# APPLICATION NOTE

MITSUBISHI ELECTRIC
Silicon RF Power Semiconductors

Document NO. AN-UHF-122
Date : 28th Feb. 2011
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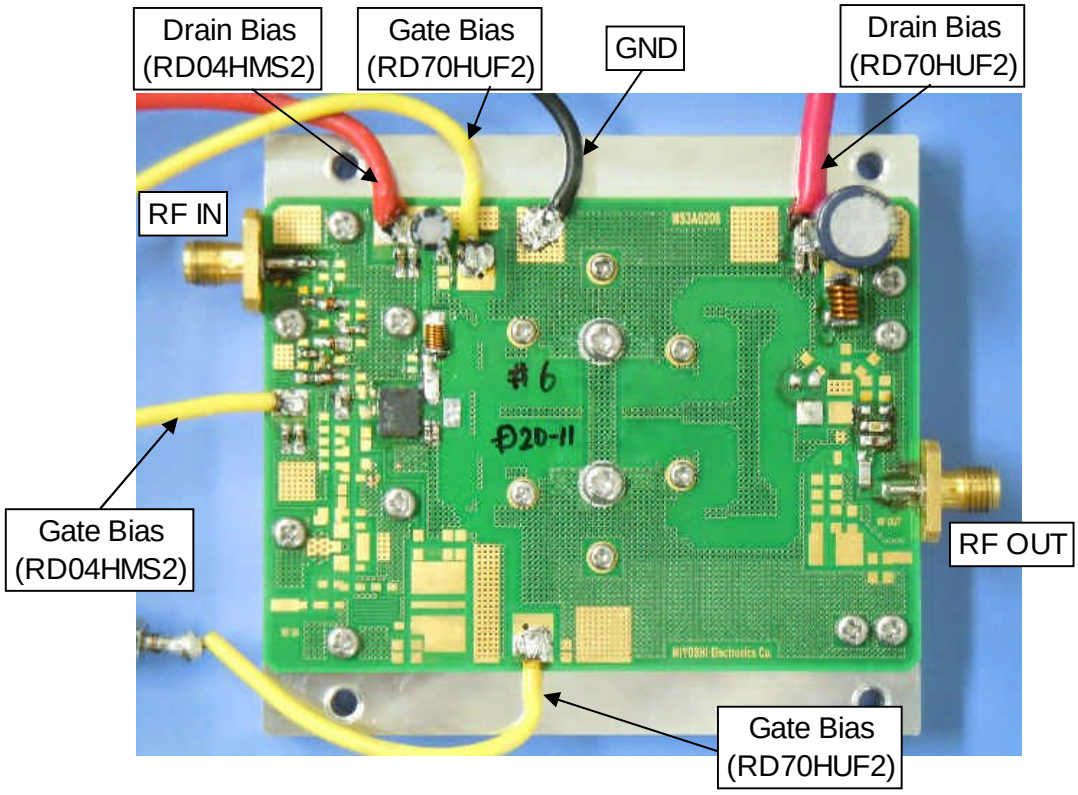
**SUBJECT:** RD04HMS2 & RD70HUF2 two-stage amplifier at f=380-470MHz.(Vdd=12.5V)

**Features:**

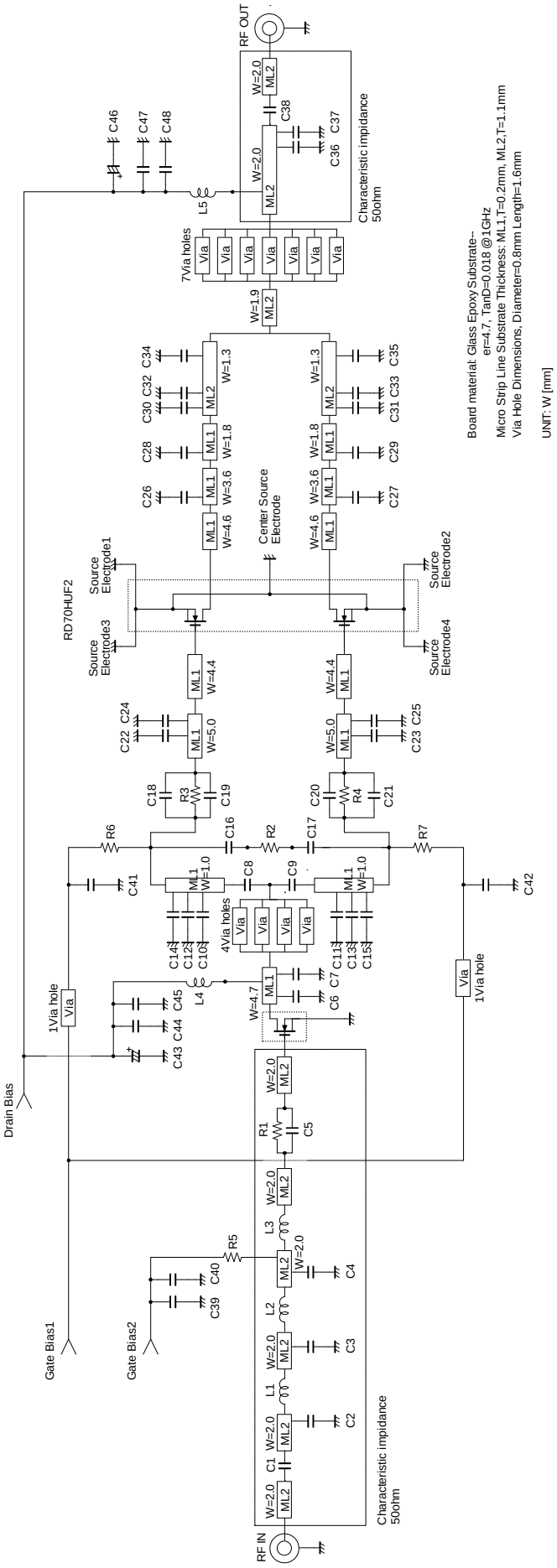
- The evaluation board for RD04HMS2 & RD70HUF2 two-stage amplifier
- Frequency: 380-470MHz
- Vdd: 12.5V
- Input power: 0.2W
- Output power: 79-88W
- Quiescent Current: RD04HMS2 ; 0.1A, RD70HUF2 ; 1A
- Operating Current: 12-13A
- Surface-mounted RF power amplifier structure




