APPLICATION NOTE

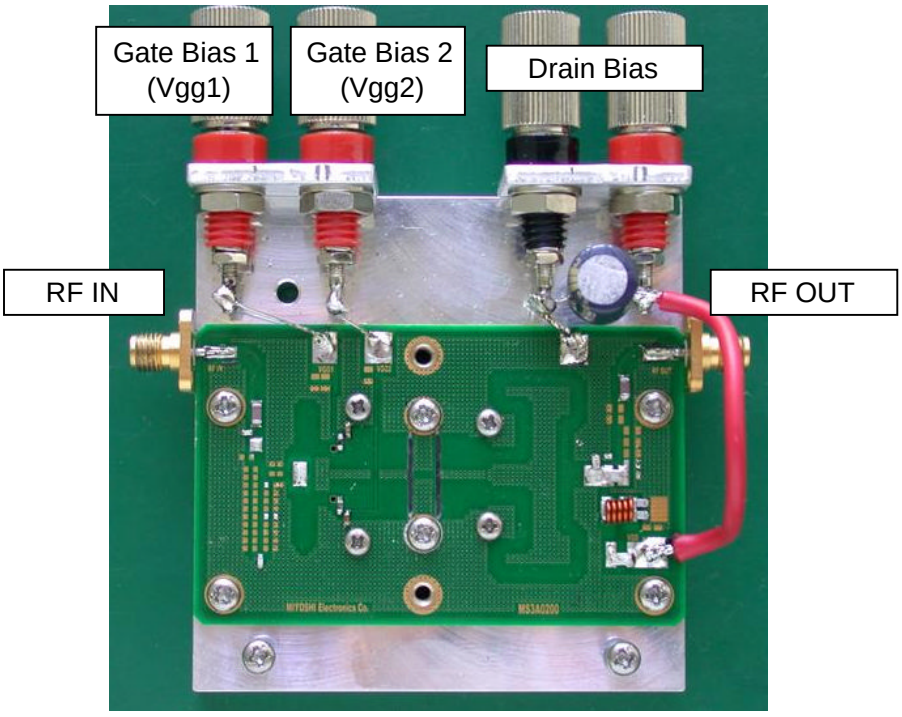
MITSUBISHI ELECTRIC
Silicon RF Power Semiconductors

Document NO. AN-UHF-113
Date : 27th May 2011
Prepared : Y.Koashi
K.Mori
Confirmed : T.Okawa
(Taking charge of Silicon RF by
MIYOSHI Electronics)

SUBJECT: RD70HUF2 single-stage amplifier with f=450-530MHz evaluation board

Features:

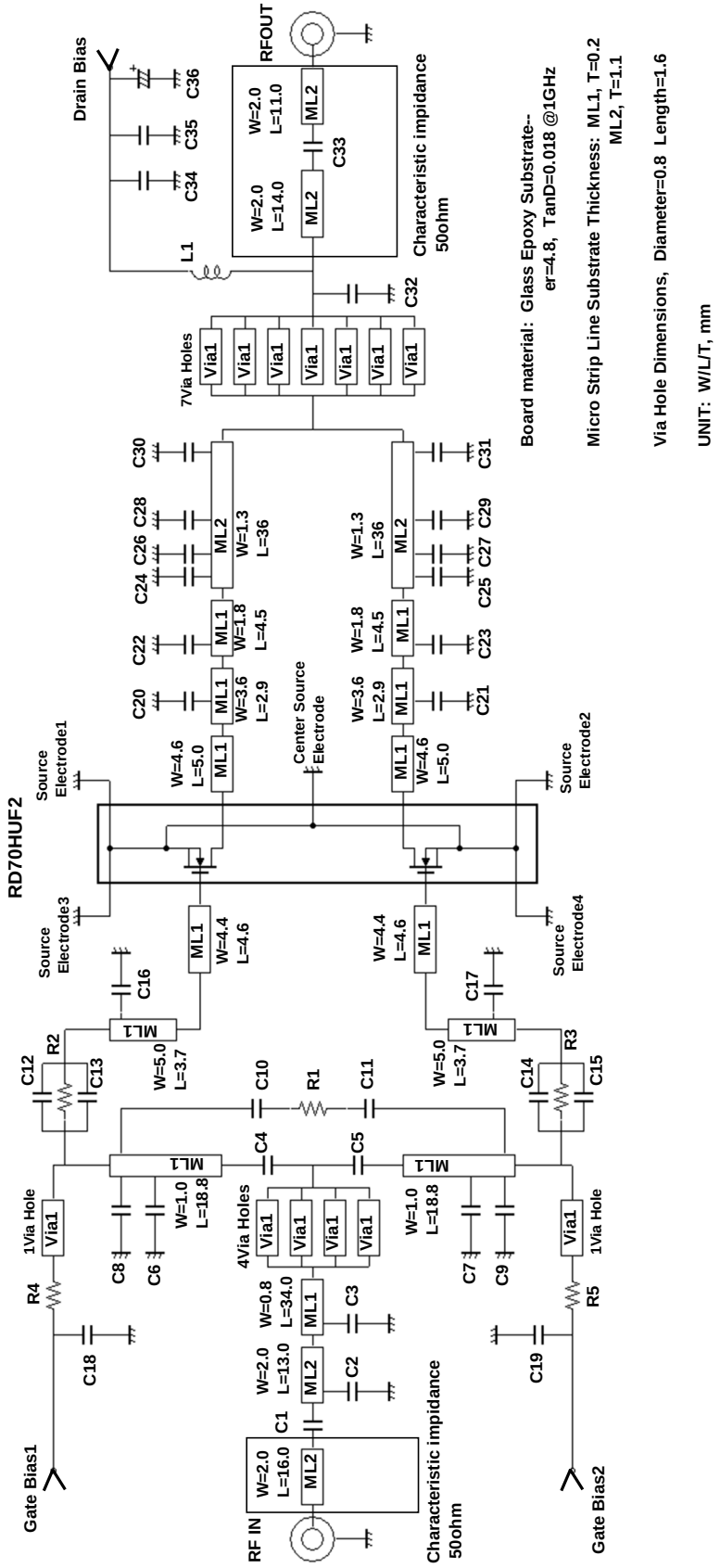
- The evaluation board for RD70HUF2
- Frequency: 450-530MHz
- Typical input power: 5.5W
- Typical output power: 75W
- Quiescent current: Total is 1000mA, 500mA per one FET chip
- Operating current: approx. 10A
- Surface-mounted RF power amplifier structure



