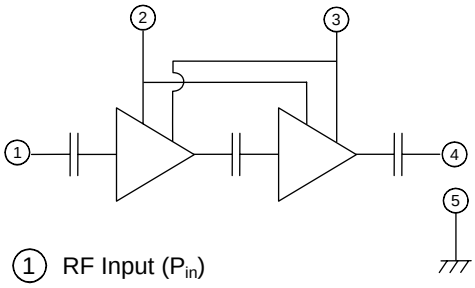
RA01L9595M

RoHS Compliance , 952-954MHz 1.4W 3.3V, 2 Stage Amp. For RFID READER / WRITER

DESCRIPTION

The RA01L9595M is a 1.4-watt RF MOSFET Amplifier Module. The battery can be connected directly to the drain of the enhancement-mode MOSFET transistors.
The output power and drain current increase as the gate voltage increases. With a gate voltage around 0.5V (minimum), output power and drain current increases substantially. The nominal output power becomes available at 1.5V (typical) and 2.0V (maximum). At V_{GG}=2.0V, the typical gate current is 1mA.

BLOCK DIAGRAM



1. RF Input (P_{in})
2. Gate Voltage (V_{GG}), Power Control
3. Drain Voltage (V_{DD}), Battery
4. RF Output (P_{out})
5. RF Ground

PACKAGE CODE: H58

FEATURES

- Enhancement-Mode MOSFET Transistors (I_{DD}≅0 @ V_{DD}=3.3V, V_{GG}=0V)
- P_{out}>1.4W, η_T>35% @ V_{DD}=3.3V, V_{GG}=2.0V, P_{in}=30mW
- Frequency Range: 952-954MHz
- Low-Power Control Current I_{GG}=1mA (typ) at V_{GG}=2.0V
- Module Size: 9.1 x 9.2 x 1.8 mm

RoHS COMPLIANCE

- RA01L9595M -101 is a RoHS compliance products.
- RoHS compliance is indicate by the letter “G” after the Lot Marking.
- This product include the lead in the Glass of electronic parts and the lead in electronic Ceramic parts.

  How ever,it is applicable to the following exceptions of RoHS Directions.

  1. Lead in the Glass of a cathode-ray tube, electronic parts, and fluorescent tubes.
  2. Lead in electronic Ceramic parts.

ORDERING INFORMATION:

ORDER NUMBER	SUPPLY FORM
RA01L9595M -101	Antistatic tray, 25 modules/tray

MAXIMUM RATINGS (T_{case}=+25deg.C. unless otherwise specified)

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V_{DD}	Drain Voltage	V_{GG}<2.0V, Z_G=Z_L=50ohm	6	V
V_{GG}	Gate Voltage	V_{DD}<3.3V, P_{in}=0mW, Z_G=Z_L=50ohm	3	V
P_{in}	Input Power	f=952-954MHz, V_{GG}<2.0V Z_G=Z_L=50ohm	50	mW
P_{out}	Output Power		4	W
$T_{case(OP)}$	Operation Case Temperature Range		-30 to +90	°C
T_{stg}	Storage Temperature Range		-40 to +110	°C

The above parameters are independently guaranteed.

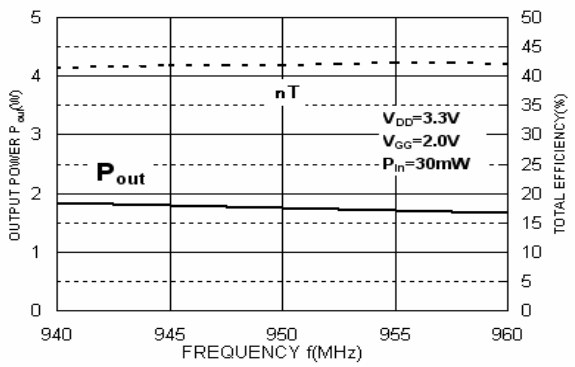
ELECTRICAL CHARACTERISTICS (T_{case}=+25°C , Z_G=Z_L=50Ω, unless otherwise specified)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
f	Frequency Range		952		954	MHz
P_{out}	Output Power	V_{DD}=3.3V V_{GG}=2.0V P_{iN}=30mW	1.4			W
η_T	Total Efficiency		35			%
$2f_o$	2nd Harmonic				-30	dBc
ρ_{in}	Input VSWR				4.4:1	—
—	Stability	V_{DD}=2.5/3.3/6.0V, V_{GG}=0.5-2.0V, P_{IN}=20-50mW , Po<2.5W Zg=50ohm, Load VSWR=4:1	No parasitic oscillation			—
—	Load VSWR Tolerance	V_{DD}=6.0V, P_{iN}=30mW, P_{out} =2W (V_{GG} control), Zg=50ohm, Load VSWR=20:1	No degradation or destroy			—

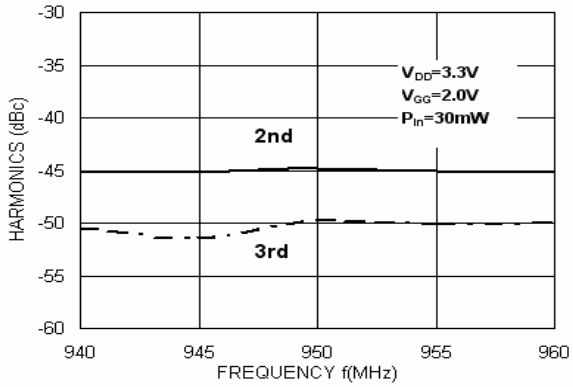
All parameters, conditions, ratings, and limits are subject to change without notice.