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 | 6.2 pF | 1608 | Hi-Q 100 V | GQM1882C2A6R2CB01D | 1 | MURATA MANUFACTURING CO. |
| C 3 | 22 pF | 1608 | Hi-Q 50 V | GQM1882C1H220JB01D | 1 | MURATA MANUFACTURING CO. |
| C 4 | 36 pF | 1608 | Hi-Q 50 V | GQM1882C1H360JB01D | 1 | MURATA MANUFACTURING CO. |
| C 5 | 24 pF | 1608 | Hi-Q 50 V | GQM1882C1H240JB01D | 1 | MURATA MANUFACTURING CO. |
| C 6 | 27 pF | 1608 | Hi-Q 50 V | GQM1882C1H270JB01D | 1 | MURATA MANUFACTURING CO. |
| C 7 | 27 pF | 1608 | Hi-Q 50 V | GQM1882C1H270JB01D | 1 | MURATA MANUFACTURING CO. |
| C 8 | 100 pF | 1608 | 50 V | GRM1882C1H101JA01D | 1 | MURATA MANUFACTURING CO. |
| C 9 | 100 pF | 1608 | 50 V | GRM1882C1H101JA01D | 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 | 62 pF | 2012 | Hi-Q 250 V | GQM2195C2E620JB12D | 1 | MURATA MANUFACTURING CO. |
| C 19 | 62 pF | 2012 | Hi-Q 250 V | GQM2195C2E620JB12D | 1 | MURATA MANUFACTURING CO. |
| C 20 | 62 pF | 2012 | Hi-Q 250 V | GQM2195C2E620JB12D | 1 | MURATA MANUFACTURING CO. |
| C 21 | 62 pF | 2012 | Hi-Q 250 V | GQM2195C2E620JB12D | 1 | MURATA MANUFACTURING CO. |
| C 22 | 8.2 pF | 1608 | Hi-Q 50 V | GQM1882C1H8R2CB01D | 1 | MURATA MANUFACTURING CO. |
| C 23 | 8.2 pF | 1608 | Hi-Q 50 V | GQM1882C1H8R2CB01D | 1 | MURATA MANUFACTURING CO. |
| C 24 | 9.1 pF | 1608 | Hi-Q 50 V | GQM1882C1H9R1CB01D | 1 | MURATA MANUFACTURING CO. |
| C 25 | 9.1 pF | 1608 | Hi-Q 50 V | GQM1882C1H9R1CB01D | 1 | MURATA MANUFACTURING CO. |
| C 26 | 43 pF | 2012 | Hi-Q 250 V | GQM2195C2E430JB12D | 1 | MURATA MANUFACTURING CO. |
| C 27 | 43 pF | 2012 | Hi-Q 250 V | GQM2195C2E430JB12D | 1 | MURATA MANUFACTURING CO. |
| C 28 | 43 pF | 2012 | Hi-Q 250 V | GQM2195C2E430JB12D | 1 | MURATA MANUFACTURING CO. |
| C 29 | 43 pF | 2012 | Hi-Q 250 V | GQM2195C2E430JB12D | 1 | MURATA MANUFACTURING CO. |
| C 30 | 12 pF | 2012 | Hi-Q 250 V | GQM2195C2E120JB12D | 1 | MURATA MANUFACTURING CO. |
| C 31 | 12 pF | 2012 | Hi-Q 250 V | GQM2195C2E120JB12D | 1 | MURATA MANUFACTURING CO. |
| C 32 | 24 pF | 2012 | Hi-Q 250 V | GQM2195C2E240JB12D | 1 | MURATA MANUFACTURING CO. |
| C 33 | 24 pF | 2012 | Hi-Q 250 V | GQM2195C2E240JB12D | 1 | MURATA MANUFACTURING CO. |
| C 34 | 7.5 pF | 2012 | Hi-Q 250 V | GQM2195C2E7R5CB12D | 1 | MURATA MANUFACTURING CO. |
| C 35 | 7.5 pF | 2012 | Hi-Q 250 V | GQM2195C2E7R5CB12D | 1 | MURATA MANUFACTURING CO. |
| C 36 | 2.7 pF | 2012 | Hi-Q 250 V | GQM2195C2E2R7CB12D | 1 | MURATA MANUFACTURING CO. |
| C 37 | 2.7 pF | 2012 | Hi-Q 250 V | GQM2195C2E2R7CB12D | 1 | MURATA MANUFACTURING CO. |
| C 38 | 330 pF | 3216 | 200 V | GRM31M2C2D331JY21B | 1 | MURATA MANUFACTURING CO. |
| C 39 | 10000 pF | 1608 | 50 V | GRM188B11H103KA01 | 1 | MURATA MANUFACTURING CO. |
| C 40 | 1000 pF | 1608 | 50 V | GRM1882C1H102JA01 | 1 | MURATA MANUFACTURING CO. |
| C 41 | 1000 pF | 1608 | 50 V | GRM1882C1H102JA01 | 1 | MURATA MANUFACTURING CO. |
| C 42 | 1000 pF | 1608 | 50 V | GRM1882C1H102JA01 | 1 | MURATA MANUFACTURING CO. |
| C 43 | 22 µF | - | 50 V | H1002 | 1 | NICHICON Corporation |
| C 44 | 10000 pF | 1608 | 50 V | GRM188B11H103KA01 | 1 | MURATA MANUFACTURING CO. |
| C 45 | 1000 pF | 1608 | 50 V | GRM1882C1H102JA01 | 1 | MURATA MANUFACTURING CO. |
| C 46 | 220 µF | - | 35 V | EEUFC1V221 | 1 | Panasonic Corporation |
| C 47 | 910 pF | 2012 | 50 V | GRM2162C1H911JA01D | 1 | MURATA MANUFACTURING CO. |
| C 48 | 910 pF | 2012 | 50 V | GRM2162C1H911JA01D | 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 | 8 nH * | 0.23 mm | 1.1 mm | 2 | 2302S | 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 | 2.2 ohm | 2012 | RPC10T2R2J | 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 | 2 | 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 | - |

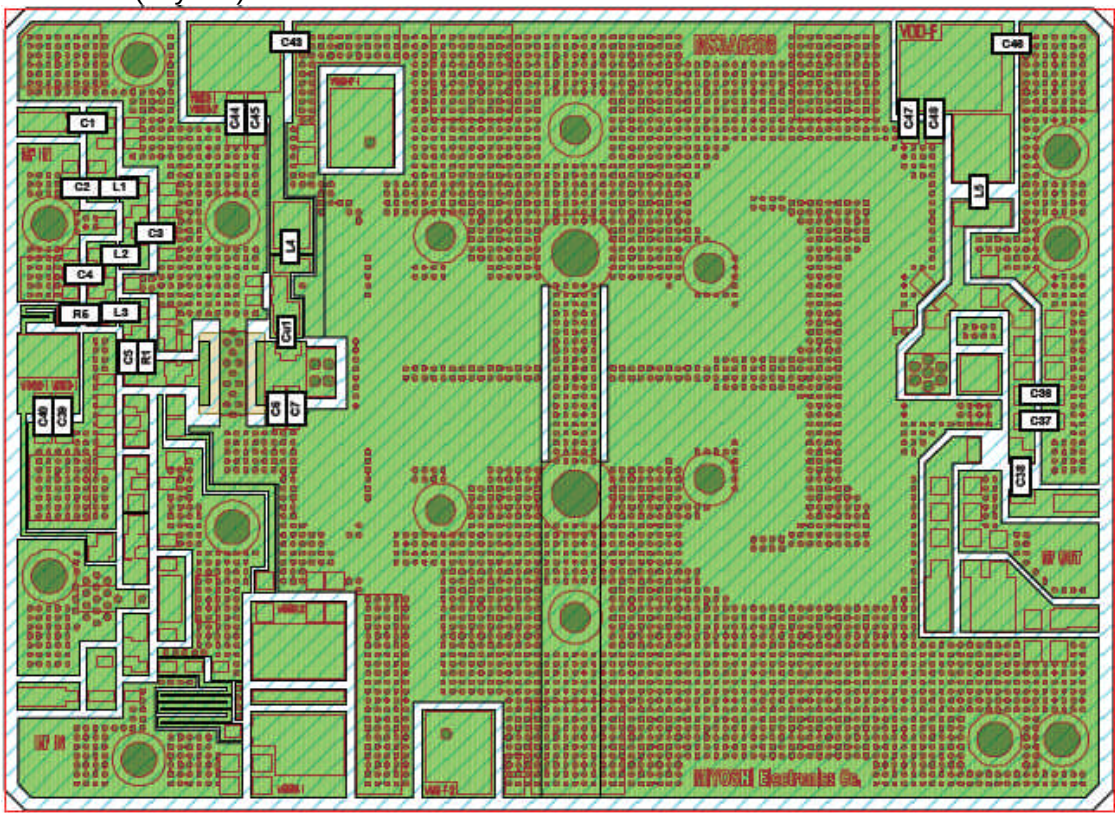
- **Standard Deliverable**

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

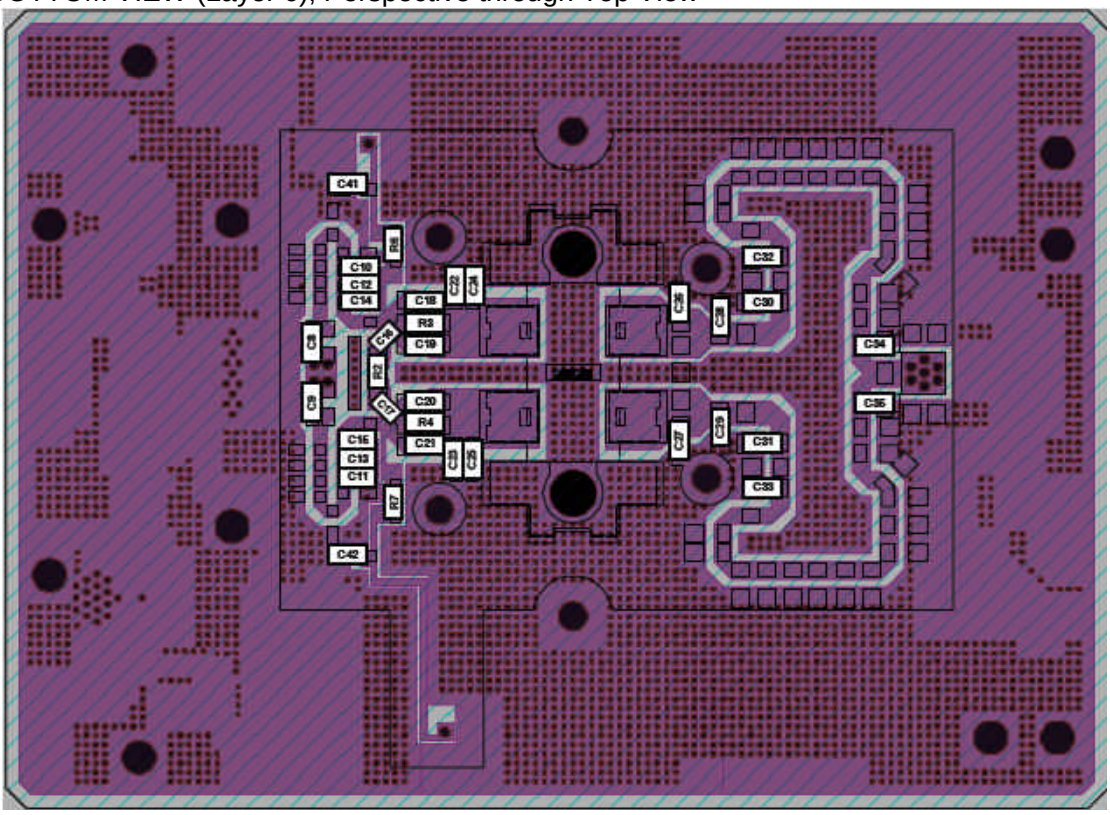
## 3. PCB Layout

BOARD OUTLINE: 82.5*60.0(mm)

TOP VIEW (Layer 1)

