APPLICATION NOTE

MITSUBISHI ELECTRIC
Silicon RF Power Semiconductors

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Date :06th Oct. 2011
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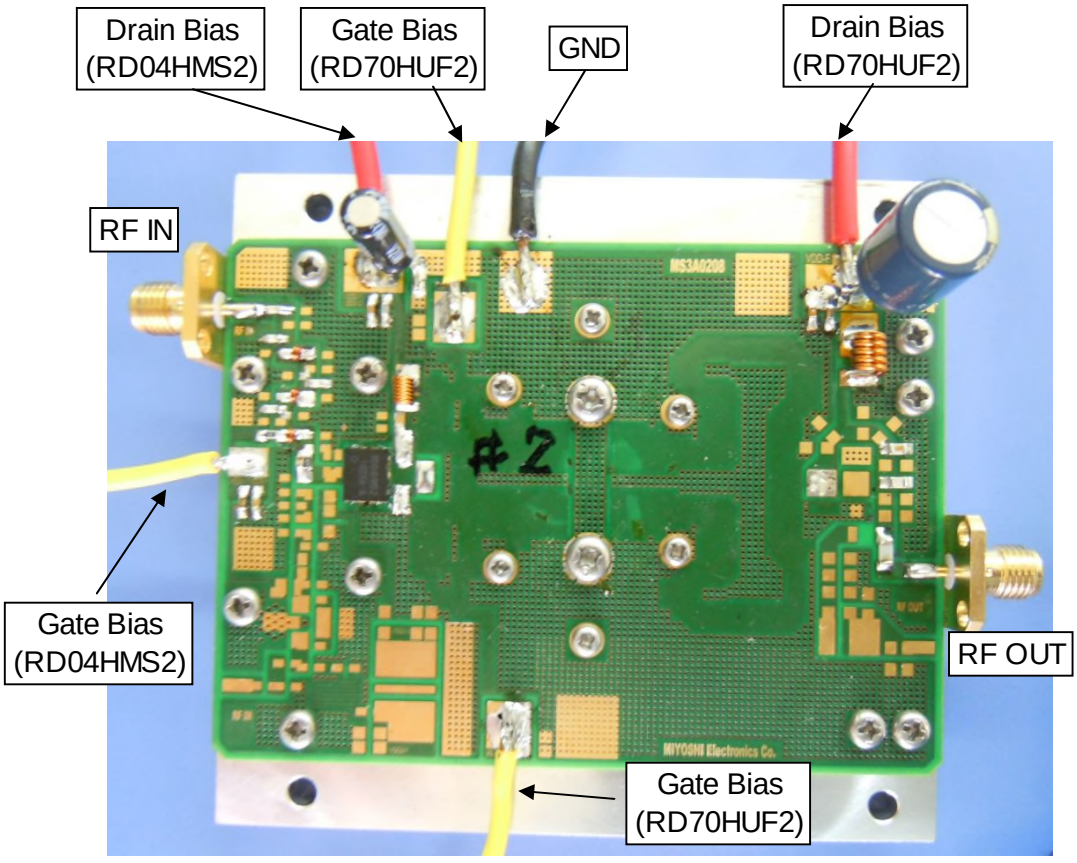
(Taking charge of Silicon RF by
MIYOSHI Electronics)

SUBJECT: RD04HMS2 & RD70HUF2 two-stage amplifier at f=330-400MHz.(Vdd=12.5V)

Features:

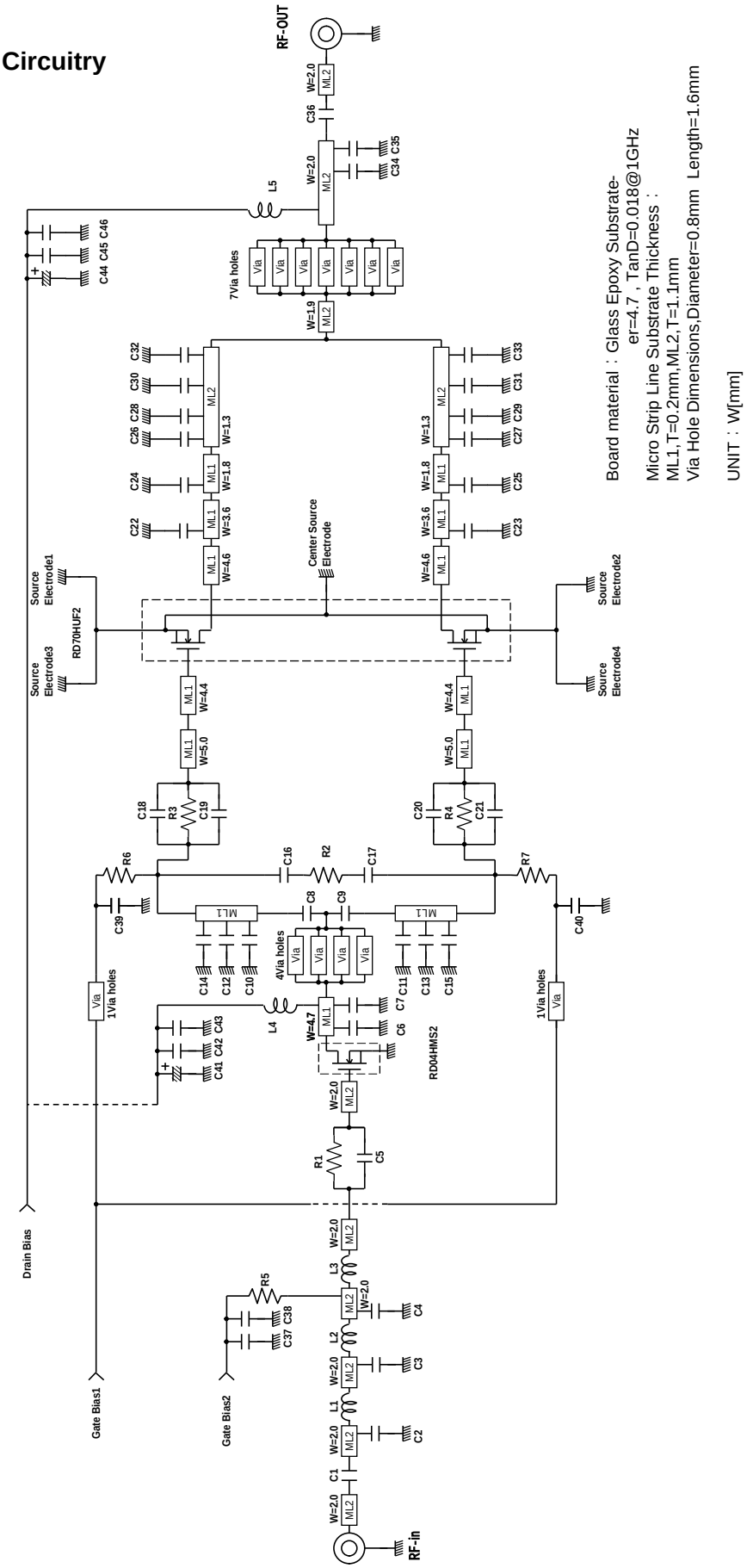
- The evaluation board for RD04HMS2 & RD70HUF2 two-stage amplifier
- Frequency: 330-400MHz
- Vdd: 12.5V
- Input power: 0.2W
- Output power: 79-85W
- Quiescent Current: RD04HMS2 ; 0.1A, RD70HUF2 ; 1A
- Operating Current: 9.5-11A
- Surface-mounted RF power amplifier structure



PCB L=82.5mm W=60.0mm

Contents

1. Equivalent Circuitry



2. Component List and Standard Deliverable

- Component List

No.	Description	P/N	Qty	Manufacturer
Tr 1	MOSFET	RD04HMS2	1	Mitsubishi Electric Corporation
Tr 2	MOSFET	RD70HUF2	1	Mitsubishi Electric Corporation

