< Silicon RF Power MOS FET (Discrete) >

RD60HMP2

RoHS Compliance, Silicon MOSFET Power Transistor, 870 MHz, 60 W, 12.5 V

DESCRIPTION

RD60HMP2 is a MOSFET type transistor specifically designed for 870 MHz RF power amplifier applications.

FEATURES

- Supply with Tape and Reel. 500 Units per Reel
- Plastic Package
- High Power and High Efficiency
  P_{out} = 70 W typ., Drain Effi.=65% typ.
  @ V_{DS} = 12.5 V, f = 870 MHz
- Integrated gate protection diode.

APPLICATION

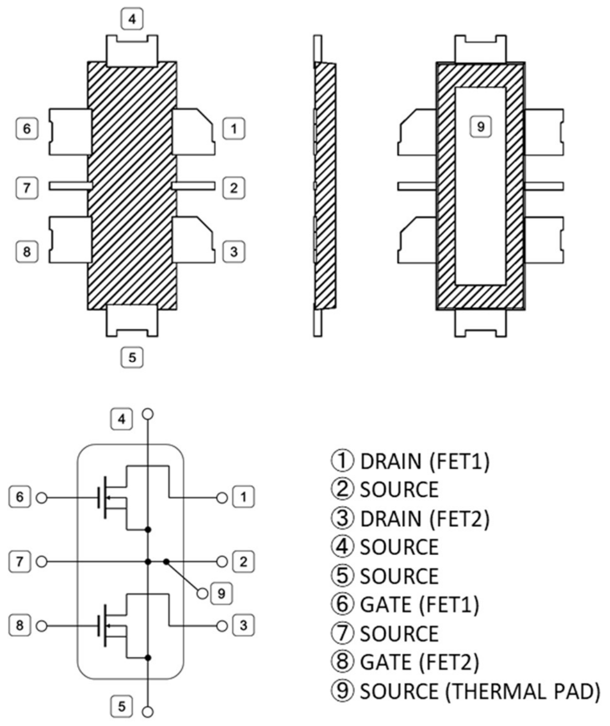
For output stage of high power amplifiers in 800 MHz-band mobile radio sets.

RoHS COMPLIANT

EU RoHS compliant.

RoHS Directive: 2011/65/EU, (EU)2015/863

PIN CONNECTIONS



MAXIMUM RATINGS (Tcase= +25 ℃, ZG=ZL=50Ω UNLESS OTHERWISE SPECIFIED

SYMBOL	PARAMETER	CONDITIONS	RATINGS	UNIT
V_{DSS}	Drain to Source Voltage	V_{GS} = 0 V	40	V
V_{GSS}	Gate to Source Voltage	V_{DS} = 0 V	-5/+10	V
P_{ch}	Channel Dissipation	With infinite heat sink.	385	W
P_{in}	Input Power	-	14	W
I_D	Drain Current	-	20	A
T_{ch}	Channel Temperature	-	175	°C
T_{stg}	Storage Temperature	-	-40 to +175	°C

Note : Each Maximum Ratings is Guaranteed Independently.

ELECTRICAL CHARACTERISTICS (Tcase=+25 ℃, ZG=ZL=50Ω UNLESS OTHERWISE SPECIFIED)

SYMBOL	PARAMETER	CONDITIONS	LIMITS			UNIT
			MIN.	TYP.	MAX.	
I_{DSS}*1	Zero Gate Voltage Drain Current	V_{DS} = 37 V, V_{GS} = 0 V	-	-	150	μA
I_{GSS}*1	Gate to Source Leak Current	V_{GS} = 10 V, V_{DS} = 0 V	-	-	2.5	μA
V_{TH}*1	Gate Threshold Voltage	V_{DS} = 12 V, I_{DS} = 1 mA	1.6	2.1	2.6	V
P_{out}*2	Output Power	f = 870 MHz, V_{DS} = 12.5 V, P_{in} = 7.0W, I_{DQ} = 1.0A	60	70	-	W
η_D*2	Drain Efficiency		60	65	-	%
VSWRT1*2, 3	Load VSWR Tolerance	Load VSWR = 65:1 (All Phase), f = 870 MHz, V_{DS} = 16.3 V, P_{in} = 3.5 W (Z_G=Z_L=50Ω), I_{DQ} = 1.0A	No destroy			-
VSWRT2*2	Load VSWR Tolerance	Load VSWR=20:1(All Phase) V_{DS} =16.3V increased after P_{out} adjusted to 60 W(Z_G/Z_L=50Ω) by P_{in} (under 870MHz, V_{DS} =12.5V and I_{DQ}=1.0 A)	No destroy			-

*1: One side characteristics out of the two FETs
*2: measured with Mitsubishi 870 MHz test fixture.
*3: This parameter is sampling check (22pcs / Wafer Lot).