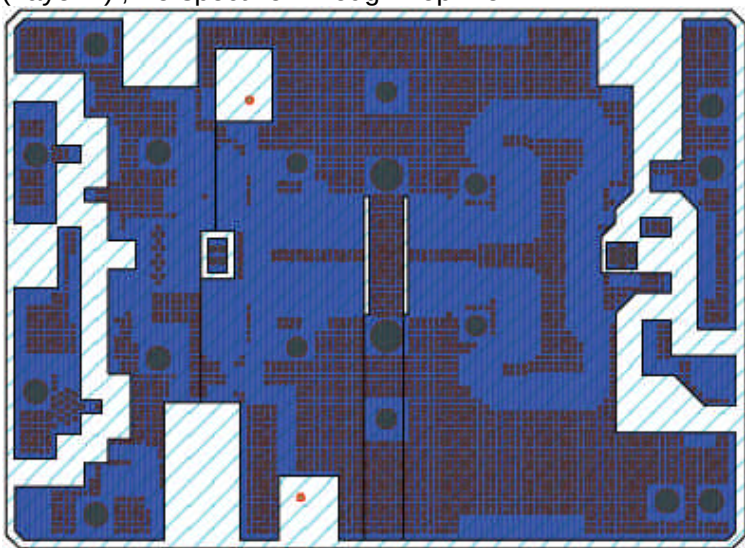



BOTTOM VIEW (Layer 6), Perspective through Top View

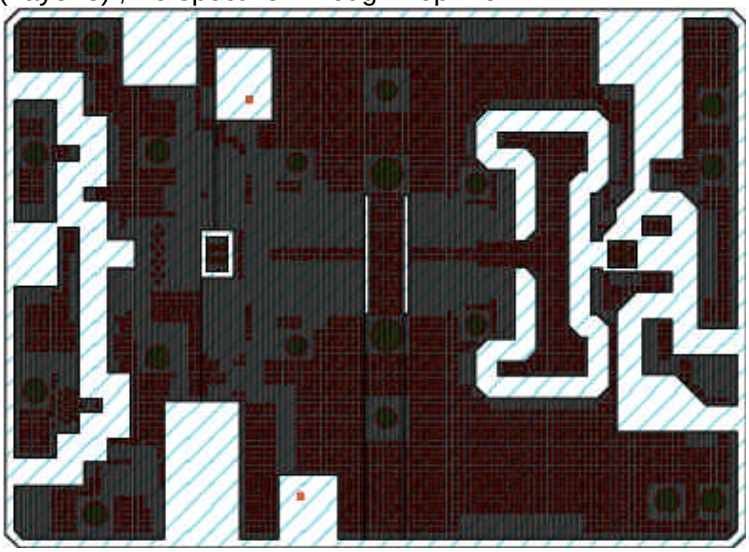


BOARD OUTLINE: 82.5*60.0(mm)

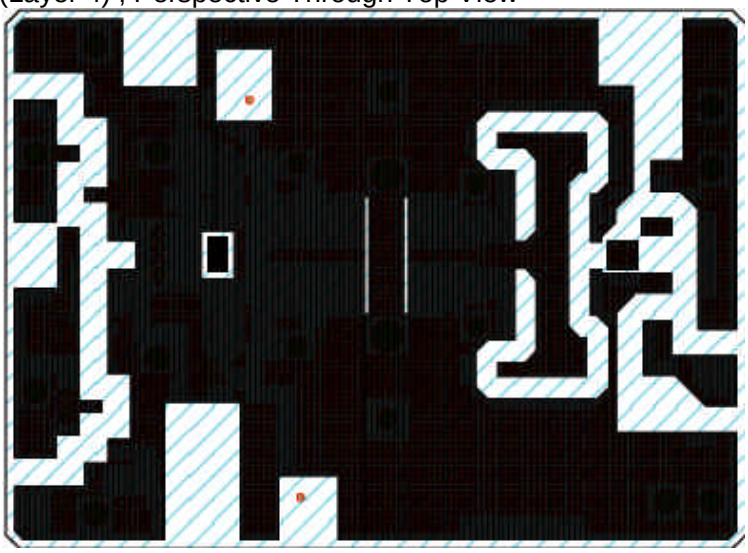
Internal Layer (Layer 2) , Perspective Through Top View



Internal Layer (Layer 3) , Perspective Through Top View

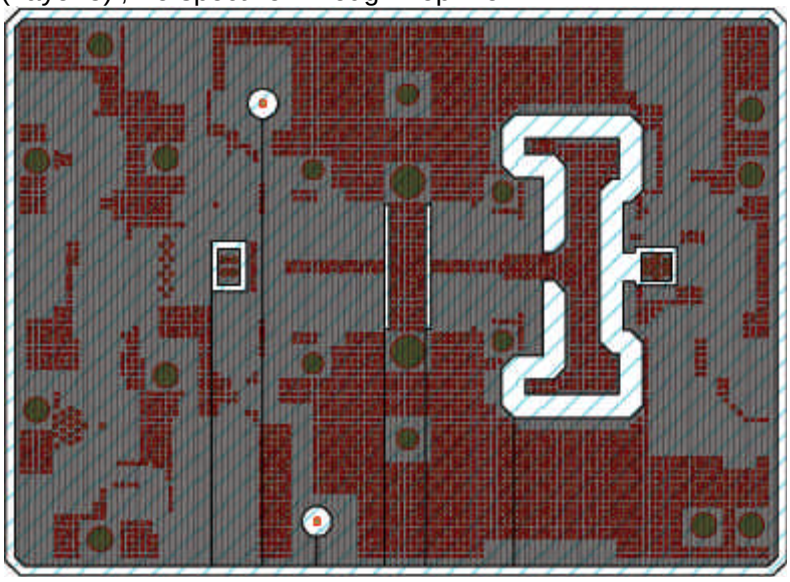


Internal Layer (Layer 4) , Perspective Through Top View



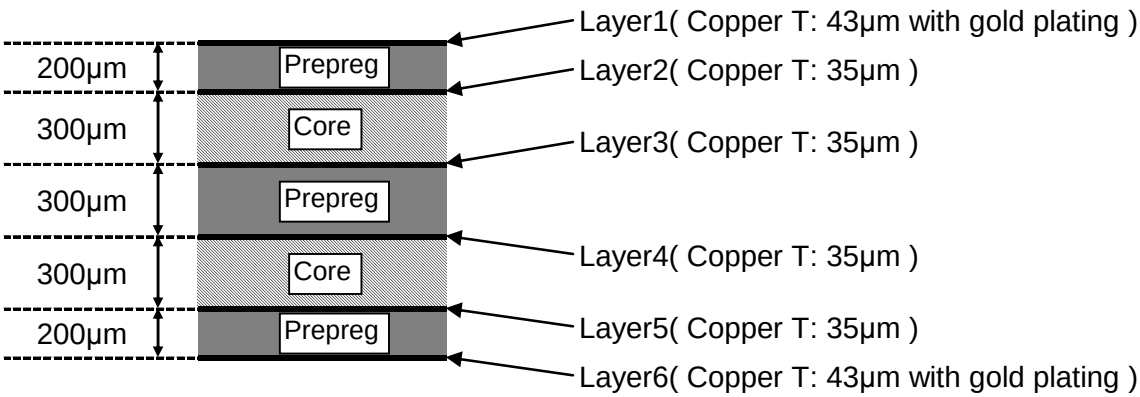
BOARD OUTLINE: 82.5*60.0(mm)