PCB L=75mm W=46mm

Contents

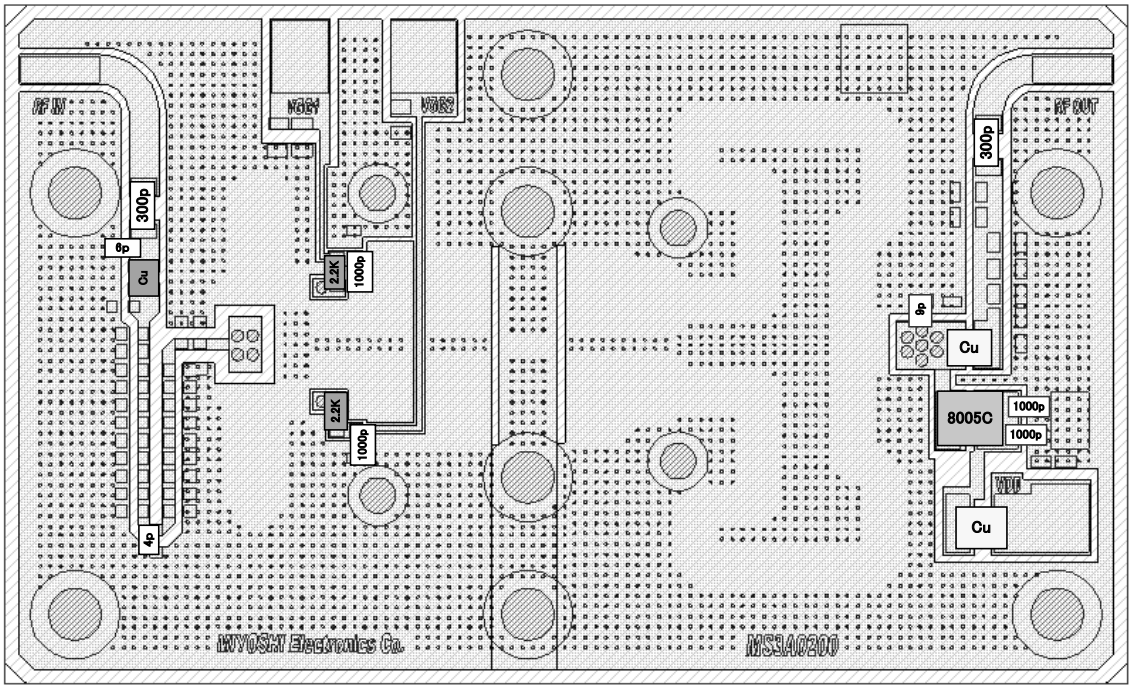
1. Equivalent Circuitry



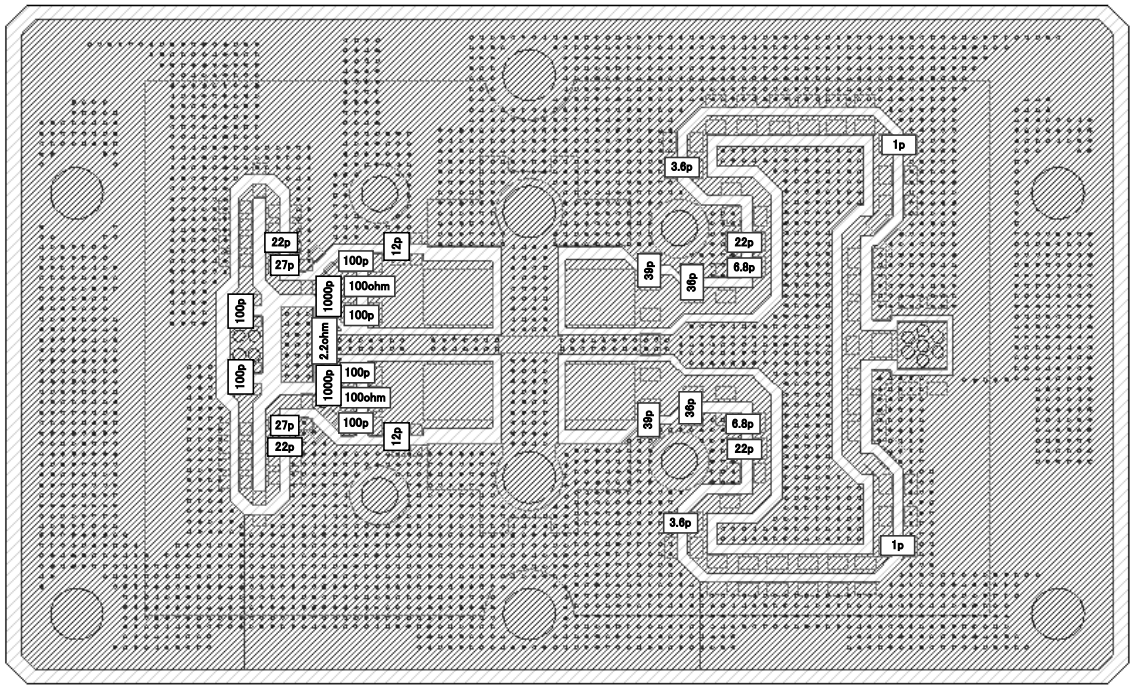
2. PCB Layout

BOARD OUTLINE: 75.0*46.0(mm)

TOP VIEW (Layer 1)

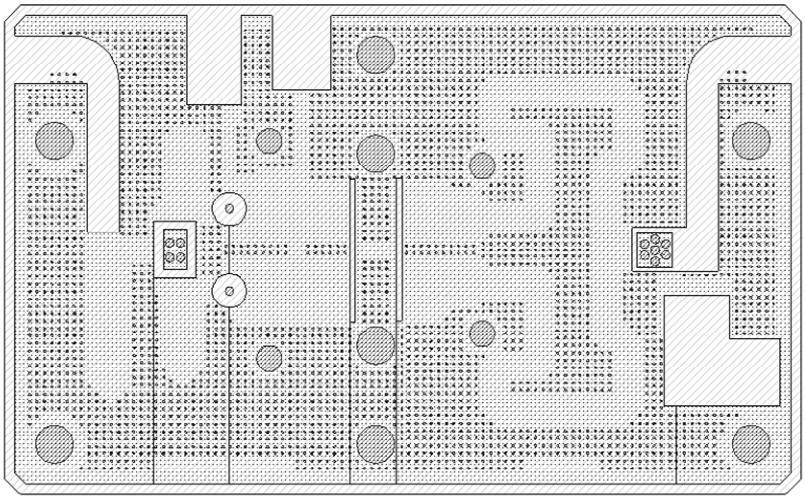


BOTTOM VIEW (Layer 4), Perspective through Top View

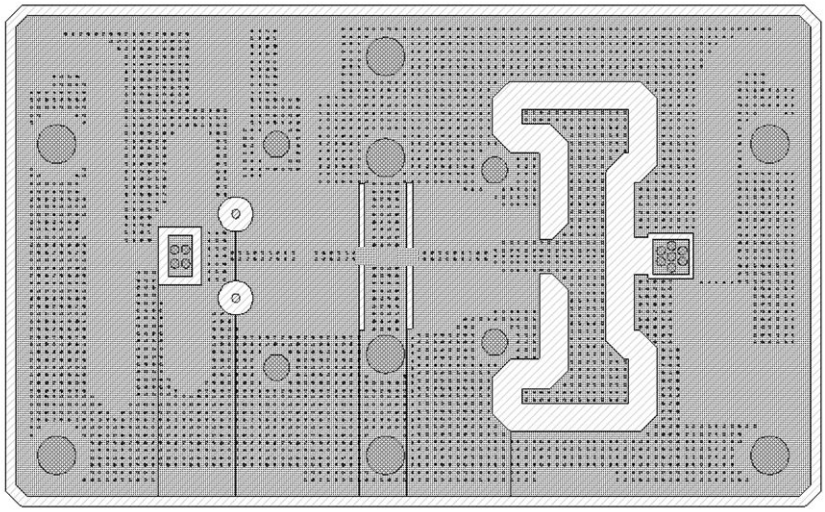


BOARD OUTLINE: 75.0*46.0(mm)

