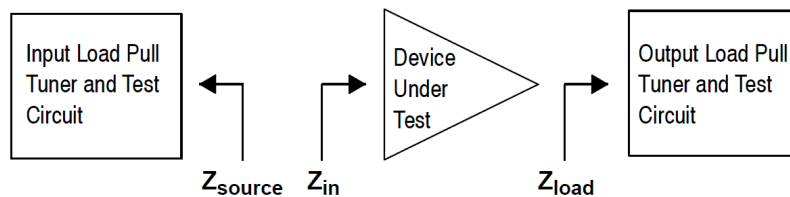
f (MHz)	Z <sub>source</sub> (Ω)	Max Drain Efficiency				
		P1dB				
		Z <sub>load</sub> (Ω)	Gain (dB)	(dBm)	(W)	η <sub>D</sub> (%)
940	0.79+j3.77	15.64+j10.22	27.30	42.32	17.06	75.05
1400	0.88+j0.15	8.25+j10.23	24.34	41.15	13.03	70.22
1840	0.88+j0.45	3.08+j7.71	22.00	41.05	12.74	68.39
2170	1.44-j2.25	2.85+j2.87	20.88	40.96	12.47	64.59
2300	1.26-j2.34	2.78+j2.35	20.55	41.24	13.30	65.87
2450	1.28-j5.38	2.73+j2.38	18.92	41.08	12.82	64.56
2600	1.04-j3.53	2.50+j2.50	18.42	41.00	12.59	61.32

f (MHz)	Z <sub>source</sub> (Ω)	Max Drain Efficiency				
		P3dB				
		Z <sub>load</sub> (Ω)	Gain (dB)	(dBm)	(W)	η <sub>D</sub> (%)
940	1.04+j3.12	14.08+j12.60	27.95	42.95	19.72	82.84
1400	0.88+j0.15	8.20+j10.78	24.36	42.10	16.22	75.58
1840	0.88+j0.45	3.19+j7.63	21.96	42.08	16.14	70.21
2170	1.44-j2.25	3.32+j2.47	20.63	42.15	16.41	65.03
2300	1.26-j2.34	2.86+j2.22	20.47	41.97	15.74	65.88
2450	1.28-j5.38	2.87+j2.26	18.83	41.92	15.56	65.01
2600	1.04-j3.53	3.25+j2.39	18.32	41.71	14.83	61.42

**测试条件: 12V 漏极电压, 140mA 静态电流, 脉冲连续波信号, 40us 脉宽, 4% 占空比**

f (MHz)	Z <sub>source</sub> (Ω)	Max Drain Efficiency				
		P1dB				
		Z <sub>load</sub> (Ω)	Gain (dB)	(dBm)	(W)	η <sub>D</sub> (%)
2110	1.12-4.12j	3.02-j0.65	18.5	36.39	4.36	60.78

f (MHz)	Z <sub>source</sub> (Ω)	Max Drain Efficiency				
		P3dB				
		Z <sub>load</sub> (Ω)	Gain (dB)	(dBm)	(W)	η <sub>D</sub> (%)
2110	1.12-4.12j	2.95-j0.65	18.5	37.36	5.45	64.93



## 8. 参考设计

### 8.1 2110-2170MHz

#### 8.1.1 电路设计版图及元件清单

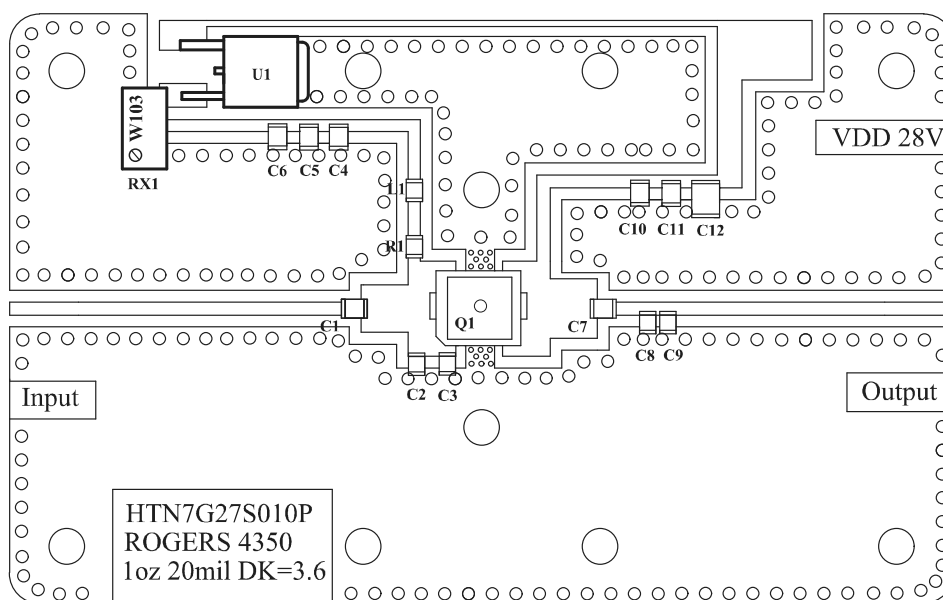


图 1. HTN7G27S010P 测试电路元件布局——2110-2170MHz

表 9. 参考设计电路元件清单

Part	Description	Part Number	Manufacturer
C1, C4, C7, C10	8.2pF Chip Capacitors	GQM2195C2E8R2BB12	Murata
C2	2.4pF Chip Capacitors	GQM2195C2E2R4BB12	Murata
C3	2.2pF Chip Capacitors	GQM2195C2E2R2CB12	Murata
C8, C9	2.0pF Chip Capacitors	GQM2195C2E2R0CB12	Murata
C5, C11	10nF Chip Capacitors	GRM31MR72A103KA01L	Murata
C6	1uF Chip Capacitors	1206	Arbitrary



C12	10uF, 50 V Electrolytic Capacitor	MCGPR50V107M13X26	Multicomp
R1	30ohm Chip Resistor	0603	Arbitrary
L1	22nH Chip Inductor	0603	Arbitrary
PCB	Rogers RO4350B, 0.020, $\epsilon_r = 3.6$	---	Arbitrary

### 8.1.2 测试数据图

连续波

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , CW Signal.