TYPICAL PERFORMANCE (Vdd=3.3V,T_{case}=+25deg.C, Z_G=Z_L=50Ω, unless otherwise specified)

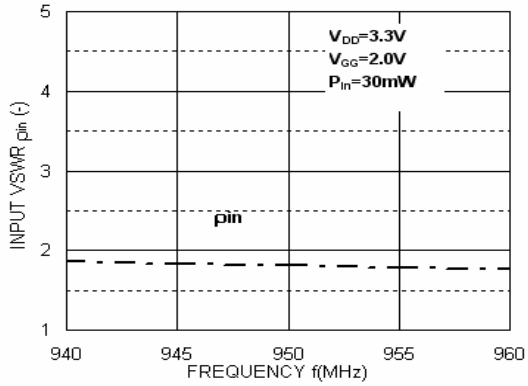
OUTPUT POWER, TOTAL EFFICIENCY, versus FREQUENCY



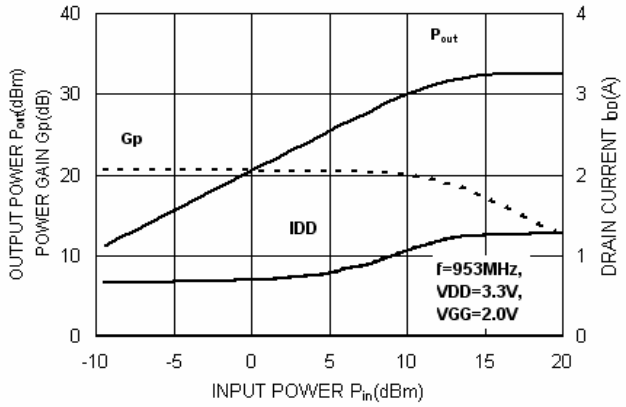
2nd, 3rd HARMONICS versus FREQUENCY



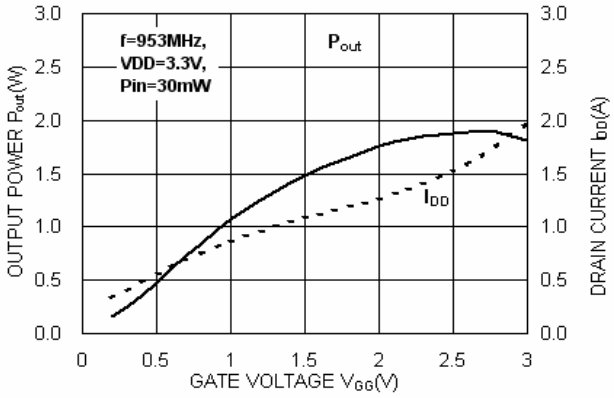
INPUT VSWR versus FREQUENCY



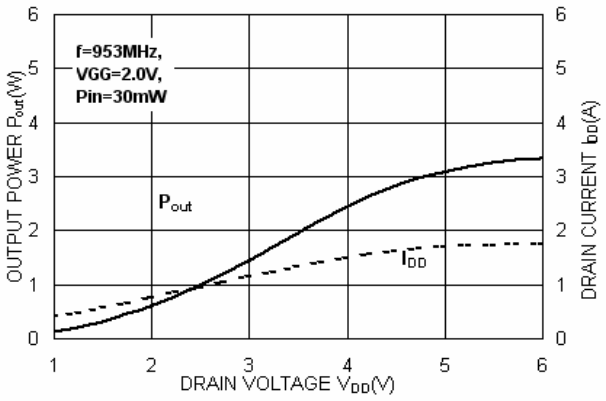
OUTPUT POWER, POWER GAIN and DRAIN CURRENT versus INPUT POWER



OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE

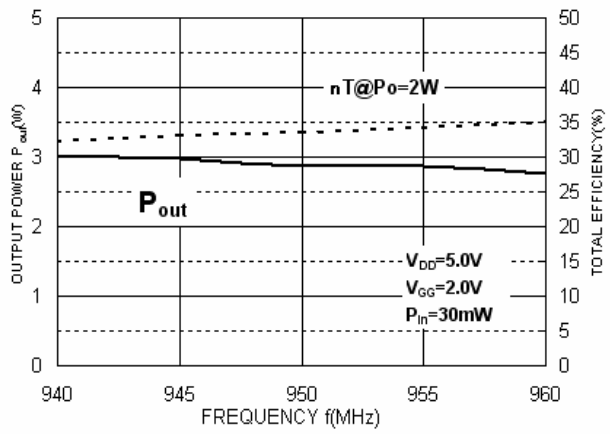


OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE

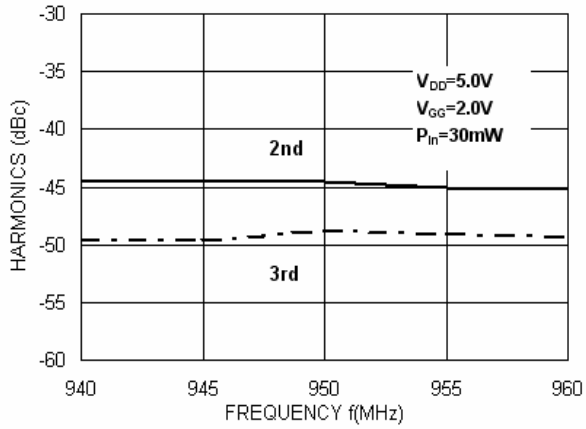


TYPICAL PERFORMANCE (Vdd=5.0V,T_{case}=+25deg.C, Z_G=Z_L=50Ω, unless otherwise specified)

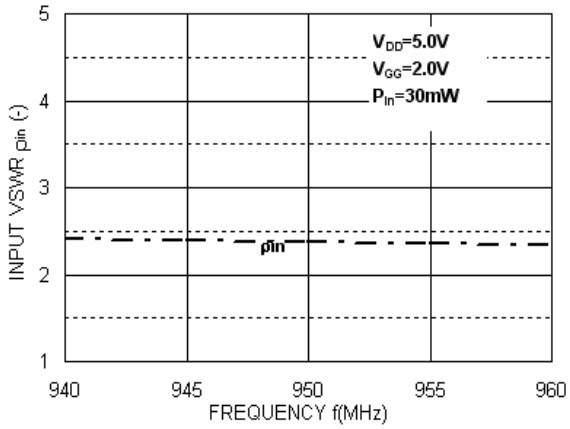
OUTPUT POWER, TOTAL EFFICIENCY, versus FREQUENCY



