APPLICATION NOTE

MITSUBISHI ELECTRIC
Silicon RF Power Semiconductors

Document NO. AN-VHF-049
Date : 27th May 2011
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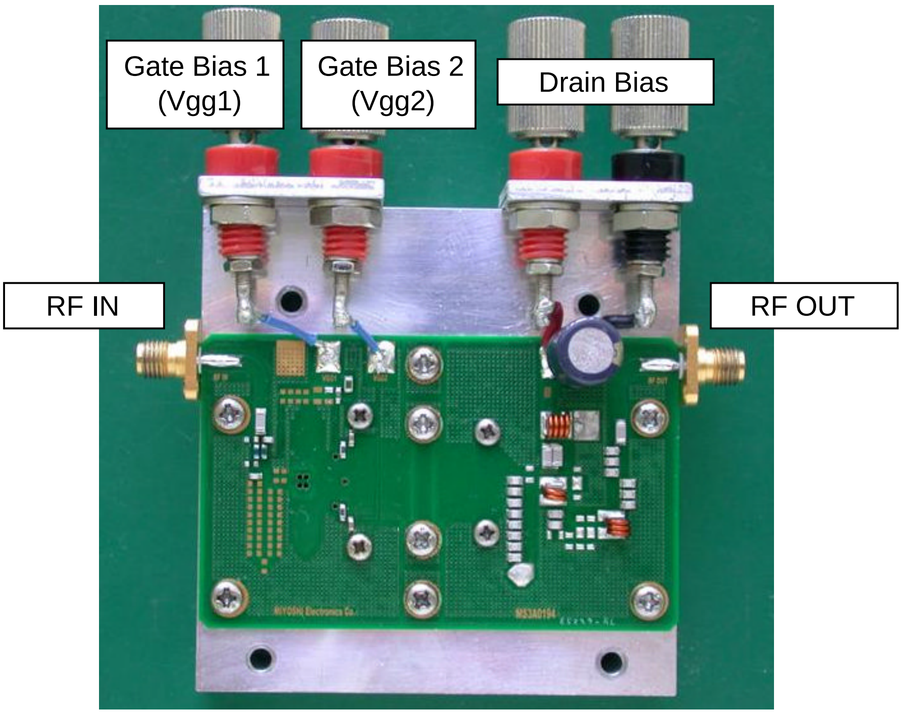
(Taking charge of Silicon RF by
MIYOSHI Electronics)

SUBJECT: RD70HUF2 single-stage amplifier with f=135-175MHz evaluation board

Features:

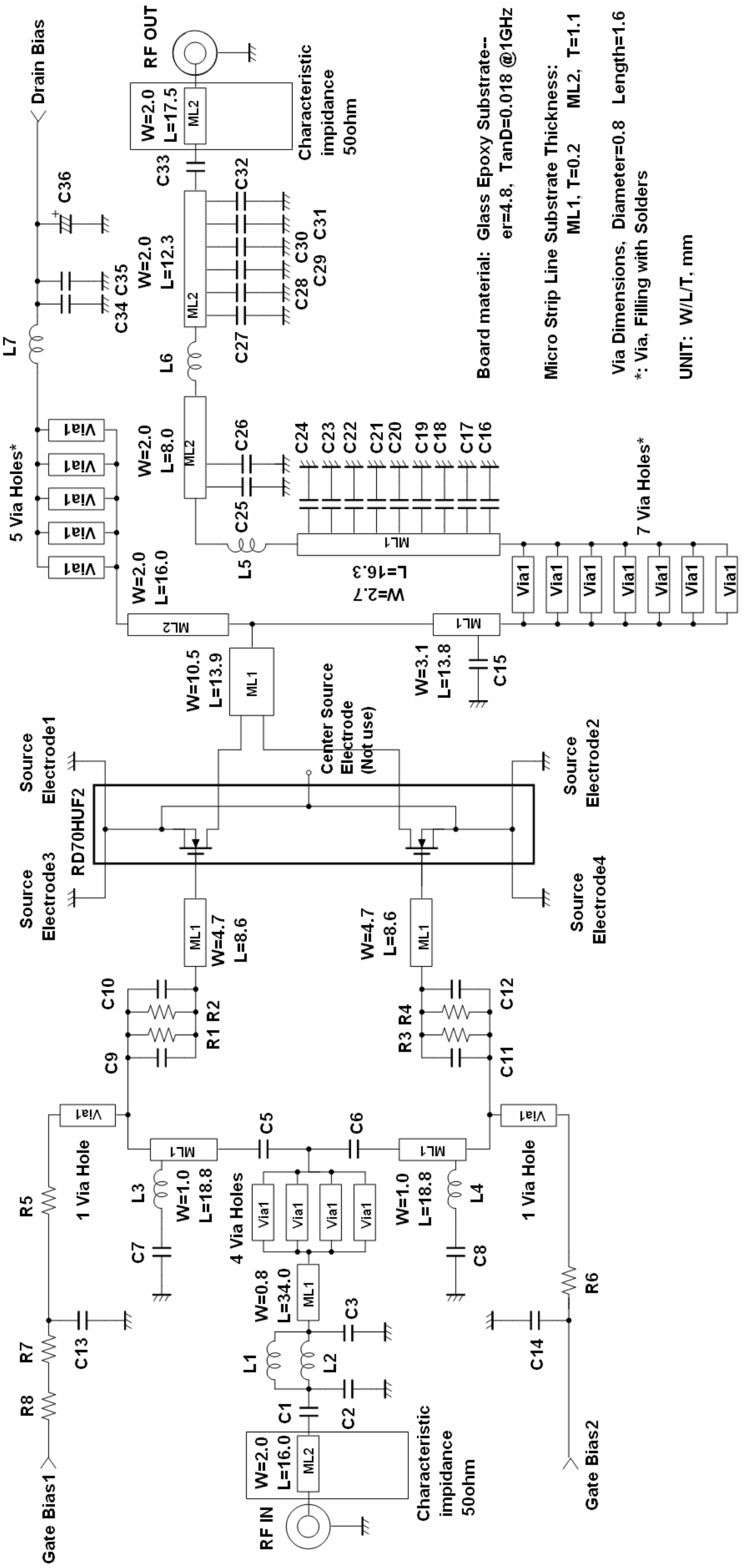
- The evaluation board for RD70HUF2
- Frequency: 135-175MHz
- Typical input power: 4W
- Typical output power: 80W
- Quiescent current: Total is 1000mA, 500mA per one FET chip
- Operating current: approx. 10A
- Surface-mounted RF power amplifier structure