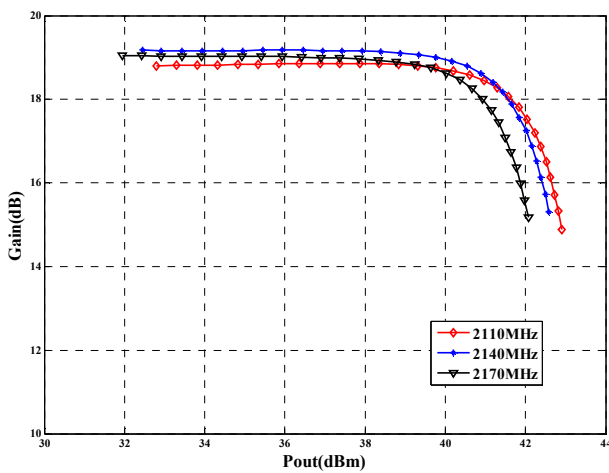


图 2. Gain VS Pout

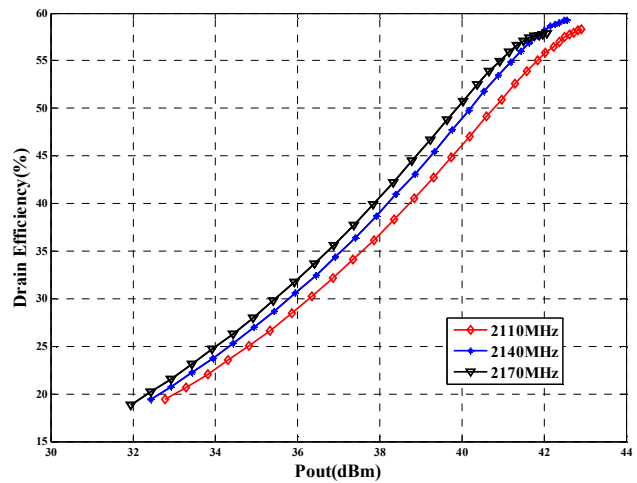


图 3. Drain Efficiency VS Pout

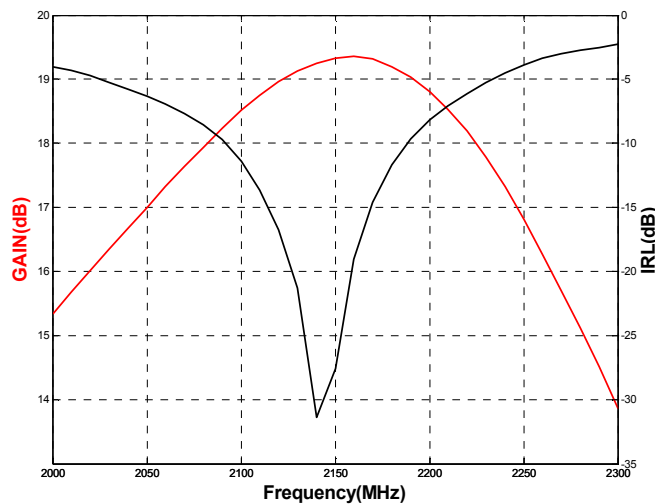
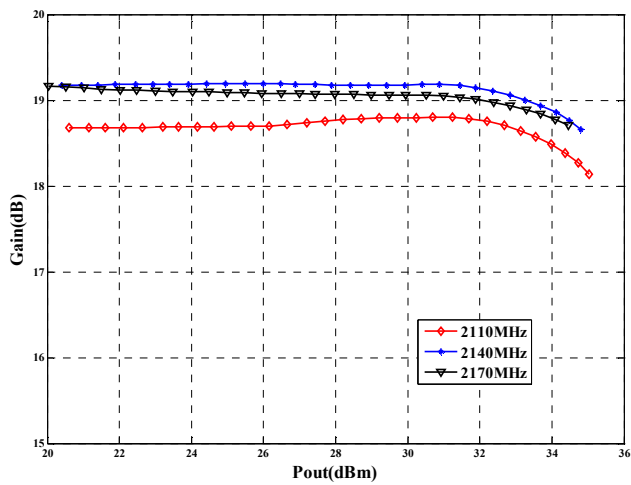


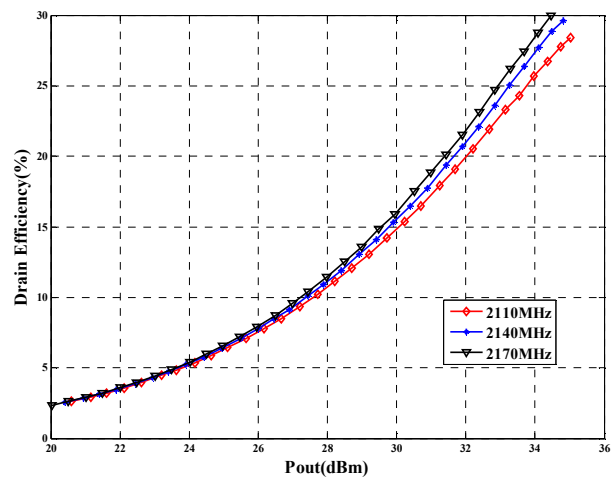
图 4. Broadband Frequency Response

**单载波 W-CDMA**

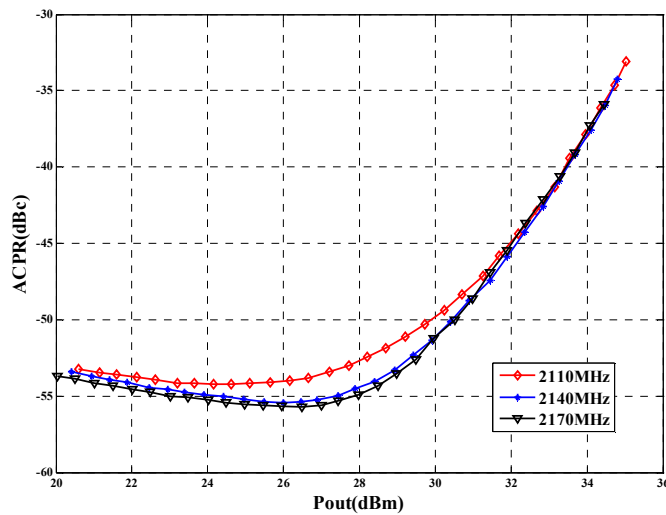
**测试条件:**  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , Single Carrier W-CDMA, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.



**图 5. Gain VS Pout**



**图 6. Drain Efficiency VS Pout**



**图 7. ACPR VS Pout**

### 互调产物随载波间距的变化

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ ,  $P_{out}=7.6W$  (PEP), Two-Tone Measurements,  
 $(f_1 + f_2)/2 = \text{Center Frequency of } 2140MHz$ .

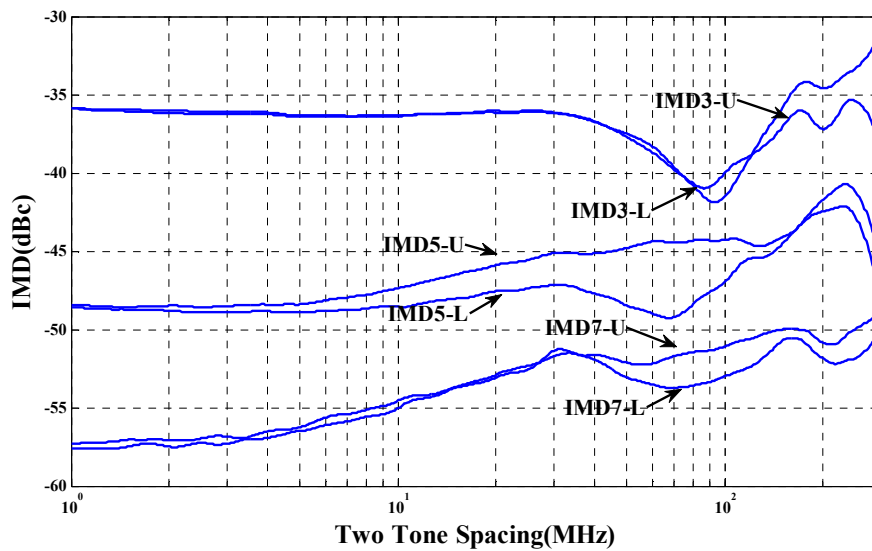


图 8. Intermodulation Distortion Products VS Two Tone Spacing

### 不同温度下

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ ,  $f=2140MHz$ , CW Signal.