No.	Description			P/N	Qty	Manufacturer
	Capacitance	Size	Remarks			
C 1	100 pF	1608	50 V	GRM1882C1H101JA01D	1	MURATA MANUFACTURING CO.
C 2	9.1 pF	1608	Hi-Q 50 V	GQM1882C1H9R1CB01D	1	MURATA MANUFACTURING CO.
C 3	30 pF	1608	Hi-Q 50 V	GQM1882C1H300JB01D	1	MURATA MANUFACTURING CO.
C 4	39 pF	1608	Hi-Q 50 V	GQM1882C1H390JB01D	1	MURATA MANUFACTURING CO.
C 5	24 pF	1608	Hi-Q 50 V	GQM1882C1H240JB01D	1	MURATA MANUFACTURING CO.
C 6	20 pF	1608	Hi-Q 50 V	GQM1882C1H200JB01D	1	MURATA MANUFACTURING CO.
C 7	20 pF	1608	Hi-Q 50 V	GQM1882C1H200JB01D	1	MURATA MANUFACTURING CO.
C 8	150 pF	1608	50 V	GRM1882C1H151JA01D	1	MURATA MANUFACTURING CO.
C 9	150 pF	1608	50 V	GRM1882C1H151JA01D	1	MURATA MANUFACTURING CO.
C 10	22 pF	1608	Hi-Q 50 V	GQM1882C1H220JB01D	1	MURATA MANUFACTURING CO.
C 11	22 pF	1608	Hi-Q 50 V	GQM1882C1H220JB01D	1	MURATA MANUFACTURING CO.
C 12	22 pF	1608	Hi-Q 50 V	GQM1882C1H220JB01D	1	MURATA MANUFACTURING CO.
C 13	22 pF	1608	Hi-Q 50 V	GQM1882C1H220JB01D	1	MURATA MANUFACTURING CO.
C 14	22 pF	1608	Hi-Q 50 V	GQM1882C1H220JB01D	1	MURATA MANUFACTURING CO.
C 15	22 pF	1608	Hi-Q 50 V	GQM1882C1H220JB01D	1	MURATA MANUFACTURING CO.
C 16	910 pF	2012	50 V	GRM2162C1H911JA01D	1	MURATA MANUFACTURING CO.
C 17	910 pF	2012	50 V	GRM2162C1H911JA01D	1	MURATA MANUFACTURING CO.
C 18	100 pF	2012	Hi-Q 250 V	GQM2195C2E101JB12D	1	MURATA MANUFACTURING CO.
C 19	100 pF	2012	Hi-Q 250 V	GQM2195C2E101JB12D	1	MURATA MANUFACTURING CO.
C 20	100 pF	2012	Hi-Q 250 V	GQM2195C2E101JB12D	1	MURATA MANUFACTURING CO.
C 21	100 pF	2012	Hi-Q 250 V	GQM2195C2E101JB12D	1	MURATA MANUFACTURING CO.
C 22	100 pF	2012	Hi-Q 250 V	GQM2195C2E101JB12D	1	MURATA MANUFACTURING CO.
C 23	100 pF	2012	Hi-Q 250 V	GQM2195C2E101JB12D	1	MURATA MANUFACTURING CO.
C 24	68 pF	2012	Hi-Q 250 V	GQM2195C2E680JB12D	1	MURATA MANUFACTURING CO.
C 25	68 pF	2012	Hi-Q 250 V	GQM2195C2E680JB12D	1	MURATA MANUFACTURING CO.
C 26	30 pF	2012	Hi-Q 250 V	GQM2195C2E300JB12D	1	MURATA MANUFACTURING CO.
C 27	30 pF	2012	Hi-Q 250 V	GQM2195C2E300JB12D	1	MURATA MANUFACTURING CO.
C 28	36 pF	2012	Hi-Q 250 V	GQM2195C2E360JB12D	1	MURATA MANUFACTURING CO.
C 29	36 pF	2012	Hi-Q 250 V	GQM2195C2E360JB12D	1	MURATA MANUFACTURING CO.
C 30	11 pF	2012	Hi-Q 250 V	GQM2195C2E110JB12D	1	MURATA MANUFACTURING CO.
C 31	11 pF	2012	Hi-Q 250 V	GQM2195C2E110JB12D	1	MURATA MANUFACTURING CO.
C 32	9.1 pF	2012	Hi-Q 250 V	GQM2195C2E9R1CB12D	1	MURATA MANUFACTURING CO.
C 33	9.1 pF	2012	Hi-Q 250 V	GQM2195C2E9R1CB12D	1	MURATA MANUFACTURING CO.
C 34	4.3 pF	2012	Hi-Q 250 V	GQM2195C2E4R3CB12D	1	MURATA MANUFACTURING CO.
C 35	4.3 pF	2012	Hi-Q 250 V	GQM2195C2E4R3CB12D	1	MURATA MANUFACTURING CO.
C 36	330 pF	3216	200 V	GRM31M2C2D331JY21B	1	MURATA MANUFACTURING CO.
C 37	10000 pF	1608	50 V	GRM188B11H103KA01	1	MURATA MANUFACTURING CO.
C 38	1000 pF	1608	50 V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 39	1000 pF	1608	50 V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 40	1000 pF	1608	50 V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 41	22 µF	-	50 V	H1002	1	NICHICON Corporation
C 42	10000 pF	1608	50 V	GRM188B11H103KA01	1	MURATA MANUFACTURING CO.
C 43	1000 pF	1608	50 V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 44	220 µF	-	35 V	EEUFC1V221	1	Panasonic Corporation
C 45	10000 pF	1608	50 V	GRM188B11H103KA01	1	MURATA MANUFACTURING CO.
C 46	1000 pF	1608	50 V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.

* Inductor of Rolling Coil measurement condition : f=100MHz

No.	Description				P/N	Qty	Manufacturer	Remarks
	Inductance	Diameter						
		Wire Φ	Inside Φ	T/N of coils				
L 1	12 nH *	0.23 mm	1.1 mm	3	2303A	1	YC Corporation Co.,Ltd.	Enameled wire
L 2	8 nH *	0.23 mm	1.1 mm	2	2302S	1	YC Corporation Co.,Ltd.	Enameled wire
L 3	12 nH *	0.23 mm	1.1 mm	3	2303A	1	YC Corporation Co.,Ltd.	Enameled wire
L 4	37 nH *	0.40 mm	1.6 mm	7	4007C	1	YC Corporation Co.,Ltd.	Enameled wire
L 5	25 nH *	0.80 mm	2.2 mm	5	8005C	1	YC Corporation Co.,Ltd.	Enameled wire

No.	Description		P/N	Qty	Manufacturer
	Resistance	Size			
R 1	47 ohm	1608	RPC05N470J	1	TAIYOSHA ELECTRIC CO.
R 2	2.4 ohm	2012	RPC10T2R4J	1	TAIYOSHA ELECTRIC CO.
R 3	100 ohm	2012	RPC10T101J	1	TAIYOSHA ELECTRIC CO.
R 4	100 ohm	2012	RPC10T101J	1	TAIYOSHA ELECTRIC CO.
R 5	3900 ohm	1608	RPC05T392J	1	TAIYOSHA ELECTRIC CO.
R 6	2700 ohm	1608	RPC05T272J	1	TAIYOSHA ELECTRIC CO.
R 7	2700 ohm	1608	RPC05T272J	1	TAIYOSHA ELECTRIC CO.

No.	Description	P/N	Qty	Manufacturer
Pb	PCB	MS3A0208	1	Homebuilt
⋁ OPTION				
Rc	SMA female connector	PAF-S00-002	2	GIGALANE Corporation
Bc 1	Bias connector red color	TM-605R	2	MSK Corporation
Bc 2	Bias connector black color	TM-605B	1	MSK Corporation
Pe	Aluminum pedestal	-	1	Homebuilt
Pd	Thermal Silicon Compound	G746	-	Shin-Etsu Chemical Co.,Ltd
Cu 1	Copper plate 2.8 x 1.8 x 0.4t (mm)	-	1	Homebuilt
	Conducting wire	-	6	Homebuilt
	Screw M3	-	2	-
	Screw M2.6	-	10	-
	Screw M2	-	10	-

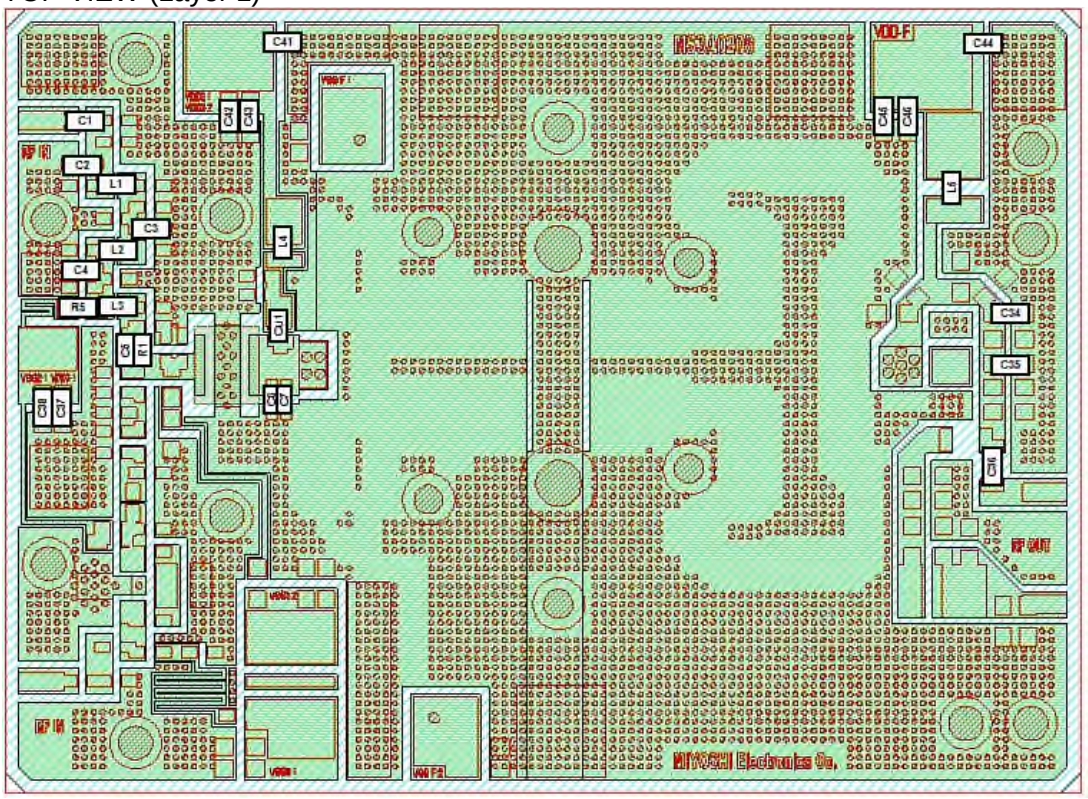
- **Standard Deliverable**

TYPE1	Evaluation Board assembled with all the component
TYPE2	PCB (raw board)