Internal Layer (Layer 5) , Perspective Through Top View



Substrate Condition

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

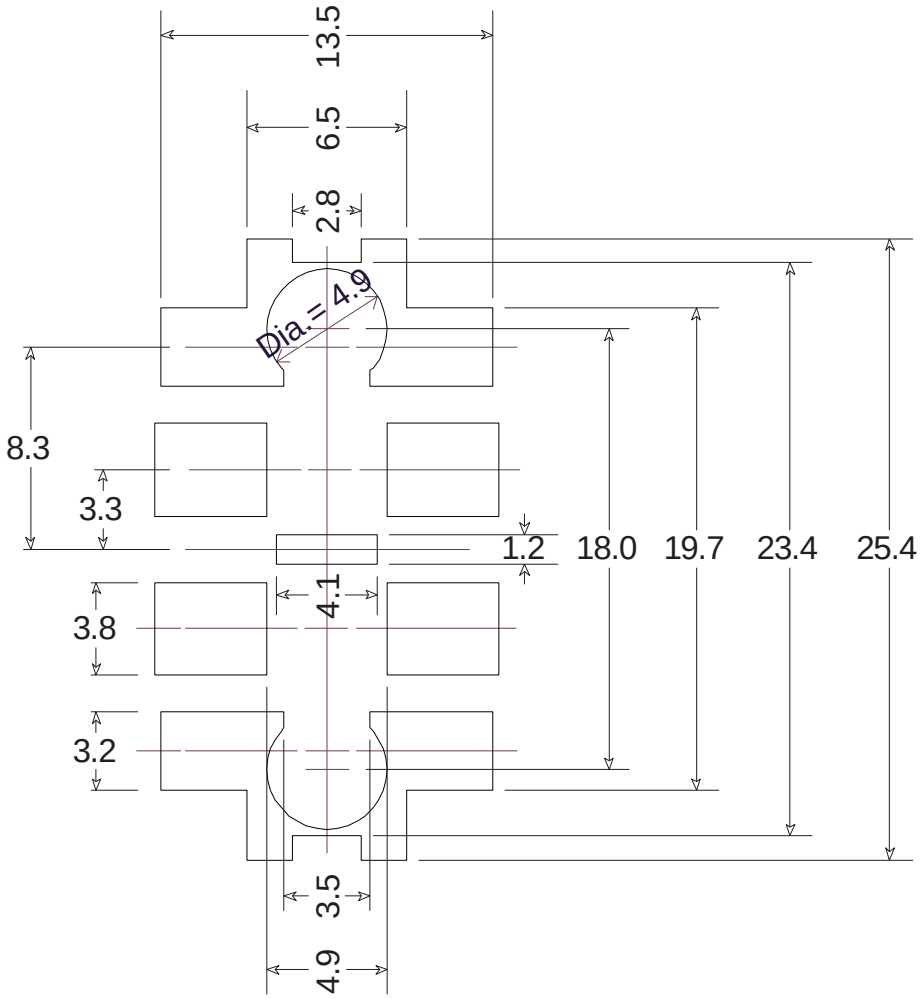



er: 4.7, TanD:0.018 @1GHz

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

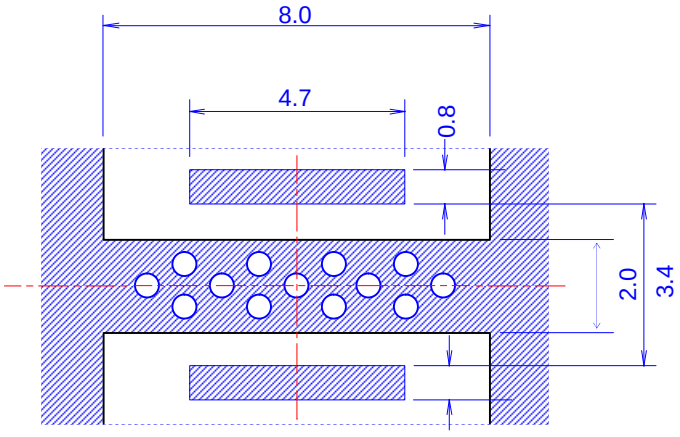
## 4. Standard Land Pattern Dimensions

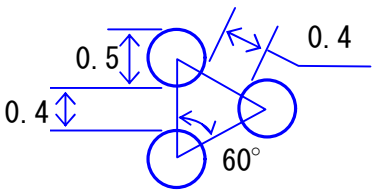
### 4-1. RD70HUF2




**UNIT: mm**

### 4-2. RD04HMS2



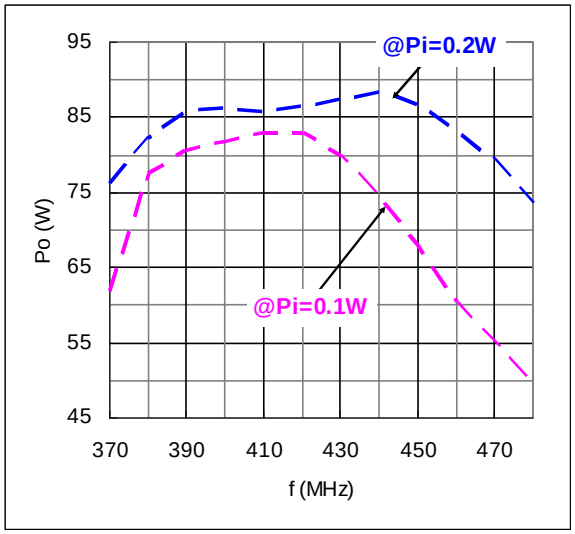

REGULAR TRIANGLE ARRANGEMENT
THROUGH HOLE

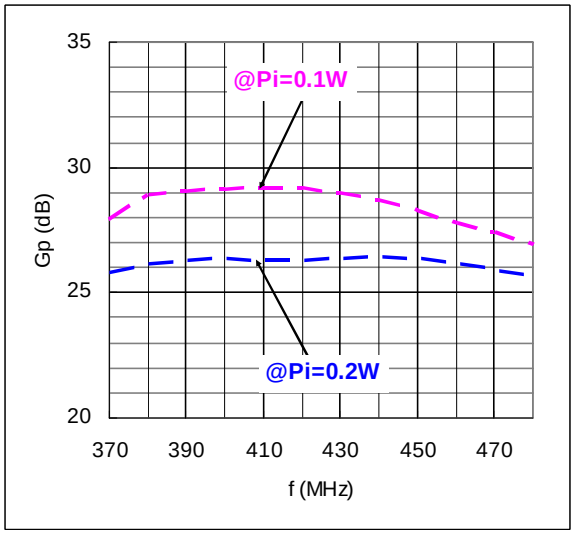
**UNIT: mm**

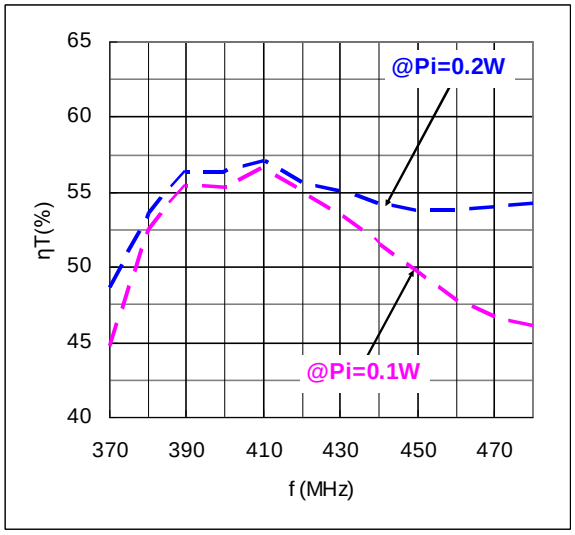
## 5. Typical RF Characteristics

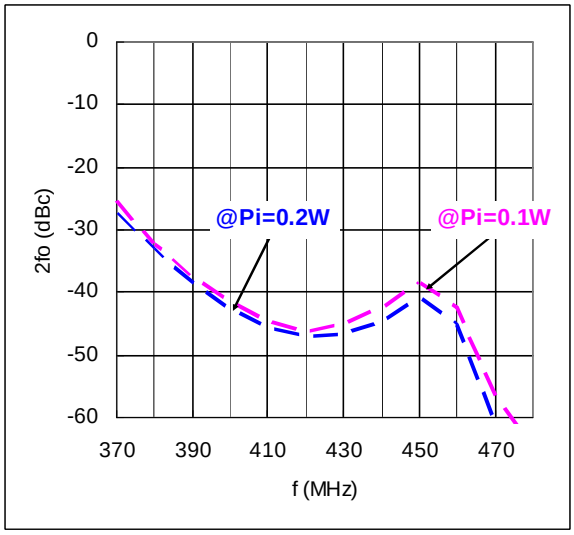
### 5-1. Frequency characteristics

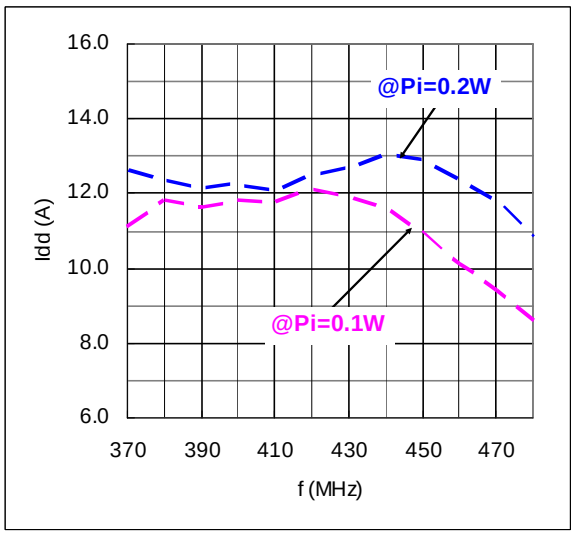
@ **Pin Control** (@**Pi=0.2W**, **0.1W**), Vdd=12.5V, Idq=1.1A (Vgg=2.67V)

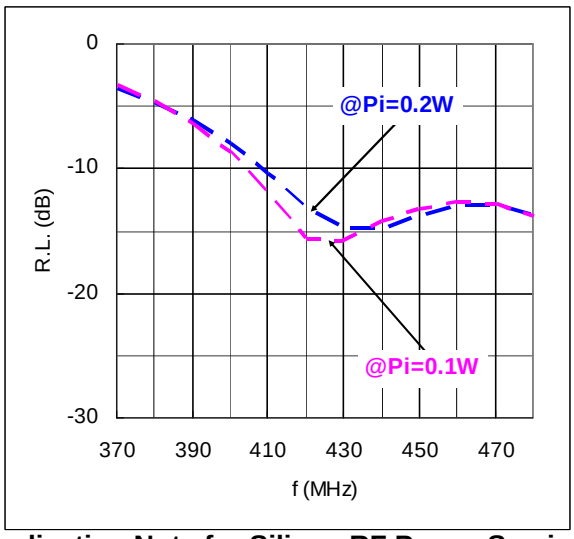


## 5-1-1. Frequency characteristics data

@ **Pi=0.2W**, Vdd=12.5V, Idq=1.1A (Vgg=2.67V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)