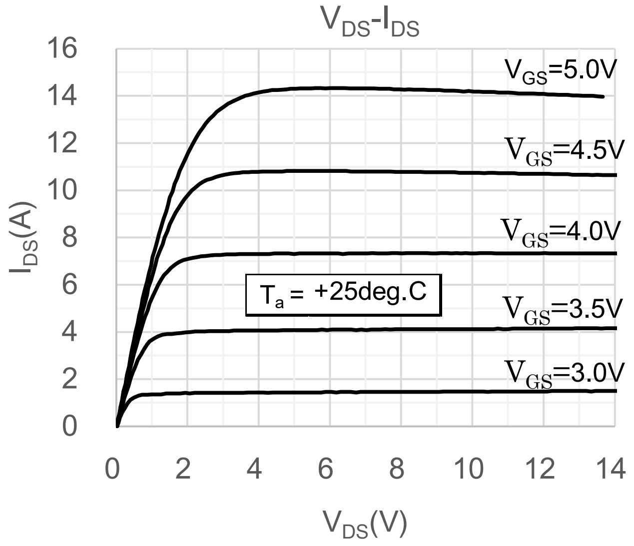
THERMAL CHARACTERISTICS (Tcase =+25℃ UNLESS OTHERWISE SPECIFIED)

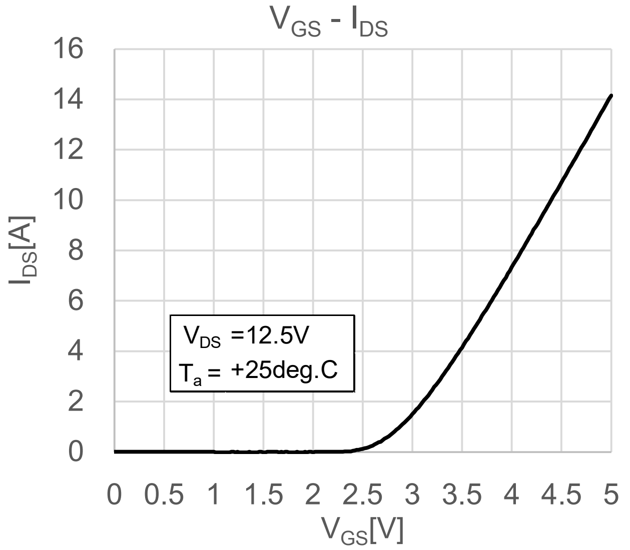
SYMBOL	PARAMETER	CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
Rth(j-c) *4	Thermal Resistance	Junction to Case	-	0.23	0.39	°C /W

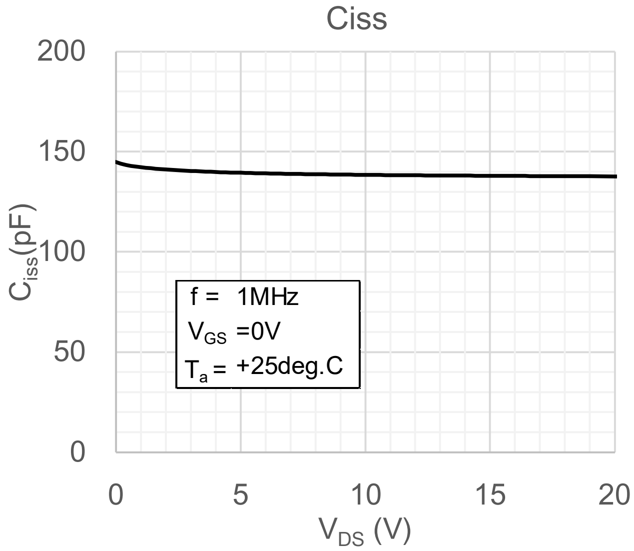
*4: This parameter is sampling check (22pcs / Assembly Lot).