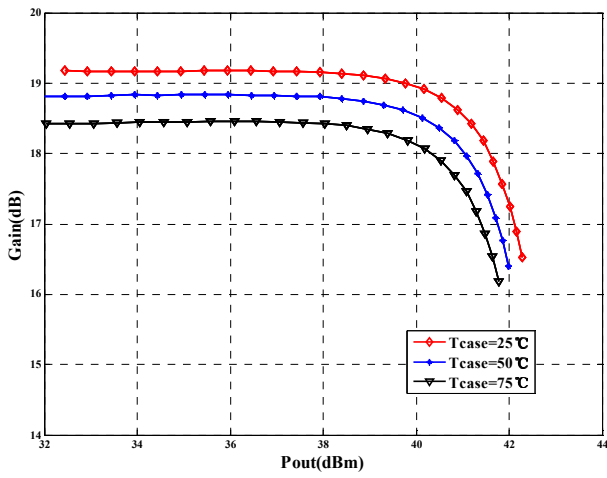


图 9. Gain VS Pout

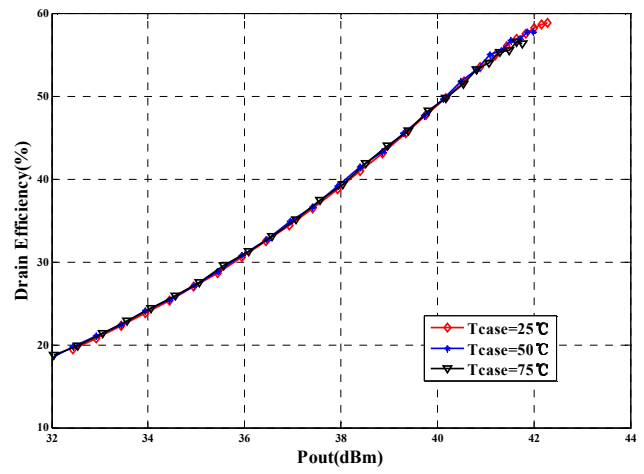


图 10. Drain Efficiency VS Pout

\*注: Tcase 表示散热结构件温度。

## 8.2 920-960MHz

### 8.2.1 电路设计版图及元件清单

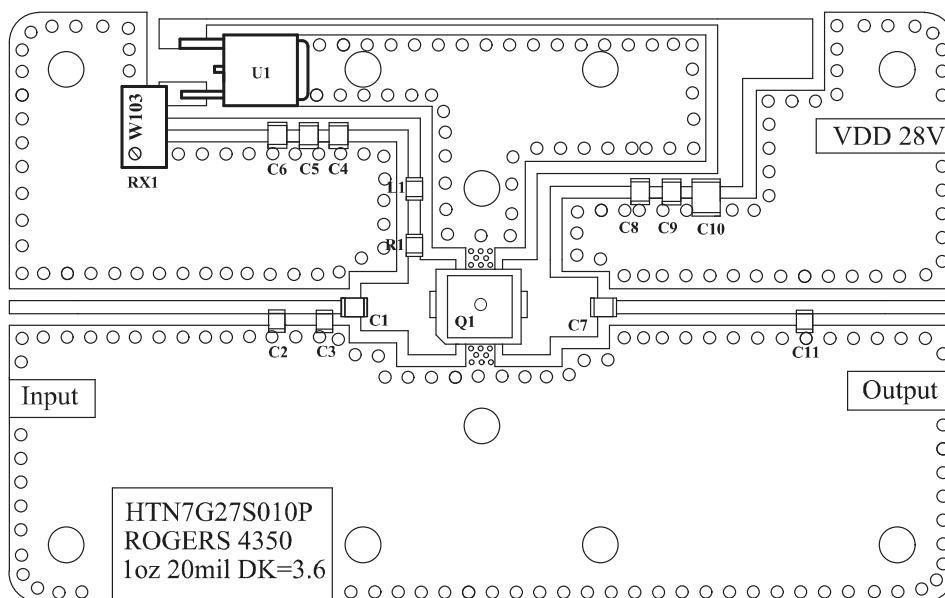


图 11. HTN7G27S010P 测试电路元件布局——920-960MHz

表 10. 参考设计电路元件清单

Part	Description	Part Number	Manufacturer
C1, C4, C7, C8	68pF Chip Capacitors	GQM2195C2E680JB12	Murata
C2, C3	8.0pF Chip Capacitors	GQM2195C2E8R0BB12	Murata
C11	4.7pF Chip Capacitors	GQM2195C2E4R7BB12	Murata
C5, C9	10nF Chip Capacitors	GRM31MR72A103KA01L	Murata
C6	1uF Chip Capacitors	1206	Arbitrary
C10	10uF, 50 V Electrolytic Capacitor	MCGPR50V107M13X26	Multicomp
R1	30ohm Chip Resistor	0603	Arbitrary
L1	47nH Chip Inductor	0603	Arbitrary
PCB	Rogers RO4350B, 0.020, $\epsilon_r = 3.6$	D53402	Arbitrary

### 8.2.2 测试数据图

连续波

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , CW Signal.