2nd, 3rd HARMONICS versus FREQUENCY



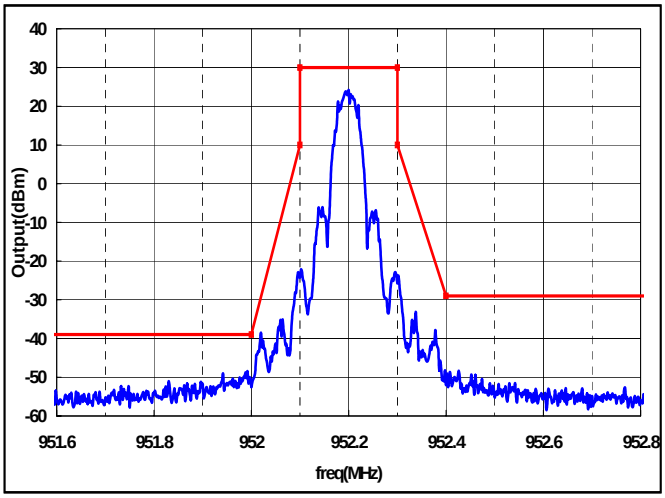
INPUT VSWR versus FREQUENCY



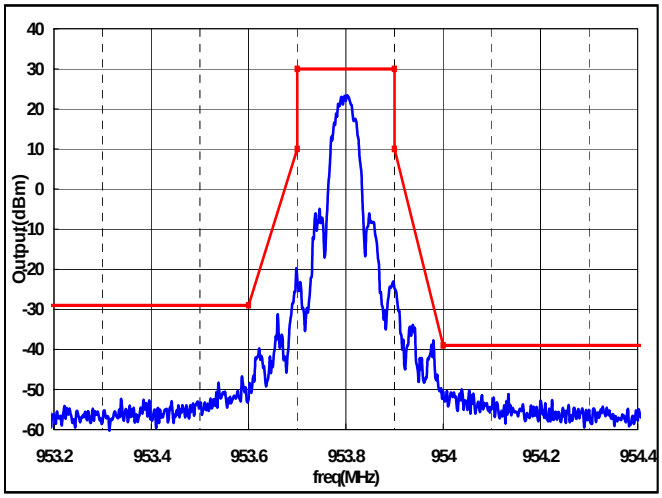
TYPICAL PERFORMANCE (Vdd=3.3V, Vgg=2V, Pout=1W , Modulation Type：BPSK , Ta=25deg.C)