PCB L=75mm W=46mm

Contents

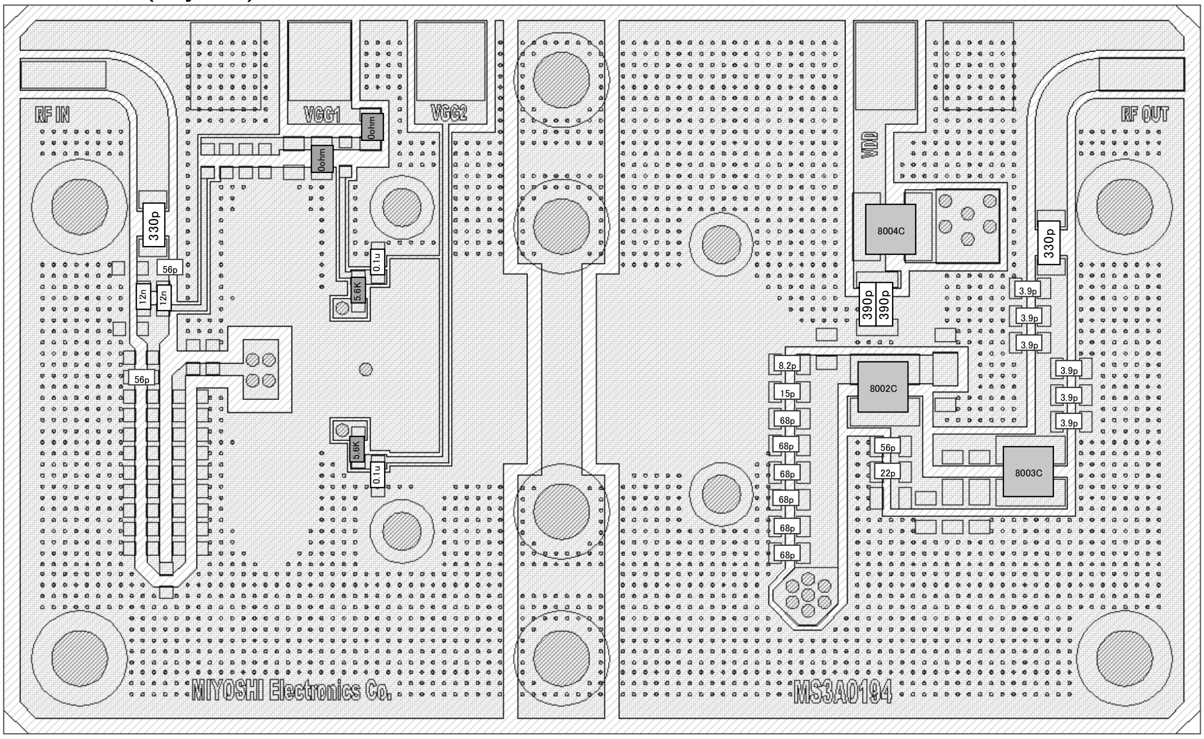
1. Equivalent Circuitry



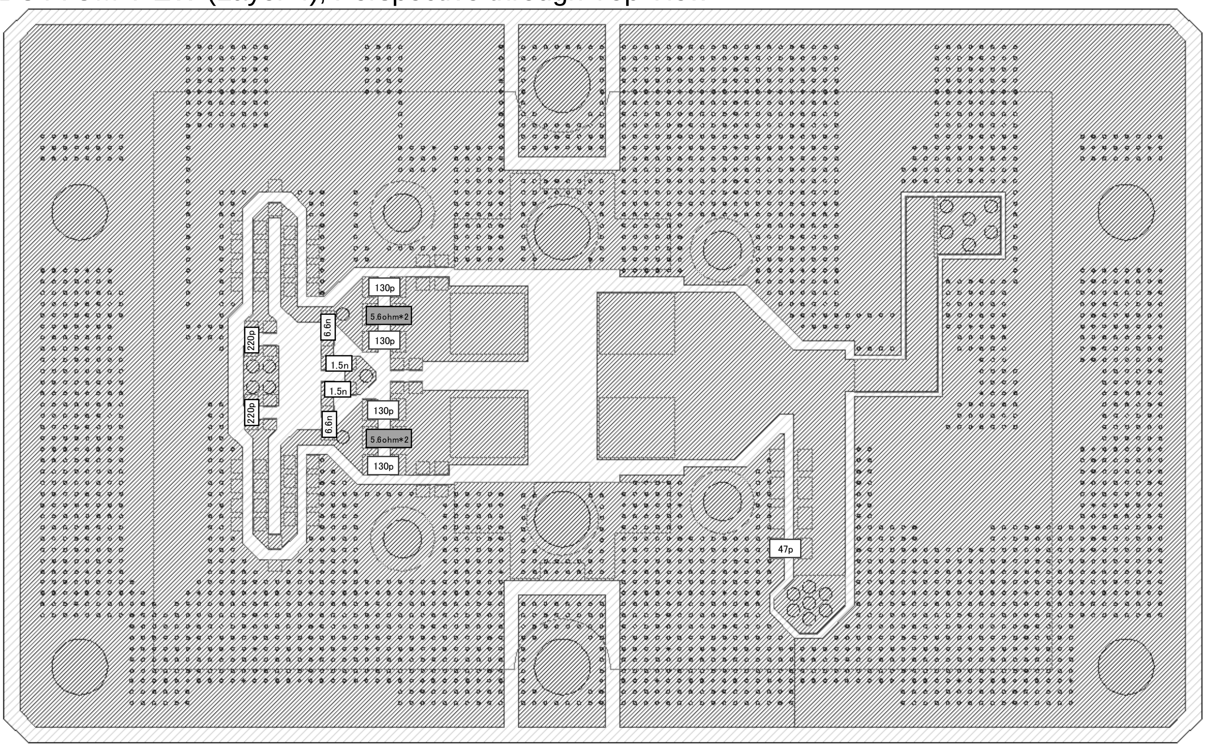
2. PCB Layout

BOARD OUTLINE: 75.0*46.0(mm)

TOP VIEW (Layer 1)

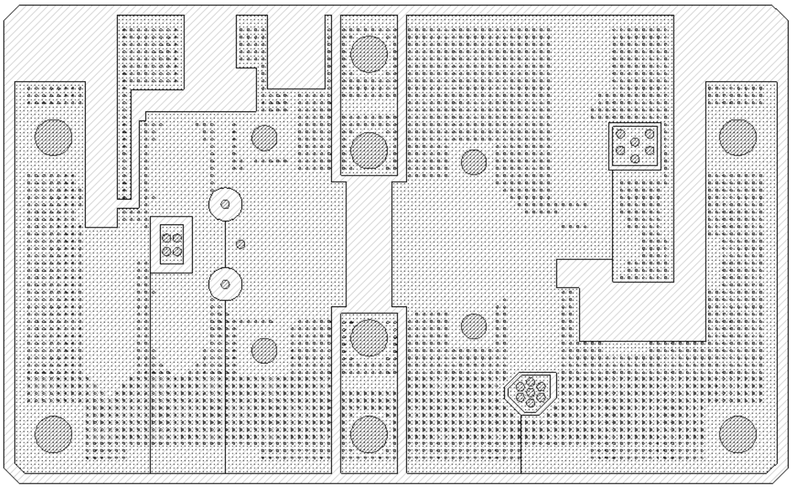


BOTTOM VIEW (Layer 4), Perspective through Top View

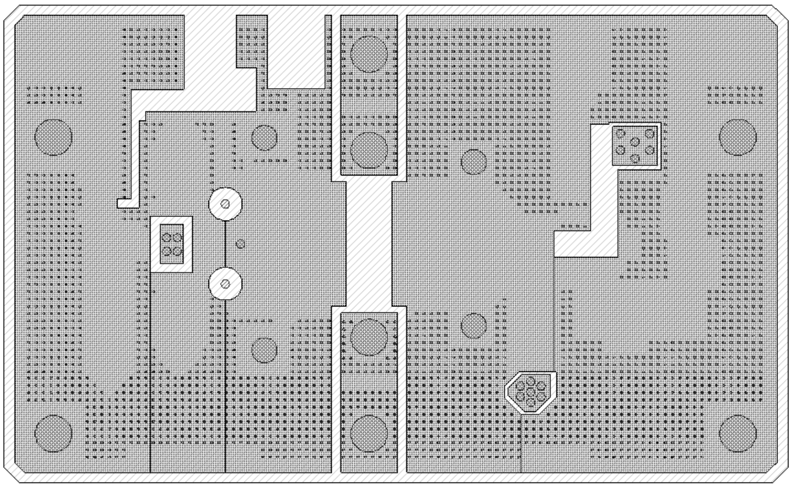


BOARD OUTLINE: 75.0*46.0(mm)

Internal Layer (Layer 2) , Perspective Through Top View

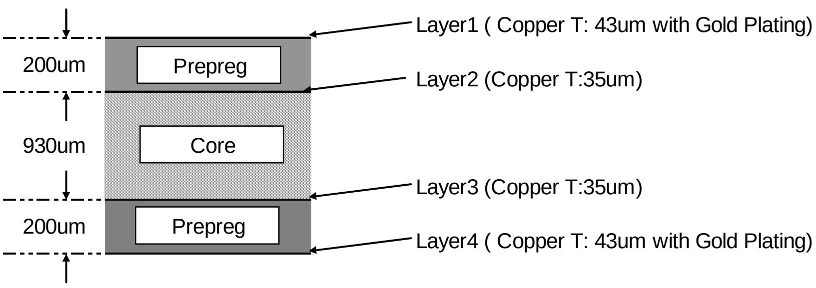


Internal Layer (Layer 3) , Perspective Through Top View



Substrate Condition

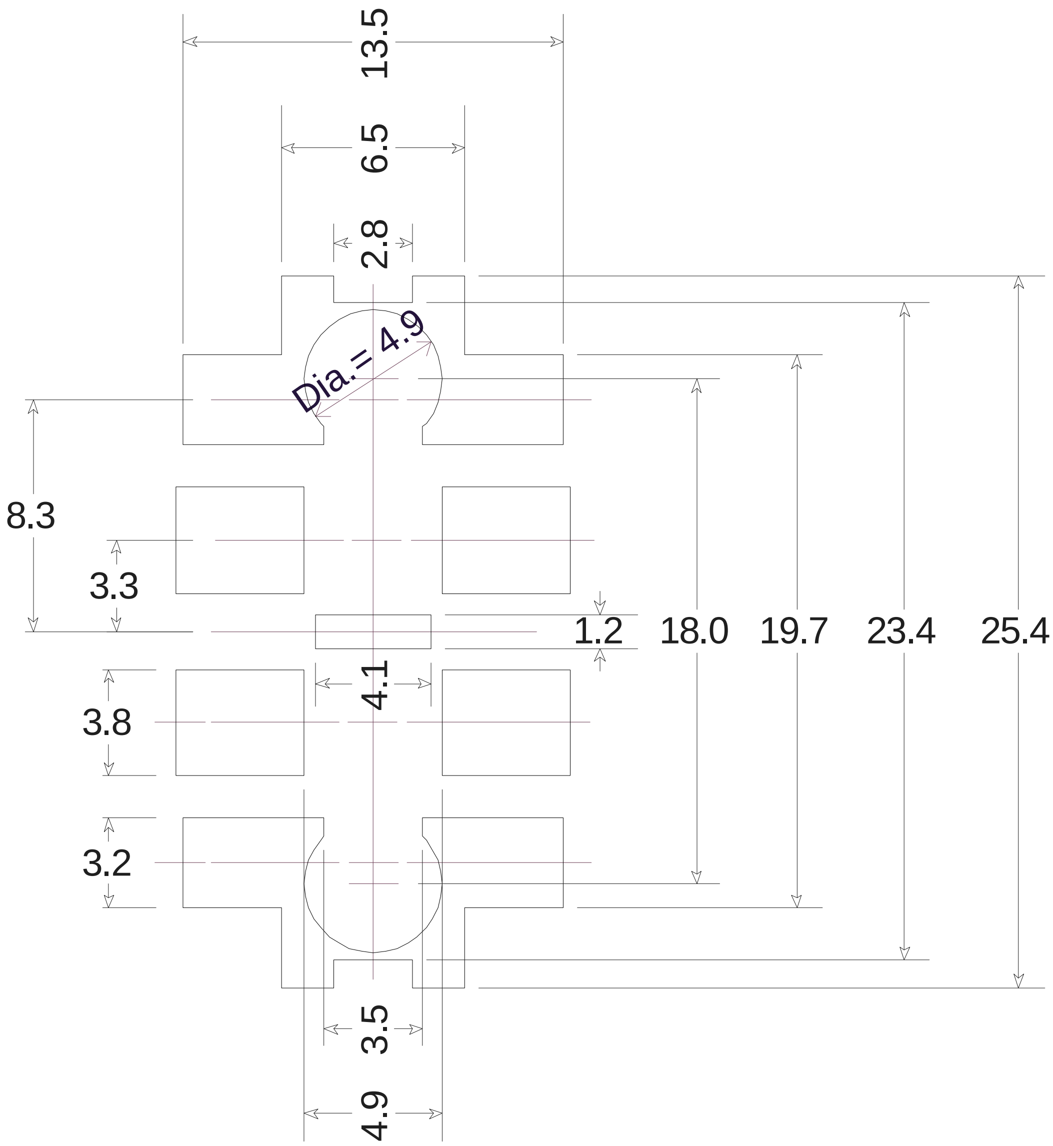
Nomial Total Completed Thickness (included resist coating): 1.6mm