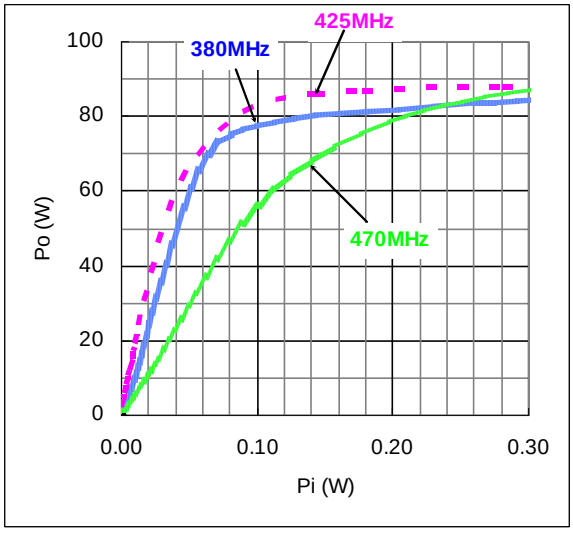
| f (MHz) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) | 2fo (dBc) | 3fo (dBc) | R.L. (dB) |
|---|---|---|---|---|---|---|---|---|
| 380 | 82.2 | 49.2 | 26.1 | 12.3 | 53.5 | -33 | -69.1 | -4.7 |
| 390 | 85.7 | 49.3 | 26.3 | 12.2 | 56.3 | -38 | -69.2 | -6.1 |
| 400 | 86.3 | 49.4 | 26.3 | 12.3 | 56.4 | -43 | -69.3 | -7.9 |
| 410 | 85.7 | 49.3 | 26.3 | 12.1 | 57.1 | -46 | -69.3 | -10.4 |
| 420 | 86.5 | 49.4 | 26.3 | 12.5 | 55.6 | -47 | -69.1 | -13.0 |
| 430 | 87.5 | 49.4 | 26.4 | 12.7 | 55.1 | -47 | -69.2 | -14.7 |
| 440 | 88.3 | 49.5 | 26.4 | 13.1 | 54.3 | -45 | -69.3 | -14.9 |
| 450 | 86.7 | 49.4 | 26.4 | 12.9 | 53.8 | -41 | -69.2 | -13.8 |
| 460 | 83.0 | 49.2 | 26.2 | 12.4 | 53.8 | -45 | -68.4 | -13.0 |
| 470 | 79.4 | 49.0 | 26.0 | 11.8 | 54.0 | -61 | -68.6 | -12.9 |

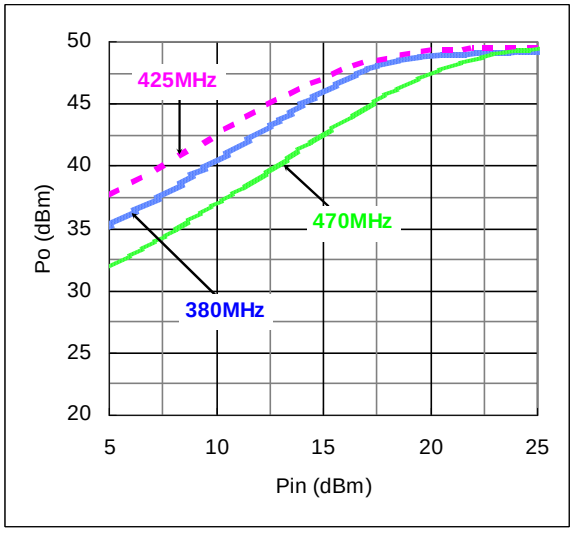
@ **Pi=0.1W**, Vdd=12.5V, Idq=1.1A (Vgg=2.67V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)

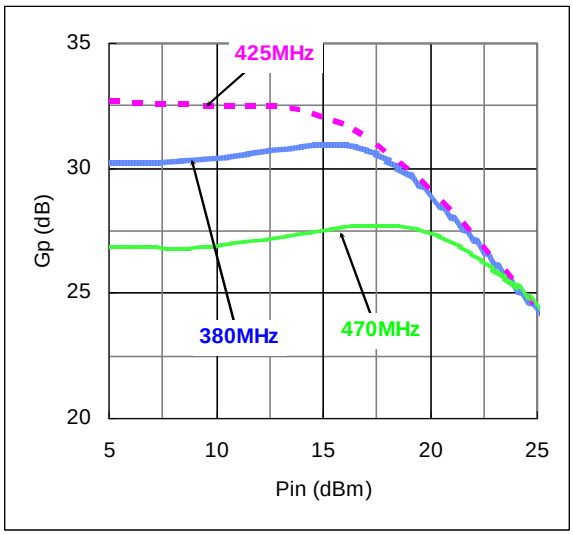
| f (MHz) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) | 2fo (dBc) | 3fo (dBc) | R.L. (dB) |
|---|---|---|---|---|---|---|---|---|
| 380 | 77.4 | 48.9 | 28.9 | 11.8 | 52.5 | -32 | -68.8 | -4.6 |
| 390 | 80.5 | 49.1 | 29.0 | 11.6 | 55.5 | -38 | -68.9 | -6.4 |
| 400 | 81.8 | 49.1 | 29.1 | 11.8 | 55.3 | -42 | -69.0 | -8.7 |
| 410 | 83.0 | 49.2 | 29.2 | 11.8 | 56.7 | -45 | -69.1 | -12.0 |
| 420 | 83.0 | 49.2 | 29.2 | 12.1 | 55.0 | -46 | -69.1 | -15.6 |
| 430 | 79.8 | 49.0 | 29.0 | 11.9 | 53.6 | -45 | -68.8 | -15.8 |
| 440 | 74.5 | 48.7 | 28.7 | 11.6 | 51.6 | -42 | -68.6 | -14.2 |
| 450 | 67.8 | 48.3 | 28.3 | 10.9 | 49.7 | -38 | -68.1 | -13.3 |
| 460 | 60.4 | 47.8 | 27.8 | 10.1 | 47.8 | -42 | -67.2 | -12.7 |
| 470 | 55.1 | 47.4 | 27.4 | 9.4 | 46.8 | -57 | -66.8 | -12.8 |

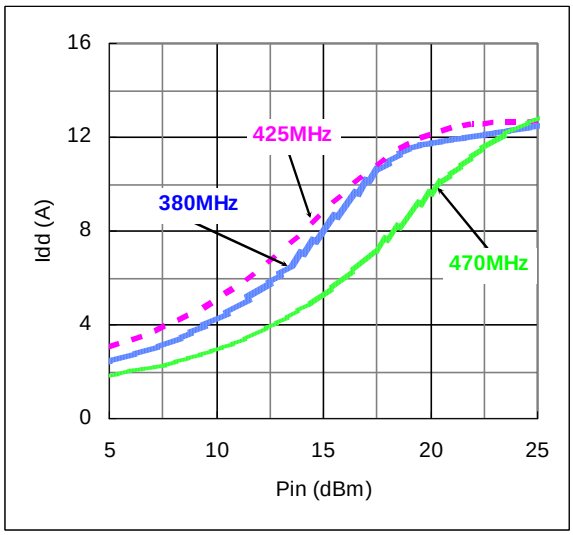
## 5-2. Pout vs. Pin characteristics

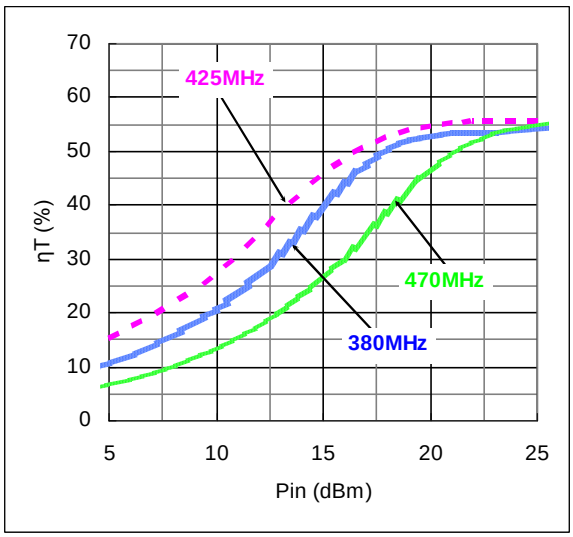
@ Vdd=12.5V, Idq=1.1A (Vgg=2.67V), **f=380MHz, 425MHz, 470MHz**



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

[Conditions ; Vdd=12.5V, Idq=1.1A (Vgg=2.67V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)]