Output Power versus FREQUENCY

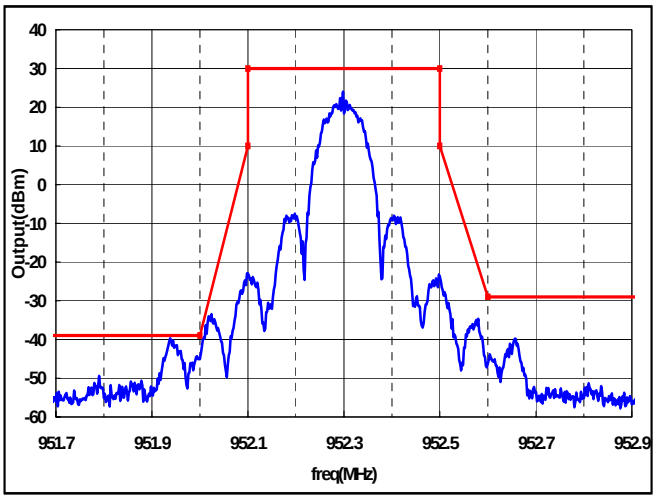
CF=952.2MHz
DataRate：40Kbps



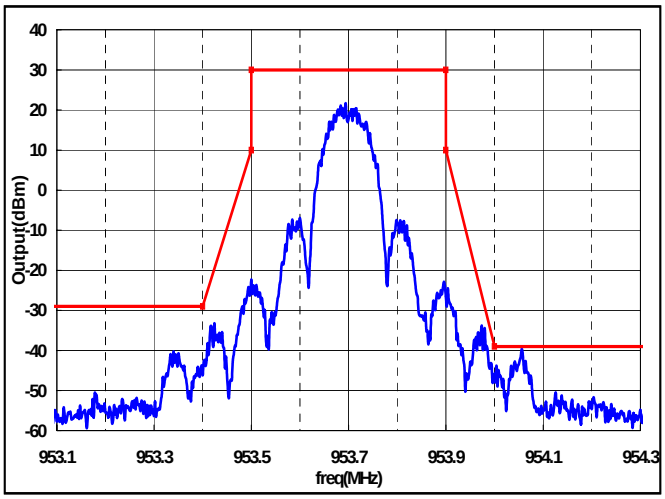
CF=953.8MHz,
DataRate：40Kbps



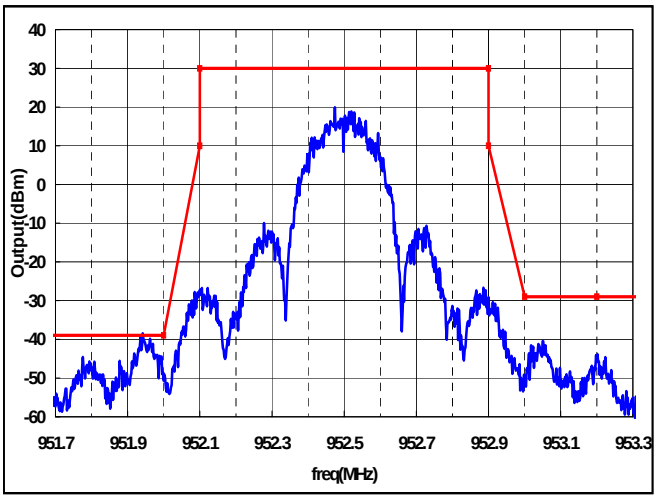
CF=952.3MHz,
DataRate：80Kbps



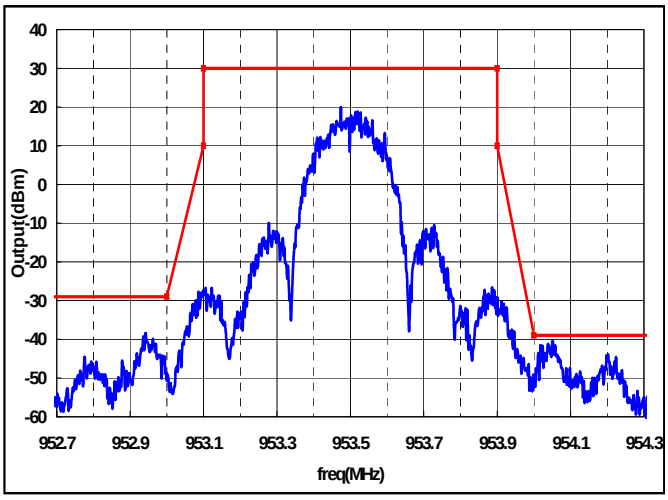
CF=953.7MHz
DataRate：80Kbps



CF=952.5MHz,
DataRate：160Kbps



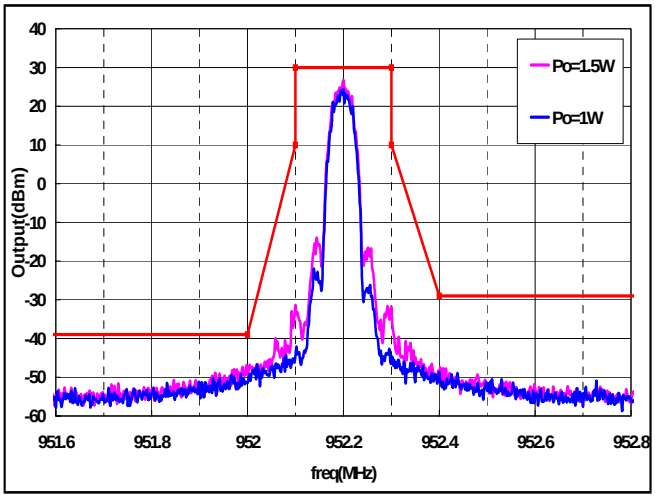
CF=953.5MHz
DataRate：160Kbps



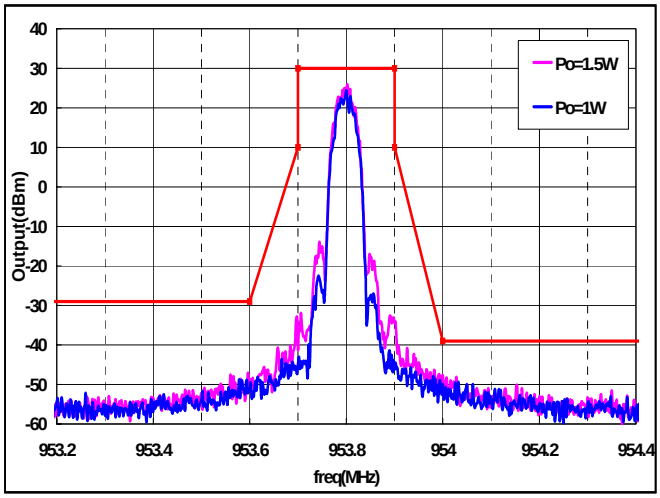
TYPICAL PERFORMANCE (Vdd=5.0V, Vgg=2V, Modulation Type：BPSK , Pin control, Ta=25deg.C)