Internal Layer (Layer 2) , Perspective Through Top View

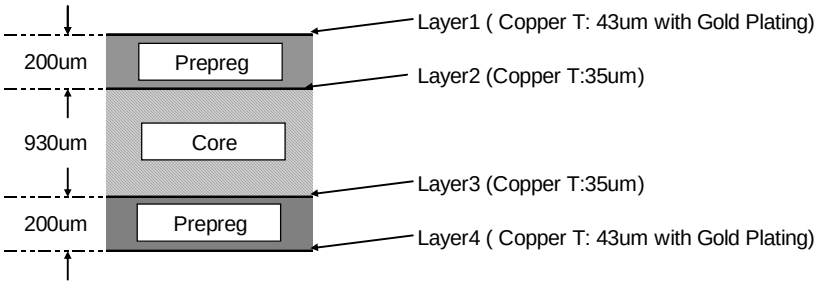


Internal Layer (Layer 3) , Perspective Through Top View



Substrate Condition

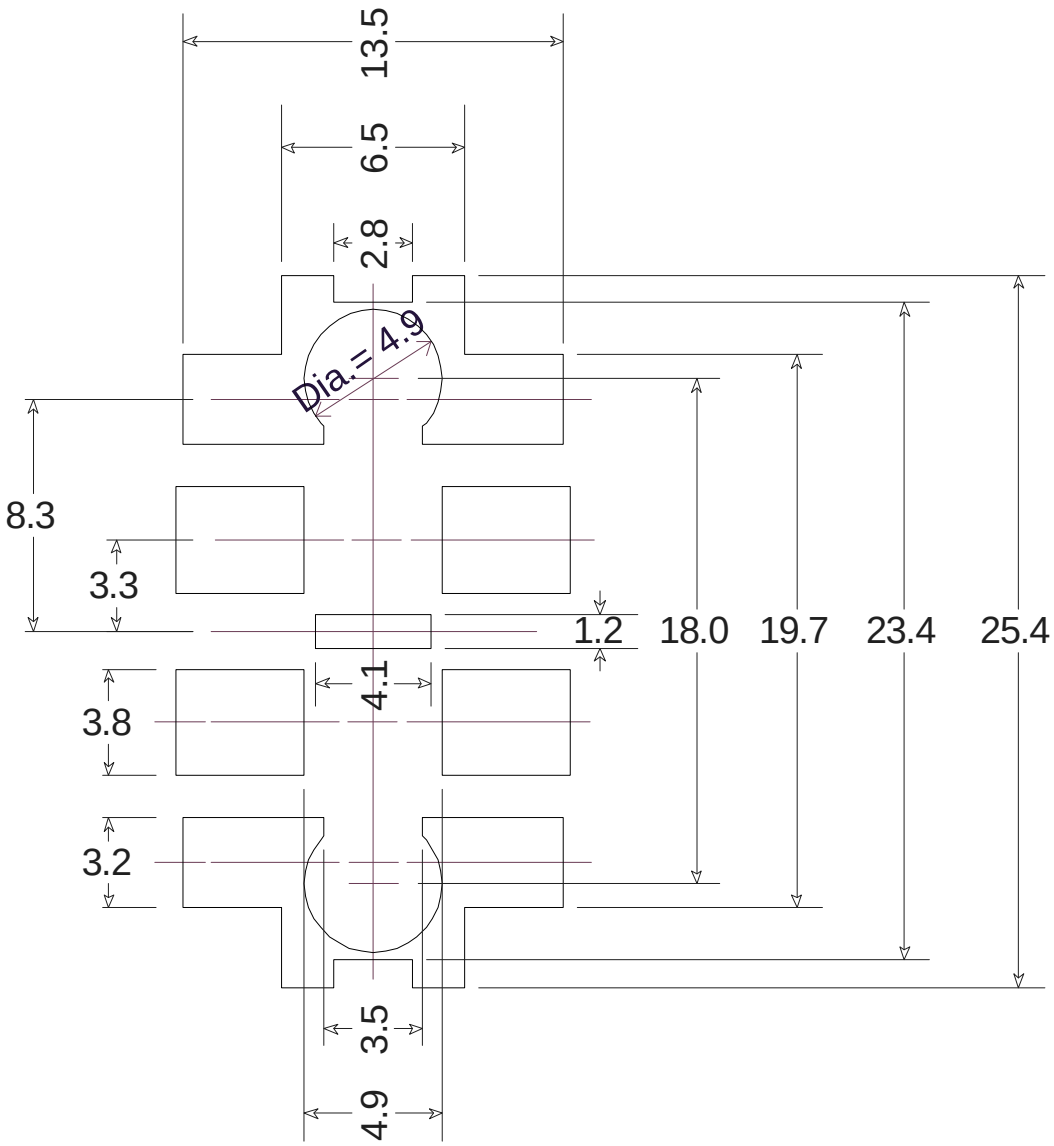
Nomial Total Completed Thickness (included resist coating): 1.6mm



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

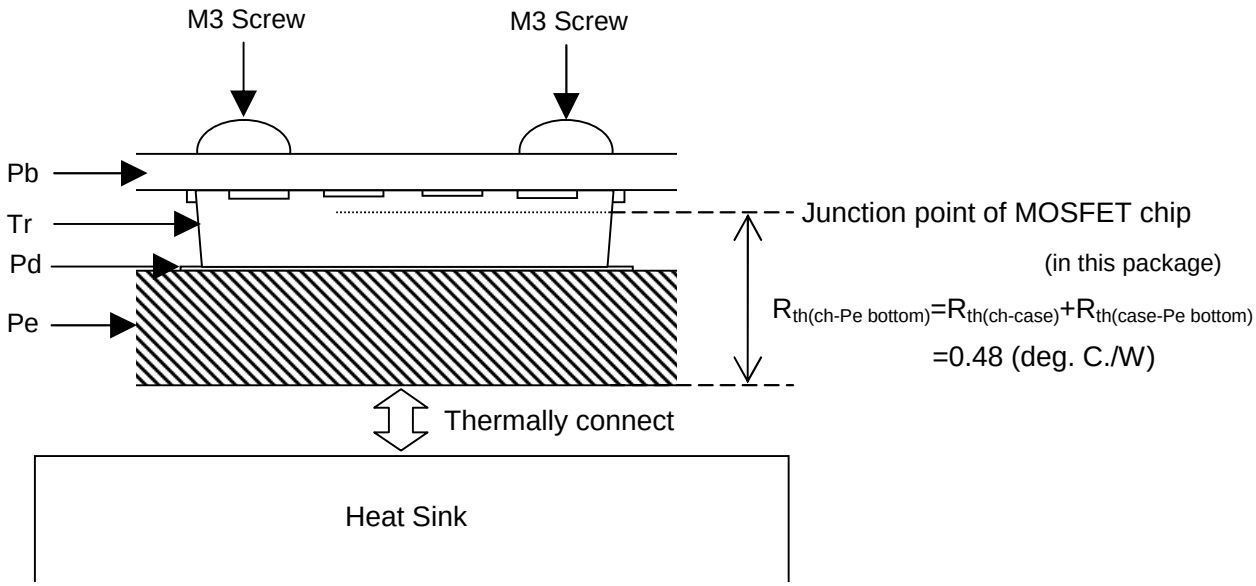
No.	Description				P/N	Qty	Manufacturer
Tr	MOSFET				RD70HUF2	1	Mitsubishi Electric Corporation
C 1	330 pF	3216		200V	GRM31M2C2D331JY21B	1	MURATA MANUFACTURING CO.
C 2	6 pF	1608	Hi-Q	100V	GQM1882C2A6R0DB01	1	MURATA MANUFACTURING CO.
C 3	4 pF	1608	Hi-Q	100V	GQM1882C2A4R0CB01	1	MURATA MANUFACTURING CO.
C 4	100 pF	1608	Hi-Q	50V	GQM1882C1H101JB01	1	MURATA MANUFACTURING CO.
C 5	100 pF	1608	Hi-Q	50V	GQM1882C1H101JB01	1	MURATA MANUFACTURING CO.
C 6	22 pF	1608	Hi-Q	50V	GQM1882C1H220JB01	1	MURATA MANUFACTURING CO.
C 7	22 pF	1608	Hi-Q	50V	GQM1882C1H220JB01	1	MURATA MANUFACTURING CO.
C 8	27 pF	1608	Hi-Q	50V	GQM1882C1H270JB01	1	MURATA MANUFACTURING CO.
C 9	27 pF	1608	Hi-Q	50V	GQM1882C1H270JB01	1	MURATA MANUFACTURING CO.
C 10	1000 pF	1608		50V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 11	1000 pF	1608		50V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 12	100 pF	2012	Hi-Q	50V	GQM2192C1H101JB01	1	MURATA MANUFACTURING CO.
C 13	100 pF	2012	Hi-Q	50V	GQM2192C1H101JB01	1	MURATA MANUFACTURING CO.
C 14	100 pF	2012	Hi-Q	50V	GQM2192C1H101JB01	1	MURATA MANUFACTURING CO.
C 15	100 pF	2012	Hi-Q	50V	GQM2192C1H101JB01	1	MURATA MANUFACTURING CO.
C 16	12 pF	1608	Hi-Q	50V	GQM1882C1H120JB01	1	MURATA MANUFACTURING CO.
C 17	12 pF	1608	Hi-Q	50V	GQM1882C1H120JB01	1	MURATA MANUFACTURING CO.
C 18	1000 pF	1608	Hi-Q	50V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 19	1000 pF	1608	Hi-Q	50V	GRM1882C1H102JA01	1	MURATA MANUFACTURING CO.
C 20	39 pF	2012	Hi-Q	50V	GQM2192C1H390JB01	1	MURATA MANUFACTURING CO.
C 21	39 pF	2012	Hi-Q	50V	GQM2192C1H390JB01	1	MURATA MANUFACTURING CO.
C 22	36 pF	2012	Hi-Q	50V	GQM2192C1H360JB01	1	MURATA MANUFACTURING CO.
C 23	36 pF	2012	Hi-Q	50V	GQM2192C1H360JB01	1	MURATA MANUFACTURING CO.
C 24	10 pF	2012	Hi-Q	100V	GQM2192C2A100JB01	1	MURATA MANUFACTURING CO.
C 25	10 pF	2012	Hi-Q	100V	GQM2192C2A100JB01	1	MURATA MANUFACTURING CO.
C 26	24 pF	2012	Hi-Q	50V	GQM2192C1H240JB01	1	MURATA MANUFACTURING CO.
C 27	24 pF	2012	Hi-Q	50V	GQM2192C1H240JB01	1	MURATA MANUFACTURING CO.
C 28	3.6 pF	2012	Hi-Q	100V	GQM2193C2A3R6CB01	1	MURATA MANUFACTURING CO.
C 29	3.6 pF	2012	Hi-Q		GQM2193C2A3R6CB01	1	MURATA MANUFACTURING CO.
C 30	1 pF	2012	Hi-Q		GQM2194C2A1R0CB01	1	MURATA MANUFACTURING CO.
C 31	1 pF	2012	Hi-Q		GQM2194C2A1R0CB01	1	MURATA MANUFACTURING CO.
C 32	9 pF	2012	Hi-Q		GQM2192C2A9R0DB01	1	MURATA MANUFACTURING CO.
C 33	330 pF	3216		200V	GRM31M2C2D331JY21B	1	MURATA MANUFACTURING CO.
C 34	1000 pF	2012		100V	GRM2162C2A102JA01	1	MURATA MANUFACTURING CO.
C 35	1000 pF	2012		100V	GRM2162C2A102JA01	1	MURATA MANUFACTURING CO.
C 36	220 uF			35V	EEUFC1V221	1	Panasonic Corporation
L 1	25 nH *	Diameter: Wire=0.8mm Inside=2.2mm T/N of coils=5				1	YC CORPORATION Co.,Ltd.
R 1	2.2 ohm	2012			RPC10T2R2J	1	TAIYOSHA ELECTRIC CO.
R 2	100 ohm	2012			RPC10T101J	1	TAIYOSHA ELECTRIC CO.
R 3	100 ohm	2012			RPC10T101J	1	TAIYOSHA ELECTRIC CO.
R 4	2.2k ohm	1608			RPC05T222J	1	TAIYOSHA ELECTRIC CO.
R 5	2.2k ohm	1608			RPC05T222J	1	TAIYOSHA ELECTRIC CO.
Pb	PCB				MS3A0200	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+5.5W) 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