@ **f=380MHz**

| Pi (W) | Pi (dBm) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) | 2fo (dBc) | 3fo (dBc) | R.L. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.003 | 5.1 | 3.44 | 35.4 | 30.3 | 2.50 | 10.9 | -28 | < -50 | -5.0 |
| 0.005 | 7.3 | 5.69 | 37.6 | 30.3 | 3.11 | 14.5 | -28 | < -50 | -4.5 |
| 0.009 | 9.5 | 9.7 | 39.9 | 30.4 | 3.98 | 19.2 | -27 | < -60 | -4.2 |
| 0.014 | 11.5 | 16.3 | 42.1 | 30.6 | 5.11 | 25.3 | -27 | < -60 | -4.1 |
| 0.023 | 13.5 | 27.4 | 44.4 | 30.8 | 6.59 | 33.0 | -27 | < -60 | -4.1 |
| 0.036 | 15.6 | 45.3 | 46.6 | 31.0 | 8.58 | 42.0 | -28 | < -60 | -4.1 |
| 0.057 | 17.5 | 65.3 | 48.2 | 30.6 | 10.6 | 49.3 | -31 | < -60 | -4.2 |
| 0.090 | 19.5 | 76.7 | 48.9 | 29.3 | 11.7 | 52.4 | -32 | < -60 | -4.6 |
| 0.114 | 20.6 | 78.9 | 49.0 | 28.4 | 11.9 | 53.2 | -33 | < -60 | -4.7 |
| 0.144 | 21.6 | 80.4 | 49.1 | 27.5 | 12.0 | 53.5 | -33 | < -60 | -4.7 |
| 0.181 | 22.6 | 81.7 | 49.1 | 26.5 | 12.2 | 53.7 | -33 | < -60 | -4.7 |
| 0.231 | 23.6 | 83.0 | 49.2 | 25.6 | 12.3 | 53.9 | -33 | < -60 | -4.7 |
| 0.292 | 24.7 | 84.3 | 49.3 | 24.6 | 12.4 | 54.2 | -33 | < -60 | -4.7 |

@ **f=425MHz**

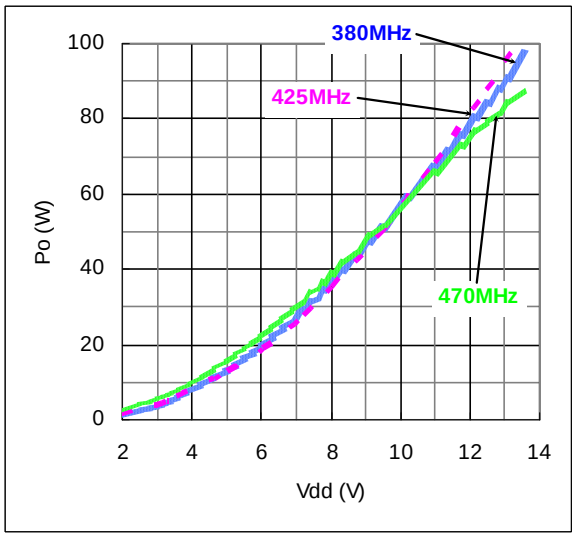
| Pi (W) | Pi (dBm) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) | 2fo (dBc) | 3fo (dBc) | R.L. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.003 | 5.0 | 5.81 | 37.6 | 32.7 | 3.01 | 15.3 | -38 | < -50 | -10.2 |
| 0.005 | 7.2 | 9.3 | 39.7 | 32.5 | 3.73 | 19.7 | -38 | < -50 | -14.0 |
| 0.009 | 9.3 | 15.1 | 41.8 | 32.4 | 4.70 | 25.4 | -38 | < -60 | -20.2 |
| 0.014 | 11.4 | 24.2 | 43.8 | 32.5 | 5.92 | 32.3 | -38 | < -60 | -20.4 |
| 0.022 | 13.4 | 38.0 | 45.8 | 32.4 | 7.49 | 40.3 | -38 | < -60 | -17.0 |
| 0.035 | 15.4 | 54.3 | 47.4 | 31.9 | 9.19 | 47.0 | -40 | < -60 | -15.8 |
| 0.056 | 17.4 | 69.8 | 48.4 | 31.0 | 10.8 | 51.7 | -43 | < -60 | -15.8 |
| 0.090 | 19.6 | 81.1 | 49.1 | 29.5 | 11.9 | 54.3 | -45 | < -60 | -16.8 |
| 0.114 | 20.6 | 84.1 | 49.3 | 28.7 | 12.3 | 54.9 | -46 | < -60 | -17.1 |
| 0.142 | 21.5 | 85.9 | 49.3 | 27.8 | 12.4 | 55.2 | -47 | < -60 | -15.7 |
| 0.177 | 22.5 | 86.9 | 49.4 | 26.9 | 12.5 | 55.4 | -47 | < -60 | -14.6 |
| 0.224 | 23.5 | 87.5 | 49.4 | 25.9 | 12.6 | 55.5 | -47 | < -60 | -13.6 |
| 0.280 | 24.5 | 87.9 | 49.4 | 25.0 | 12.6 | 55.6 | -47 | < -60 | -12.9 |

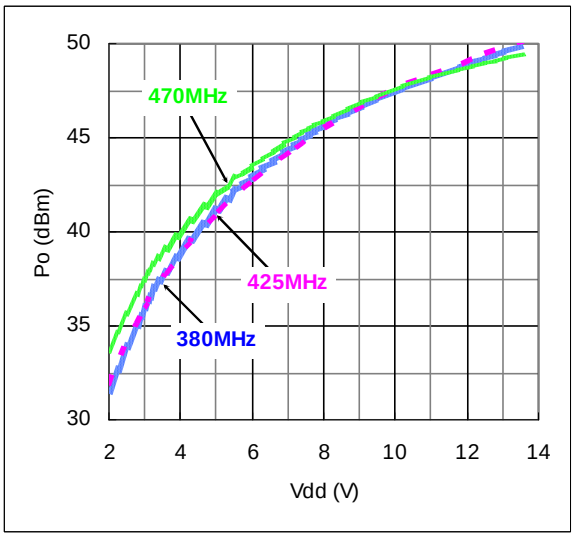
@ **f=470MHz**

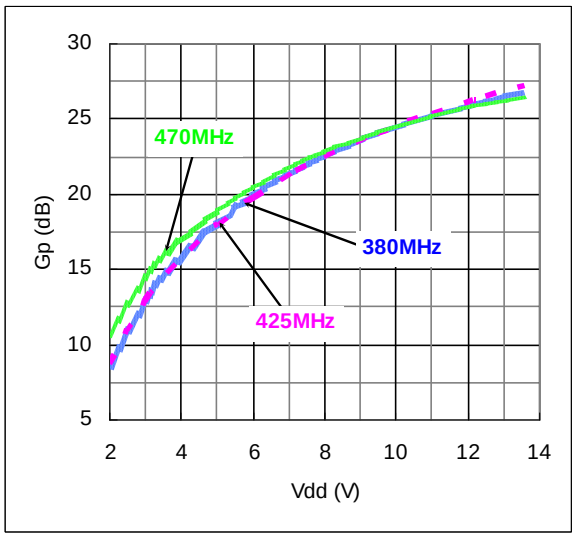
| Pi (W) | Pi (dBm) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) | 2fo (dBc) | 3fo (dBc) | R.L. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.003 | 4.9 | 1.52 | 31.8 | 26.9 | 1.85 | 6.5 | -51 | < -50 | -10.3 |
| 0.005 | 7.1 | 2.48 | 33.9 | 26.8 | 2.19 | 8.9 | -52 | < -51 | -15.1 |
| 0.008 | 9.3 | 4.12 | 36.2 | 26.9 | 2.70 | 12.1 | -53 | < -53 | -25.8 |
| 0.014 | 11.3 | 6.90 | 38.4 | 27.1 | 3.40 | 16.1 | -53 | < -55 | -16.6 |
| 0.022 | 13.3 | 11.6 | 40.7 | 27.3 | 4.33 | 21.3 | -54 | < -60 | -14.9 |
| 0.035 | 15.4 | 19.9 | 43.0 | 27.6 | 5.61 | 28.1 | -54 | < -60 | -14.1 |
| 0.055 | 17.4 | 32.8 | 45.2 | 27.7 | 7.19 | 36.3 | -54 | < -60 | -13.7 |
| 0.089 | 19.5 | 51.1 | 47.1 | 27.6 | 9.11 | 44.7 | -56 | < -60 | -13.6 |
| 0.112 | 20.5 | 60.1 | 47.8 | 27.3 | 10.00 | 48.0 | -58 | < -60 | -12.9 |
| 0.140 | 21.5 | 68.4 | 48.4 | 26.9 | 10.82 | 50.5 | -59 | < -60 | -12.9 |
| 0.177 | 22.5 | 75.5 | 48.8 | 26.3 | 11.5 | 52.4 | -61 | < -60 | -12.9 |
| 0.223 | 23.5 | 81.5 | 49.1 | 25.6 | 12.1 | 53.8 | -62 | < -60 | -12.9 |
| 0.286 | 24.6 | 86.1 | 49.4 | 24.8 | 12.6 | 54.6 | -63 | < -60 | -13.0 |