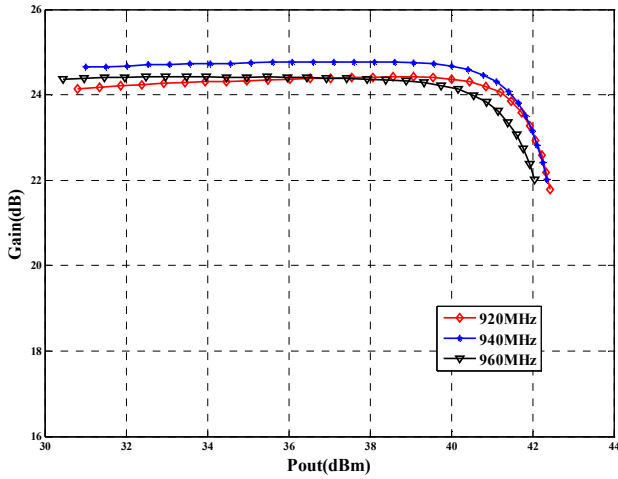


图 12. Gain VS Pout

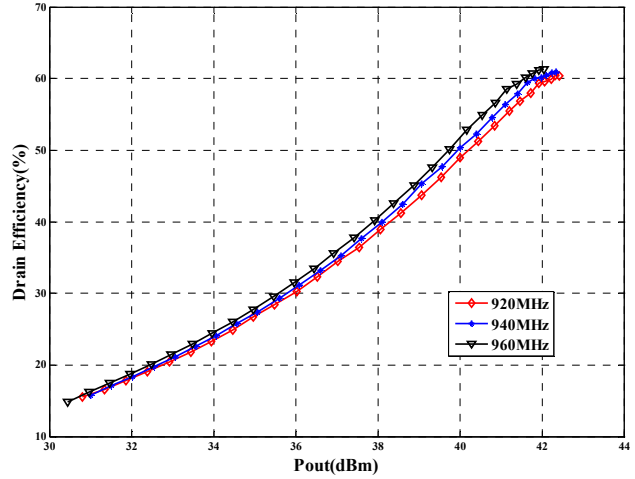


图 13. Drain Efficiency VS Pout

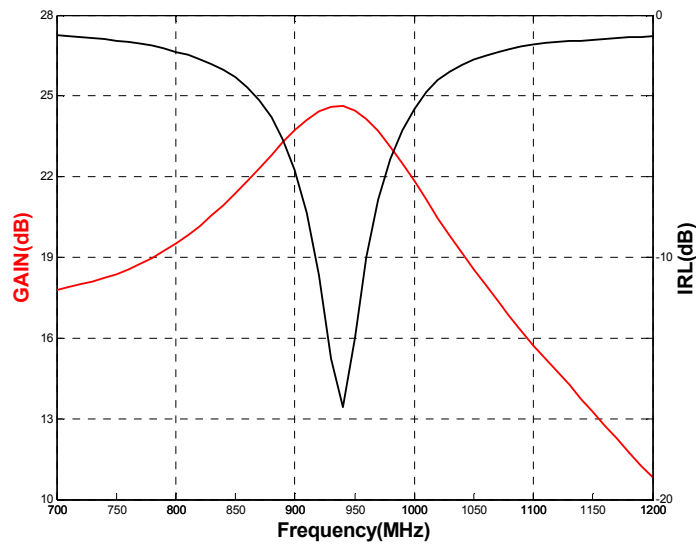


图 14. Broadband Frequency Response

单载波 W-CDMA

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , Single Carrier W-CDMA, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

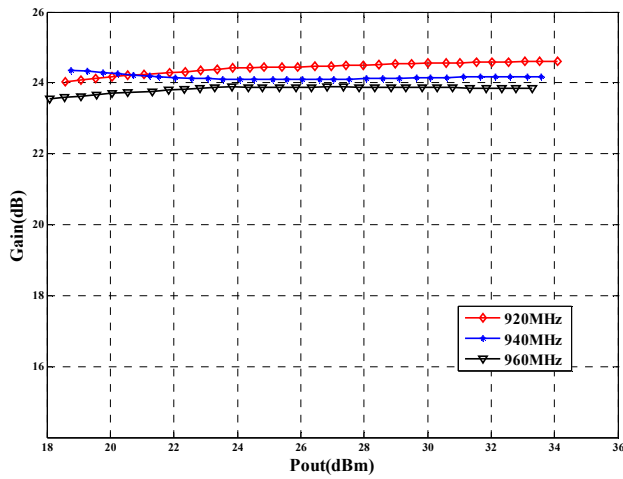


图 15. Gain VS Pout

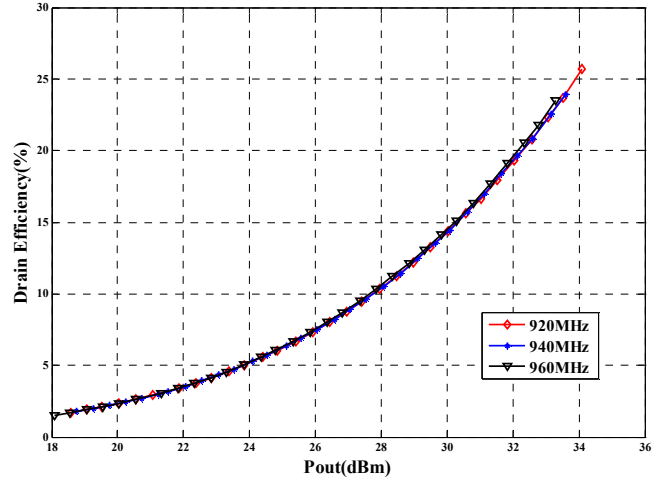


图 16. Drain Efficiency VS Pout

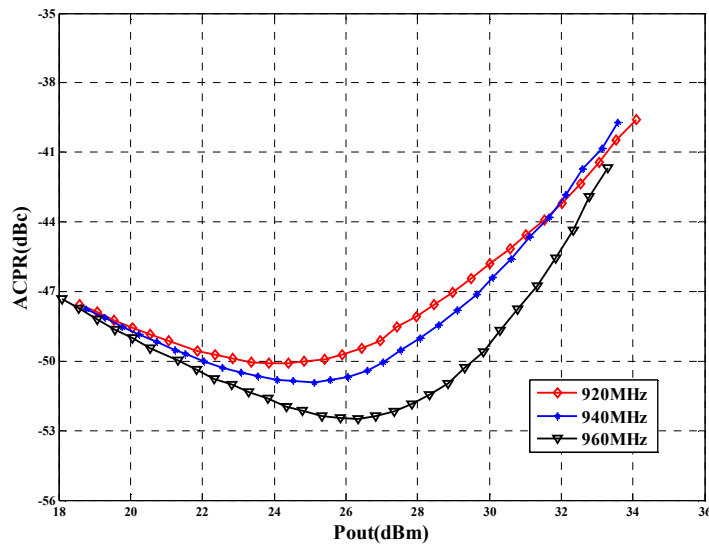


图 17. ACPR VS Pout

## 8.3 2400-2500MHz

### 8.3.1 电路设计版图及元件清单

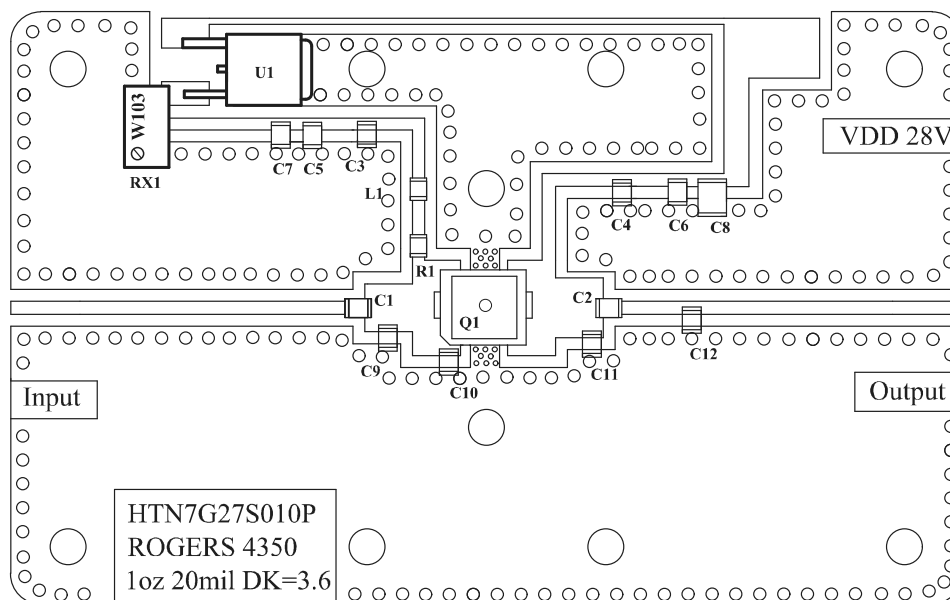


图 18. HTN7G27S010P 测试电路元件布局——2400-2500MHz

表 11. 参考设计电路元件清单

Part	Description	Part Number	Manufacturer
C2, C3, C4	6.2pF Chip Capacitors	ATC100B6R2JT500XT	ATC
C1	2.0pF Chip Capacitors	ATC100B2R0JT500XT	ATC
C9	0.3pF	ATC100B0R3JT500XT	ATC
C10	1.8pF Chip Capacitors	ATC100B1R8JT500XT	ATC
C11	2.2pF Chip Capacitors	GQM2195C2E2R2CB12	Murata
C12	1.2	GQM2195C2E1R2CB12	Murata
C5, C6	10nF Chip Capacitors	GRM31MR72A103KA01L	Murata
C7	1uF Chip Capacitors	1206	Arbitrary
C8	10uF, 50 V Electrolytic Capacitor	MCGPR50V107M13X26	Multicomp
R1	10ohm Chip Resistor	0603	Arbitrary
L1	6.8nH Chip Inductor	0603	Arbitrary
PCB	Rogers RO4350B, 0.020, $\epsilon_r = 3.6$	D53402	Arbitrary



### 8.3.2 测试数据图

连续波

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=130mA$ , CW Signal.