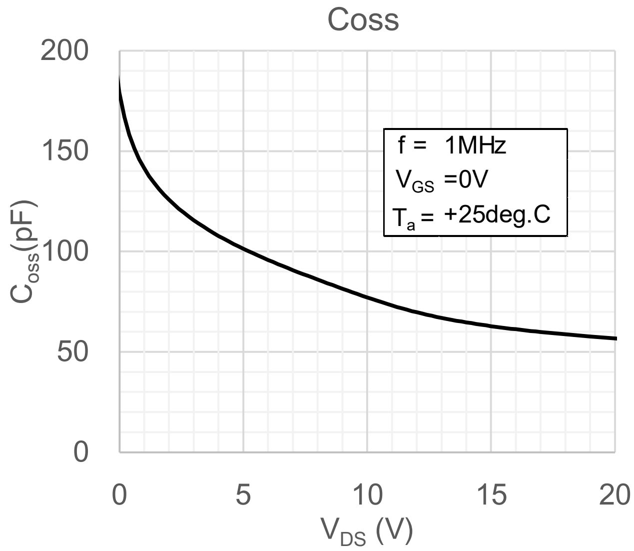
TYPICAL DC CHARACTERISTICS (One side characteristics out of the two FETs)

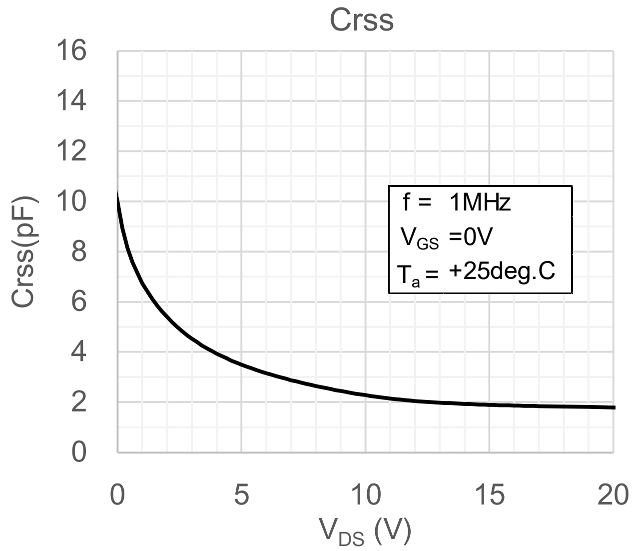
(These are only typical curves and devices are not necessarily guaranteed at these curves.)