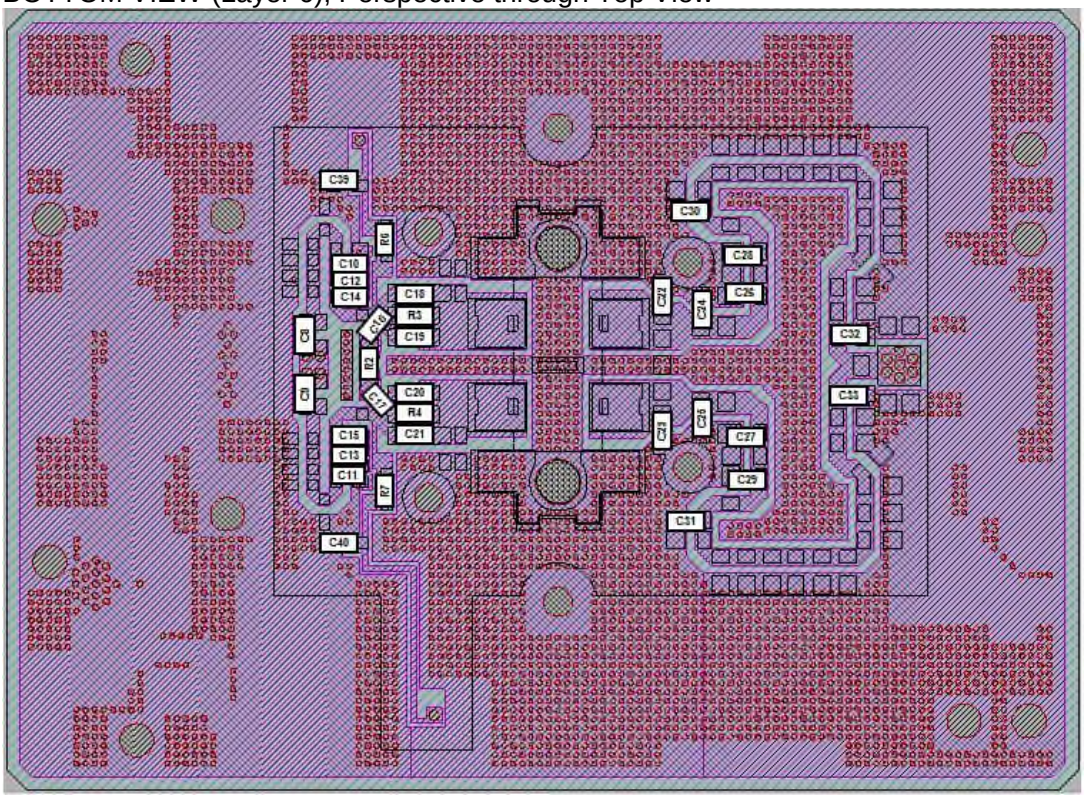
3. PCB Layout

BOARD OUTLINE: 82.5*60.0(mm)

TOP VIEW (Layer 1)

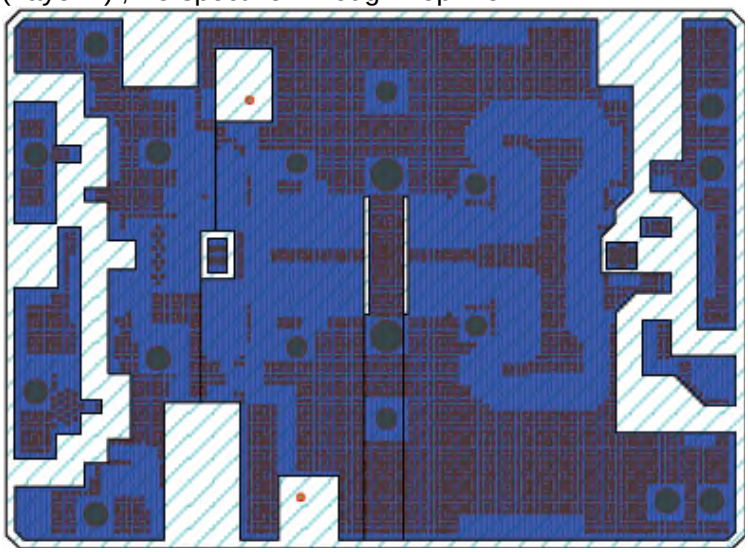


BOTTOM VIEW (Layer 6), Perspective through Top View

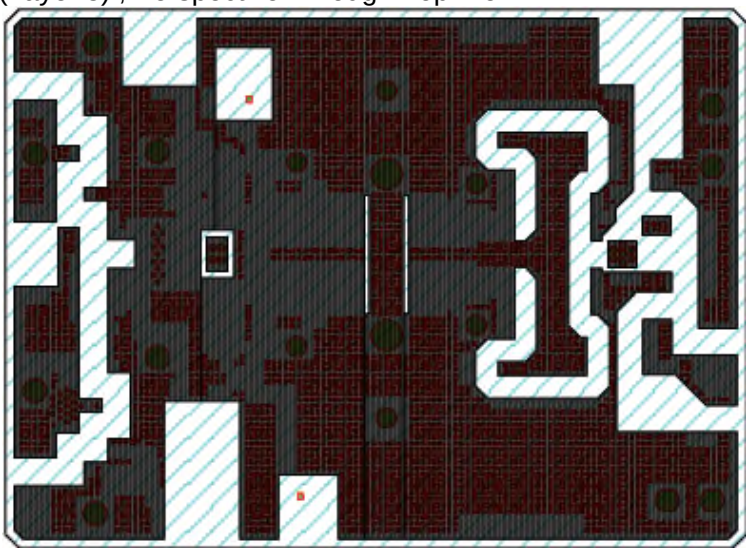


BOARD OUTLINE: 82.5*60.0(mm)

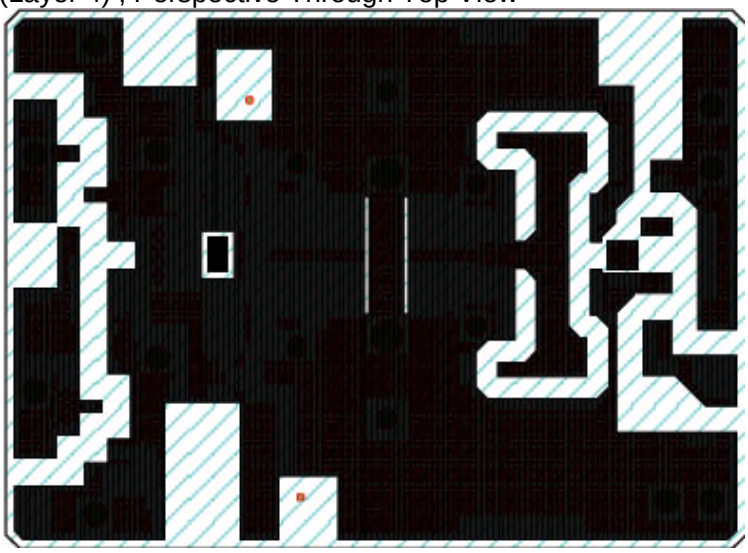
Internal Layer (Layer 2) , Perspective Through Top View



Internal Layer (Layer 3) , Perspective Through Top View

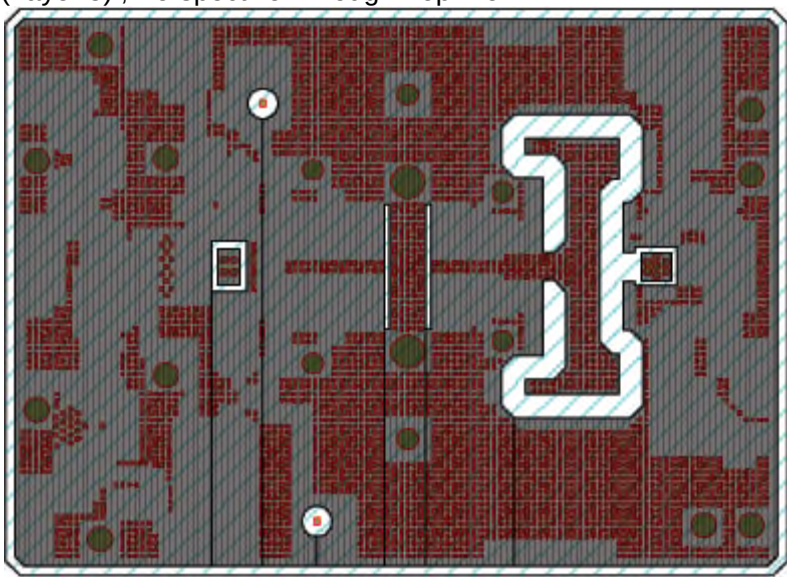


Internal Layer (Layer 4) , Perspective Through Top View



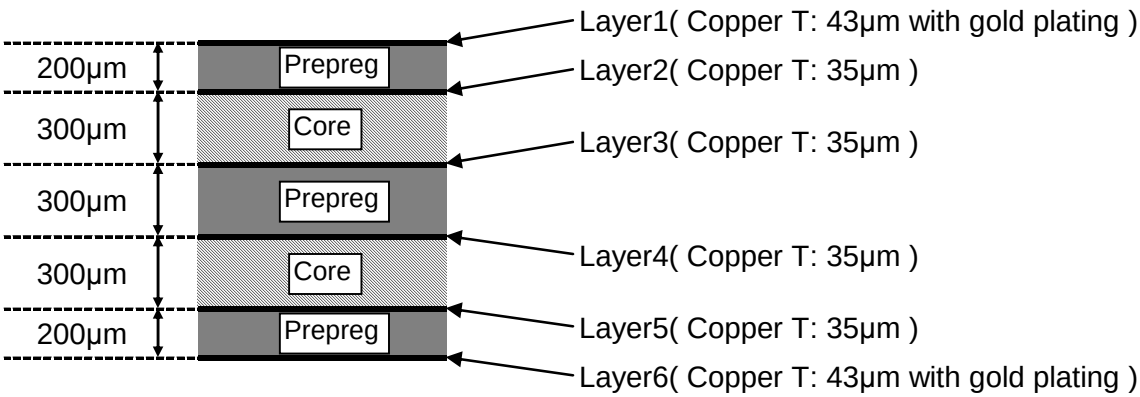
BOARD OUTLINE: 82.5*60.0(mm)