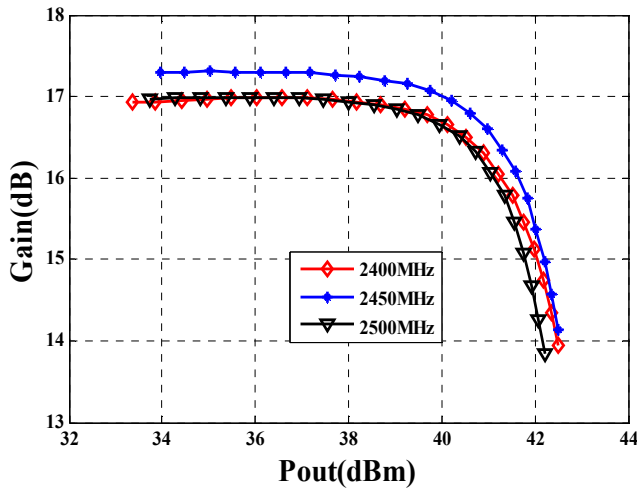


图 19. Gain VS Pout Figure

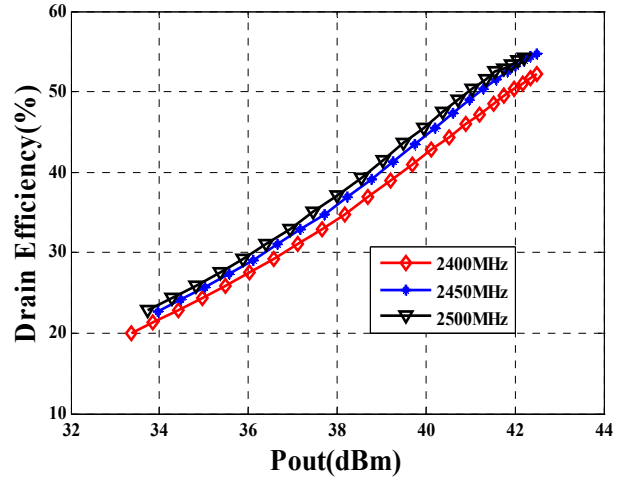


图 20. Drain Efficiency VS Pout

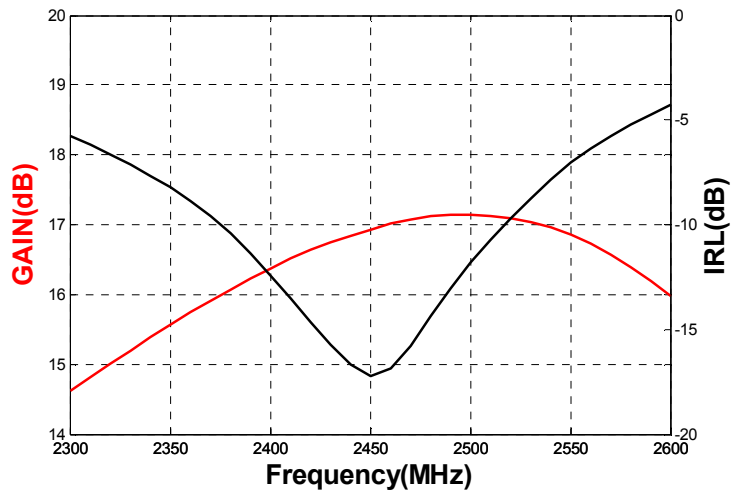


图 21. Broadband Frequency Response

## 8.4 2620-2690MHz

### 8.4.1 电路设计版图及元件清单

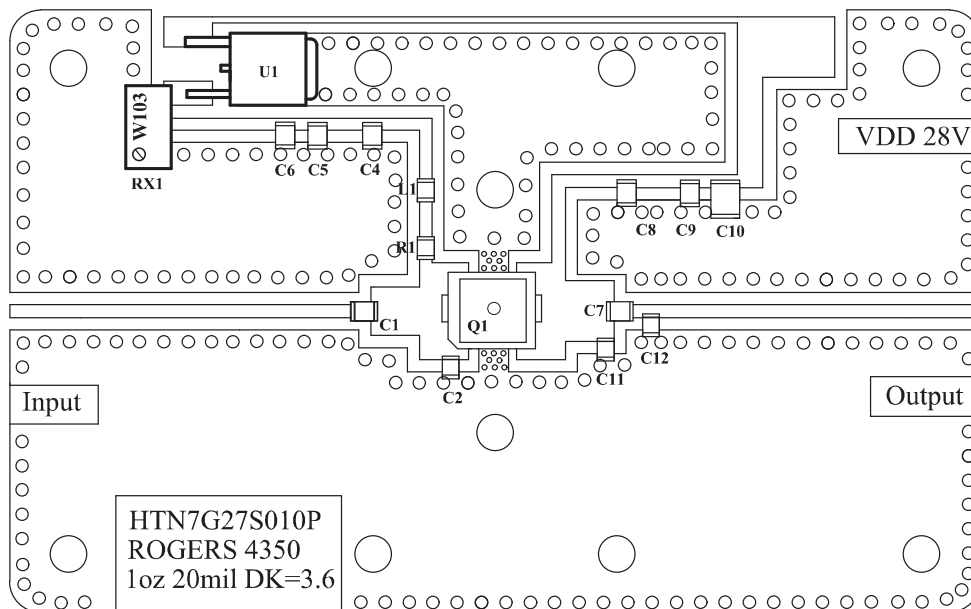


图 22. HTN7G27S010P 测试电路元件布局——2620-2690MHz

表 12. 参考设计电路元件清单

Part	Description	Part Number	Manufacturer
C1, C4, C7, C8	6.8pF Chip Capacitors	GQM2195C2E6R8BB12	Murata
C2	1.6pF Chip Capacitors	GQM2195C2E1R6CB12	Murata
C11, C12	1.5pF Chip Capacitors	GQM2195C2E1R5CB12	Murata
C5, C9	10nF Chip Capacitors	GRM31MR72A103KA01L	Murata
C6	1uF Chip Capacitors	1206	Arbitrary
C10	10uF, 50 V Electrolytic Capacitor	MCGPR50V107M13X26	Multicomp
R1	30ohm Chip Resistor	0603	Arbitrary
L1	10nH Chip Inductor	0603	Arbitrary
PCB	Rogers RO4350B, 0.020, $\epsilon_r = 3.6$	D53402	Arbitrary

### 8.4.2 测试数据图

连续波

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , CW Signal.