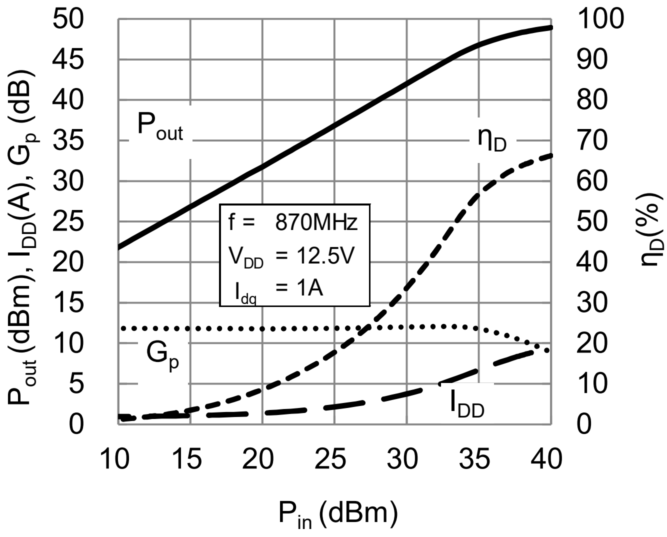


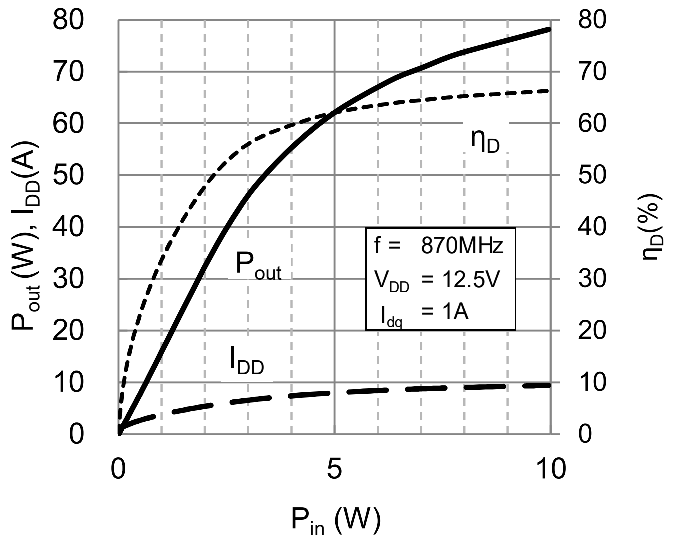


TYPICAL RF CHARACTERISTICS of Mitsubishi 870 MHz test fixture (P_{in} vs P_{out}, η_D, I_{DD}, G_p)

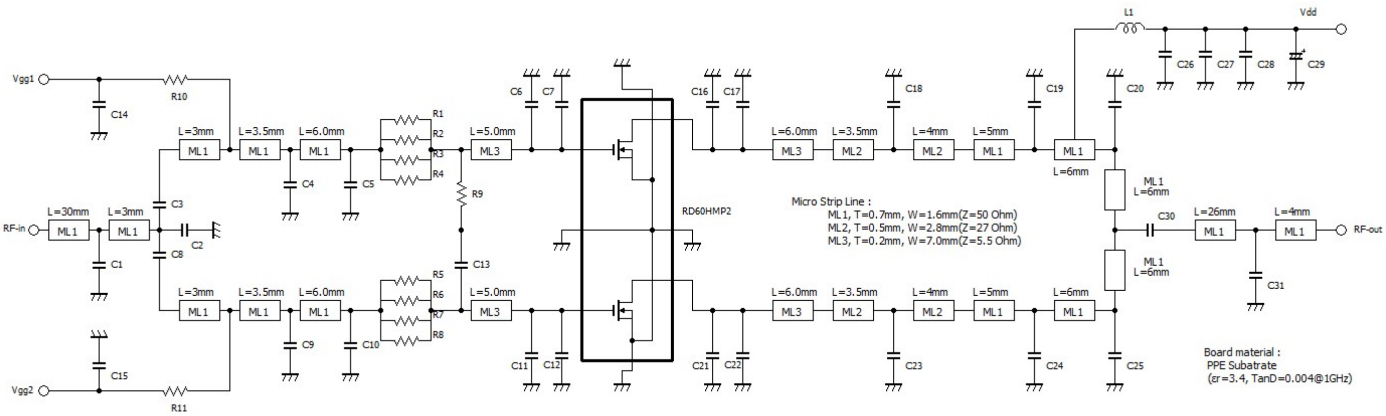
(These are only typical curves and devices are not necessarily guaranteed at these curves.)

V_{DD} = 12.5V, I_{dq} = 1.0A, T_a = 25deg.C, f=870MHz.





EQUIVALENT CIRCUITRY for Mitsubishi 870 MHz test fixture



COMPONENT LIST of Mitsubishi 870 MHz test fixture

No.	Description Capacitance		Size	Remarks
C1	2	pF	1608	Hi-Q 250V
C4, C9	3.6	pF	1608	Hi-Q 250V
C2	3	pF	1608	Hi-Q 250V
C3, C8, C13, C30	75	pF	1608	Hi-Q
C5, C6, C10, C11	5.1	pF	1608	Hi-Q 250V
C7, C12, C17, C22	9	pF	1608	Hi-Q 250V
C16, C21	10	pF	1608	Hi-Q 250V
C18, C23	2.4	pF	1608	Hi-Q 250V
C19, C24	4	pF	1608	Hi-Q 250V
C20, C25, C31	1	pF	1608	Hi-Q 250V
C14, C15, C26	1000	pF	2012	50V
C27	22	nF	2012	50V
C28	0.22	uF	2012	50V
C29	220	uF	-	35V