Output Power versus FREQUENCY

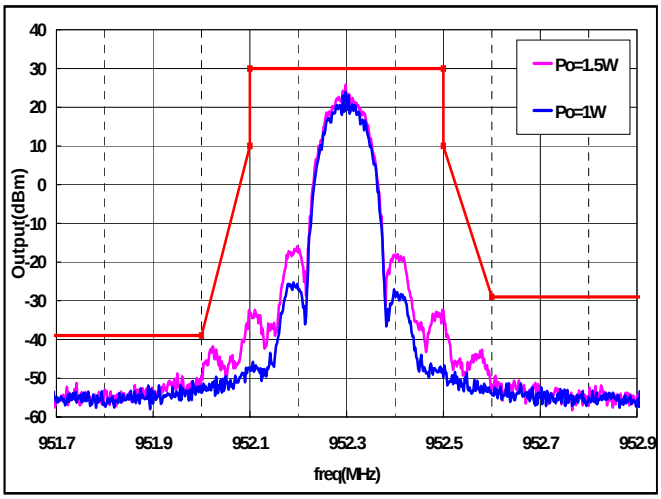
CF=952.2MHz
DataRate：40Kbps



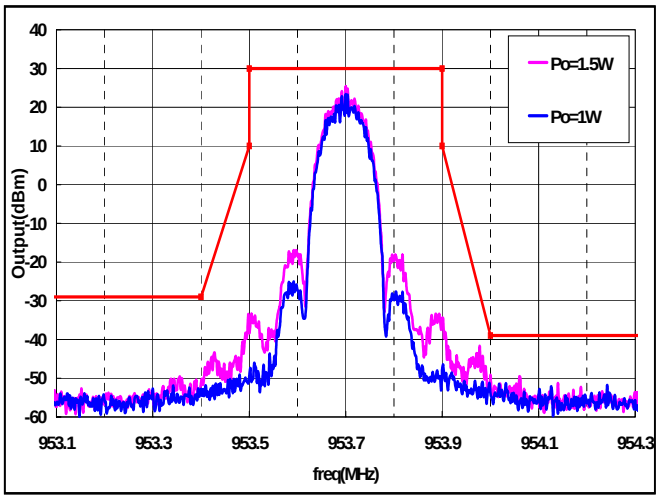
CF=953.8MHz,
DataRate：40Kbps



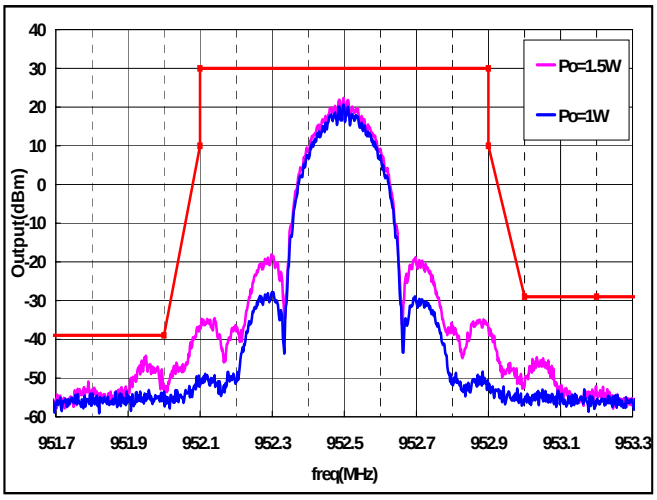
CF=952.3MHz,
DataRate：80Kbps



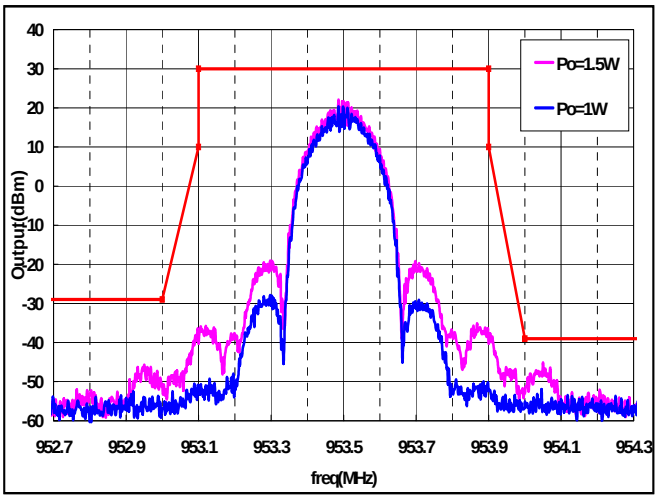
CF=953.7MHz
DataRate：80Kbps



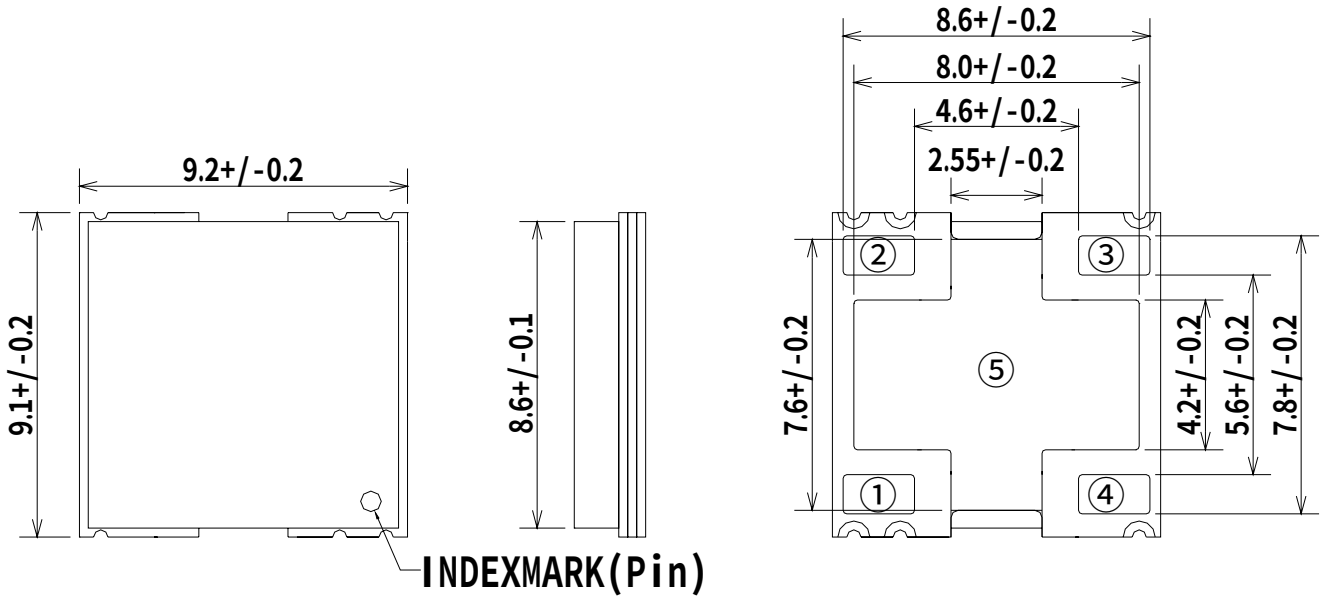
CF=952.5MHz,
DataRate：160Kbps

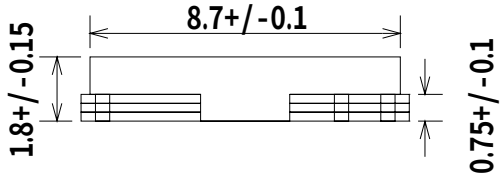


CF=953.5MHz
DataRate：160Kbps



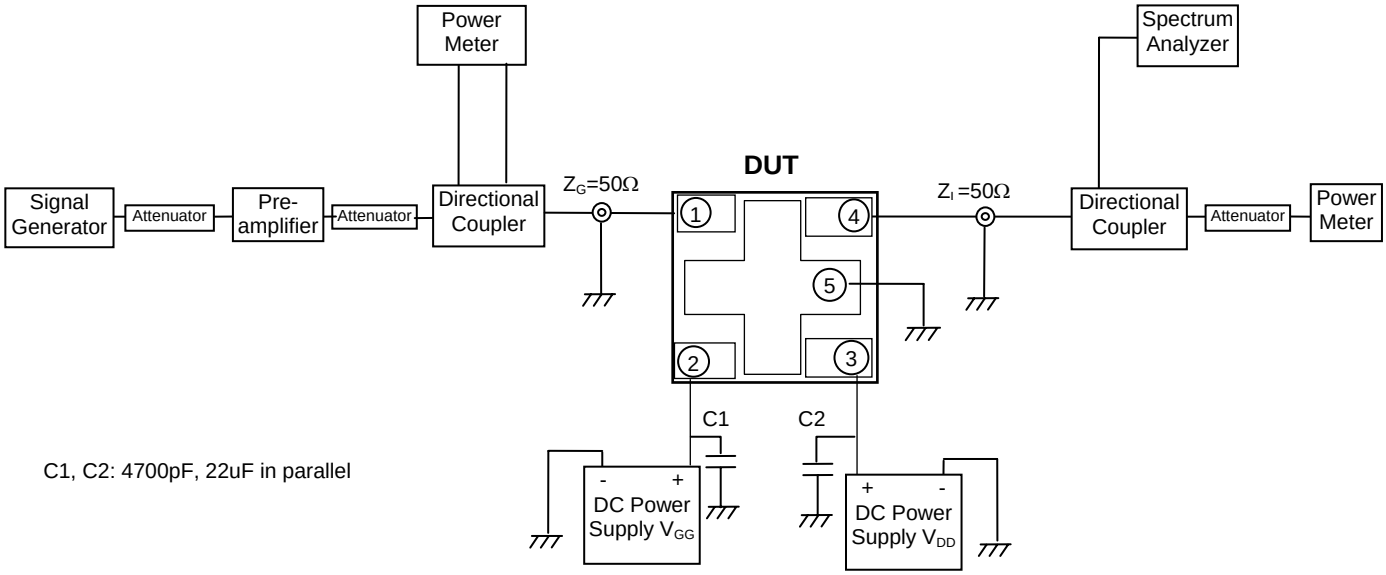
OUTLINE DRAWING (mm)





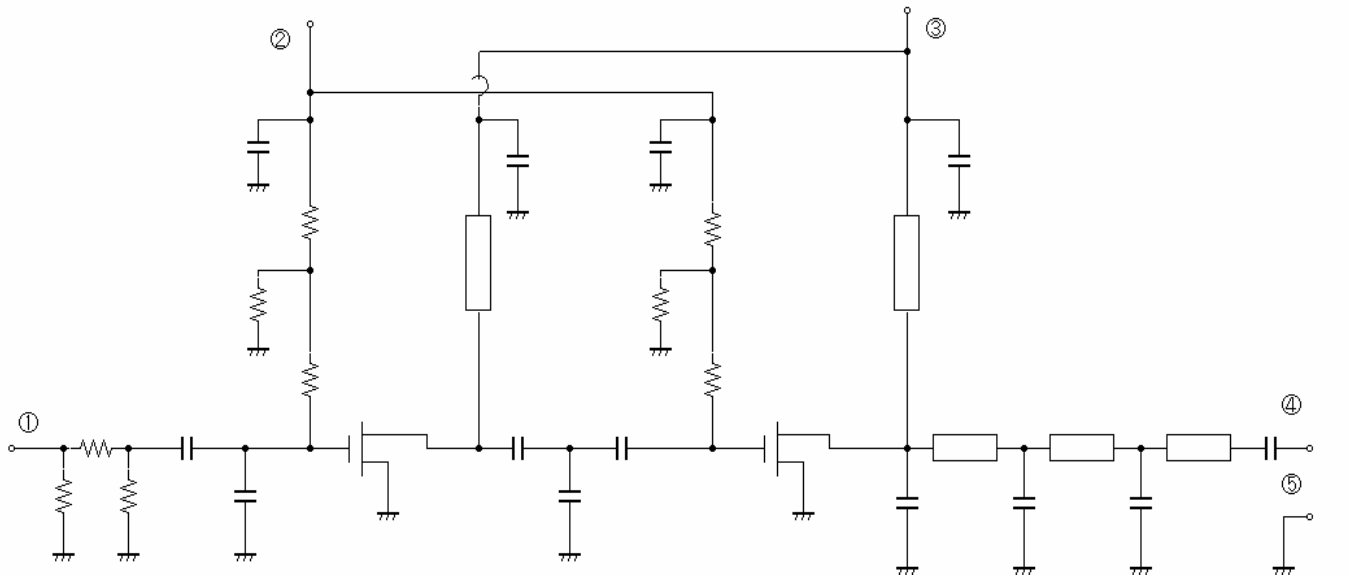
① RF Input (P_{in})
② Gate Voltage (V_{GG})
③ Drain Voltage (V_{DD})
④ RF Output (P_{out})
⑤ RF Ground (Case)

TEST BLOCK DIAGRAM



① RF Input (P_{in})
② Gate Voltage (V_{GG})
③ Drain Voltage (V_{DD})
④ RF Output (P_{out})
⑤ RF Ground

EQUIVALENT CIRCUIT



RECOMMENDATIONS and APPLICATION INFORMATION:

Construction:

This module consists of an alumina substrate. For mechanical protection, a metal cap is attached (witch makes the improvement of RF radiation easy). The MOSFET transistor chips are die bonded onto the substrate, wire bonded to the substrate, and coated with resin. Lines on the substrate (eventually inductors), chip capacitors, and resistors form the bias and matching circuits. The DC and RF connection is provided at the backside of substrate.
Following conditions must be avoided:
a) Bending forces on the alumina substrate (for example, by fast thermal changes)
b) Defluxing solvents reacting with the resin coating on the MOSFET chips (for example, Trichloroethylene)
c) Frequent on/off switching that causes thermal expansion of the resin
d) ESD, surge, over voltage in combination with load VSWR, and oscillation

ESD:

This MOSFET module is sensitive to ESD voltages down to 1000V. Appropriate ESD precautions are required.