Internal Layer (Layer 5) , Perspective Through Top View



Substrate Condition

Nomial Total Completed Thickness (included resist coating) : 1.6mm

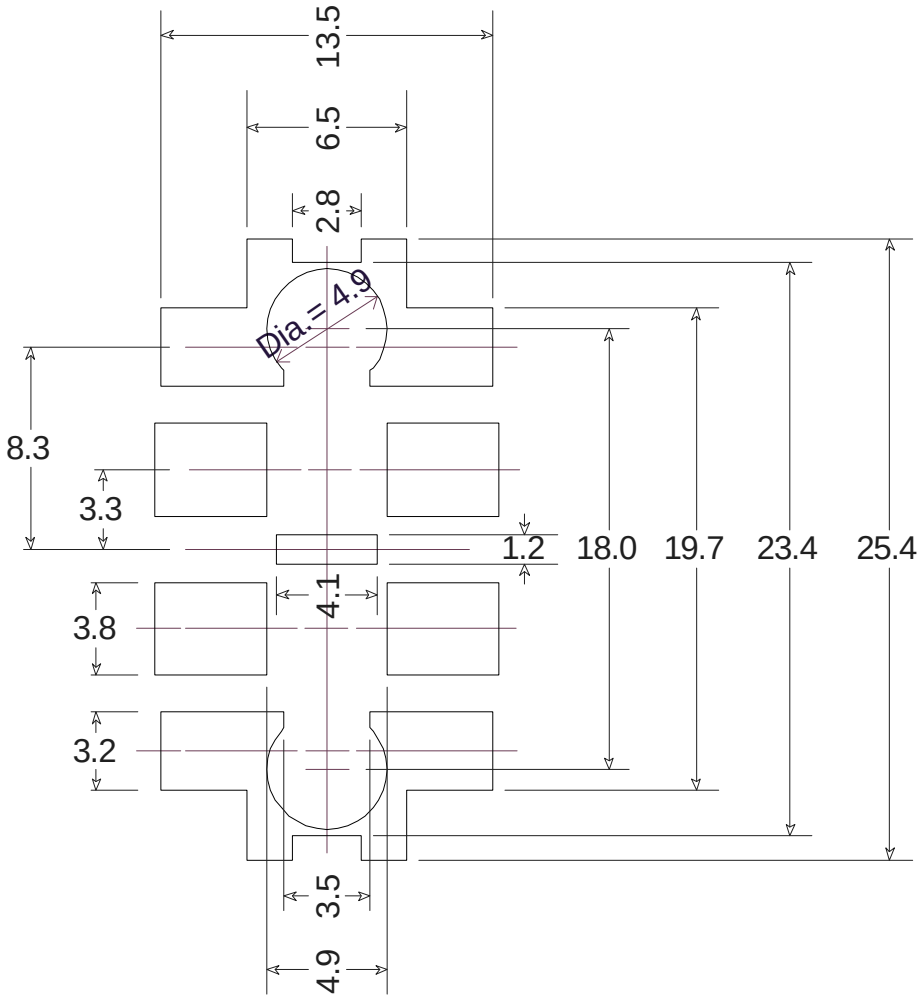


er: 4.7, TanD:0.018 @1GHz

Material: MCL-E-679G(R), Hitachi Chemical Co.

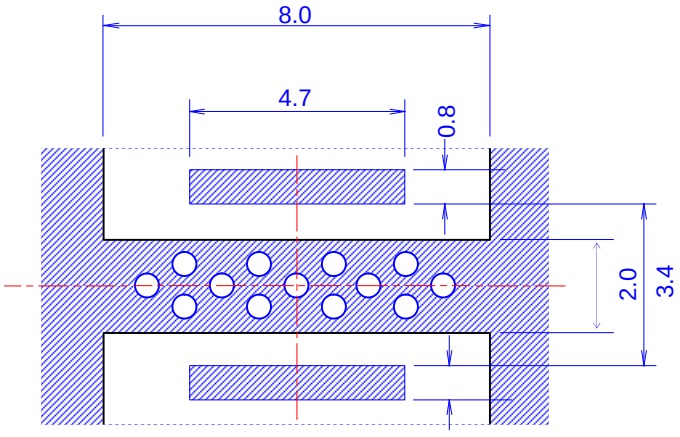
4. Standard Land Pattern Dimensions

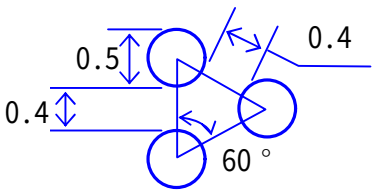
4-1. RD70HUF2



UNIT: mm

4-2. RD04HMS2





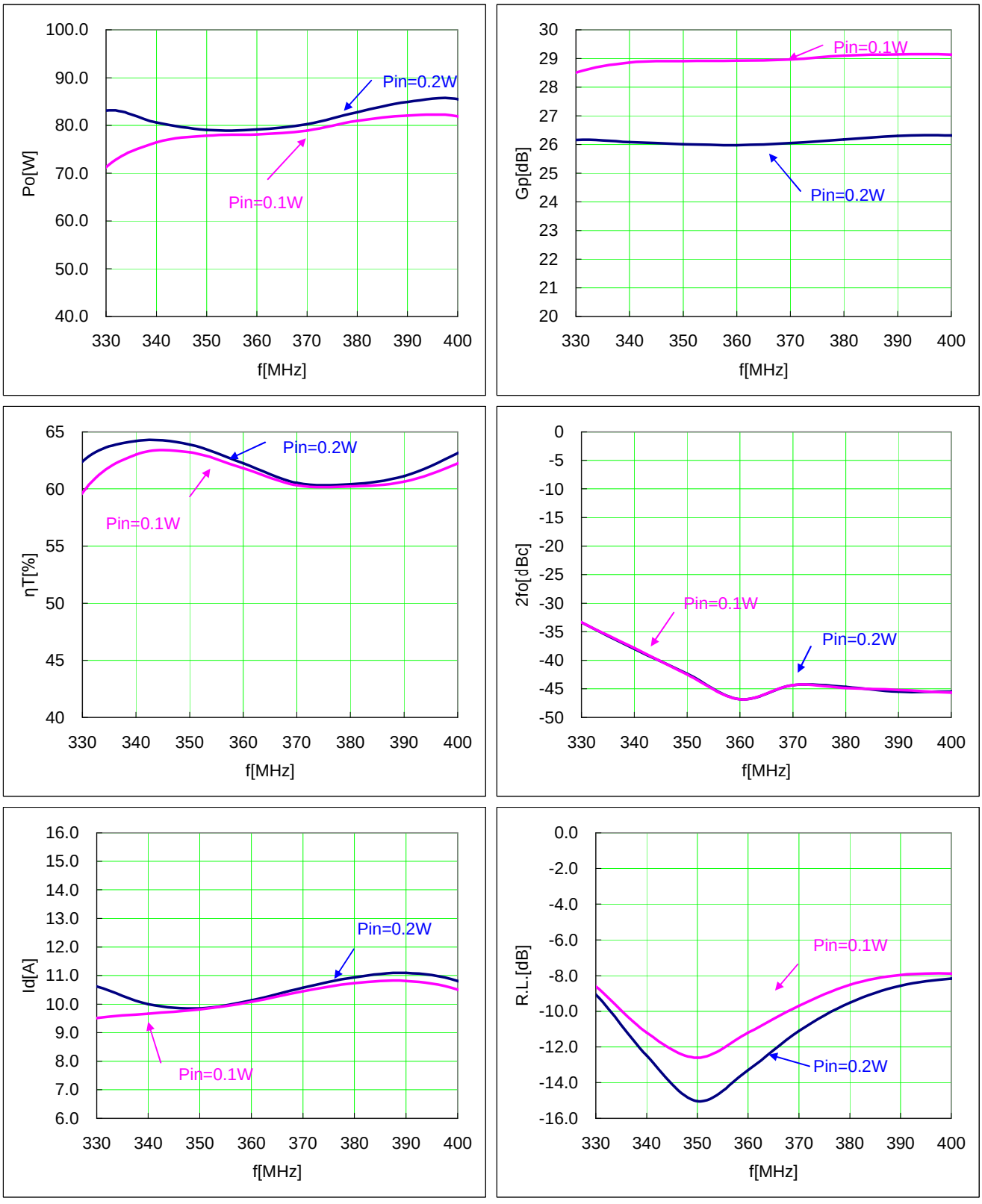
REGULAR TRIANGLE ARRANGEMENT
THROUGH HOLE

UNIT: mm

5. Typical RF Characteristics

5-1. Frequency characteristics

@ **Pin Control** (@**Pi=0.2W**, **0.1W**), Vdd=12.5V, Idq=1.1A (Vgg=2.647V)



5-1-1. Frequency characteristics data

@ **Pi=0.2W**, Vdd=12.5V, Idq=1.1A (Vgg=2.647V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)

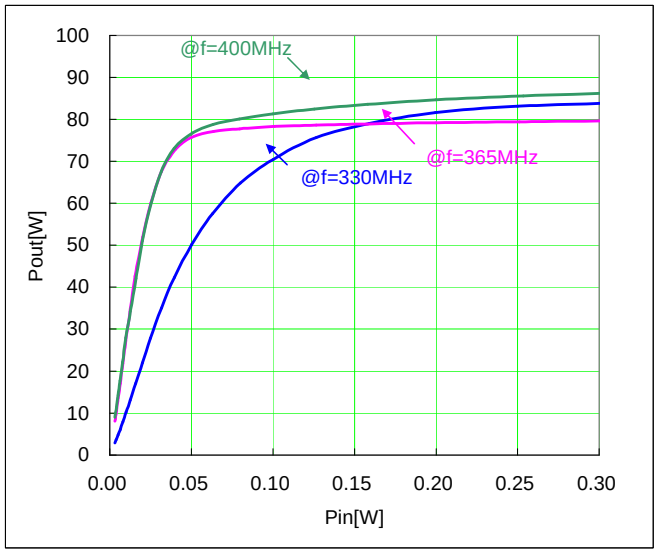
f [MHz]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	P.A.E. [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
330	49.20	83.1	26.2	10.62	62.5	62.4	-33.3	-54.2	-9.1
340	49.06	80.6	26.1	10.00	64.4	64.2	-38.0	-51.3	-12.5
350	48.98	79.1	26.0	9.85	64.0	63.9	-42.3	-53.0	-15.0
360	48.99	79.2	26.0	10.13	62.4	62.2	-46.8	-55.2	-13.3
370	49.04	80.2	26.0	10.57	60.7	60.5	-44.3	<-60	-11.1
380	49.18	82.8	26.2	10.94	60.6	60.4	-44.7	<-60	-9.5
390	49.29	84.9	26.3	11.09	61.3	61.1	-45.5	<-60	-8.6
400	49.32	85.5	26.3	10.81	63.3	63.1	-45.5	<-60	-8.2