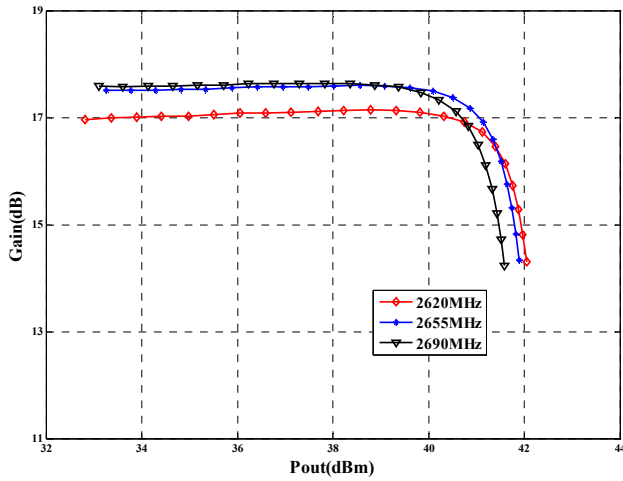


图 23. Gain VS Pout

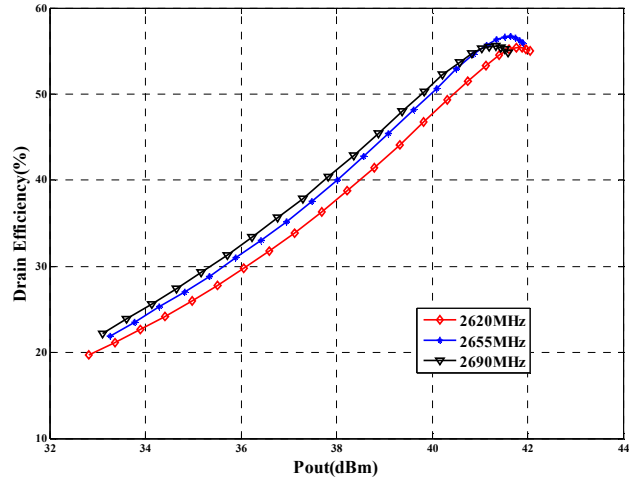


图 24. Drain Efficiency VS Pout

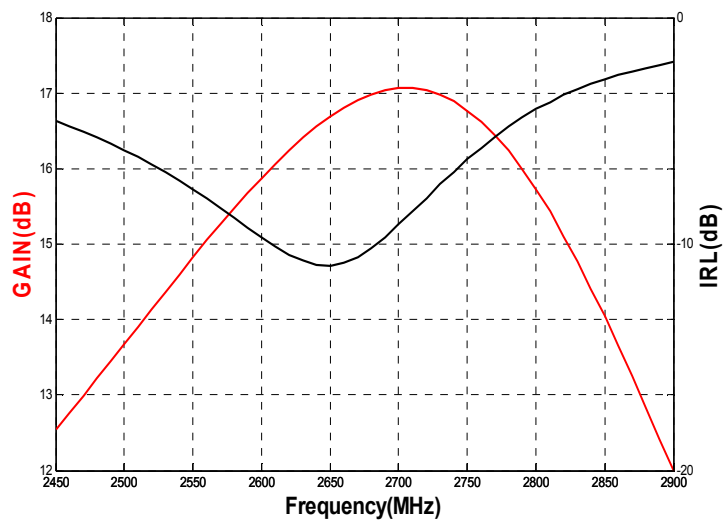


图 25. Broadband Frequency Response

单载波 W-CDMA

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , Single Carrier W-CDMA, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