Thermal Design of the Heat Sink:

At P_{out}=1.4W, V_{DD}=3.3V and P_{in}=30mW each stage transistor operating conditions are:

Stage	P_{in} (W)	P_{out} (W)	$R_{th(ch-case)}$ (°C/W)	I_{DD} @ η_T=40% (A)	V_{DD} (V)
1st	0.03	0.3	57.2	0.11	3.3
2nd	0.3	1.4	7.6	1.10	

The channel temperatures of each stage transistor $T_{ch} = T_{case} + (V_{DD} \times I_{DD} - P_{out} + P_{in}) \times R_{th(ch-case)}$ are:

$T_{ch1} = T_{case} + (3.3V \times 0.11A - 0.3W + 0.03W) \times 57.2°C/W = T_{case} + 5.3\ °C$
$T_{ch2} = T_{case} + (3.3V \times 1.10A - 1.4W + 0.3W) \times 7.6°C/W = T_{case} + 19.2\ °C$

For long-term reliability, it is best to keep the module case temperature (T_{case}) below 70°C. For an ambient temperature T_{air}=45°C and P_{out}=3W, the required thermal resistance $R_{th\ (case-air)} = (T_{case} - T_{air}) / ((P_{out} / \eta_T) - P_{out} + P_{in})$ of the heat sink, including the contact resistance, is:

$R_{th(case-air)} = (70°C - 45°C) / (1.4W/35\% - 1.4W + 0.03W) = 9.51°C/W$

When mounting the module with the thermal resistance of 9.51°C/W, the channel temperature of each stage transistor is:

$T_{ch1} = T_{air} + 30.3\ °C$
$T_{ch2} = T_{air} + 44.2\ °C$

The 175°C maximum rating for the channel temperature ensures application under derated conditions.

Output Power Control:

The recommended method to control the output power is by the input power (Pin).

Oscillation:

To test RF characteristics, this module is put on a fixture with two bias decoupling capacitors each on gate and drain, a 4.700 pF chip capacitor, located close to the module, and a 22 µF (or more) electrolytic capacitor.
When an amplifier circuit around this module shows oscillation, the following may be checked:
a) Do the bias decoupling capacitors have a low inductance pass to the case of the module?
b) Is the load impedance Z_L=50Ω
c) Is the source impedance Z_G=50Ω

ATTENTION:

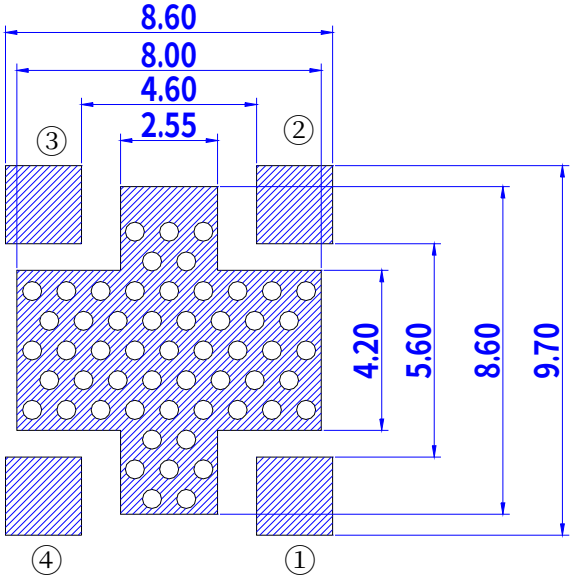
1.High Temperature; This product might have a heat generation while operation,Please take notice that have a possibility to receive a burn to touch the operating product directly or touch the product until cold after switch off. At the near the product,do not place the combustible material that have possibilities to arise the fire.
2. Generation of High Frequency Power; This product generate a high frequency power. Please take notice that do not leakage the unnecessary electric wave and use this products without cause damage for human and property per normal operation.
3. Before use; Before use the product,Please design the equipment in consideration of the risk for human and electric wave obstacle for equipment.

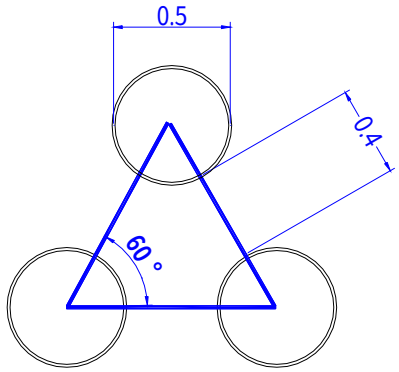
PRECAUTION FOR THE USE OF MITSUBISHI SILICON RF POWER AMPLIFIER DEVICES:

1.The specifications of mention are not guarantee values in this data sheet. Please confirm additional details regarding operation of these products from the formal specification sheet. For copies of the formal specification sheets, please contact one of our sales offices.
2.RA series products (RF power amplifier modules) are designed for consumer mobile communication terminals and were not specifically designed for use in other applications. In particular, while these products are highly reliable for their designed purpose, they are not manufactured under a quality assurance testing protocol that is sufficient to guarantee the level of reliability typically deemed necessary for critical communications elements. Examples of critical communications elements would include transmitters for base station applications and fixed station applications that operate with long term continuous transmission and a higher on-off frequency during transmitting, especially for systems that may have a high impact to society.
3.RA series products use MOSFET semiconductor technology. They are sensitive to ESD voltage therefore appropriate ESD precautions are required.
4.In order to maximize reliability of the equipment, it is better to keep the devices temperature low. It is recommended to utilize a sufficient sized heat-sink in conjunction with other cooling methods as needed (fan, etc.) to keep the case temperature for RA series products lower than 60deg/C under standard conditions, and less than 90deg/C under extreme conditions.
5.RA series products are designed to operate into a nominal load impedance of 50 ohms. Under the condition of operating into a severe high load VSWR approaching an open or short, an over load condition could occur. In the worst case there is risk for burn out of the transistors and burning of other parts including the substrate in the module.
6.The formal specification includes a guarantee against parasitic oscillation under a specified maximum load mismatch condition. The inspection for parasitic oscillation is performed on a sample basis on our manufacturing line. It is recommended that verification of no parasitic oscillation be performed at the completed equipment level also.
7.For specific precautions regarding assembly of these products into the equipment, please refer to the supplementary items in the specification sheet.
8.Warranty for the product is void if the products protective cap (lid) is removed or if the product is modified in any way from it's original form.
9.For additional "Safety first" in your circuit design and notes regarding the materials, please refer the last page of this data sheet.