Er: 4.7 @ 1GHz
TanD: 0.018 @ 1GHz

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

3. Standard Land Pattern Dimensions



UNIT: mm

4. Component List

- Component List

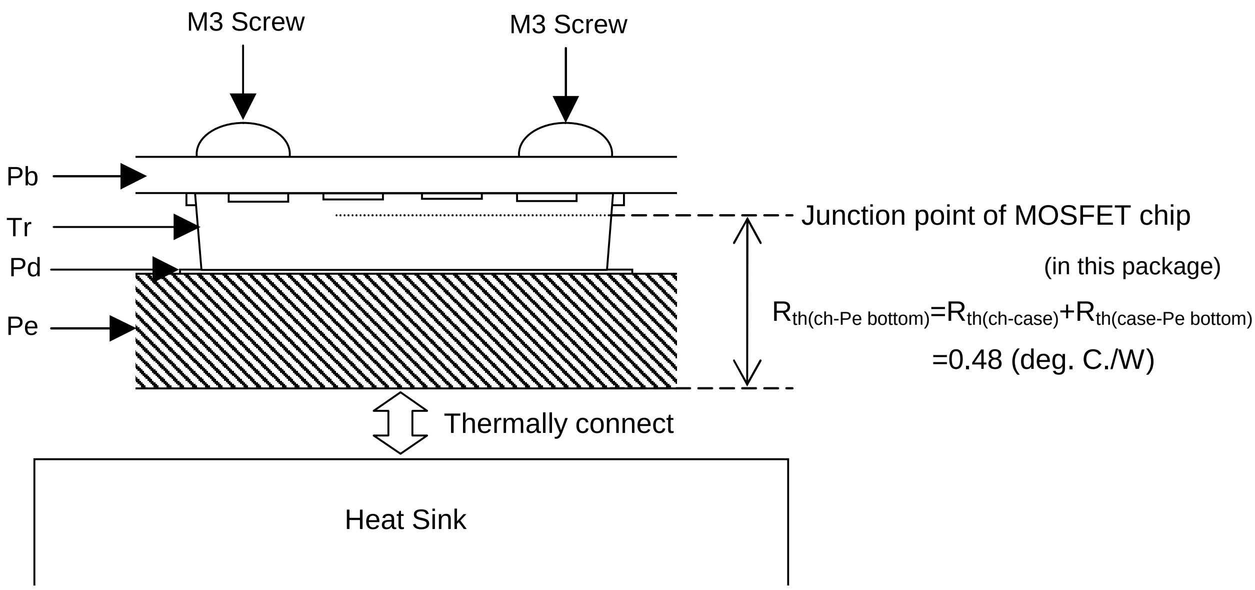
No.		Description	P/N	Qty	Manufacturer
Tr		MOSFET	RD70HUF2	1	Mitsubishi Electric Corporation
C	1	300 pF 3216 200V	GRM31M2C2D331JY21B	1	MURATA MANUFACTURING CO.
C	2	56 pF 1608 Hi-Q 50V	GQM1882C1H560JB01	1	MURATA MANUFACTURING CO.
C	3	56 pF 1608 Hi-Q 50V	GQM1882C1H560JB01	1	MURATA MANUFACTURING CO.
C	5	220 pF 1608 50V	GRM1882C1H221JA01	1	MURATA MANUFACTURING CO.
C	6	220 pF 1608 50V	GRM1882C1H221JA01	1	MURATA MANUFACTURING CO.
C	7	1500 pF 1608 50V	GRM1882C1H152JA01	1	MURATA MANUFACTURING CO.
C	8	1500 pF 1608 50V	GRM1882C1H152JA01	1	MURATA MANUFACTURING CO.
C	9	130 pF 2012 100V	GRM2162C2A131JA01	1	MURATA MANUFACTURING CO.
C	10	130 pF 2012 100V	GRM2162C2A131JA01	1	MURATA MANUFACTURING CO.
C	11	130 pF 2012 100V	GRM2162C2A131JA01	1	MURATA MANUFACTURING CO.
C	12	130 pF 2012 100V	GRM2162C2A131JA01	1	MURATA MANUFACTURING CO.
C	13	0.1 uF 1608 16V	GRM188B11C104KA01	1	MURATA MANUFACTURING CO.
C	14	0.1 uF 1608 16V	GRM188B11C104KA01	1	MURATA MANUFACTURING CO.
C	15	47 pF 2012 Hi-Q 50V	GQM2192C1H470JB01	1	MURATA MANUFACTURING CO.
C	16	68 pF 2012 Hi-Q 50V	GQM2192C1H680JB01	1	MURATA MANUFACTURING CO.
C	17	68 pF 2012 Hi-Q 50V	GQM2192C1H680JB01	1	MURATA MANUFACTURING CO.
C	18	68 pF 2012 Hi-Q 50V	GQM2192C1H680JB01	1	MURATA MANUFACTURING CO.
C	19	68 pF 2012 Hi-Q 50V	GQM2192C1H680JB01	1	MURATA MANUFACTURING CO.
C	20	68 pF 2012 Hi-Q 50V	GQM2192C1H680JB01	1	MURATA MANUFACTURING CO.
C	21	68 pF 2012 Hi-Q 50V	GQM2192C1H680JB01	1	MURATA MANUFACTURING CO.
C	22	15 pF 2012 Hi-Q 100V	GQM2192C2A150JB01	1	MURATA MANUFACTURING CO.
C	23	8.2 pF 2012 Hi-Q 100V	GQM2192C2A8R2DB01	1	MURATA MANUFACTURING CO.
C	25	56 pF 2012 Hi-Q 50V	GQM2192C1H560JB01	1	MURATA MANUFACTURING CO.
C	26	22 pF 2012 Hi-Q 50V	GQM2192C1H220JB01	1	MURATA MANUFACTURING CO.
C	27	3.9 pF 2012 Hi-Q 100V	GQM2193C2A3R9CB01	1	MURATA MANUFACTURING CO.
C	28	3.9 pF 2012 Hi-Q 100V	GQM2193C2A3R9CB01	1	MURATA MANUFACTURING CO.
C	29	3.9 pF 2012 Hi-Q 100V	GQM2193C2A3R9CB01	1	MURATA MANUFACTURING CO.
C	30	3.9 pF 2012 Hi-Q 100V	GQM2193C2A3R9CB01	1	MURATA MANUFACTURING CO.
C	31	3.9 pF 2012 Hi-Q 100V	GQM2193C2A3R9CB01	1	MURATA MANUFACTURING CO.
C	32	3.9 pF 2012 Hi-Q 100V	GQM2193C2A3R9CB01	1	MURATA MANUFACTURING CO.
C	33	330 pF 3216 200V	GRM31M2C2D331JY21B	1	MURATA MANUFACTURING CO.
C	34	390 pF 3216 200V	GRM31M2C2D391JY21B	1	MURATA MANUFACTURING CO.
C	35	390 pF 3216 200V	GRM31M2C2D391JY21B	1	MURATA MANUFACTURING CO.
C	36	220 uF 35V	EEUFC1V221	1	Panasonic Corporation
L	1	12 nH 1608	LQG18HH12N00	1	MURATA MANUFACTURING CO.
L	2	12 nH 1608	LQG18HH12N00	1	MURATA MANUFACTURING CO.
L	3	8 nH * Diameter: Wire=0.2mm Inside=1.4mm T/N of coils=2		1	YC CORPORATION Co.,Ltd.
L	4	8 nH * Diameter: Wire=0.2mm Inside=1.4mm T/N of coils=2		1	YC CORPORATION Co.,Ltd.
L	5	8 nH * Diameter: Wire=0.8mm Inside=2.2mm T/N of coils=2		1	YC CORPORATION Co.,Ltd.
L	6	12 nH * Diameter: Wire=0.8mm Inside=2.2mm T/N of coils=3		1	YC CORPORATION Co.,Ltd.
L	7	17 nH * Diameter: Wire=0.8mm Inside=2.2mm T/N of coils=4		1	YC CORPORATION Co.,Ltd.
R	1	5.6 ohm 2012	RPC10T5R6J	1	TAIYOSHA ELECTRIC CO.
R	2	5.6 ohm 2012	RPC10T5R6J	1	TAIYOSHA ELECTRIC CO.
R	3	5.6 ohm 2012	RPC10T5R6J	1	TAIYOSHA ELECTRIC CO.
R	4	5.6 ohm 1608	RPC10T5R6J	1	TAIYOSHA ELECTRIC CO.
R	5	5.6k ohm 1608	RPC05T562J	1	TAIYOSHA ELECTRIC CO.
R	6	5.6k ohm 1608	RPC05T562J	1	TAIYOSHA ELECTRIC CO.
R	7	0 ohm 1608	RPC05T0R0	1	TAIYOSHA ELECTRIC CO.
R	8	0 ohm 1608	RPC05T0R0	1	TAIYOSHA ELECTRIC CO.
Pb		PCB	MS3A0194	1	Homebuilt
Rc		SMA female connector	PAF-S00-002	2	GIGALANE Corporation
Bc	1	Bias connector red color	TM-605R	3	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
Sbc		Support of bias connectors		2	Homebuilt
		Conductiong wire		4	Homebuilt
		Screw M3		10	-
		Screw M2.6		4	-
		Screw M2		4	-