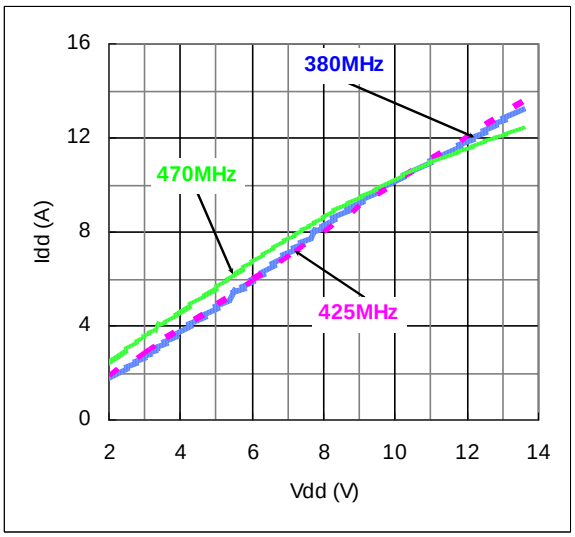
## 5-3. Pout vs. Vdd characteristics

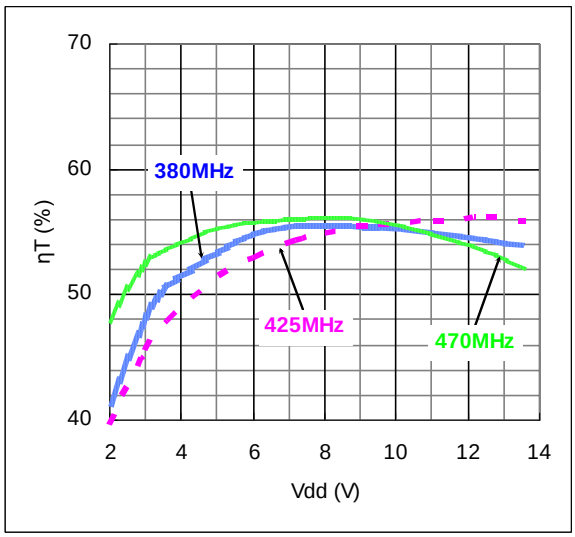
@ Pi=0.2W (=23dBm), Idq=1.1A(Vgg=2.67V), **f=380MHz, 425MHz, 470MHz**



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

[Conditions ; Pi=0.2W (=23dBm), Idq=1.1A (Vgg=2.67V, RD04HMS2 ; 0.1A, RD70HUF2 ; 1A)]

@ **f=380MHz**

| Vdd (V) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) |
|---|---|---|---|---|---|
| 2.0 | 1.4 | 31.5 | 8.5 | 1.73 | 41.3 |
| 3.0 | 3.9 | 36.0 | 12.9 | 2.72 | 48.3 |
| 3.6 | 6.1 | 37.8 | 14.8 | 3.33 | 50.6 |
| 5.0 | 13.0 | 41.1 | 18.1 | 4.85 | 53.5 |
| 6.0 | 19.7 | 43.0 | 19.9 | 5.98 | 54.9 |
| 7.2 | 29.2 | 44.7 | 21.6 | 7.32 | 55.6 |
| 8.0 | 36.6 | 45.6 | 22.6 | 8.22 | 55.6 |
| 9.5 | 51.2 | 47.1 | 24.1 | 9.7 | 55.4 |
| 11.0 | 66.8 | 48.3 | 25.2 | 11.0 | 55.0 |
| 12.5 | 84.1 | 49.3 | 26.2 | 12.3 | 54.5 |
| 13.6 | 97.3 | 49.9 | 26.9 | 13.3 | 54.0 |

@ **f=425MHz**

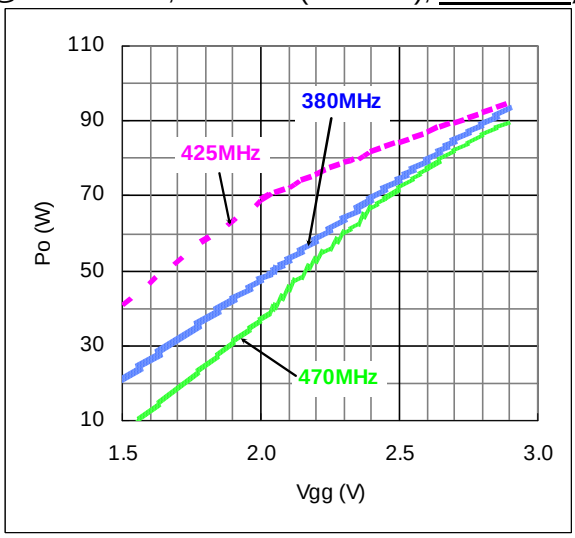
| Vdd (V) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) |
|---|---|---|---|---|---|
| 2.0 | 1.5 | 31.8 | 8.8 | 1.91 | 39.6 |
| 3.0 | 3.9 | 35.9 | 12.9 | 2.86 | 45.5 |
| 3.6 | 6.0 | 37.8 | 14.7 | 3.47 | 48.0 |
| 5.0 | 12.6 | 41.0 | 18.0 | 4.90 | 51.5 |
| 6.0 | 18.9 | 42.8 | 19.7 | 5.94 | 52.9 |
| 7.2 | 28.1 | 44.5 | 21.5 | 7.18 | 54.3 |
| 8.0 | 35.2 | 45.5 | 22.4 | 8.01 | 54.9 |
| 9.5 | 50.6 | 47.0 | 24.0 | 9.56 | 55.6 |
| 11.0 | 68.2 | 48.3 | 25.3 | 11.1 | 55.9 |
| 12.5 | 87.9 | 49.4 | 26.4 | 12.5 | 56.1 |
| 13.6 | 103.3 | 50.1 | 27.1 | 13.6 | 55.8 |

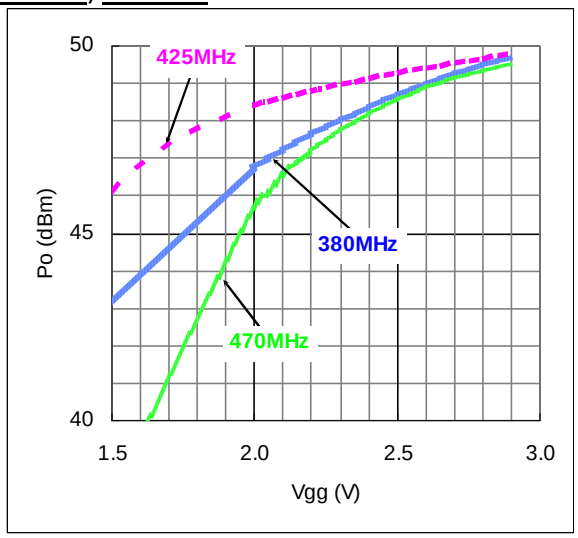
@ **f=470MHz**

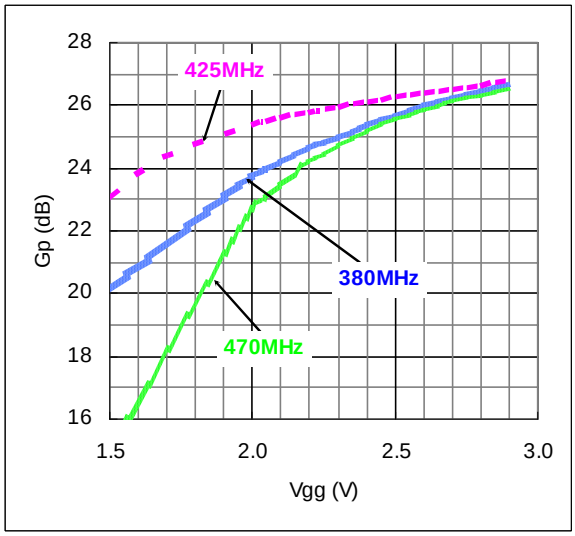
| Vdd (V) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) |
|---|---|---|---|---|---|
| 2.0 | 2.3 | 33.6 | 10.6 | 2.41 | 47.9 |
| 3.0 | 5.5 | 37.4 | 14.4 | 3.52 | 52.4 |
| 3.6 | 8.1 | 39.1 | 16.0 | 4.17 | 53.6 |
| 5.0 | 15.7 | 42.0 | 18.9 | 5.66 | 55.2 |
| 6.0 | 22.3 | 43.5 | 20.5 | 6.69 | 55.7 |
| 7.2 | 31.8 | 45.0 | 22.0 | 7.87 | 56.0 |
| 8.0 | 38.6 | 45.9 | 22.8 | 8.59 | 56.2 |
| 9.5 | 52.1 | 47.2 | 24.1 | 9.82 | 55.8 |
| 11.0 | 65.8 | 48.2 | 25.2 | 10.92 | 54.9 |
| 12.5 | 79.3 | 49.0 | 26.0 | 11.9 | 53.4 |
| 13.6 | 87.9 | 49.4 | 26.4 | 12.4 | 52.1 |