10. Please refer to the additional precautions in the formal specification sheet.

P.C.B Land Pattern Recommendation



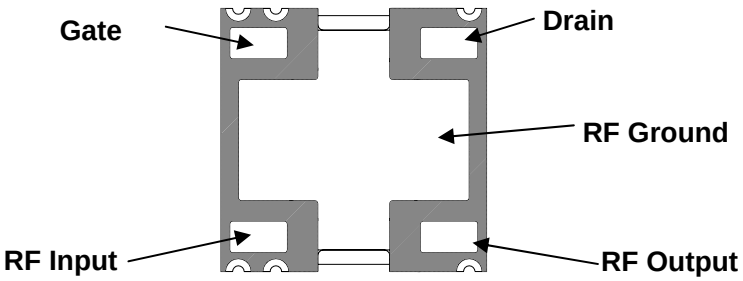


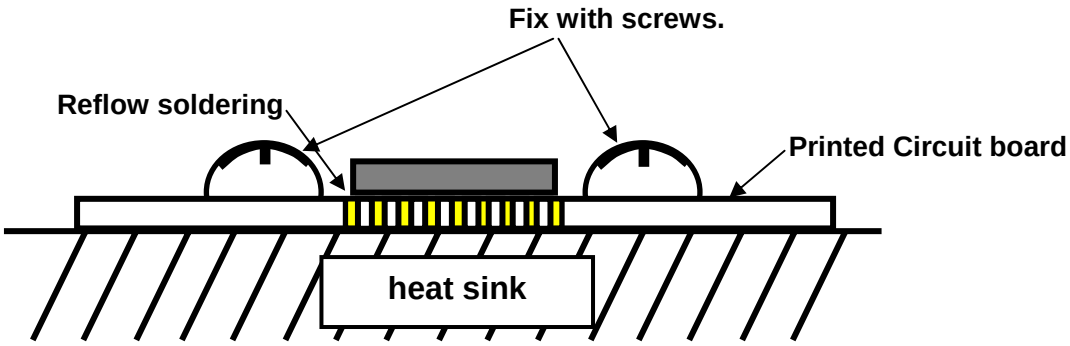
EQUILATERAL TRIANGLE ARRANGEMENT THROUGH HOLE

Mounting method

Mitsubishi recommends device mounting like Fig.1. In order to heat radiation, we recommend to fix the PCB and heat sink by screw. This PCB has through holes that filled up with resin to restrain the solder flow under the RF Ground. The interval of through holes is 0.4mm and these holes are arranged in the shape of equilateral triangles.

Fig.1



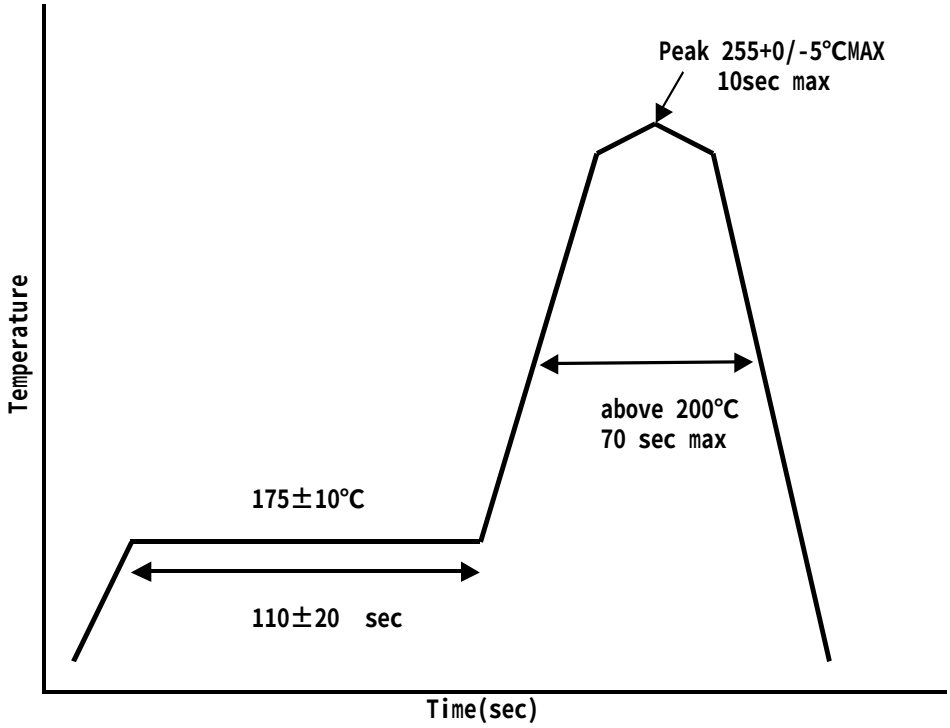


Note: Mitsubishi Heat Sink size=30 * 60 * 10 Unit: mm

Reflow soldering

Regarding to reflow soldering, Mitsubishi recommend the heat profile of Fig.2. Reflow soldering is able to do till 3 times.

Fig.2



Keep safety first in your circuit designs !

Mitsubishi Electric Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

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