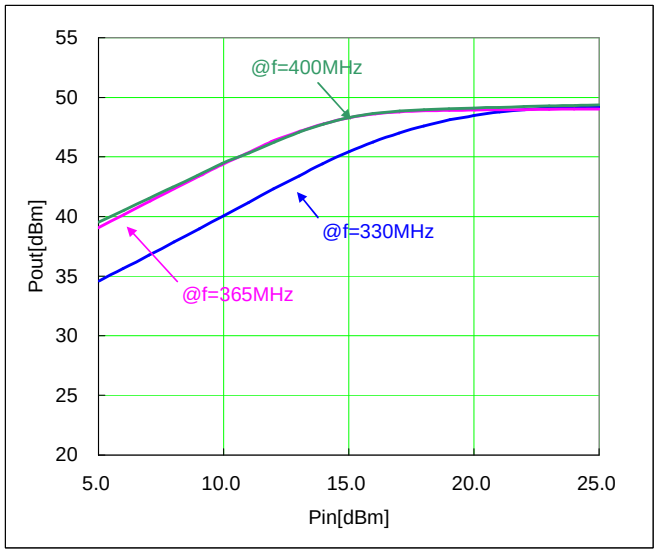
@ **Pi=0.1W**, Vdd=12.5V, Idq=1.1A (Vgg=2.647V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)

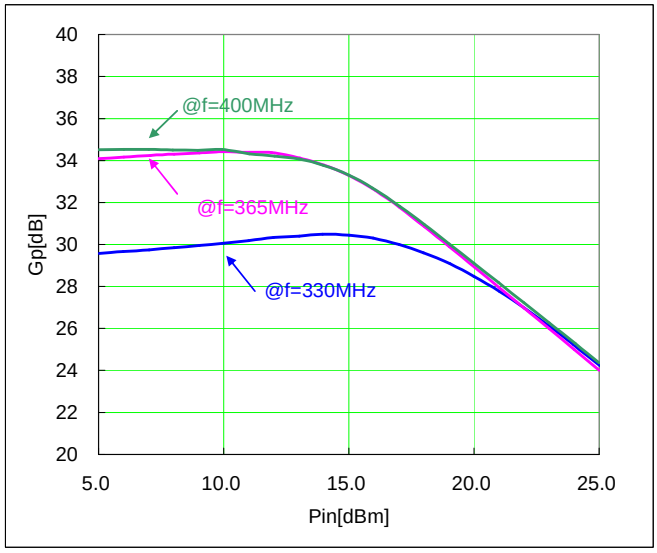
f [MHz]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	P.A.E. [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
330	48.53	71.3	28.5	9.51	59.7	59.6	-33.3	-52.3	-8.6
340	48.83	76.4	28.9	9.67	63.1	63.0	-37.8	-51.8	-11.2
350	48.91	77.9	28.9	9.82	63.3	63.2	-42.5	-51.7	-12.6
360	48.93	78.1	28.9	10.08	61.9	61.8	-46.8	<-60	-11.2
370	48.97	78.9	29.0	10.45	60.4	60.3	-44.3	-59.8	-9.7
380	49.08	81.0	29.1	10.74	60.3	60.2	-44.8	<-60	-8.5
390	49.14	82.1	29.1	10.81	60.7	60.6	-45.2	-57.5	-8.0
400	49.13	81.9	29.1	10.51	62.3	62.2	-45.7	-58.8	-7.9

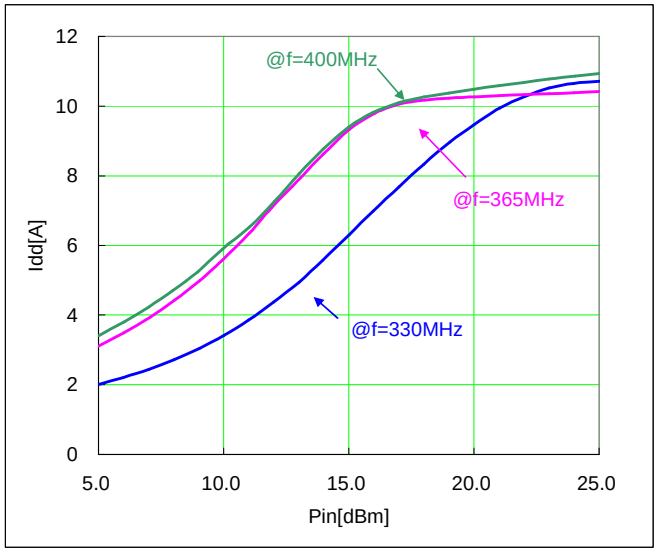
5-2. Pout vs. Pin characteristics

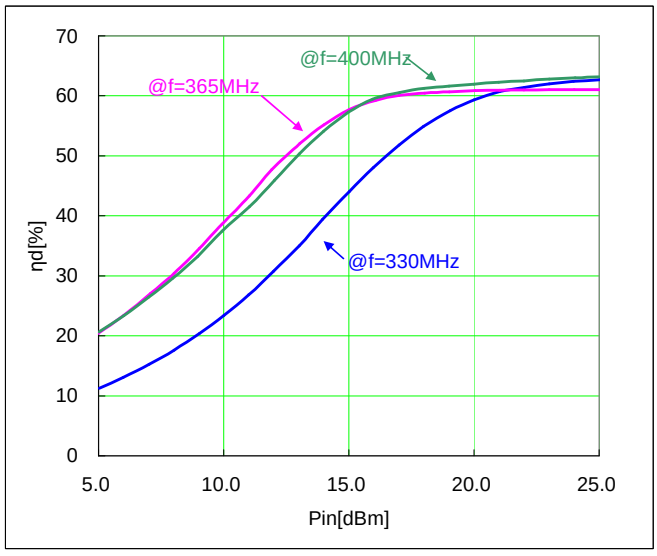
@ Vdd=12.5V, Idq=1.1A (Vgg=2.647V), **f=330MHz, 365MHz, 400MHz**











5-2-2. Pout vs. Pin characteristics data

[Conditions ; Vdd=12.5V, Idq=1.1A (Vgg=2.647V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)]

@ **f=330MHz**

Pin [dBm]	Pin [W]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
5.0	0.003	34.60	2.88	29.58	2.01	11.2	-33.3	-47.7	-8.2
6.0	0.004	35.64	3.67	29.66	2.21	13.0	-32.8	-46.8	-8.2
7.0	0.005	36.76	4.74	29.75	2.45	15.2	-32.7	-51.2	-8.2
8.0	0.006	37.86	6.11	29.85	2.72	17.6	-32.0	-44.3	-8.2
9.0	0.008	38.97	7.90	29.95	3.05	20.4	-31.7	-54.2	-8.2
10.0	0.010	40.08	10.18	30.06	3.42	23.4	-31.3	-54.2	-8.2
11.0	0.013	41.19	13.15	30.19	3.86	26.8	-31.0	-48.0	-8.3
12.0	0.016	42.33	17.10	30.34	4.38	30.8	-31.2	-57.7	-8.3
13.0	0.020	43.41	21.92	30.40	4.95	35.0	-30.8	-57.5	-8.4
13.9	0.025	44.44	27.79	30.49	5.57	39.4	-30.8	-58.8	-8.4
15.0	0.032	45.45	35.04	30.44	6.30	44.0	-31.5	-59.3	-8.4
16.0	0.039	46.27	42.33	30.30	6.99	48.0	-32.2	-58.8	-8.4
17.0	0.050	47.00	50.14	30.00	7.69	51.8	-32.5	-59.0	-8.5
18.0	0.063	47.59	57.46	29.61	8.33	54.9	-32.8	-56.2	-8.5
19.0	0.080	48.11	64.78	29.08	8.97	57.5	-33.0	-55.5	-8.6
20.0	0.100	48.48	70.42	28.48	9.46	59.3	-33.2	-54.8	-8.7
21.0	0.127	48.79	75.62	27.76	9.95	60.7	-33.5	-54.2	-8.8
22.0	0.159	48.98	79.02	26.96	10.28	61.4	-33.5	-54.2	-9.0
23.0	0.199	49.12	81.61	26.12	10.52	62.0	-33.7	-50.0	-9.2
24.0	0.250	49.20	83.11	25.22	10.65	62.4	-33.7	-53.5	-9.4
25.0	0.319	49.24	83.97	24.21	10.71	62.7	-33.5	-53.5	-9.6

@ **f=365MHz**

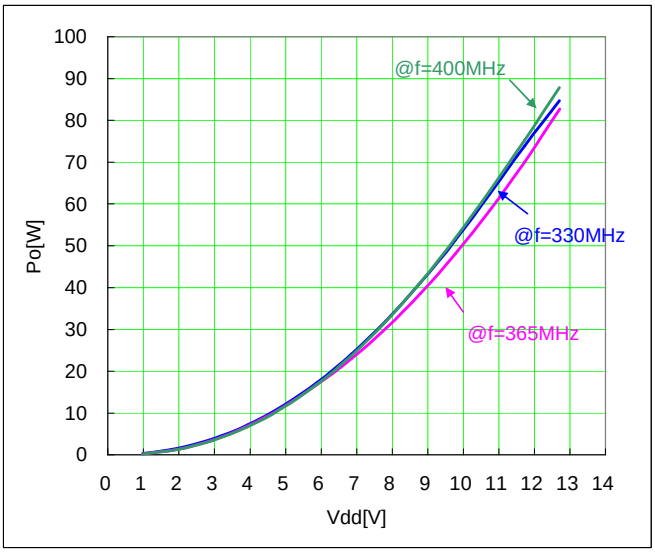
Pin [dBm]	Pin [W]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
5.0	0.003	39.06	8.05	34.09	3.11	20.4	-32.5	-44.0	-9.7
6.0	0.004	40.17	10.39	34.17	3.49	23.4	-44.0	-54.2	-9.8
7.1	0.005	41.32	13.54	34.25	3.95	27.0	-44.0	-28.8	-9.8
8.0	0.006	42.32	17.06	34.30	4.42	30.4	-43.8	-54.5	-9.8
9.0	0.008	43.39	21.83	34.36	4.98	34.6	-43.7	-58.7	-9.9
9.9	0.010	44.35	27.21	34.42	5.57	38.6	-43.5	-57.5	-9.8
11.0	0.013	45.41	34.76	34.39	6.35	43.3	-44.5	-53.7	-9.8
11.9	0.016	46.30	42.62	34.38	7.09	47.7	-35.3	-46.5	-9.7
13.0	0.020	47.16	51.95	34.11	7.93	52.0	-36.8	-45.8	-9.6
14.0	0.025	47.77	59.90	33.78	8.64	55.2	-46.2	-56.7	-9.4
15.0	0.032	48.30	67.64	33.28	9.33	57.8	-47.3	-57.2	-9.1
16.1	0.040	48.62	72.81	32.57	9.80	59.3	-48.3	-55.7	-8.8
17.0	0.050	48.79	75.74	31.78	10.06	60.1	-48.2	-55.0	-8.8
18.0	0.064	48.87	77.05	30.83	10.18	60.5	-48.3	-54.3	-9.2
19.0	0.080	48.91	77.75	29.90	10.23	60.7	-48.5	-56.8	-9.8
20.0	0.101	48.94	78.29	28.90	10.27	60.9	-46.2	-55.5	-10.4
21.0	0.126	48.95	78.59	27.93	10.30	60.9	-48.5	-56.8	-11.0
22.0	0.158	48.97	78.86	26.98	10.33	61.0	-49.0	-53.7	-11.6
23.0	0.200	48.98	79.16	25.98	10.36	61.0	-48.7	-56.8	-12.1
24.0	0.251	49.00	79.40	25.00	10.39	61.1	-48.5	-58.0	-12.6
25.0	0.316	49.01	79.64	24.01	10.42	61.1	-48.3	-59.2	-13.0