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

- **Standard Deliverable**

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

5. Thermal Design of Heat Sink



$Tch_{(delta)}$=(Pout/Efficiency-Pout+Pin) x $R_{th(ch\text{-}Pe\ bottom)}$=(65W/55%-65W+5.5) x 0.48=28.2 (deg. C.)
Also, operating Tj("$Tj_{(op)}$")=140 (deg. C.), in case of RD series that $Tch_{(max)}$=175 (deg. C.)
Therefore $T_{Pe\ bottom\text{-}air}$ as delta temperature between Pe bottom and ambient 60 deg. C.* is
$T_{Pe\ bottom\text{-}air}$="$Tj_{(op)}$" - $Tch_{(delta)}$ - $Ta_{(60deg.C.)}$=140-28.2-60=51.8 (deg. C.)

*: an instance assuming high temperature of standard ambient conditions is 60 deg. C.

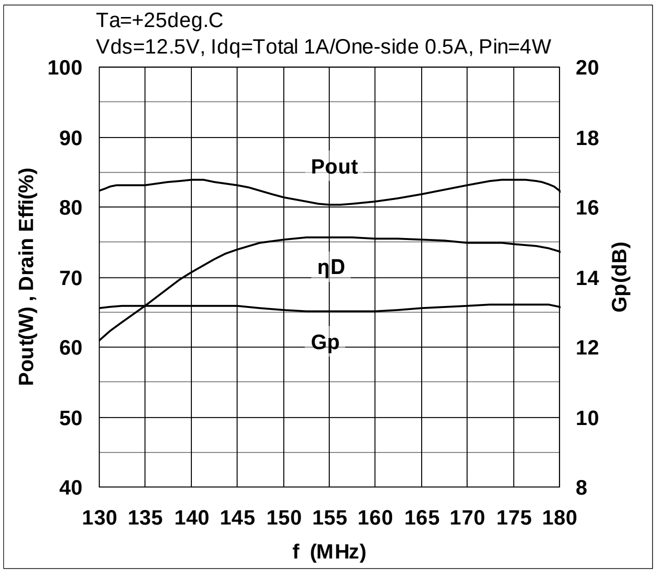
In terms of long-term reliability, "$Tj_{(op)}$" has to be kept less than 140 deg. C. i.e. $T_{Pe\ bottom\text{-}air}$ has to be less than 51.8 deg. C..
The thermal resistance of the heat sink to border it:
$Rth_{(Pe\ bottom\text{-}air)}$=$T_{Pe\ bottom\text{-}air}$/(Pout/Efficiency-Pout+Pin)=51.8/(65W/55%-65W+5.5)=0.88 (deg. C./W)
Therefore
it is preferable that the thermal resistance of the heat sink is much smaller than 0.88 deg. C./W.

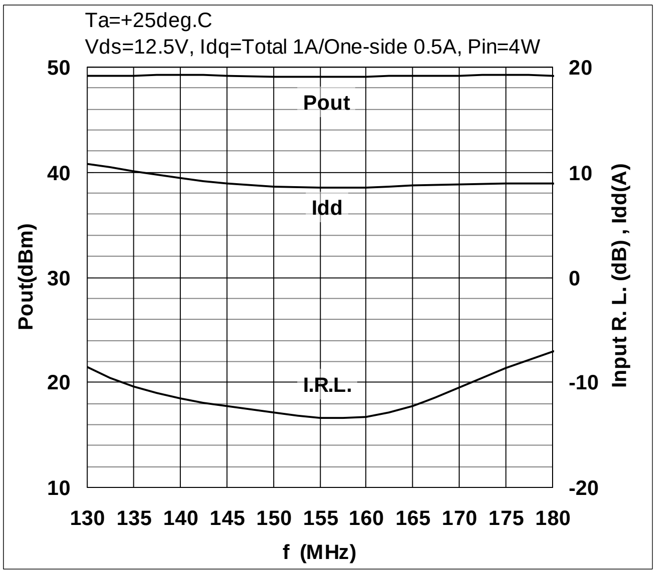
For assembly method including relevant precaution, refer to AN-GEN-070

6. Typical RF Characteristics

6-1. Frequency vs.

OUTPUT POWER, POWER GAIN, DRAIN EFFICIENCY, DRAIN CURRENT and INPUT RETURN LOSS



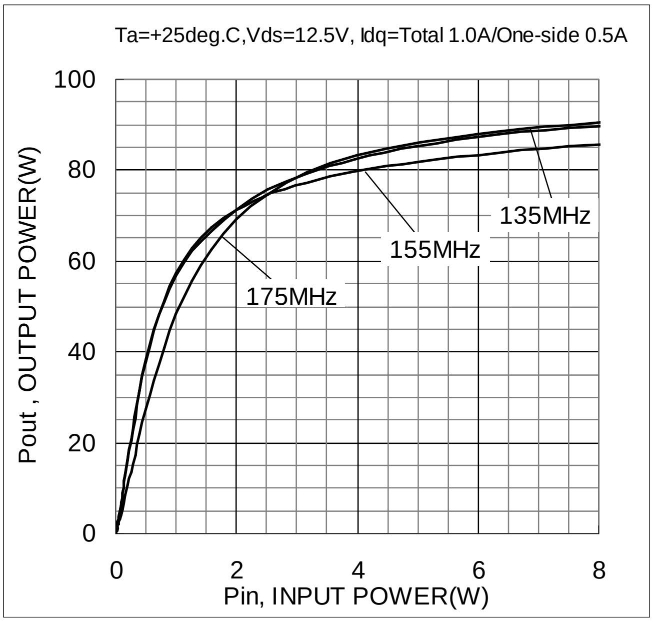


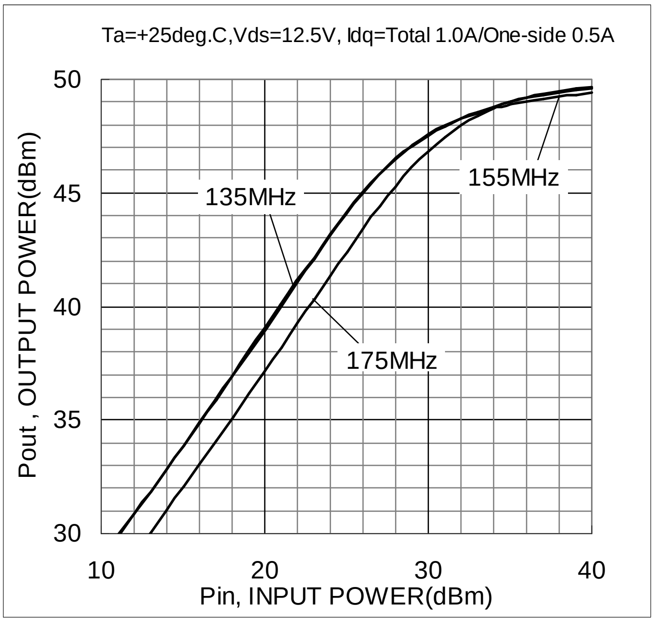
Ta=+25deg. C., Vds=12.5V, Idq=Total 1.0A/One-side 0.5A, Pin=4.0W