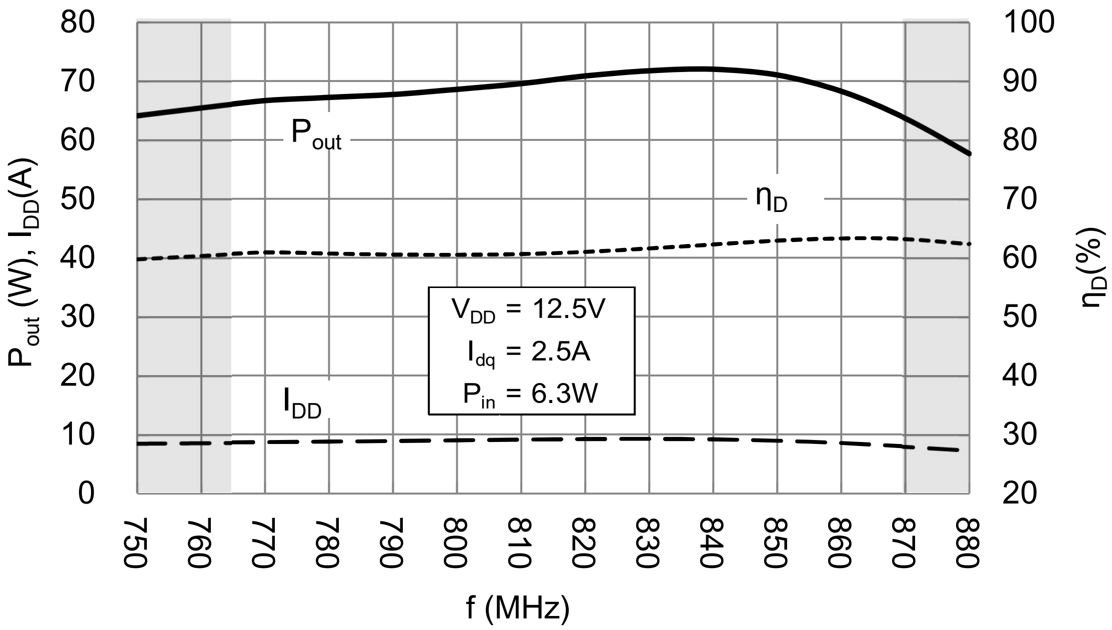
No.	Description Inductance (f=100MHz)	Diameter Wire Φ	Inside Φ	T/N
L1	17 nH	0.8 mm	3.86 mm	4

No.	Description Resistance	Size
R1～R8	2.2 Ω	2012
R9	10 Ω	1608
R10, R11	4700 Ω	1608

TYPICAL RF CHARACTERISTICS of 764-870 MHz EVB*5 (Frequency vs P_{out}, η_D, I_{DD})

(*5: Evaluation board)

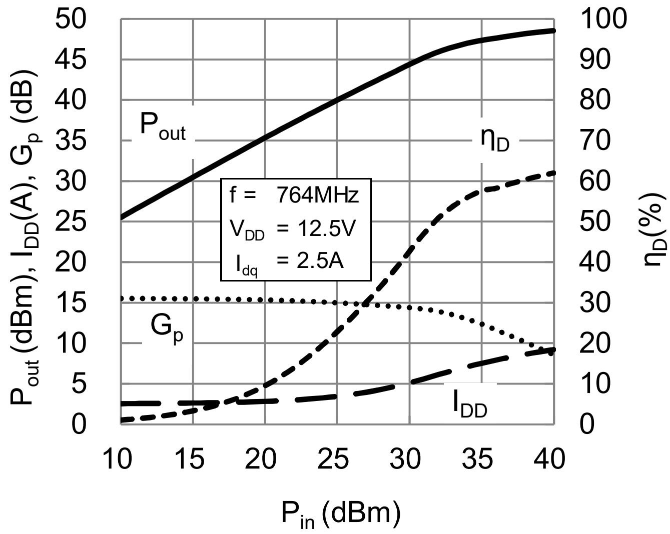
(These are only typical curves and devices are not necessarily guaranteed at these curves.)