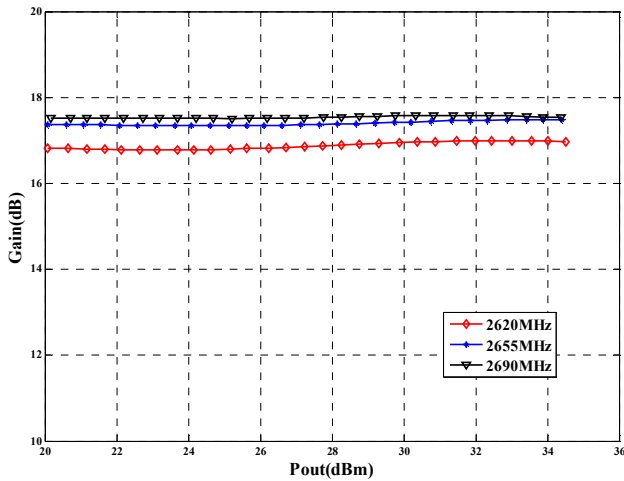


图 26. Gain VS Pout

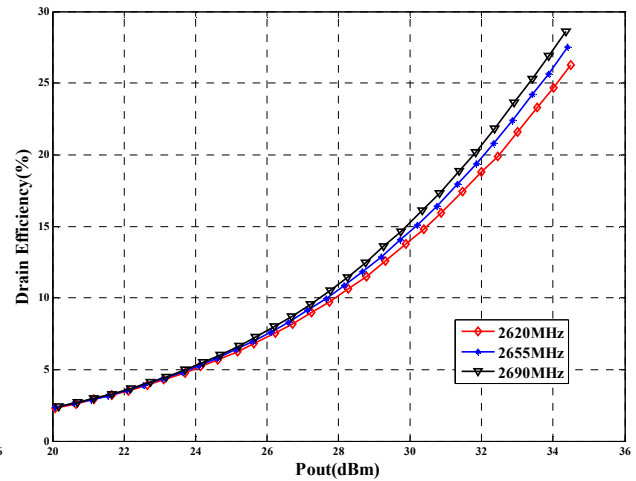


图 27. Drain Efficiency VS Pout

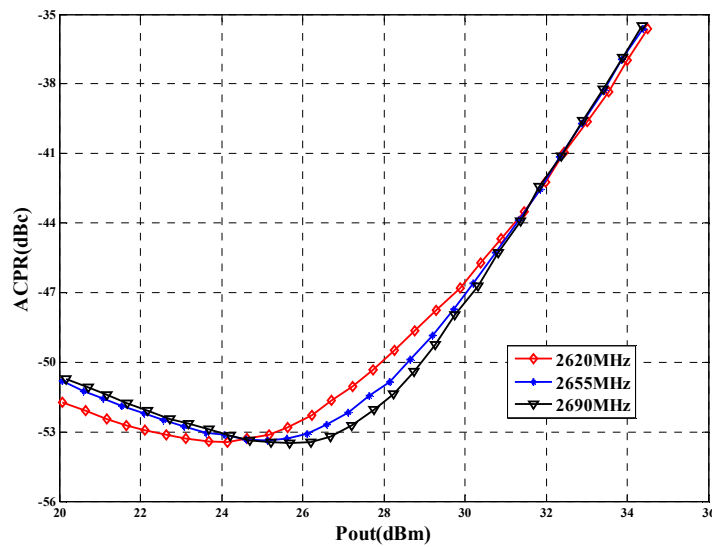


图 28. ACPR VS Pout

## 8.5 3000-3100MHz

### 8.5.1 电路设计版图及元件清单

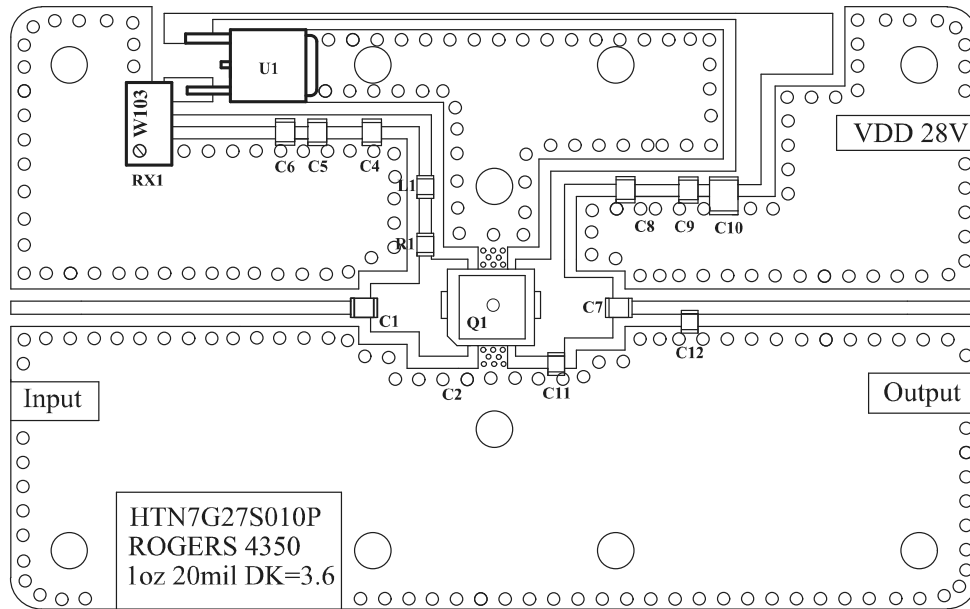


图 29. HTN7G27S010P 测试电路元件布局——3000-3100MHz

表 13. 参考设计电路元件清单

Part	Description	Part Number	Manufacturer
C4, C7, C8	5.6pF Chip Capacitors	GQM2195C2E5R6BB12	Murata
C1	4.3pF Chip Capacitors	GQM2195C2E4R3BB12	Murata
C11	1.5pF Chip Capacitors	GQM2195C2E1R5CB12	Murata
C12	0.5pF Chip Capacitors	GQM2195C2E0R5CB12	Murata
C5, C9	10nF Chip Capacitors	GRM31MR72A103KA01L	Murata
C6	1uF Chip Capacitors	1206	Arbitrary
C10	10uF, 50 V Electrolytic Capacitor	MCGPR50V107M13X26	Multicomp
R1	10ohm Chip Resistor	0603	Arbitrary
L1	6.8nH Chip Inductor	0603	Arbitrary
PCB	Rogers RO4350B, 0.020, $\epsilon_r = 3.6$	D53402	Arbitrary

### 8.5.2 测试数据图

脉冲波

测试条件:  $V_{DD}=28Vdc$ ,  $I_{DQ}=140mA$ , Pulse CW Signal, 100us Width, 10%Duty.

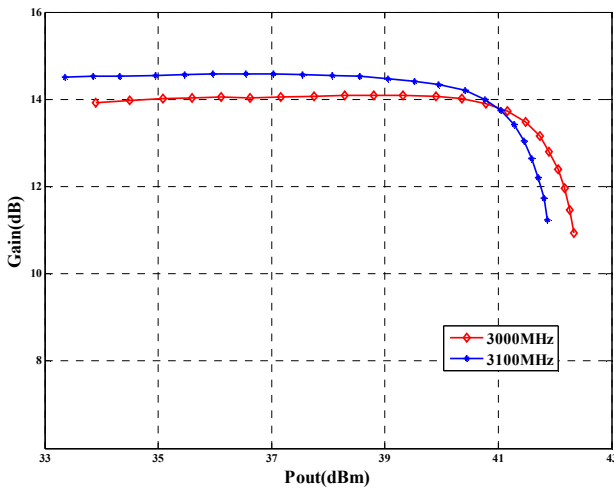


图 30. Gain VS Pout

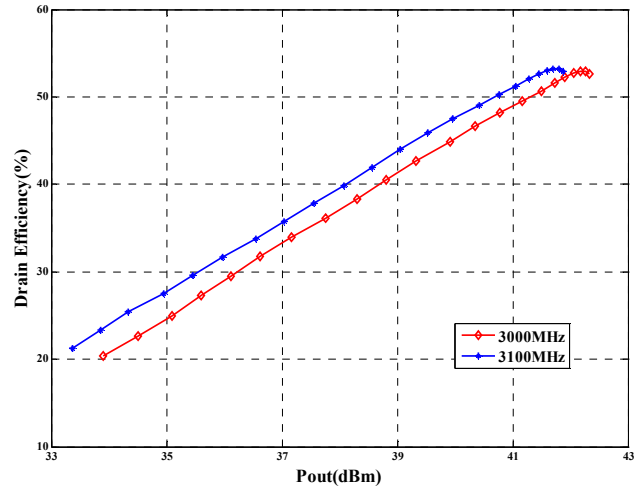


图 31. Drain Efficiency VS Pout

## 8.6 2320-2370MHz

### 8.6.1 电路设计版图及元件清单

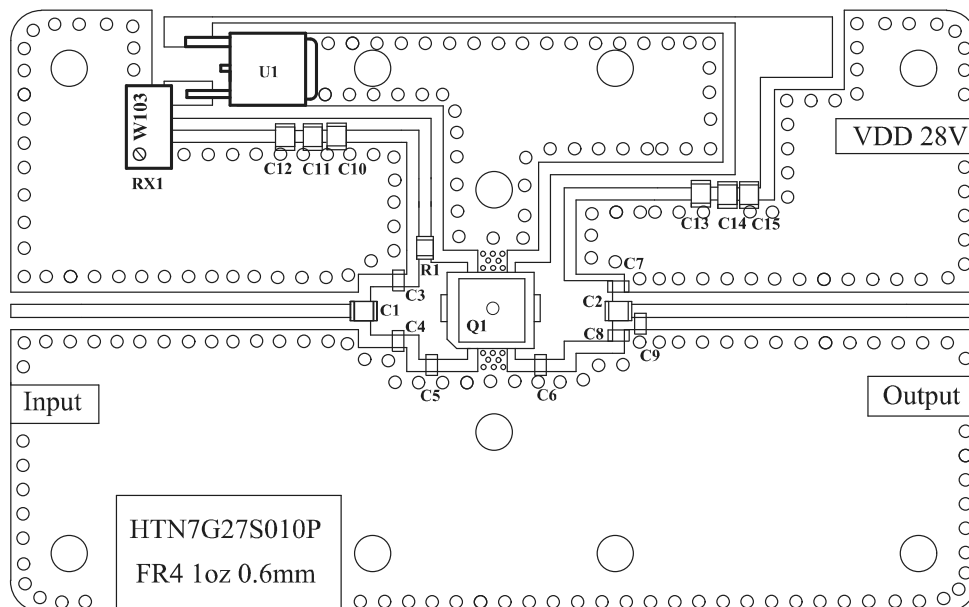


图 32. HTN7G27S010P 测试电路元件布局——2320-2370MHz

表 14. 参考设计电路元件清单

Part	Description	Part Number	Manufacturer
C1, C2	3.9pF Chip Capacitors	0603	Murata
C3	0.3pF Chip Capacitor	0603	Murata
C4, C9	0.5pF Chip Capacitors	0603	Murata
C5	2.0pF Chip Capacitor	0603	Murata
C6, C8	1.2pF Chip Capacitors	0603	Murata
C7	0.7pF Chip Capacitor	0603	Murata
C10, C13	100pF Chip Capacitors	0603	Murata
C11, C14	1.0nF Chip Capacitors	0603	Murata
C12, C15	10 uF Chip Capacitors	1206	Murata
R1	30ohm Chip Resistor	0603	风华
PCB	FR4, 0.020, $\epsilon_r = 4.6$	DEMO00502	MTL

### 8.6.2 测试数据图

连续波

测试条件:  $V_{DD}=12Vdc$ ,  $I_{DQ}=140mA$ , CW Signal.