Freq. (MHz)	Vgg1 (V)	Vgg2 (V)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Gp (dB)	ID(RF) (A)	ηadd (%)	ηD (%)	I.R.L. (dB)
130	2.75	2.74	36.0	4.0	49.2	82.4	13.1	10.81	58.0	61.0	-8.5
135	2.75	2.74	36.0	4.0	49.2	83.1	13.2	10.09	62.7	65.9	-10.4
140	2.75	2.74	36.0	4.0	49.2	83.8	13.2	9.50	67.2	70.6	-11.5
145	2.74	2.74	36.0	4.0	49.2	83.0	13.2	8.99	70.3	73.9	-12.2
150	2.74	2.74	36.1	4.0	49.1	81.4	13.1	8.64	71.7	75.4	-12.8
155	2.75	2.75	36.0	4.0	49.1	80.4	13.0	8.50	71.9	75.6	-13.4
160	2.75	2.75	36.0	4.0	49.1	80.8	13.0	8.56	71.8	75.5	-13.3
165	2.75	2.75	36.0	4.0	49.1	81.9	13.1	8.70	71.6	75.3	-12.2
170	2.75	2.75	36.0	4.0	49.2	83.0	13.2	8.86	71.4	74.9	-10.5
175	2.75	2.74	36.0	4.0	49.2	83.9	13.2	8.97	71.2	74.8	-8.6
180	2.75	2.74	36.0	4.0	49.2	82.3	13.1	8.94	70.1	73.7	-7.1

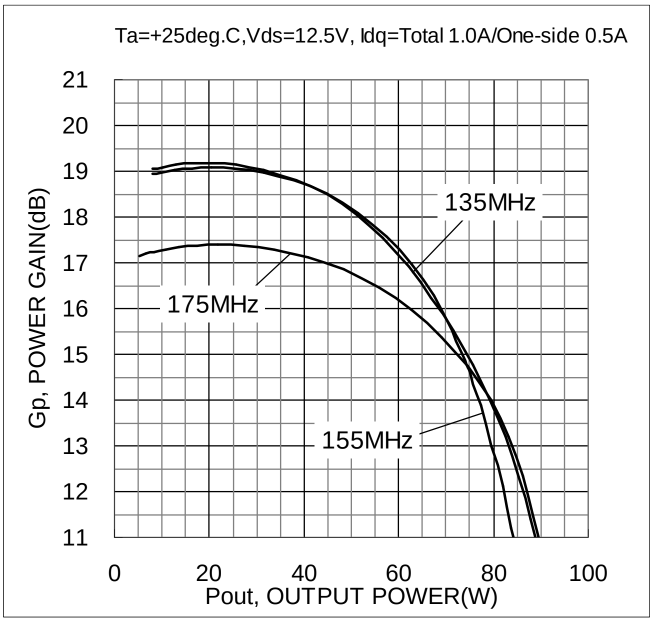
6-2. RF Power vs.