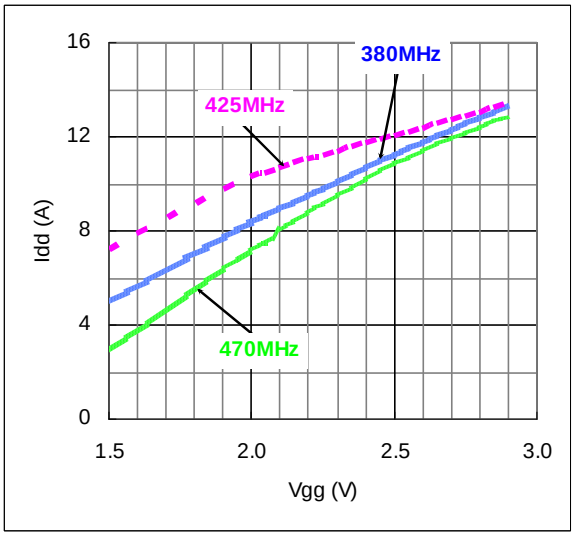
## 5-4. Pout vs. Vgg characteristics

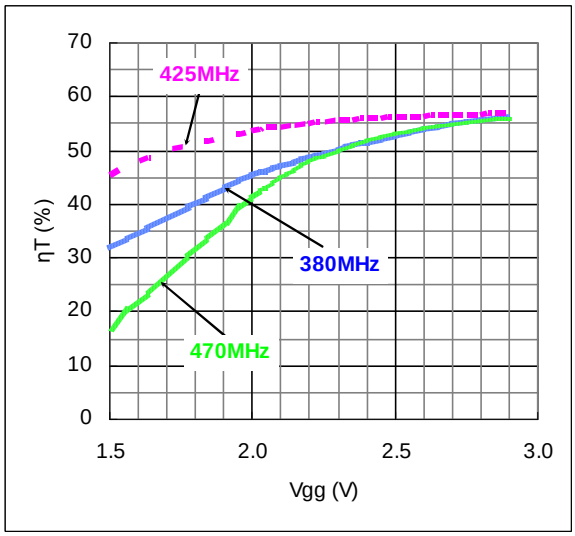
@ Vdd=12.5V, Pi=0.2W (=23dBm), **f=380MHz, 425MHz, 470MHz**

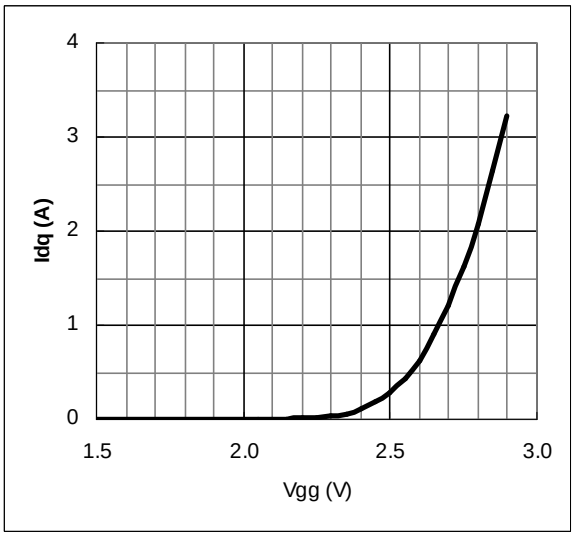


## 5-4-1. Pout vs. Vgg characteristics data

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

@ **f=380MHz**

| Vgg (V) | Idq (A) | Pi (W) | Pi (dBm) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) |
|---|---|---|---|---|---|---|---|---|
| 1.50 | 0 | 0.200 | 23.0 | 20.3 | 43.1 | 20.1 | 5.00 | 32.2 |
| 2.00 | 0.001 | 0.200 | 23.0 | 47.8 | 46.8 | 23.8 | 8.38 | 45.4 |
| 2.10 | 0.004 | 0.200 | 23.0 | 53.1 | 47.3 | 24.2 | 9.0 | 47.2 |
| 2.20 | 0.012 | 0.200 | 23.0 | 58.5 | 47.7 | 24.7 | 9.5 | 48.9 |
| 2.30 | 0.04 | 0.201 | 23.0 | 63.8 | 48.1 | 25.0 | 10.1 | 50.3 |
| 2.40 | 0.11 | 0.200 | 23.0 | 69.2 | 48.4 | 25.4 | 10.7 | 51.6 |
| 2.50 | 0.28 | 0.200 | 23.0 | 74.5 | 48.7 | 25.7 | 11.3 | 52.9 |
| 2.60 | 0.62 | 0.200 | 23.0 | 79.6 | 49.0 | 26.0 | 11.8 | 54.0 |
| 2.65 | 0.90 | 0.200 | 23.0 | 82.2 | 49.2 | 26.1 | 12.1 | 54.5 |
| 2.70 | 1.20 | 0.200 | 23.0 | 84.7 | 49.3 | 26.3 | 12.3 | 55.0 |
| 2.75 | 1.63 | 0.200 | 23.0 | 87.1 | 49.4 | 26.4 | 12.6 | 55.4 |
| 2.80 | 2.07 | 0.200 | 23.0 | 89.3 | 49.5 | 26.5 | 12.8 | 55.8 |
| 2.85 | 2.64 | 0.200 | 23.0 | 91.6 | 49.6 | 26.6 | 13.1 | 56.1 |
| 2.90 | 3.22 | 0.201 | 23.0 | 93.8 | 49.7 | 26.7 | 13.32 | 56.4 |

@ **f=425MHz**

| Vgg (V) | Idq (A) | Pi (W) | Pi (dBm) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) |
|---|---|---|---|---|---|---|---|---|
| 1.50 | 0 | 0.201 | 23.0 | 40.7 | 46.1 | 23.1 | 7.16 | 45.2 |
| 2.00 | 0.001 | 0.201 | 23.0 | 68.7 | 48.4 | 25.3 | 10.25 | 53.5 |
| 2.10 | 0.004 | 0.201 | 23.0 | 72.3 | 48.6 | 25.6 | 10.6 | 54.2 |
| 2.20 | 0.012 | 0.200 | 23.0 | 75.5 | 48.8 | 25.8 | 11.0 | 54.8 |
| 2.30 | 0.04 | 0.200 | 23.0 | 78.5 | 49.0 | 25.9 | 11.4 | 55.3 |
| 2.40 | 0.11 | 0.200 | 23.0 | 81.5 | 49.1 | 26.1 | 11.7 | 55.7 |
| 2.50 | 0.28 | 0.201 | 23.0 | 84.1 | 49.3 | 26.2 | 12.0 | 56.1 |
| 2.60 | 0.62 | 0.201 | 23.0 | 86.7 | 49.4 | 26.4 | 12.3 | 56.3 |
| 2.65 | 0.90 | 0.200 | 23.0 | 88.1 | 49.5 | 26.4 | 12.5 | 56.4 |
| 2.70 | 1.20 | 0.201 | 23.0 | 89.3 | 49.5 | 26.5 | 12.7 | 56.5 |
| 2.75 | 1.63 | 0.201 | 23.0 | 90.8 | 49.6 | 26.6 | 12.8 | 56.6 |
| 2.80 | 2.07 | 0.201 | 23.0 | 91.8 | 49.6 | 26.6 | 13.0 | 56.6 |
| 2.85 | 2.64 | 0.201 | 23.0 | 93.3 | 49.7 | 26.7 | 13.2 | 56.8 |
| 2.90 | 3.22 | 0.200 | 23.0 | 94.4 | 49.8 | 26.7 | 13.32 | 56.8 |

@ **f=470MHz**

| Vgg (V) | Idq (A) | Pi (W) | Pi (dBm) | Po (W) | Po (dBm) | Gp (dB) | Idd (A) | ηT (%) |
|---|---|---|---|---|---|---|---|---|
| 1.50 | 0 | 0.201 | 23.0 | 6.3 | 38.0 | 15.0 | 2.97 | 16.8 |
| 2.00 | 0.001 | 0.201 | 23.0 | 37.2 | 45.7 | 22.7 | 7.15 | 41.3 |
| 2.10 | 0.004 | 0.201 | 23.0 | 44.9 | 46.5 | 23.5 | 8.0 | 44.8 |
| 2.20 | 0.012 | 0.200 | 23.0 | 52.5 | 47.2 | 24.2 | 8.8 | 47.7 |
| 2.30 | 0.04 | 0.201 | 23.0 | 59.6 | 47.8 | 24.7 | 9.5 | 50.0 |
| 2.40 | 0.11 | 0.201 | 23.0 | 66.2 | 48.2 | 25.2 | 10.2 | 51.8 |
| 2.50 | 0.28 | 0.201 | 23.0 | 72.1 | 48.6 | 25.5 | 10.8 | 53.1 |
| 2.60 | 0.62 | 0.201 | 23.0 | 77.4 | 48.9 | 25.9 | 11.4 | 54.2 |
| 2.65 | 0.90 | 0.201 | 23.0 | 79.6 | 49.0 | 26.0 | 11.7 | 54.5 |
| 2.70 | 1.20 | 0.201 | 23.0 | 81.8 | 49.1 | 26.1 | 11.9 | 54.9 |
| 2.75 | 1.63 | 0.201 | 23.0 | 84.1 | 49.3 | 26.2 | 12.2 | 55.2 |
| 2.80 | 2.07 | 0.201 | 23.0 | 86.1 | 49.4 | 26.3 | 12.4 | 55.5 |
| 2.85 | 2.64 | 0.201 | 23.0 | 88.1 | 49.5 | 26.4 | 12.6 | 55.8 |
| 2.90 | 3.22 | 0.201 | 23.0 | 89.7 | 49.5 | 26.5 | 12.85 | 56.0 |