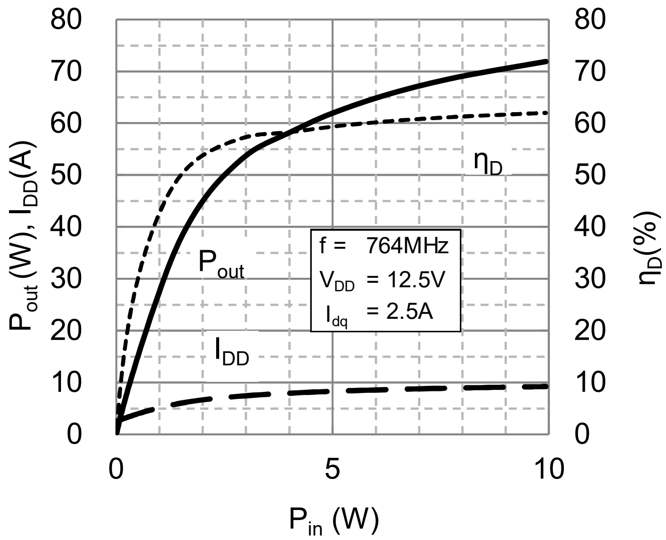


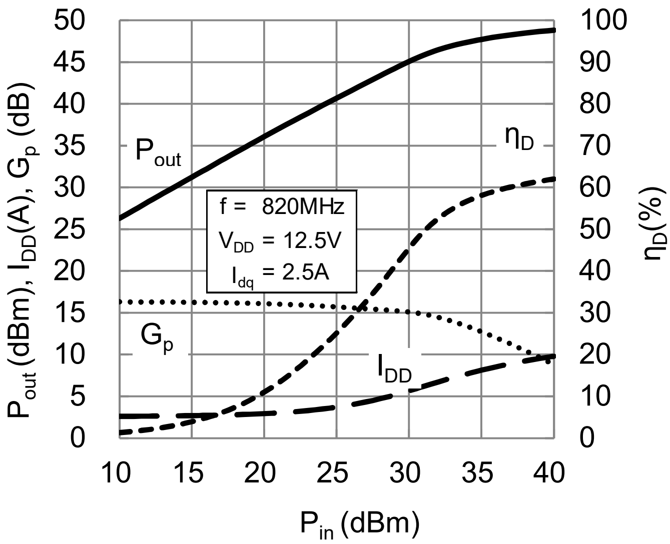
TYPICAL RF CHARACTERISTICS of 764-870 MHz EVB (P_{in} vs P_{out}, η_D, I_{DD}, G_p)

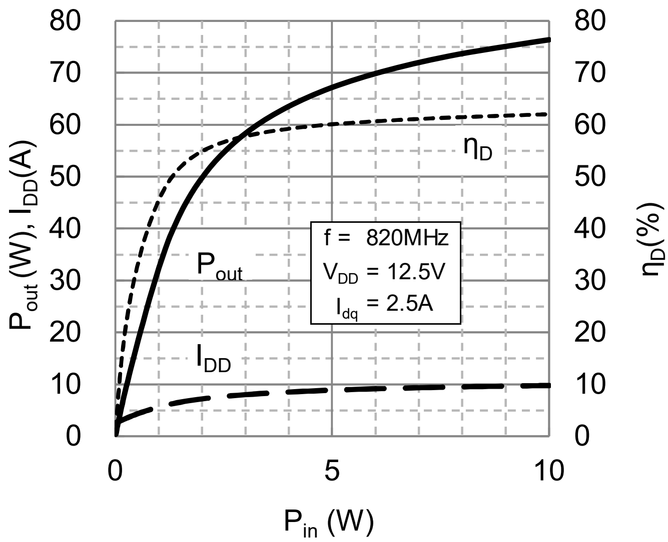
(These are only typical curves and devices are not necessarily guaranteed at these curves.)

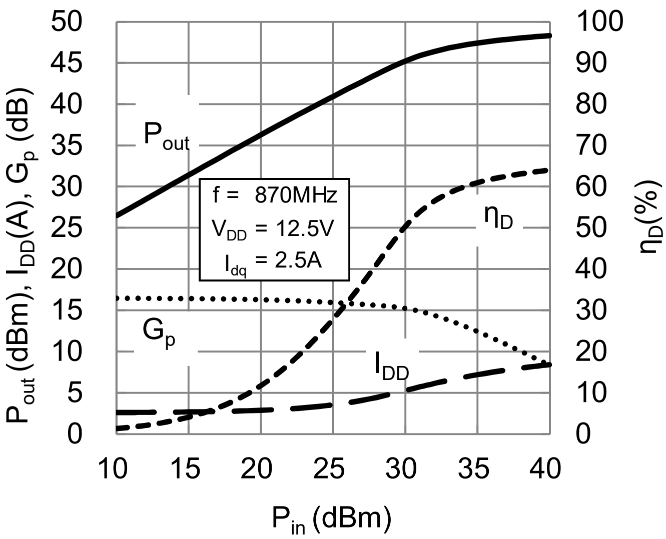
V_{DD} = 12.5V, I_{dq} = 2.5A, T_a = 25deg.C, f=764/ 820/ 870MHz.