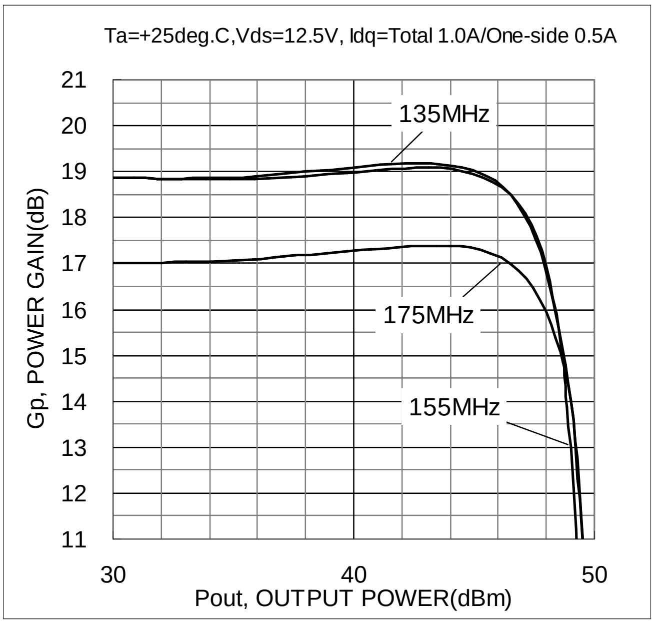
INPUT POWER



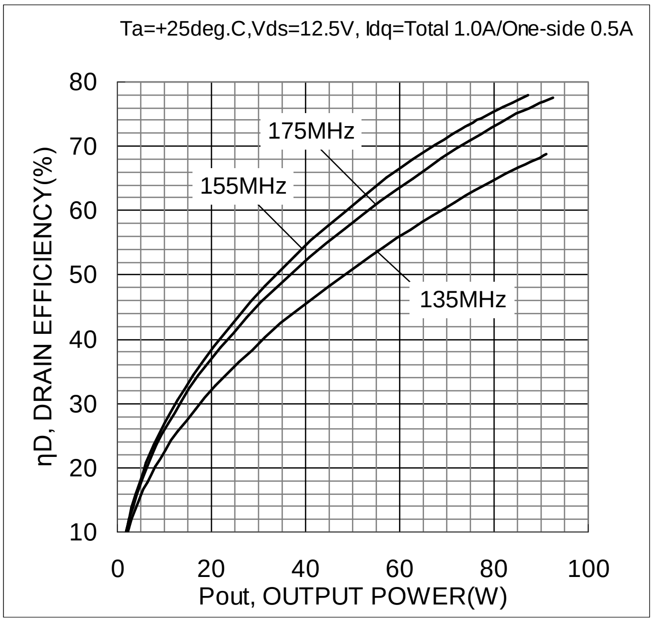


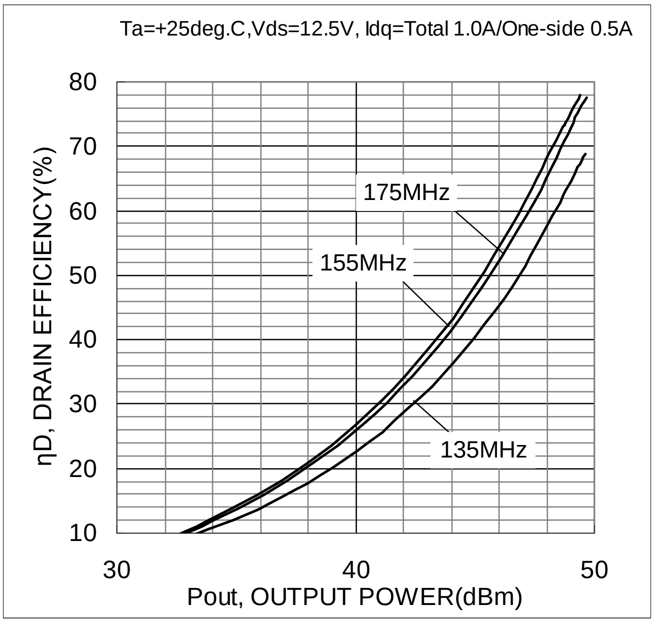
POWER GAIN



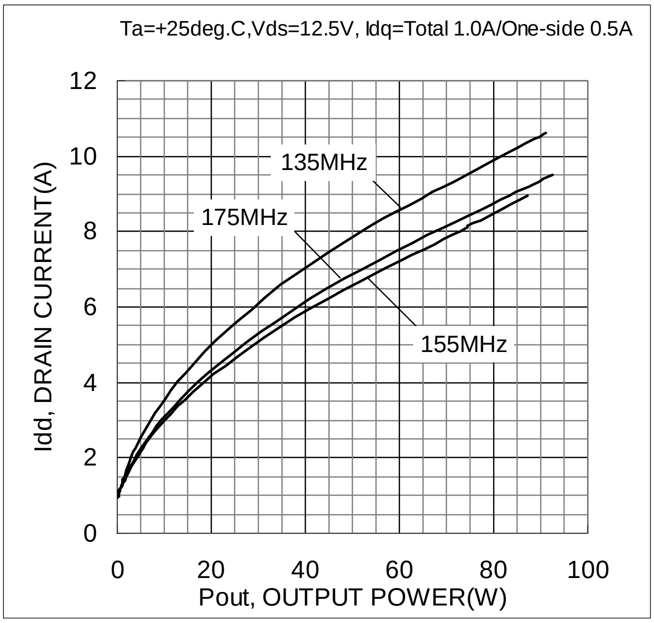


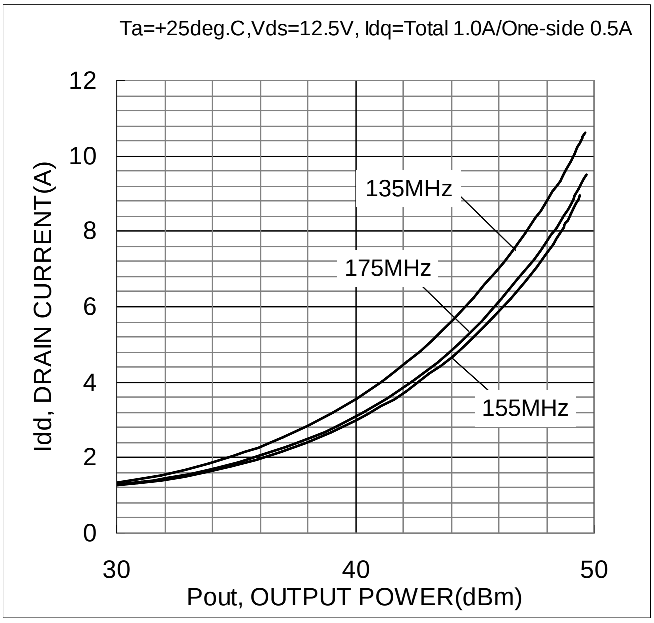
DRAIN EFFICIENCY



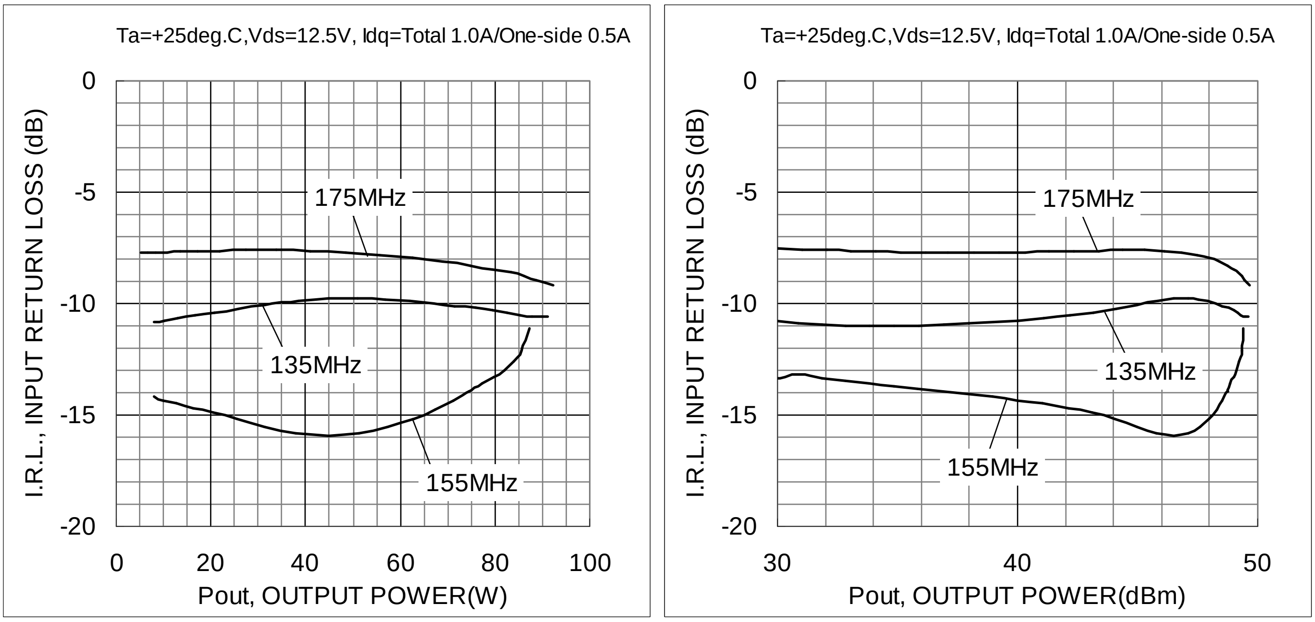


DRAIN CURRENT





INPUT RETURN LOSS



Ta=+25deg. C., Vds=12.5V, Idq=Total 1.0A/One-side 0.5A

135MHz	Vgg1	Vgg2	Pin		Pout		Gp	ID(RF)	ηadd	ηD	I.R.L.
	(V)	(V)	(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(%)	(dB)
	2.73	2.73	10.0	0.01	28.9	0.8	18.9	1.23	5.0	5.1	-10.7
	2.73	2.73	11.0	0.01	29.9	1.0	18.9	1.31	5.9	6.0	-10.8
	2.73	2.73	12.0	0.02	30.9	1.2	18.8	1.41	6.9	6.9	-10.9
	2.73	2.73	13.0	0.02	31.9	1.5	18.8	1.52	8.0	8.1	-11.0
	2.73	2.73	14.0	0.03	32.9	1.9	18.8	1.67	9.1	9.2	-11.0
	2.73	2.73	15.0	0.03	33.9	2.4	18.9	1.83	10.5	10.6	-11.0
	2.73	2.73	16.0	0.04	34.9	3.1	18.9	2.03	11.9	12.1	-11.0
	2.73	2.73	17.0	0.05	35.9	3.9	18.9	2.26	13.6	13.7	-11.0
	2.73	2.73	18.0	0.06	36.9	4.9	18.9	2.53	15.4	15.6	-11.0
	2.73	2.73	19.0	0.08	38.0	6.3	19.0	2.84	17.6	17.8	-10.9
	2.73	2.73	20.0	0.10	39.0	8.0	19.0	3.18	19.9	20.1	-10.8
	2.73	2.73	21.0	0.13	40.1	10.2	19.1	3.58	22.5	22.8	-10.8
	2.73	2.73	22.0	0.16	41.1	12.9	19.1	4.01	25.4	25.7	-10.7
	2.73	2.73	23.0	0.20	42.2	16.6	19.2	4.54	28.8	29.2	-10.6
	2.73	2.73	24.0	0.25	43.2	20.8	19.2	5.08	32.3	32.7	-10.4
	2.73	2.73	25.0	0.31	44.1	25.7	19.1	5.65	36.0	36.4	-10.2
	2.73	2.73	26.0	0.39	45.0	31.4	19.0	6.24	39.8	40.3	-10.0
	2.73	2.73	27.0	0.51	45.8	38.4	18.8	6.90	44.0	44.6	-9.9
	2.73	2.73	28.0	0.63	46.5	44.9	18.5	7.45	47.5	48.2	-9.8
	2.73	2.73	29.0	0.80	47.1	51.0	18.1	7.93	50.7	51.5	-9.8
	2.73	2.73	30.0	1.00	47.5	56.8	17.5	8.35	53.4	54.4	-9.8
	2.73	2.73	31.0	1.26	47.9	62.1	16.9	8.72	55.8	57.0	-9.9
	2.73	2.73	32.0	1.59	48.3	67.0	16.2	9.04	57.9	59.3	-10.0
	2.73	2.73	33.0	2.01	48.5	71.6	15.5	9.34	59.6	61.3	-10.1
	2.73	2.73	34.0	2.52	48.8	75.8	14.8	9.61	61.0	63.1	-10.2
	2.73	2.73	35.0	3.17	49.0	79.4	14.0	9.84	62.0	64.6	-10.3
	2.73	2.73	36.0	3.96	49.2	82.6	13.2	10.04	62.6	65.8	-10.4
	2.73	2.73	37.0	5.02	49.3	85.3	12.3	10.22	62.9	66.8	-10.5
	2.73	2.73	38.0	6.35	49.4	87.8	11.4	10.39	62.8	67.6	-10.6
	2.73	2.73	39.0	7.97	49.5	89.7	10.5	10.51	62.2	68.3	-10.6
	2.73	2.73	40.0	10.09	49.6	91.2	9.6	10.61	61.2	68.8	-10.6