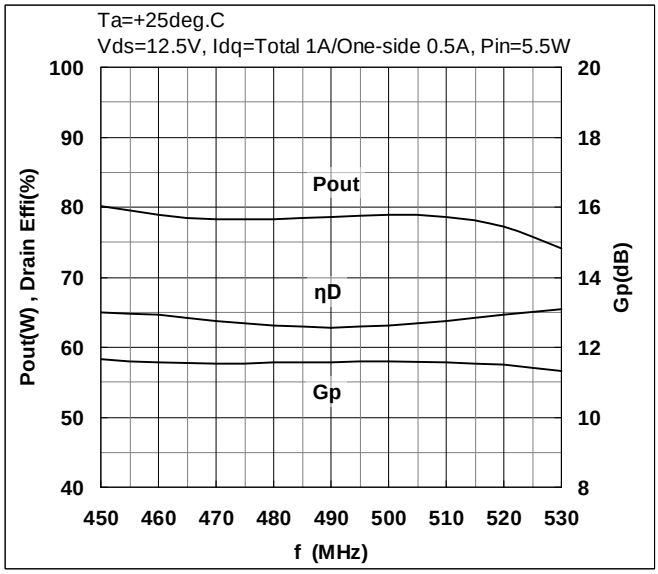
it is preferable that the thermal resistance of the heat sink is much smaller than 0.88 deg. C./W.

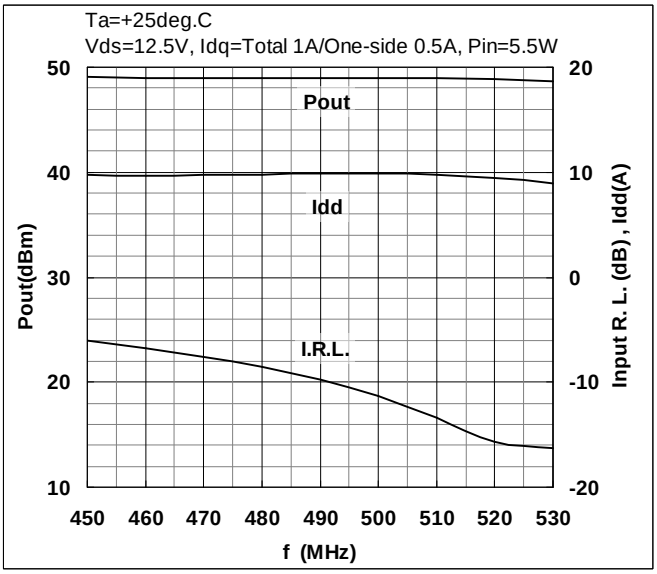
For assembly method including relevant precaution, refer to AN-GEN-070

6. Typical RF Characteristics

6-1. Frequency vs.

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



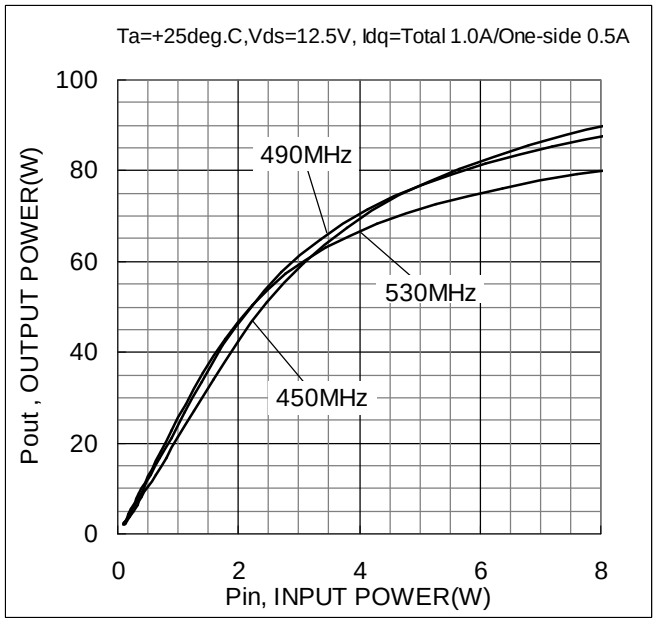


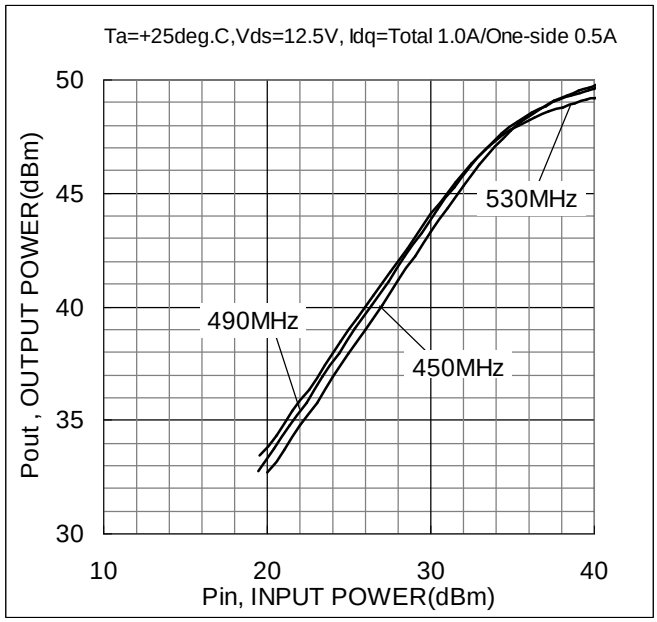
Ta=+25deg. C., Vds=12.5V, Idq=Total 1.0A/One-side 0.5A, Pin=5.5W

Freq.	Vgg1	Vgg2	Pin		Pout		Gp	ID(RF)	ηadd	ηD	I.R.L.
(MHz)	(V)	(V)	(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(%)	(dB)
450	2.63	2.63	37.4	5.5	49.0	80.2	11.7	9.76	60.6	65.0	-6.0
460	2.63	2.63	37.4	5.5	49.0	78.9	11.6	9.66	60.1	64.6	-6.7
470	2.63	2.63	37.4	5.5	48.9	78.2	11.5	9.73	59.2	63.7	-7.6
480	2.63	2.63	37.4	5.5	48.9	78.3	11.6	9.81	58.8	63.2	-8.6
490	2.63	2.63	37.4	5.5	49.0	78.6	11.6	9.91	58.4	62.8	-9.8
500	2.63	2.63	37.4	5.5	49.0	79.0	11.6	9.91	58.7	63.1	-11.3
510	2.63	2.63	37.4	5.5	49.0	78.6	11.6	9.78	59.2	63.6	-13.4
520	2.63	2.63	37.4	5.5	48.9	77.1	11.5	9.45	60.0	64.6	-15.7
530	2.63	2.63	37.4	5.5	48.7	74.2	11.3	8.96	60.6	65.5	-16.3

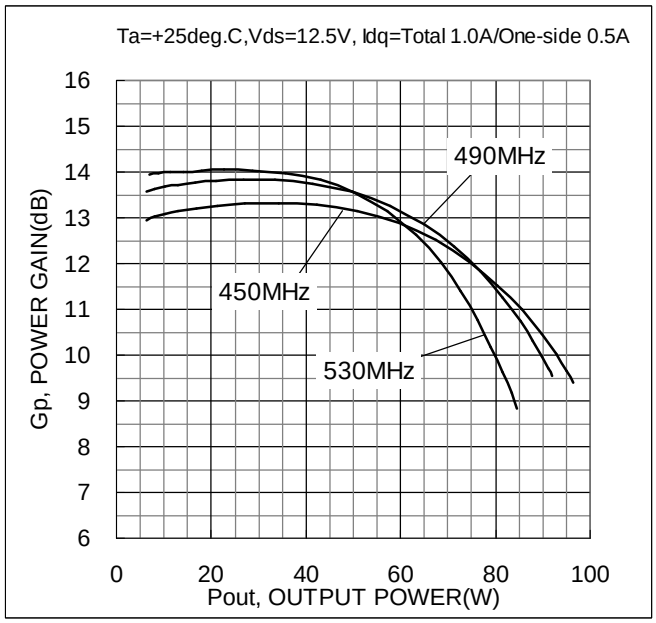
6-2. RF Power vs.