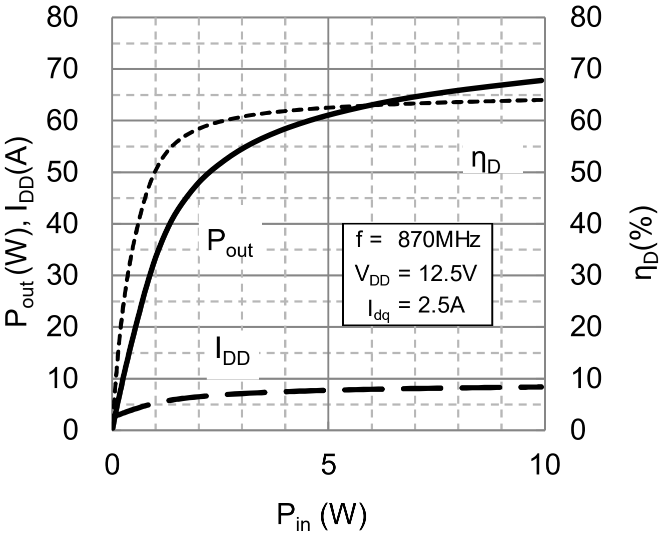








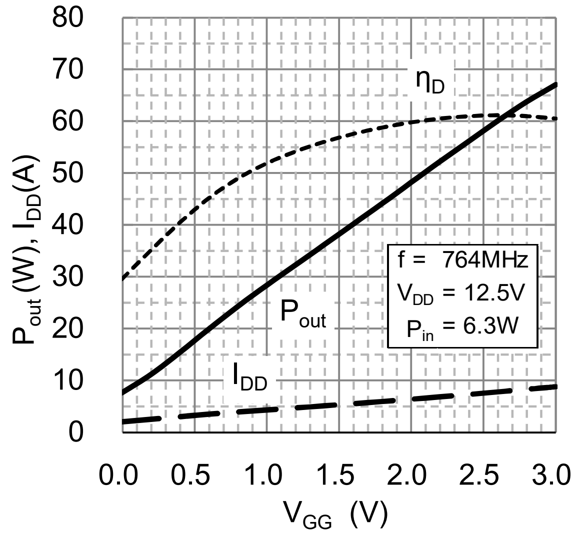


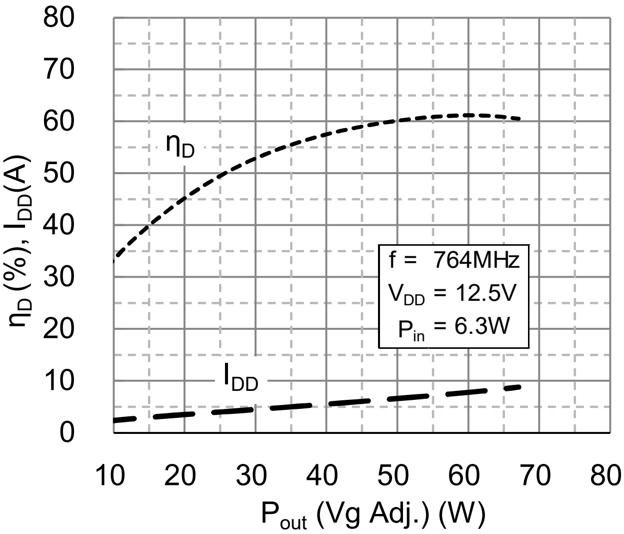


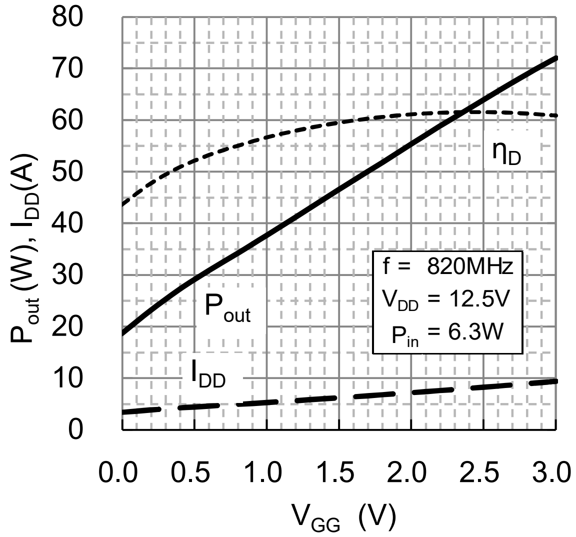
TYPICAL RF CHARACTERISTICS of 764-870 MHz EVB (V_{GG} vs P_{out}, η_D, I_{DD}, G_p)