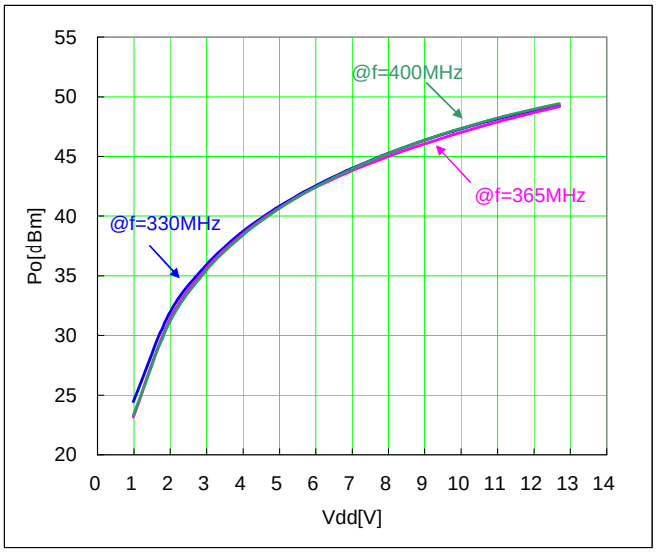
@ **f=400MHz**

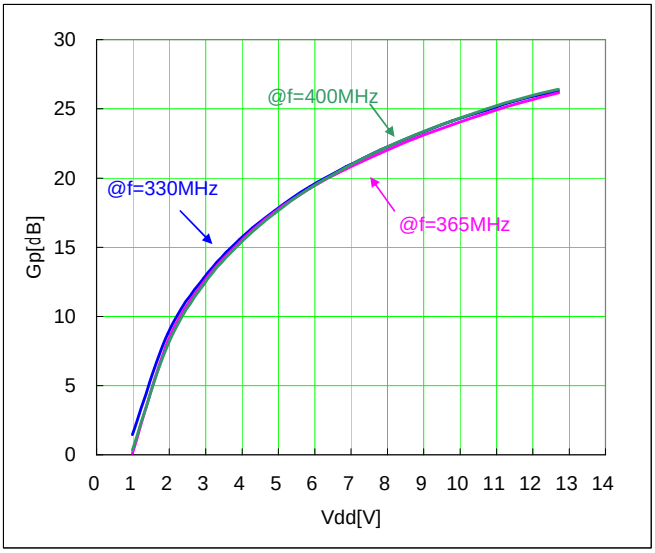
Pin [dBm]	Pin [W]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
5.0	0.003	39.52	8.96	34.51	3.41	20.7	-45.0	-54.2	-7.2
6.0	0.004	40.54	11.31	34.52	3.81	23.4	-44.7	-54.8	-7.3
7.0	0.005	41.53	14.23	34.52	4.24	26.5	-45.2	-54.8	-7.2
8.0	0.006	42.47	17.67	34.50	4.71	29.6	-44.5	-56.0	-7.3
9.0	0.008	43.44	22.07	34.48	5.24	33.3	-44.5	-56.0	-7.3
9.9	0.010	44.45	27.87	34.52	5.88	37.5	-44.7	-52.5	-7.3
11.0	0.013	45.34	34.19	34.32	6.53	41.5	-44.5	-55.0	-7.5
12.0	0.016	46.24	42.11	34.21	7.27	46.0	-45.0	-53.8	-7.6
13.0	0.020	47.08	51.05	34.07	8.06	50.3	-45.3	-53.5	-7.6
14.0	0.025	47.76	59.66	33.77	8.78	54.1	-45.7	-55.5	-7.6
15.0	0.032	48.30	67.54	33.31	9.40	57.3	-45.7	-56.2	-7.6
16.0	0.039	48.64	73.09	32.69	9.81	59.4	-45.5	-54.5	-7.5
17.0	0.050	48.85	76.69	31.82	10.11	60.6	-45.7	-55.0	-7.5
18.0	0.063	48.96	78.72	30.95	10.26	61.3	-45.8	-55.0	-7.6
19.0	0.079	49.03	80.06	30.04	10.38	61.6	-45.8	-58.3	-7.7
20.0	0.100	49.10	81.33	29.10	10.49	62.0	-45.2	-55.8	-7.9
21.0	0.125	49.16	82.46	28.18	10.59	62.3	-45.5	-58.2	-8.0
22.0	0.158	49.22	83.53	27.23	10.68	62.5	-45.5	-54.2	-8.1
23.0	0.200	49.28	84.63	26.27	10.78	62.8	-45.2	-54.5	-8.1
24.0	0.253	49.32	85.59	25.29	10.87	63.0	-45.3	-54.0	-8.2
25.0	0.316	49.36	86.35	24.37	10.94	63.2	-45.5	-56.2	-8.3

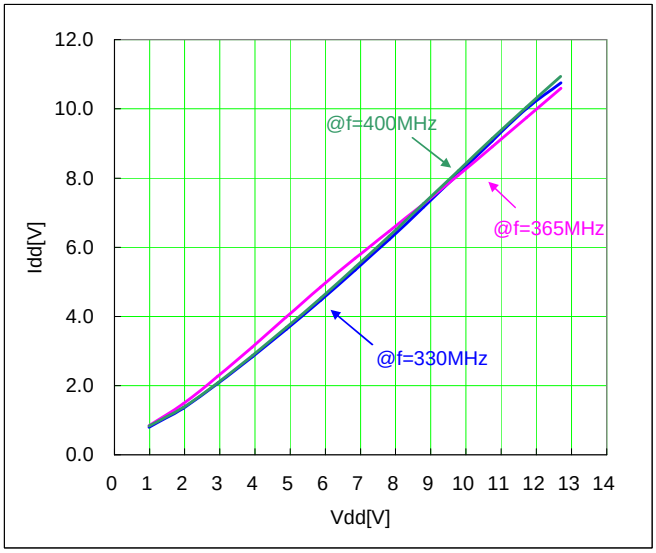
5-3. Pout vs. Vdd characteristics

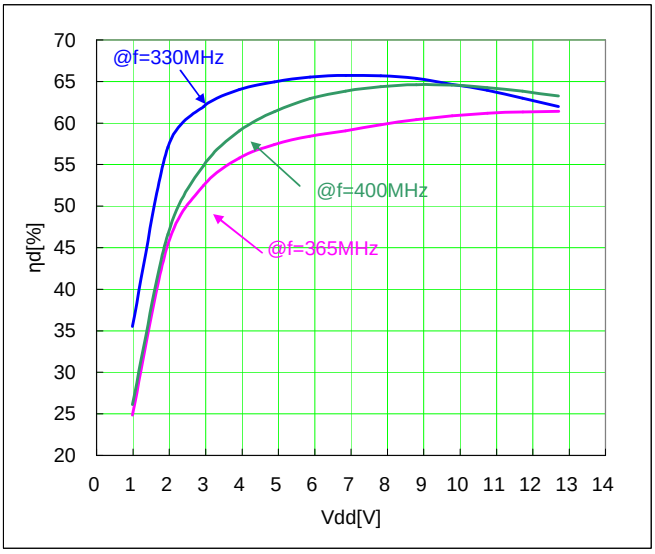
@ Pi=0.2W (=23dBm), Idq=1.1A(Vgg=2.647V), **f=330MHz, 365MHz, 400MHz**











5-3-1. Pout vs. Vdd characteristics data

[Conditions ; Pi=0.2W (=23dBm), Idq=1.1A (Vgg=2.647V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)]

@ **f=330MHz**

Vdd [V]	Idq [A]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
1.0	0.777	24.5	0.3	1.5	0.80	35.5	-38.7	-39.5	-10.2
2.0	0.968	31.8	1.5	8.8	1.35	57.1	-40.7	-46.8	-10.4
2.9	0.879	35.8	3.8	12.8	2.06	62.0	-38.3	-50.7	-10.5
3.9	0.905	38.5	7.1	15.6	2.84	64.0	-37.7	-52.3	-10.5
4.9	0.930	40.6	11.5	17.6	3.63	64.9	-55.8	-56.2	-10.4
5.9	0.957	42.4	17.2	19.4	4.48	65.5	-36.0	-56.7	-10.3
6.9	0.987	43.8	24.1	20.8	5.35	65.7	-35.7	-55.0	-10.1
7.8	1.016	45.1	32.0	22.0	6.24	65.7	-35.3	<-60	-9.9
8.8	1.048	46.1	41.2	23.1	7.16	65.4	-34.8	-56.5	-9.6
9.8	1.083	47.1	51.4	24.1	8.12	64.7	-34.5	-54.8	-9.4
10.7	1.121	47.9	62.3	24.9	9.07	63.9	-34.2	-54.3	-9.2
11.7	1.163	48.7	73.8	25.7	10.00	63.0	-33.8	-54.3	-9.0
12.7	1.209	49.3	84.7	26.3	10.75	62.0	-33.3	-53.3	-9.1