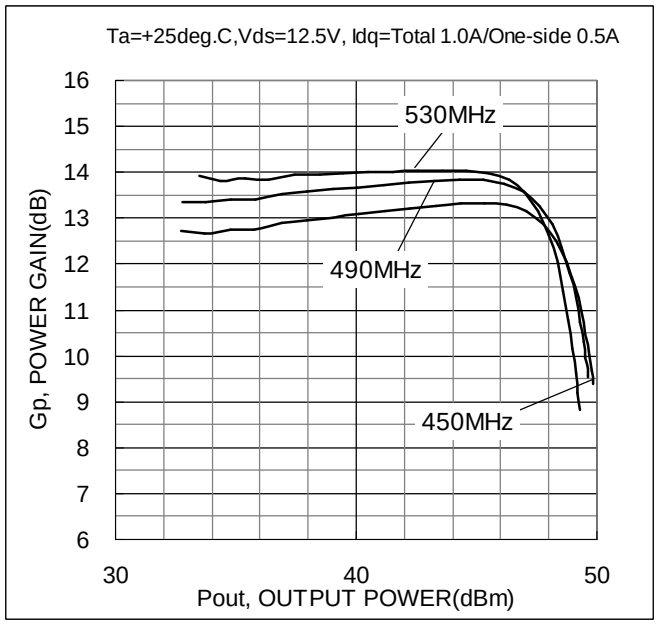
INPUT POWER



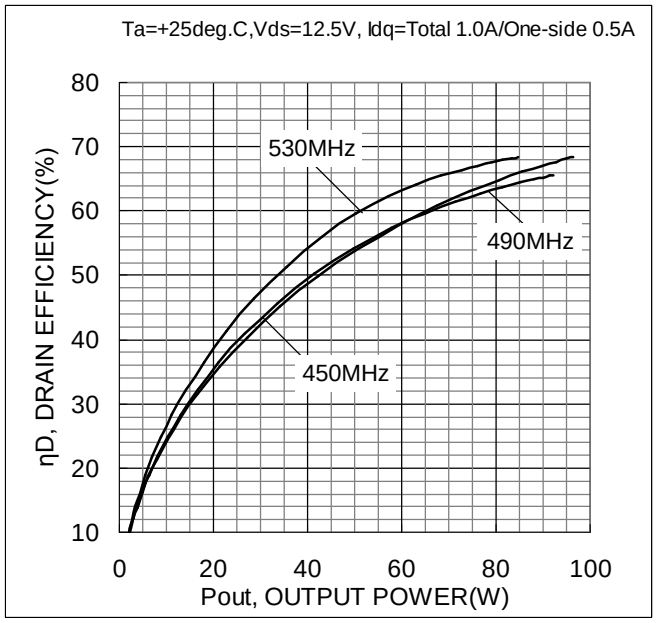


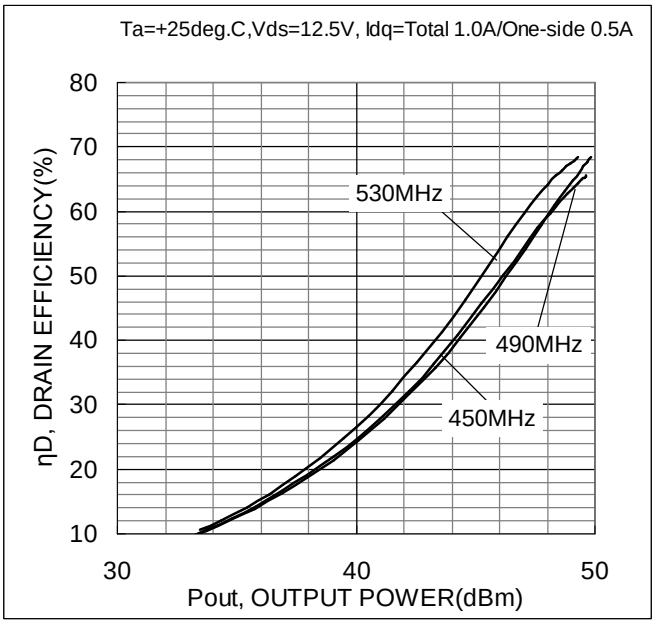
POWER GAIN



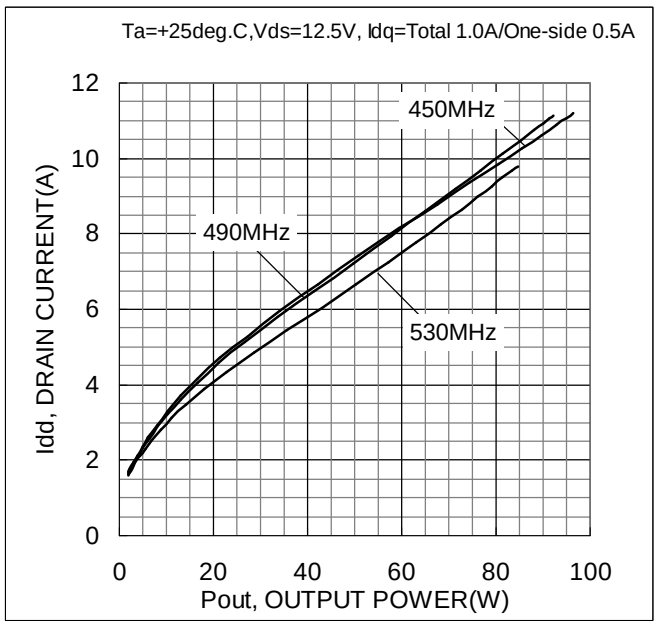


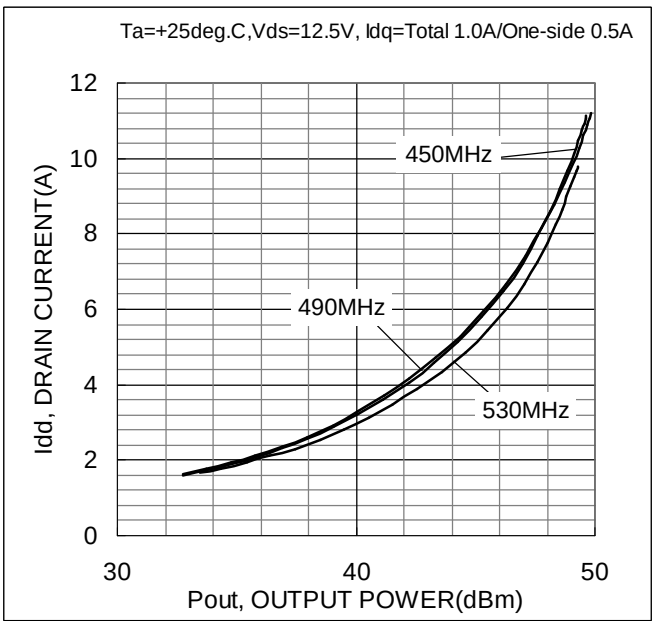
DRAIN EFFICIENCY



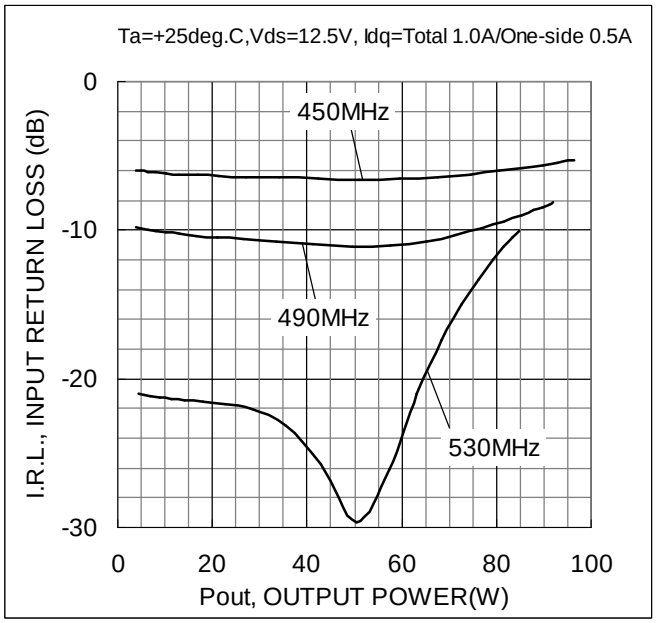


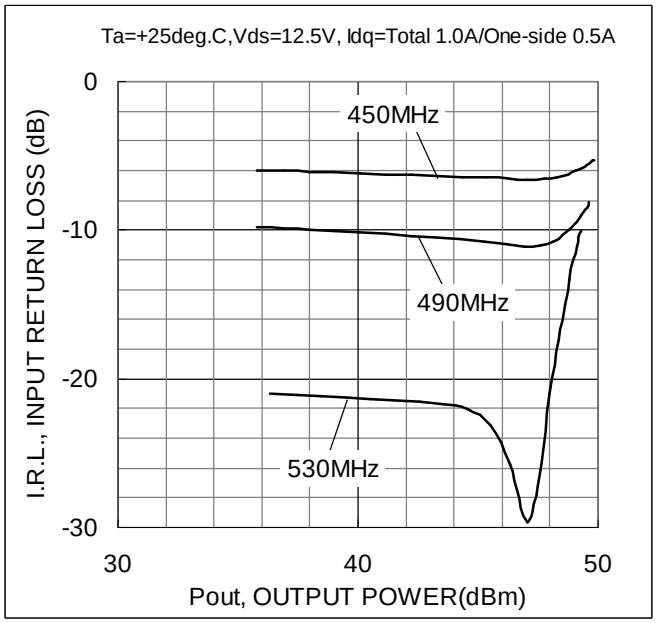
DRAIN CURRENT





INPUT RETURN LOSS





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

450MHz	Vgg1	Vgg2	Pin		Pout		Gp	ID(RF)	ηadd	ηD	I.R.L.
	(V)	(V)	(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(%)	(dB)
	2.63	2.63	20.0	0.10	32.7	1.9	12.7	1.61	8.6	9.1	-5.8
	2.63	2.63	21.0	0.13	33.7	2.3	12.7	1.76	9.9	10.4	-5.9
	2.63	2.63	22.0	0.16	34.8	3.0	12.8	1.93	11.6	12.2	-5.9
	2.63	2.63	23.0	0.20	35.8	3.8	12.8	2.13	13.2	13.9	-6.0
	2.63	2.63	24.0	0.25	36.9	4.9	12.9	2.35	15.5	16.4	-6.0
	2.63	2.63	25.0	0.32	38.0	6.2	13.0	2.61	17.8	18.7	-6.1
	2.63	2.63	26.0	0.40	39.0	8.0	13.0	2.93	20.3	21.4	-6.1
	2.63	2.63	27.0	0.50	40.1	10.2	13.1	3.29	23.3	24.5	-6.2
	2.63	2.63	28.0	0.63	41.2	13.1	13.1	3.70	26.5	27.8	-6.2
	2.63	2.63	29.0	0.80	42.2	16.8	13.2	4.16	30.1	31.7	-6.3
	2.63	2.63	30.0	1.01	43.3	21.4	13.3	4.70	34.1	35.8	-6.3
	2.63	2.63	31.0	1.27	44.3	27.1	13.3	5.29	38.5	40.4	-6.4
	2.63	2.63	32.0	1.59	45.3	34.1	13.3	5.95	43.1	45.2	-6.5
	2.63	2.63	33.0	1.99	46.3	42.3	13.3	6.68	47.6	50.0	-6.6
	2.63	2.63	33.9	2.47	47.1	51.0	13.1	7.43	51.5	54.2	-6.6
	2.63	2.63	34.9	3.07	47.8	59.6	12.9	8.14	54.8	57.8	-6.5
	2.63	2.63	35.8	3.79	48.3	67.5	12.5	8.78	57.4	60.8	-6.4
	2.63	2.63	36.7	4.66	48.7	74.5	12.0	9.35	59.1	63.1	-6.2
	2.63	2.63	37.5	5.67	49.1	80.5	11.5	9.85	60.2	64.7	-6.0
	2.63	2.63	38.3	6.81	49.3	85.6	11.0	10.26	60.8	66.1	-5.8