155MHz

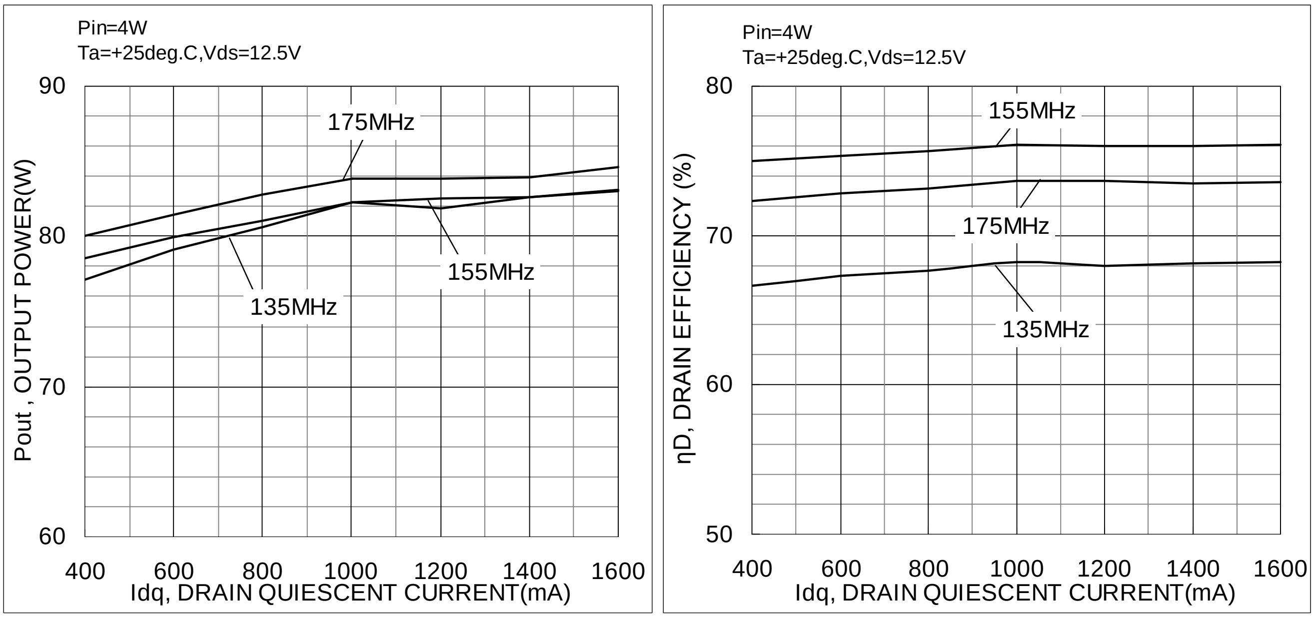
Vgg1 (V)	Vgg2 (V)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Gp (dB)	ID(RF) (A)	ηadd (%)	ηD (%)	I.R.L. (dB)
2.73	2.74	10.0	0.01	28.9	0.8	18.9	1.20	5.1	5.2	-13.1
2.73	2.74	11.0	0.01	29.9	1.0	18.9	1.25	6.1	6.2	-13.4
2.73	2.74	12.0	0.02	30.9	1.2	18.8	1.32	7.3	7.4	-13.2
2.73	2.74	13.0	0.02	31.9	1.5	18.8	1.40	8.6	8.8	-13.4
2.73	2.74	14.0	0.03	32.8	1.9	18.8	1.50	10.1	10.3	-13.5
2.73	2.74	15.0	0.03	33.8	2.4	18.8	1.62	11.8	11.9	-13.6
2.73	2.74	16.0	0.04	34.8	3.0	18.8	1.77	13.6	13.8	-13.7
2.73	2.74	17.0	0.05	35.9	3.9	18.8	1.94	15.7	15.9	-13.8
2.73	2.74	18.0	0.06	36.9	4.9	18.9	2.15	18.0	18.2	-13.9
2.73	2.74	19.0	0.08	37.9	6.2	18.9	2.39	20.5	20.8	-14.1
2.73	2.74	20.0	0.10	39.0	7.9	18.9	2.67	23.4	23.7	-14.2
2.73	2.74	21.0	0.13	40.0	10.0	19.0	2.98	26.5	26.8	-14.3
2.73	2.74	22.0	0.16	41.1	12.8	19.0	3.35	30.1	30.5	-14.5
2.73	2.74	23.0	0.20	42.1	16.2	19.1	3.76	34.1	34.5	-14.7
2.73	2.74	24.0	0.25	43.1	20.5	19.1	4.22	38.4	38.9	-14.9
2.73	2.74	25.0	0.32	44.1	25.4	19.1	4.69	42.8	43.4	-15.2
2.73	2.74	26.0	0.40	45.0	31.4	19.0	5.21	47.6	48.2	-15.5
2.73	2.74	27.0	0.50	45.8	37.9	18.8	5.73	52.3	53.0	-15.8
2.73	2.74	28.0	0.63	46.5	44.7	18.5	6.22	56.7	57.5	-15.9
2.73	2.74	29.0	0.80	47.1	51.3	18.1	6.67	60.7	61.6	-15.8
2.73	2.74	30.0	1.00	47.6	57.3	17.6	7.05	63.9	65.1	-15.5
2.73	2.74	31.0	1.26	48.0	62.8	17.0	7.39	66.6	68.0	-15.2
2.73	2.74	32.0	1.59	48.3	67.4	16.3	7.68	68.6	70.2	-14.7
2.73	2.74	33.0	2.00	48.5	71.1	15.5	7.92	69.9	71.9	-14.3
2.73	2.74	34.0	2.52	48.7	74.6	14.7	8.13	70.9	73.3	-13.9
2.73	2.74	35.0	3.16	48.9	77.2	13.9	8.31	71.3	74.4	-13.6
2.73	2.74	36.0	3.99	49.0	79.7	13.0	8.46	71.6	75.3	-13.3
2.73	2.74	37.0	5.03	49.1	81.9	12.1	8.61	71.5	76.2	-13.0
2.73	2.74	38.0	6.35	49.2	83.8	11.2	8.73	71.0	76.8	-12.6
2.73	2.74	39.0	7.95	49.3	85.5	10.3	8.84	70.2	77.4	-12.1
2.73	2.74	40.0	10.02	49.4	87.1	9.4	8.94	69.0	77.9	-11.1

175MHz

Vgg1 (V)	Vgg2 (V)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Gp (dB)	ID(RF) (A)	ηadd (%)	ηD (%)	I.R.L. (dB)
2.73	2.74	10.0	0.01	27.1	0.5	17.0	1.14	3.5	3.6	-7.3
2.73	2.74	11.0	0.01	28.0	0.6	17.0	1.18	4.2	4.3	-7.4
2.73	2.73	12.0	0.02	29.0	0.8	17.0	1.23	5.1	5.2	-7.5
2.73	2.74	13.0	0.02	30.0	1.0	17.0	1.29	6.1	6.3	-7.5
2.73	2.74	14.0	0.03	31.0	1.3	17.0	1.37	7.3	7.4	-7.6
2.73	2.74	15.0	0.03	32.1	1.6	17.0	1.46	8.6	8.8	-7.6
2.73	2.74	16.0	0.04	33.1	2.0	17.0	1.57	10.1	10.3	-7.6
2.73	2.74	17.0	0.05	34.1	2.6	17.1	1.71	11.7	12.0	-7.7
2.73	2.74	18.0	0.06	35.1	3.2	17.1	1.88	13.6	13.9	-7.7
2.73	2.74	19.0	0.08	36.1	4.1	17.1	2.07	15.6	15.9	-7.7
2.73	2.74	20.0	0.10	37.1	5.2	17.1	2.28	17.8	18.1	-7.7
2.73	2.74	21.0	0.13	38.2	6.6	17.2	2.55	20.3	20.7	-7.7
2.73	2.74	22.0	0.16	39.3	8.4	17.2	2.85	23.2	23.6	-7.7
2.73	2.74	23.0	0.20	40.3	10.7	17.3	3.20	26.4	26.9	-7.7
2.73	2.74	24.0	0.25	41.3	13.6	17.3	3.58	29.8	30.4	-7.7
2.73	2.74	25.0	0.32	42.4	17.3	17.4	4.02	33.7	34.4	-7.6
2.73	2.74	26.0	0.40	43.4	21.9	17.4	4.52	38.1	38.8	-7.6
2.73	2.74	27.0	0.50	44.4	27.5	17.4	5.06	42.6	43.4	-7.6
2.73	2.74	28.0	0.63	45.3	33.8	17.3	5.62	47.2	48.1	-7.6
2.73	2.74	29.0	0.79	46.1	40.9	17.1	6.20	51.8	52.8	-7.6
2.73	2.73	30.0	1.00	46.8	48.4	16.8	6.76	56.1	57.3	-7.7
2.73	2.73	31.0	1.26	47.5	55.7	16.5	7.26	60.0	61.4	-7.8
2.73	2.73	32.0	1.59	48.0	62.6	16.0	7.71	63.4	65.0	-8.0
2.73	2.73	33.0	2.00	48.4	69.0	15.4	8.10	66.2	68.2	-8.1
2.73	2.73	34.0	2.51	48.7	74.7	14.7	8.43	68.5	70.8	-8.3
2.73	2.73	35.0	3.17	49.0	79.5	14.0	8.72	70.0	72.9	-8.5
2.73	2.73	36.0	3.99	49.2	83.3	13.2	8.95	70.9	74.4	-8.6
2.73	2.73	37.0	5.04	49.4	86.2	12.3	9.13	71.1	75.5	-8.8
2.73	2.73	38.0	6.32	49.5	88.5	11.5	9.28	70.9	76.3	-8.9
2.73	2.73	39.0	7.97	49.6	90.5	10.6	9.40	70.2	77.0	-9.1
2.73	2.73	40.0	10.04	49.7	92.4	9.6	9.52	69.2	77.6	-9.2

6-3. Drain Quiescent Current vs.