@ **f=365MHz**

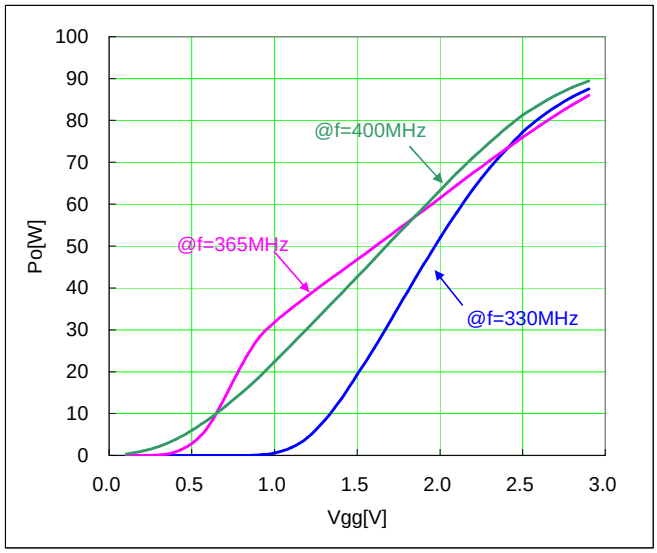
Vdd [V]	Idq [A]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
1.0	0.765	23.2	0.2	0.1	0.85	24.9	-43.7	-43.8	-16.0
2.0	0.957	31.2	1.3	8.2	1.47	45.3	-50.3	-51.2	-15.1
2.9	0.864	35.4	3.5	12.5	2.27	52.5	-53.5	-56.0	-14.2
3.9	0.891	38.3	6.8	15.3	3.12	55.8	-54.8	-57.0	-13.5
4.9	0.917	40.5	11.2	17.5	3.98	57.4	-56.7	-59.2	-13.0
5.9	0.945	42.2	16.6	19.2	4.86	58.4	-56.8	<-60	-12.7
6.8	0.975	43.6	23.0	20.6	5.68	59.1	-54.8	<-60	-12.9
7.8	1.006	44.8	30.2	21.8	6.46	59.8	-53.7	-59.7	-12.9
8.8	1.040	45.9	38.6	22.9	7.26	60.4	-53.7	<-60	-12.8
9.8	1.075	46.8	48.1	23.9	8.08	60.9	-53.7	<-60	-12.7
10.7	1.113	47.7	58.5	24.7	8.90	61.2	-52.0	<-60	-12.5
11.7	1.154	48.5	70.1	25.5	9.74	61.3	-52.2	<-60	-12.3
12.7	1.199	49.2	82.7	26.2	10.59	61.4	-51.5	<-60	-12.2

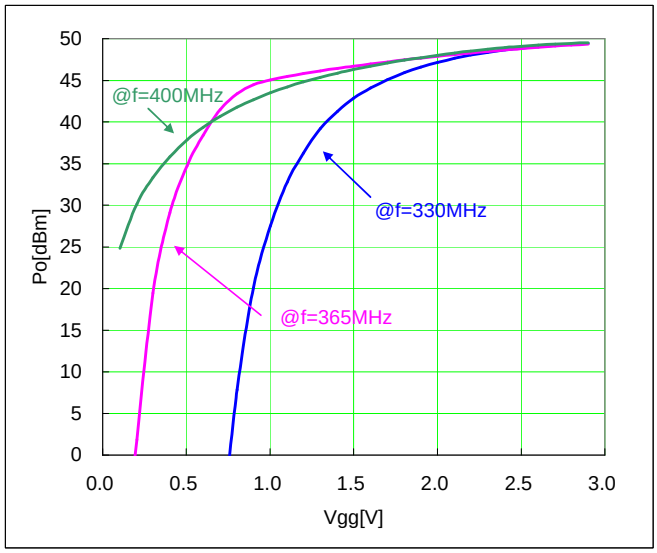
@ **f=400MHz**

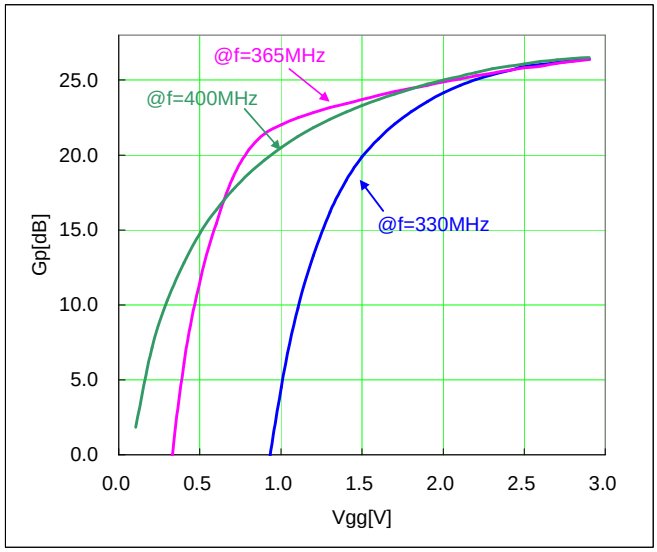
Vdd [V]	Idq [A]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
1.0	0.757	23.3	0.2	0.4	0.84	26.1	-44.0	-44.0	-9.8
2.0	0.949	31.0	1.3	8.0	1.38	46.6	-52.0	-52.2	-9.7
2.9	0.856	35.3	3.4	12.3	2.09	54.9	-52.2	-54.5	-9.5
3.9	0.884	38.2	6.7	15.2	2.87	59.0	-51.0	-53.8	-9.3
4.9	0.910	40.4	11.1	17.4	3.68	61.4	-51.3	-54.7	-9.1
5.9	0.938	42.2	16.8	19.3	4.54	62.9	-50.5	-54.8	-8.9
6.9	0.968	43.8	23.7	20.8	5.43	63.8	-49.2	-54.0	-8.6
7.8	0.998	45.0	31.8	22.0	6.33	64.4	-48.7	-55.8	-8.4
8.8	1.030	46.2	41.3	23.2	7.27	64.6	-48.5	-55.5	-8.2
9.8	1.065	47.1	51.8	24.1	8.21	64.6	-47.8	-54.3	-8.1
10.7	1.103	48.0	63.1	25.0	9.14	64.3	-47.5	-55.8	-8.0
11.7	1.144	48.8	75.2	25.8	10.05	63.8	-47.7	<-60	-8.1
12.7	1.189	49.4	87.8	26.4	10.94	63.3	-46.8	<-60	-8.1

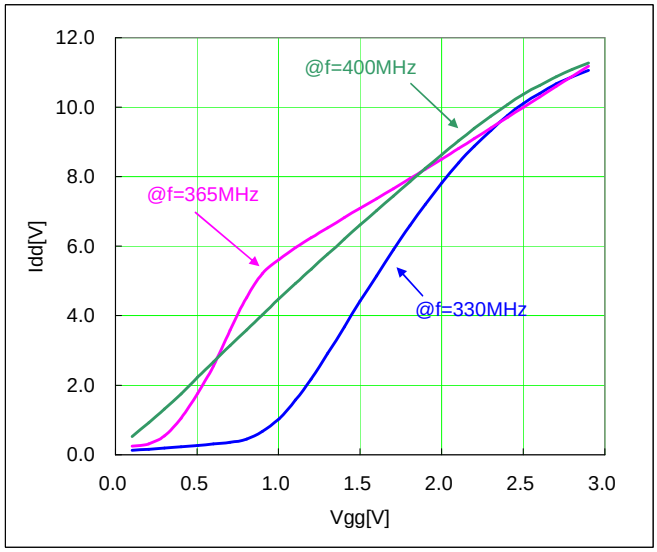
5-4. Pout vs. Vgg characteristics

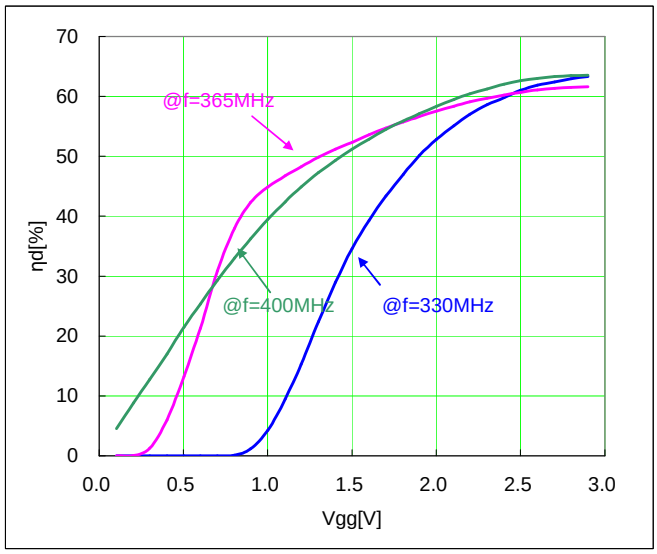
@ Vdd=12.5V, Pi=0.2W (=23dBm), **f=330MHz**, **365MHz**, **400MHz**

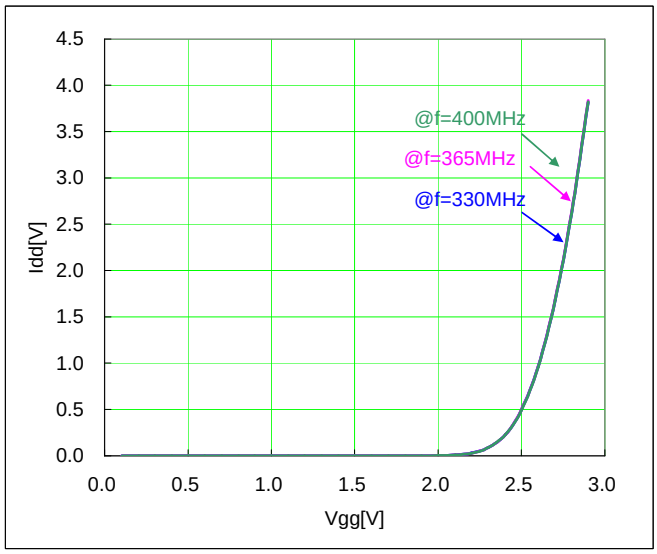












5-4-1. Pout vs. Vgg characteristics data

[Conditions ; Pi=0.2W (=23dBm), Vdd=12.5V]