	2.63	2.63	39.1	8.06	49.5	89.8	10.5	10.61	61.0	67.0	-5.6
	2.63	2.63	39.7	9.24	49.7	92.8	10.0	10.88	60.9	67.7	-5.5
	2.63	2.63	40.1	10.25	49.8	94.9	9.7	11.05	60.8	68.1	-5.3
	2.63	2.63	40.4	11.09	49.8	96.5	9.4	11.19	60.5	68.4	-5.3

490MHz

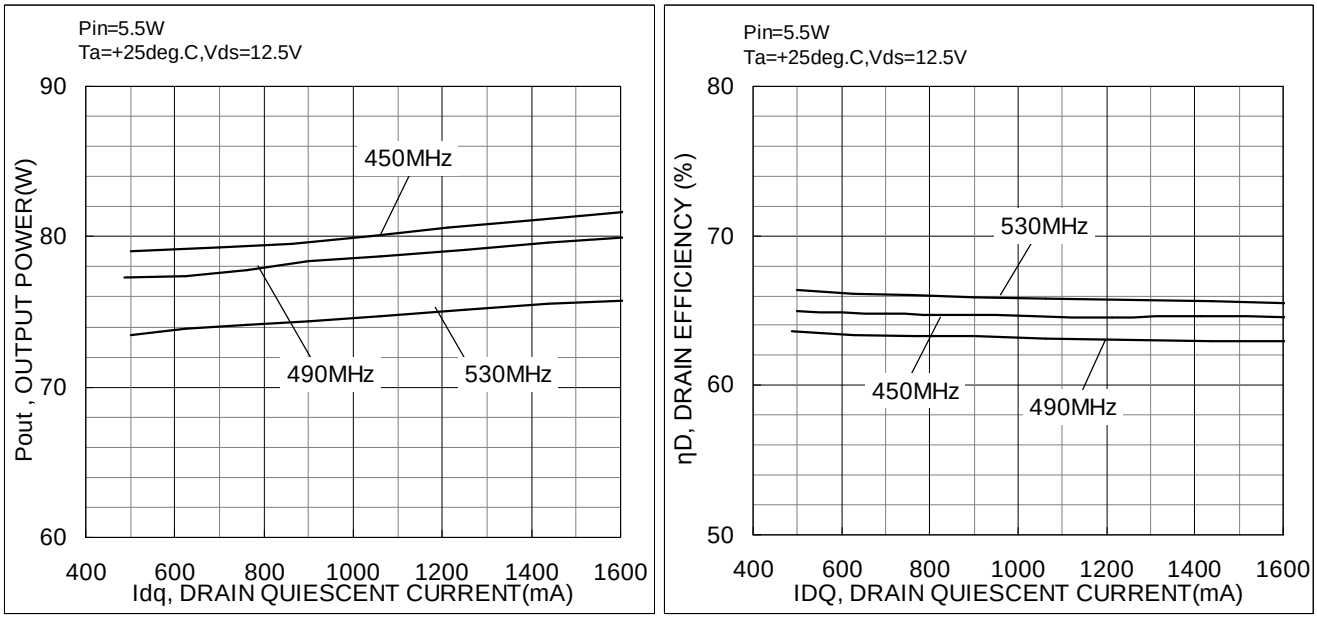
Vgg1	Vgg2	Pin		Pout		Gp	ID(RF)	ηadd	ηD	I.R.L.
(V)	(V)	(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(%)	(dB)
2.63	2.63	20.4	0.11	33.7	2.4	13.3	1.74	10.2	10.7	-9.7
2.63	2.63	21.4	0.14	34.8	3.0	13.4	1.90	11.9	12.5	-9.8
2.63	2.63	22.4	0.17	35.8	3.8	13.4	2.09	13.6	14.2	-9.8
2.63	2.63	23.4	0.22	36.9	4.9	13.5	2.31	15.9	16.6	-9.9
2.63	2.63	24.4	0.27	38.0	6.3	13.6	2.58	18.2	19.0	-10.0
2.63	2.63	25.4	0.35	39.0	8.0	13.6	2.86	20.9	21.9	-10.1
2.63	2.63	26.4	0.44	40.1	10.2	13.7	3.21	23.8	24.9	-10.2
2.63	2.63	27.4	0.55	41.1	13.0	13.7	3.61	27.1	28.3	-10.3
2.63	2.63	28.4	0.70	42.2	16.6	13.8	4.06	30.8	32.1	-10.4
2.63	2.63	29.4	0.88	43.2	21.1	13.8	4.56	34.9	36.4	-10.5
2.63	2.63	30.4	1.11	44.3	26.7	13.8	5.14	39.2	40.9	-10.6
2.63	2.63	31.4	1.39	45.3	33.5	13.8	5.78	43.8	45.7	-10.8
2.63	2.63	32.4	1.74	46.2	41.4	13.8	6.49	48.2	50.3	-11.0
2.63	2.63	33.4	2.18	47.0	49.7	13.6	7.23	51.9	54.2	-11.1
2.63	2.63	34.3	2.72	47.6	57.7	13.3	7.94	54.7	57.4	-11.0
2.63	2.63	35.3	3.37	48.1	65.0	12.9	8.60	56.6	59.7	-10.8
2.63	2.63	36.2	4.14	48.5	71.3	12.4	9.18	57.9	61.5	-10.4
2.63	2.63	37.0	5.05	48.9	76.8	11.8	9.69	58.6	62.7	-9.9
2.63	2.63	37.8	6.09	49.1	81.5	11.3	10.13	59.0	63.7	-9.4
2.63	2.63	38.6	7.19	49.3	85.2	10.7	10.48	59.0	64.5	-9.0
2.63	2.63	39.1	8.18	49.4	87.9	10.3	10.74	58.9	64.9	-8.7
2.63	2.63	39.6	9.05	49.5	89.9	10.0	10.93	58.7	65.2	-8.4
2.63	2.63	39.9	9.74	49.6	91.3	9.7	11.05	58.5	65.5	-8.3
2.63	2.63	40.1	10.23	49.6	92.1	9.5	11.14	58.3	65.6	-8.1