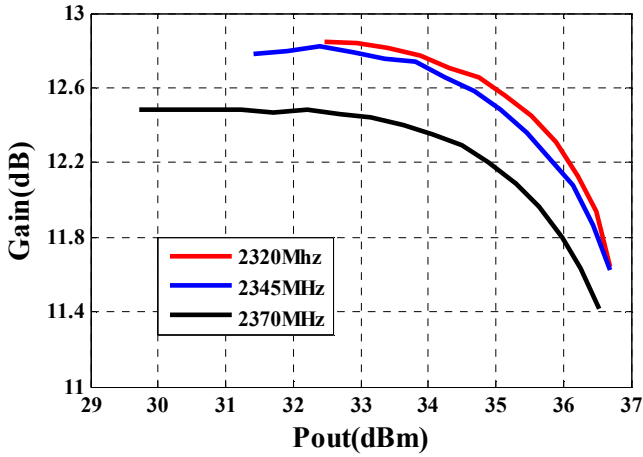


图 33. Gain VS Pout

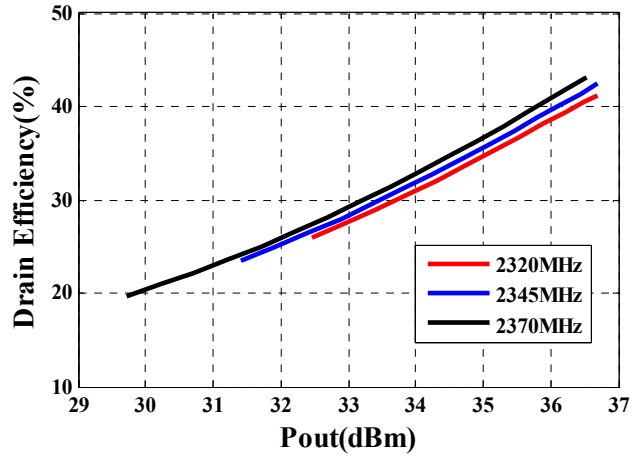
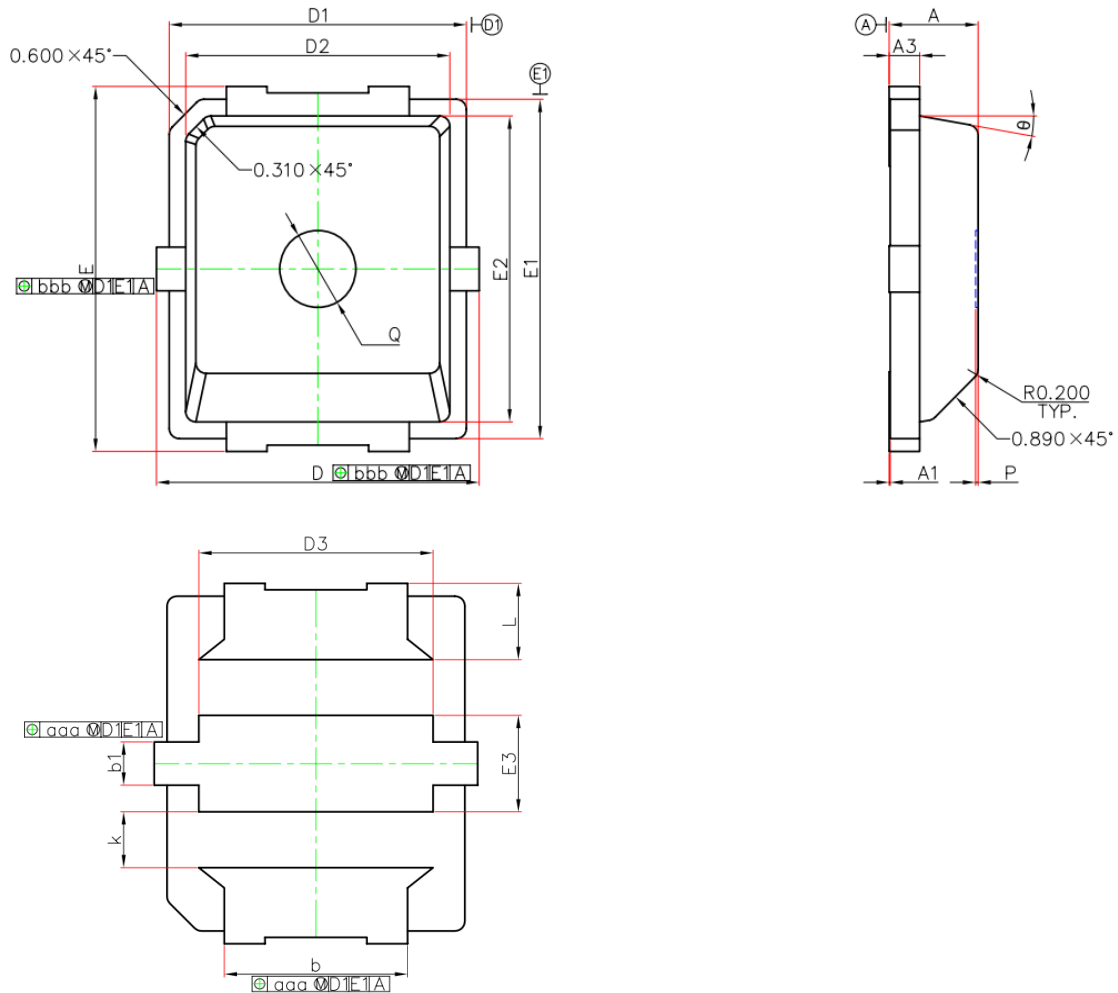


图 34. Drain Efficiency VS Pout



## 9. 封装尺寸及管脚分布

PDFN5.85×6.60-2L(PLD) PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions in Millimeters		Dimensions in Inches		Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
A	1.650	1.850	0.065	0.073	E	7.000	7.200	0.276	0.283
A1	0.000	0.050	0.000	0.002	E1	6.500	6.700	0.256	0.264
A3	0.600 REF.		0.024 REF.		E2	5.850	6.050	0.230	0.238
b	3.500	3.700	0.138	0.146	E3	1.750	2.050	0.069	0.081
b1	0.700	1.000	0.028	0.039	k	1.100 REF.		0.034 REF.	
D	6.250	6.450	0.256	0.254	L	1.400	1.600	0.055	0.063
D1	5.750	5.950	0.226	0.234	P	0.000	0.100	0.000	0.004
D2	5.100	5.300	0.201	0.209	Q	1.400	1.600	0.055	0.063
D3	4.450	4.750	0.175	0.187	θ	5°	15°	5°	15°
aaa	0.100 REF.		0.004 REF.		bbb	0.130 REF.		0.005 REF.	