@ **f=330MHz**

Vgg [V]	Idq [A]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
0.10	0.001	-24.72	0.00	-47.72	0.13	0.0	0.5	0.3	-7.8
0.20	0.001	-21.70	0.00	-44.70	0.16	0.0	-2.7	-2.8	-7.7
0.30	0.001	-20.34	0.00	-43.35	0.20	0.0	0.0	-0.7	-7.7
0.40	0.001	-18.29	0.00	-41.30	0.23	0.0	-1.0	-2.5	-7.7
0.50	0.000	-16.47	0.00	-39.46	0.27	0.0	-3.2	-4.8	-7.7
0.60	0.001	-14.96	0.00	-37.98	0.31	0.0	-6.8	-6.8	-7.7
0.70	0.000	-9.18	0.00	-32.18	0.36	0.0	-8.2	-9.3	-7.7
0.80	0.001	7.82	0.01	-15.18	0.45	0.1	-24.7	-26.2	-7.7
0.90	0.001	20.04	0.10	-2.97	0.67	1.2	-26.3	-39.0	-7.7
1.00	0.000	27.50	0.56	4.51	1.04	4.3	-27.2	-47.0	-7.7
1.10	0.001	32.78	1.90	9.79	1.57	9.4	-27.2	-45.3	-7.7
1.20	0.001	36.27	4.24	13.29	2.17	15.3	-27.7	-55.0	-7.8
1.30	0.000	39.20	8.32	16.20	2.92	22.4	-28.3	-55.0	-7.8
1.40	0.001	41.31	13.51	18.33	3.67	28.9	-29.2	-59.7	-7.9
1.50	0.001	42.87	19.36	19.87	4.41	34.6	-29.7	-53.5	-8.0
1.60	0.001	44.09	25.62	21.09	5.15	39.3	-30.7	<-60	-8.0
1.70	0.001	45.09	32.30	22.08	5.89	43.4	-31.3	-55.0	-8.1
1.80	0.001	45.92	39.08	22.90	6.59	47.0	-32.2	<-60	-8.2
1.90	0.001	46.58	45.54	23.57	7.20	50.1	-33.0	-58.8	-8.2
2.00	0.003	47.16	52.05	24.15	7.83	52.8	-33.7	<-60	-8.3
2.10	0.009	47.64	58.14	24.64	8.39	55.1	-34.5	-51.3	-8.4
2.20	0.030	48.04	63.61	25.03	8.88	57.0	-35.2	-58.8	-8.5
2.30	0.088	48.37	68.65	25.36	9.33	58.6	-35.3	-56.7	-8.7
2.40	0.227	48.65	73.20	25.63	9.76	59.8	-35.7	-55.5	-8.8
2.50	0.494	48.88	77.22	25.90	10.10	61.0	-36.0	-56.3	-8.9
2.60	0.967	49.06	80.52	26.04	10.40	61.9	-36.3	-57.2	-9.1
2.70	1.684	49.21	83.34	26.17	10.67	62.4	-36.5	-55.7	-9.3
2.80	2.612	49.32	85.58	26.32	10.87	63.0	-36.2	-56.7	-9.4
2.90	3.814	49.42	87.56	26.41	11.06	63.3	-36.5	-57.7	-9.6

@ **f=365MHz**

Vgg [V]	Idq [A]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
0.10	0.000	-16.79	0.00	-39.78	0.25	0.0	-4.2	-5.3	-13.0
0.20	0.001	1.82	0.00	-21.17	0.31	0.0	-21.0	-22.0	-12.7
0.30	0.000	19.42	0.09	-3.56	0.55	1.3	-35.7	-39.3	-12.5
0.40	0.000	29.08	0.81	6.10	1.05	6.0	-37.0	-47.3	-12.3
0.50	0.001	34.75	2.99	11.78	1.77	13.3	-38.3	-54.7	-12.2
0.60	0.000	38.39	6.90	15.42	2.55	21.3	-39.2	-57.2	-12.0
0.70	0.001	41.48	14.05	18.46	3.58	30.8	-40.0	-59.7	-11.8
0.80	0.001	43.39	21.81	20.37	4.53	38.0	-40.9	<-60	-11.6
0.90	0.001	44.45	27.88	21.43	5.21	42.3	-41.2	<-60	-11.2
1.00	0.000	45.04	31.89	22.02	5.61	44.9	-41.7	<-60	-11.2
1.10	0.001	45.46	35.17	22.48	5.95	46.7	-42.3	<-60	-11.2
1.20	0.001	45.81	38.08	22.83	6.24	48.3	-42.8	<-60	-11.2
1.30	0.001	46.14	41.11	23.16	6.53	49.9	-43.2	<-60	-11.3
1.40	0.001	46.44	44.05	23.43	6.82	51.2	-43.6	<-60	-11.5
1.50	0.001	46.70	46.80	23.70	7.09	52.3	-44.3	<-60	-11.6
1.60	0.001	46.97	49.75	23.98	7.37	53.6	-45.0	<-60	-11.7
1.70	0.000	47.22	52.70	24.24	7.65	54.7	-45.3	<-60	-11.8
1.80	0.001	47.46	55.67	24.46	7.94	55.7	-46.0	<-60	-11.9
1.90	0.001	47.67	58.52	24.66	8.22	56.6	-46.7	<-60	-12.0
2.00	0.003	47.89	61.55	24.88	8.51	57.5	-47.3	<-60	-12.1
2.10	0.009	48.10	64.61	25.09	8.81	58.4	-47.8	<-60	-12.2
2.20	0.029	48.29	67.46	25.28	9.10	59.1	-48.3	<-60	-12.2
2.30	0.089	48.48	70.39	25.47	9.40	59.7	-49.5	<-60	-12.2
2.40	0.227	48.65	73.28	25.64	9.70	60.2	-50.0	<-60	-12.2
2.50	0.497	48.81	75.97	25.81	9.99	60.7	-50.8	<-60	-12.2
2.60	0.965	48.96	78.75	25.94	10.30	61.1	-51.5	<-60	-12.2
2.70	1.693	49.10	81.34	26.12	10.60	61.3	-52.1	<-60	-12.2
2.80	2.625	49.23	83.71	26.25	10.88	61.5	-52.2	<-60	-12.2
2.90	3.834	49.35	86.03	26.39	11.18	61.6	-53.0	<-60	-12.1

@ **f=400MHz**

Vgg [V]	Idq [A]	Po [dBm]	Po [W]	Gp [dB]	Idd [A]	ηd [%]	2fo [dBc]	3fo [dBc]	R.L. [dB]
0.10	0.001	24.82	0.30	1.83	0.52	4.5	-37.8	-44.7	-9.2
0.20	0.001	30.13	1.03	7.14	0.92	8.8	-38.7	-49.8	-9.2
0.30	0.001	33.31	2.14	10.33	1.31	12.8	-38.8	-53.8	-9.2
0.40	0.001	35.79	3.80	12.82	1.75	17.0	-39.5	-54.8	-9.2
0.50	0.001	37.87	6.12	14.86	2.23	21.5	-39.8	-54.0	-9.3
0.60	0.000	39.35	8.60	16.34	2.67	25.3	-40.0	-54.5	-9.3
0.70	0.001	40.68	11.69	17.67	3.14	29.3	-40.3	-56.7	-9.3
0.80	0.001	41.78	15.07	18.78	3.60	33.0	-40.5	-51.8	-9.3
0.90	0.000	42.67	18.51	19.68	4.02	36.2	-40.7	-56.5	-9.3
1.00	0.000	43.51	22.46	20.50	4.48	39.5	-41.0	-56.3	-9.3
1.10	0.001	44.23	26.46	21.22	4.92	42.4	-41.3	-54.0	-9.3
1.20	0.001	44.82	30.36	21.82	5.34	44.9	-41.5	-56.8	-9.3
1.30	0.001	45.38	34.52	22.38	5.78	47.3	-41.8	-58.3	-9.3
1.40	0.000	45.87	38.66	22.88	6.20	49.3	-42.3	-59.8	-9.3
1.50	0.000	46.30	42.68	23.30	6.61	51.2	-42.7	-58.0	-9.2
1.60	0.000	46.71	46.83	23.71	7.02	52.9	-43.2	-56.2	-9.1
1.70	0.000	47.08	51.10	24.07	7.44	54.5	-43.7	-58.0	-9.0
1.80	0.000	47.42	55.26	24.42	7.85	55.9	-44.0	-54.8	-8.9
1.90	0.001	47.72	59.17	24.72	8.24	57.1	-44.7	-57.7	-8.9
2.00	0.003	48.02	63.37	25.01	8.64	58.4	-45.2	-55.3	-8.7
2.10	0.009	48.29	67.48	25.26	9.03	59.5	-45.3	-55.3	-8.6
2.20	0.029	48.52	71.16	25.51	9.39	60.4	-46.0	-55.0	-8.5
2.30	0.089	48.74	74.76	25.75	9.74	61.3	-46.5	-56.5	-8.4
2.40	0.228	48.94	78.27	25.93	10.07	62.1	-47.0	-58.0	-8.3
2.50	0.490	49.10	81.26	26.06	10.37	62.6	-46.5	-59.5	-8.2
2.60	0.961	49.23	83.77	26.25	10.63	63.0	-47.2	<-60	-8.2
2.70	1.684	49.35	86.08	26.35	10.88	63.3	-47.3	<-60	-8.1
2.80	2.612	49.44	87.87	26.44	11.08	63.5	-47.3	-59.5	-8.0
2.90	3.822	49.52	89.45	26.51	11.27	63.5	-47.2	<-60	-7.9