OUTPUT POWER and DRAIN EFFICIENCY



Ta=+25deg. C., Vds=12.5V, Pin=4.0W

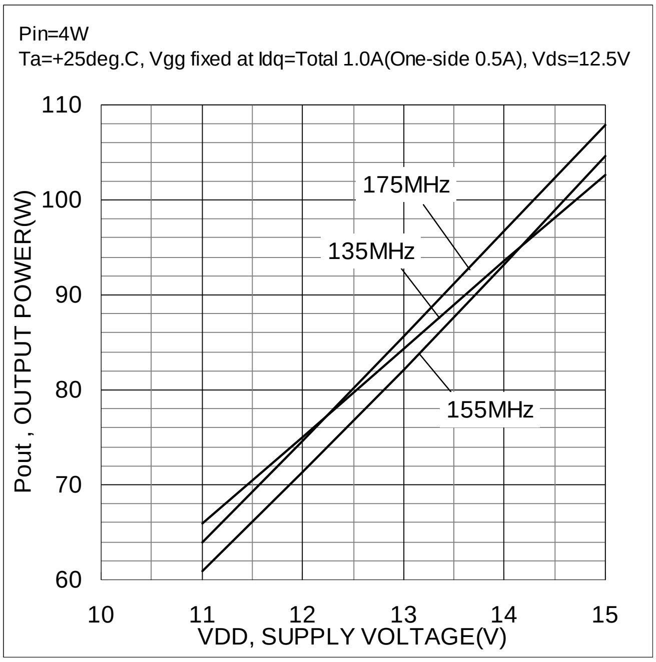
135MHz	Vgg1 (V)	Vgg2 (V)	Total Idq (mA)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Idd (A)	ηD (%)	ηadd (%)	Gain (dB)	I.R.L. (dB)
	2.60	2.60	400	36.0	4.0	49.0	77.1	9.26	66.6	63.2	12.9	-10.4
	2.64	2.65	600	36.0	4.0	49.0	79.1	9.41	67.3	63.9	12.9	-10.4
	2.68	2.69	800	36.1	4.0	49.1	80.6	9.53	67.6	64.3	13.0	-10.4
	2.73	2.73	1000	36.1	4.0	49.2	82.3	9.65	68.2	64.9	13.1	-10.4
	2.76	2.76	1200	36.1	4.0	49.3	81.9	9.64	67.9	64.6	13.1	-10.4
	2.79	2.79	1400	36.1	4.0	49.3	82.6	9.70	68.1	64.8	13.2	-10.4
	2.81	2.81	1600	36.0	4.0	49.3	83.0	9.74	68.2	64.9	13.2	-10.3

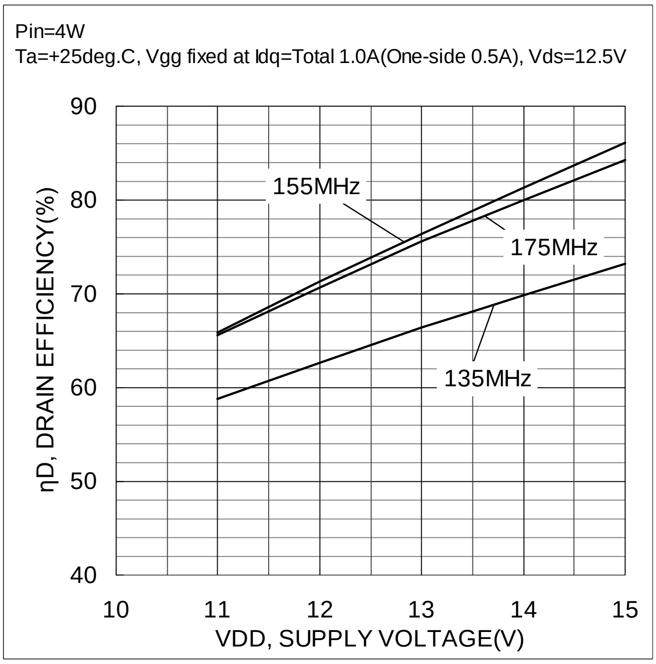
155MHz	Vgg1 (V)	Vgg2 (V)	Total Idq (mA)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Idd (A)	ηD (%)	ηadd (%)	Gain (dB)	I.R.L. (dB)
	2.60	2.60	400	36.0	4.0	48.9	78.5	8.38	75.0	71.1	12.9	-13.3
	2.64	2.66	600	36.0	4.0	48.9	80.0	8.49	75.4	71.6	13.0	-13.3
	2.68	2.70	800	36.0	4.0	49.0	81.0	8.57	75.6	71.9	13.1	-13.3
	2.73	2.74	1000	36.0	4.0	49.0	82.2	8.64	76.1	72.4	13.1	-13.4
	2.76	2.76	1200	36.0	4.0	49.1	82.5	8.68	76.0	72.3	13.1	-13.4
	2.79	2.79	1400	36.0	4.0	49.1	82.6	8.70	76.0	72.3	13.1	-13.4
	2.81	2.81	1600	36.0	4.0	49.1	83.1	8.74	76.1	72.4	13.2	-13.4

175MHz	Vgg1 (V)	Vgg2 (V)	Total Idq (mA)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Idd (A)	ηD (%)	ηadd (%)	Gain (dB)	I.R.L. (dB)
	2.60	2.60	400	36.0	4.0	49.1	80.0	8.85	72.3	68.7	13.0	-8.7
	2.64	2.65	600	36.0	4.0	49.1	81.4	8.95	72.8	69.2	13.1	-8.7
	2.68	2.69	800	36.0	4.0	49.2	82.7	9.04	73.2	69.6	13.2	-8.7
	2.73	2.73	1000	36.0	4.0	49.2	83.9	9.11	73.7	70.2	13.2	-8.7
	2.76	2.76	1200	36.0	4.0	49.2	83.9	9.11	73.7	70.2	13.2	-8.6
	2.79	2.79	1400	36.0	4.0	49.3	83.9	9.14	73.4	69.9	13.2	-8.7
	2.81	2.81	1600	36.0	4.0	49.3	84.6	9.20	73.6	70.1	13.2	-8.6

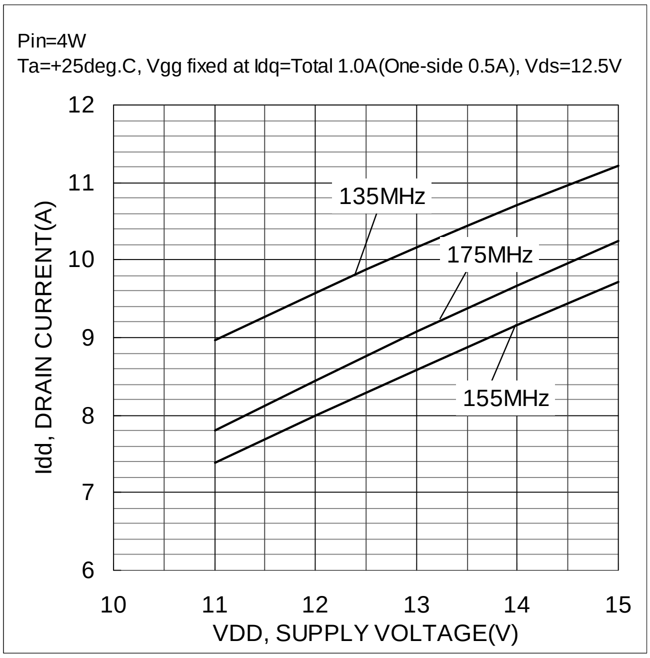
6-4. DC Power Supply vs.

OUTPUT POWER and DRAIN EFFICIENCY





DRAIN CURRENT



Ta=+25deg. C., Pin=4.0W

135MHz	Vgg1 (V)	Vgg2 (V)	Vdd (V)	Idq (mA)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Idd (A)	ηD (%)	ηadd (%)	Gain (dB)	I.R.L. (dB)
	2.73	2.73	11.0	969	36.0	4.0	48.2	65.9	8.97	58.8	55.2	12.2	-10.5
	2.73	2.73	12.0	995	36.0	4.0	48.8	75.0	9.57	62.7	59.3	12.7	-10.4
	2.73	2.73	13.0	1033	36.0	4.0	49.3	84.3	10.16	66.4	63.2	13.3	-10.4
	2.73	2.73	14.0	1067	36.0	4.0	49.7	93.5	10.70	69.9	66.9	13.7	-10.4
	2.73	2.73	15.0	1097	36.0	4.0	50.1	102.6	11.22	73.1	70.3	14.1	-10.3

155MHz	Vgg1 (V)	Vgg2 (V)	Vdd (V)	Idq (mA)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Idd (A)	ηD (%)	ηadd (%)	Gain (dB)	I.R.L. (dB)
	2.73	2.73	11.0	937	36.0	4.0	47.8	60.9	7.40	65.9	61.6	11.8	-13.0
	2.73	2.73	12.0	962	36.0	4.0	48.5	71.3	8.00	71.3	67.2	12.5	-13.2
	2.73	2.73	13.0	1020	36.0	4.0	49.1	82.1	8.59	76.4	72.7	13.1	-13.4
	2.73	2.73	14.0	1058	36.0	4.0	49.7	93.2	9.16	81.4	77.8	13.6	-13.5
	2.72	2.73	15.0	1094	36.0	4.0	50.2	104.6	9.72	86.1	82.8	14.2	-13.7

175MHz	Vgg1 (V)	Vgg2 (V)	Vdd (V)	Idq (mA)	Pin (dBm)	Pin (W)	Pout (dBm)	Pout (W)	Idd (A)	ηD (%)	ηadd (%)	Gain (dB)	I.R.L. (dB)
	2.73	2.73	11.0	947	36.1	4.0	48.1	63.9	7.80	65.6	61.5	12.0	-8.9
	2.73	2.73	12.0	982	36.0	4.0	48.7	74.6	8.44	70.7	66.9	12.7	-8.8
	2.73	2.73	13.0	1015	36.0	4.0	49.3	85.7	9.07	75.6	72.1	13.3	-8.6
	2.73	2.73	14.0	1047	36.0	4.0	49.9	96.8	9.67	80.1	76.7	13.8	-8.5
	2.73	2.73	15.0	1082	36.0	4.0	50.3	107.9	10.25	84.3	81.1	14.3	-8.4