530MHz

Vgg1	Vgg2	Pin		Pout		Gp	ID(RF)	ηadd	ηD	I.R.L.
(V)	(V)	(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(%)	(dB)
2.63	2.63	19.5	0.09	33.5	2.2	13.9	1.65	10.1	10.5	-20.5
2.63	2.63	20.5	0.11	34.3	2.7	13.8	1.78	11.5	12.0	-21.4
2.63	2.63	21.5	0.14	35.4	3.5	13.9	1.93	13.5	14.1	-20.9
2.63	2.63	22.5	0.18	36.4	4.3	13.8	2.10	15.4	16.1	-21.0
2.63	2.63	23.5	0.22	37.5	5.6	13.9	2.30	18.2	19.0	-21.1
2.63	2.63	24.5	0.28	38.5	7.0	14.0	2.54	20.9	21.7	-21.2
2.63	2.63	25.5	0.36	39.5	8.9	14.0	2.80	23.9	24.9	-21.3
2.63	2.63	26.5	0.45	40.5	11.2	14.0	3.11	27.2	28.3	-21.3
2.63	2.63	27.5	0.56	41.5	14.2	14.0	3.48	30.8	32.1	-21.4
2.63	2.63	28.5	0.71	42.6	18.0	14.0	3.88	35.1	36.5	-21.5
2.63	2.63	29.5	0.90	43.6	22.8	14.0	4.34	39.7	41.3	-21.7
2.63	2.63	30.5	1.13	44.6	28.7	14.0	4.86	44.5	46.4	-22.1
2.63	2.63	31.5	1.42	45.5	35.5	14.0	5.44	49.3	51.4	-23.1
2.63	2.63	32.5	1.78	46.3	43.0	13.8	6.05	53.7	56.0	-25.8
2.63	2.63	33.5	2.23	47.0	50.4	13.6	6.66	57.0	59.6	-29.7
2.63	2.63	34.4	2.78	47.6	57.3	13.1	7.25	59.3	62.3	-26.1
2.63	2.63	35.4	3.45	48.0	63.2	12.6	7.78	60.7	64.2	-21.0
2.63	2.63	36.3	4.29	48.4	68.4	12.0	8.25	61.4	65.5	-17.4
2.63	2.63	37.2	5.26	48.6	72.7	11.4	8.65	61.6	66.4	-15.0
2.63	2.63	38.0	6.37	48.8	76.1	10.8	8.99	61.4	67.0	-13.3
2.63	2.63	38.8	7.62	49.0	79.1	10.2	9.28	61.0	67.5	-12.0
2.63	2.63	39.5	8.89	49.1	81.5	9.6	9.50	60.5	67.9	-11.1
2.63	2.63	40.0	10.06	49.2	83.3	9.2	9.66	60.0	68.2	-10.5
2.63	2.63	40.4	11.09	49.3	84.7	8.8	9.79	59.5	68.5	-10.0

6-3. Drain Quiescent Current vs.

OUTPUT POWER and DRAIN EFFICIENCY



Ta=+25deg. C., Vds=12.5V, Pin=5.5W

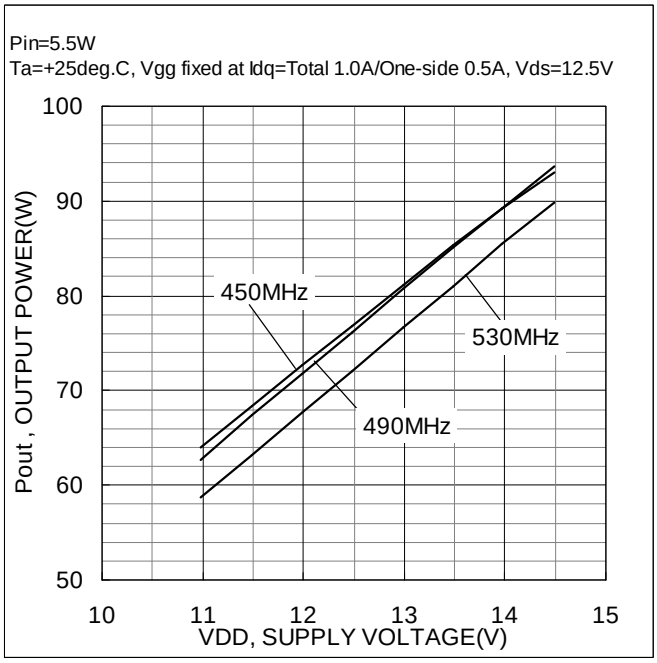
450MHz	Vgg1	Vgg2	Idq	Pin		Pout		Idd	ηD	ηadd	Gain	I.R.L.
	(V)	(V)	(mA)	(dBm)	(W)	(dBm)	(W)	(A)	(%)	(%)	(dB)	(dB)
	2.55	2.56	500	37.5	5.6	49.0	79.0	9.64	65.0	60.0	11.5	-6.0
	2.55	2.56	700	37.5	5.6	49.0	79.3	9.64	64.8	60.2	11.5	-6.0
	2.58	2.57	863	37.5	5.6	49.0	79.6	9.69	64.7	60.2	11.5	-6.0
	2.60	2.60	1038	37.5	5.6	49.0	80.0	9.76	64.6	60.1	11.5	-6.0
	2.63	2.63	1213	37.5	5.6	49.1	80.6	9.84	64.6	60.1	11.6	-6.0
	2.65	2.64	1413	37.5	5.6	49.1	81.1	9.90	64.6	60.1	11.6	-6.0
	2.68	2.67	1625	37.5	5.6	49.1	81.7	9.98	64.6	60.1	11.6	-6.1
	2.70	2.70	1850	37.5	5.6	49.1	82.2	10.04	64.6	60.2	11.7	-6.1

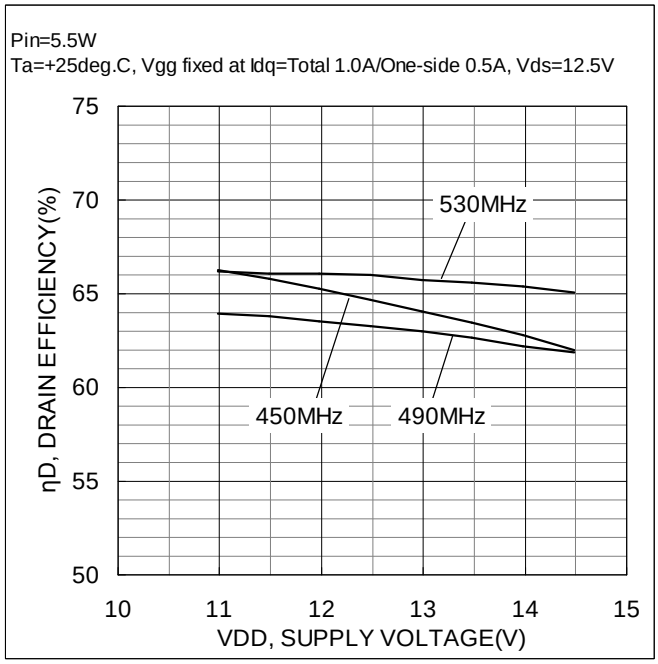
490MHz	Vgg1	Vgg2	Idq	Pin		Pout		Idd	ηD	ηadd	Gain	I.R.L.
	(V)	(V)	(mA)	(dBm)	(W)	(dBm)	(W)	(A)	(%)	(%)	(dB)	(dB)
	2.55	2.56	488	37.4	5.5	48.9	77.2	9.56	63.7	59.1	11.5	-9.6
	2.55	2.56	625	37.4	5.5	48.9	77.4	9.63	63.4	58.9	11.5	-9.6
	2.58	2.57	763	37.4	5.5	48.9	77.8	9.69	63.3	58.8	11.5	-9.6
	2.60	2.60	900	37.4	5.5	48.9	78.3	9.76	63.2	58.8	11.5	-9.7
	2.63	2.63	1063	37.4	5.5	49.0	78.7	9.82	63.1	58.7	11.6	-9.7
	2.65	2.64	1250	37.4	5.5	49.0	79.1	9.90	63.0	58.6	11.6	-9.7
	2.68	2.67	1438	37.4	5.5	49.0	79.6	9.96	63.0	58.6	11.6	-9.7
	2.70	2.70	1650	37.4	5.5	49.0	80.0	10.03	62.9	58.6	11.6	-9.7

530MHz	Vgg1	Vgg2	Idq	Pin		Pout		Idd	ηD	ηadd	Gain	I.R.L.
	(V)	(V)	(mA)	(dBm)	(W)	(dBm)	(W)	(A)	(%)	(%)	(dB)	(dB)
	2.55	2.56	500	37.4	5.5	48.7	73.4	8.71	66.3	61.4	11.3	-16.0
	2.55	2.56	625	37.4	5.5	48.7	73.9	8.79	66.2	61.2	11.3	-16.0
	2.58	2.57	763	37.4	5.5	48.7	74.1	8.84	66.0	61.1	11.3	-16.1
	2.60	2.60	900	37.4	5.5	48.7	74.4	8.89	65.9	61.0	11.3	-16.2
	2.63	2.63	1063	37.4	5.5	48.7	74.7	8.94	65.8	61.0	11.3	-16.2
	2.65	2.64	1250	37.4	5.5	48.8	75.1	9.00	65.7	60.9	11.4	-16.2
	2.68	2.67	1438	37.4	5.5	48.8	75.5	9.06	65.6	60.8	11.4	-16.2
	2.70	2.70	1650	37.4	5.5	48.8	75.8	9.11	65.5	60.7	11.4	-16.3

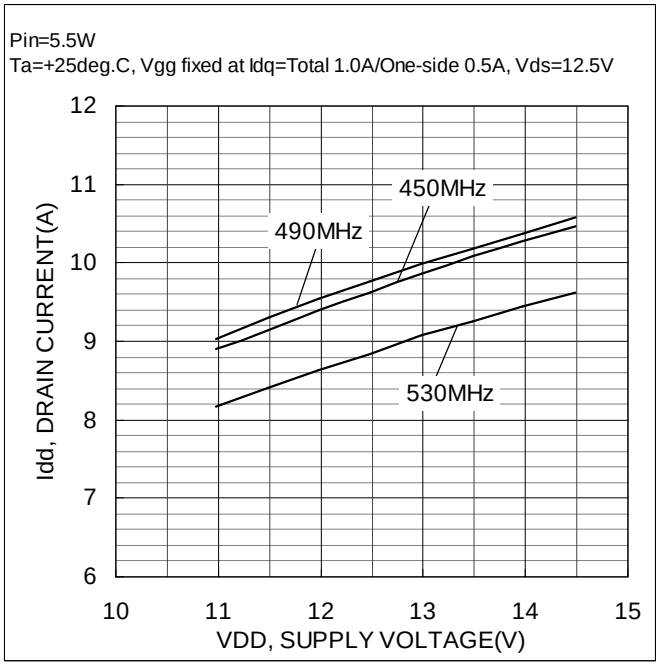
6-4. DC Power Supply vs.

OUTPUT POWER and DRAIN EFFICIENCY





DRAIN CURRENT



Ta=+25deg. C., Pin=5.5W

450MHz	Vgg1	Vgg2	Vdd	Idq	Pin		Pout		Idd	ηD	ηadd	Gain	I.R.L.
	(V)	(V)	(V)	(mA)	(dBm)	(W)	(dBm)	(W)	(A)	(%)	(%)	(dB)	(dB)
	2.63	2.63	10.98	0.988	37.4	5.5	48.1	64.0	8.90	66.3	60.6	10.7	-5.7
	2.63	2.63	11.49	1.05	37.4	5.5	48.3	68.4	9.15	65.8	60.5	11.0	-5.8
	2.63	2.63	11.98	1.088	37.4	5.5	48.6	72.7	9.40	65.3	60.3	11.2	-5.9
	2.63	2.63	12.48	1.125	37.4	5.5	48.9	76.8	9.63	64.7	60.0	11.5	-6.0
	2.63	2.63	12.99	1.15	37.4	5.5	49.1	81.1	9.86	64.1	59.7	11.7	-6.1
	2.63	2.63	13.48	1.188	37.4	5.5	49.3	85.3	10.09	63.4	59.3	11.9	-6.2
	2.63	2.63	13.98	1.225	37.4	5.5	49.5	89.2	10.28	62.8	58.9	12.1	-6.3
	2.63	2.63	14.49	1.263	37.4	5.5	49.7	93.0	10.46	62.0	58.3	12.3	-6.4

490MHz	Vgg1	Vgg2	Vdd	Idq	Pin		Pout		Idd	ηD	ηadd	Gain	I.R.L.
	(V)	(V)	(V)	(mA)	(dBm)	(W)	(dBm)	(W)	(A)	(%)	(%)	(dB)	(dB)
	2.63	2.63	10.98	0.975	37.4	5.5	48.0	62.7	9.04	64.0	58.4	10.6	-8.8
	2.63	2.63	11.49	1.038	37.4	5.5	48.3	67.4	9.30	63.8	58.6	10.9	-9.0
	2.63	2.63	11.98	1.088	37.4	5.5	48.6	71.7	9.54	63.5	58.6	11.1	-9.3
	2.63	2.63	12.48	1.125	37.4	5.5	48.8	76.1	9.76	63.2	58.7	11.4	-9.5
	2.63	2.63	12.99	1.15	37.4	5.5	49.1	80.8	9.99	63.0	58.7	11.7	-9.8
	2.63	2.63	13.48	1.188	37.4	5.5	49.3	85.0	10.18	62.7	58.6	11.9	-10.0
	2.63	2.63	13.98	1.225	37.4	5.5	49.5	89.2	10.38	62.2	58.4	12.1	-10.2
	2.63	2.63	14.49	1.263	37.4	5.5	49.7	93.7	10.58	61.8	58.2	12.3	-10.4

530MHz	Vgg1	Vgg2	Vdd	Idq	Pin		Pout		Idd	ηD	ηadd	Gain	I.R.L.
	(V)	(V)	(V)	(mA)	(dBm)	(W)	(dBm)	(W)	(A)	(%)	(%)	(dB)	(dB)
	2.63	2.63	10.98	0.975	37.4	5.5	47.7	58.8	8.18	66.2	60.0	10.3	-12.6
	2.63	2.63	11.49	1.038	37.4	5.5	48.0	63.2	8.41	66.0	60.3	10.6	-13.5
	2.63	2.63	11.98	1.075	37.4	5.5	48.3	67.6	8.64	66.1	60.7	10.9	-14.4
	2.63	2.63	12.48	1.113	37.4	5.5	48.6	72.0	8.84	66.0	61.0	11.2	-15.4
	2.63	2.63	12.99	1.138	37.4	5.5	48.8	76.7	9.07	65.8	61.0	11.4	-16.5
	2.63	2.63	13.48	1.175	37.4	5.5	49.1	81.0	9.25	65.6	61.1	11.7	-17.8
	2.63	2.63	13.98	1.213	37.4	5.5	49.3	85.5	9.45	65.4	61.2	11.9	-19.2
	2.63	2.63	14.49	1.25	37.4	5.5	49.5	89.8	9.63	65.0	61.1	12.1	-21.1