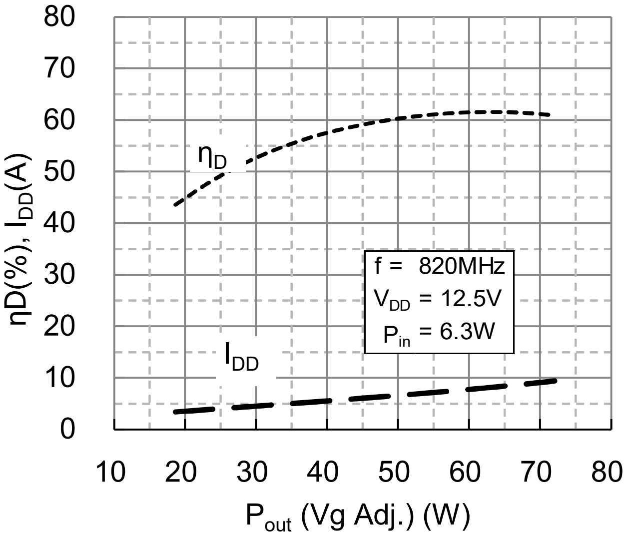
(These are only typical curves and devices are not necessarily guaranteed at these curves.)

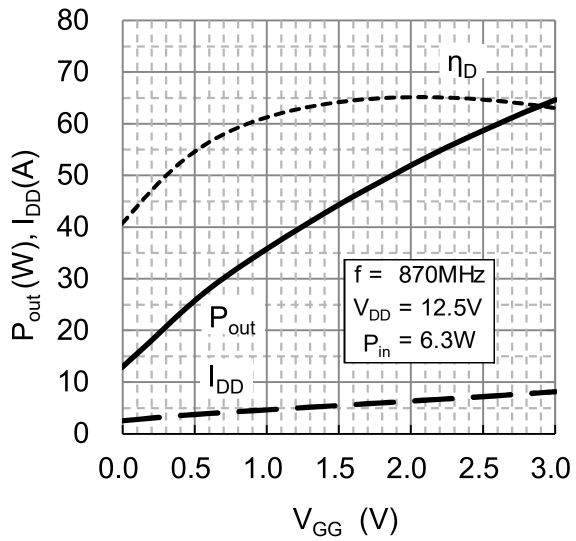
V_{DD} = 12.5V, P_{in} =38dBm (6.3W), T_a = 25deg.C, f=764/ 820/ 870MHz.

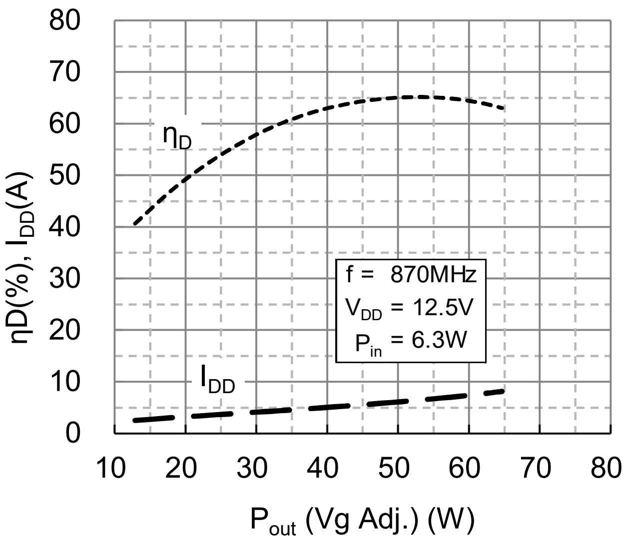




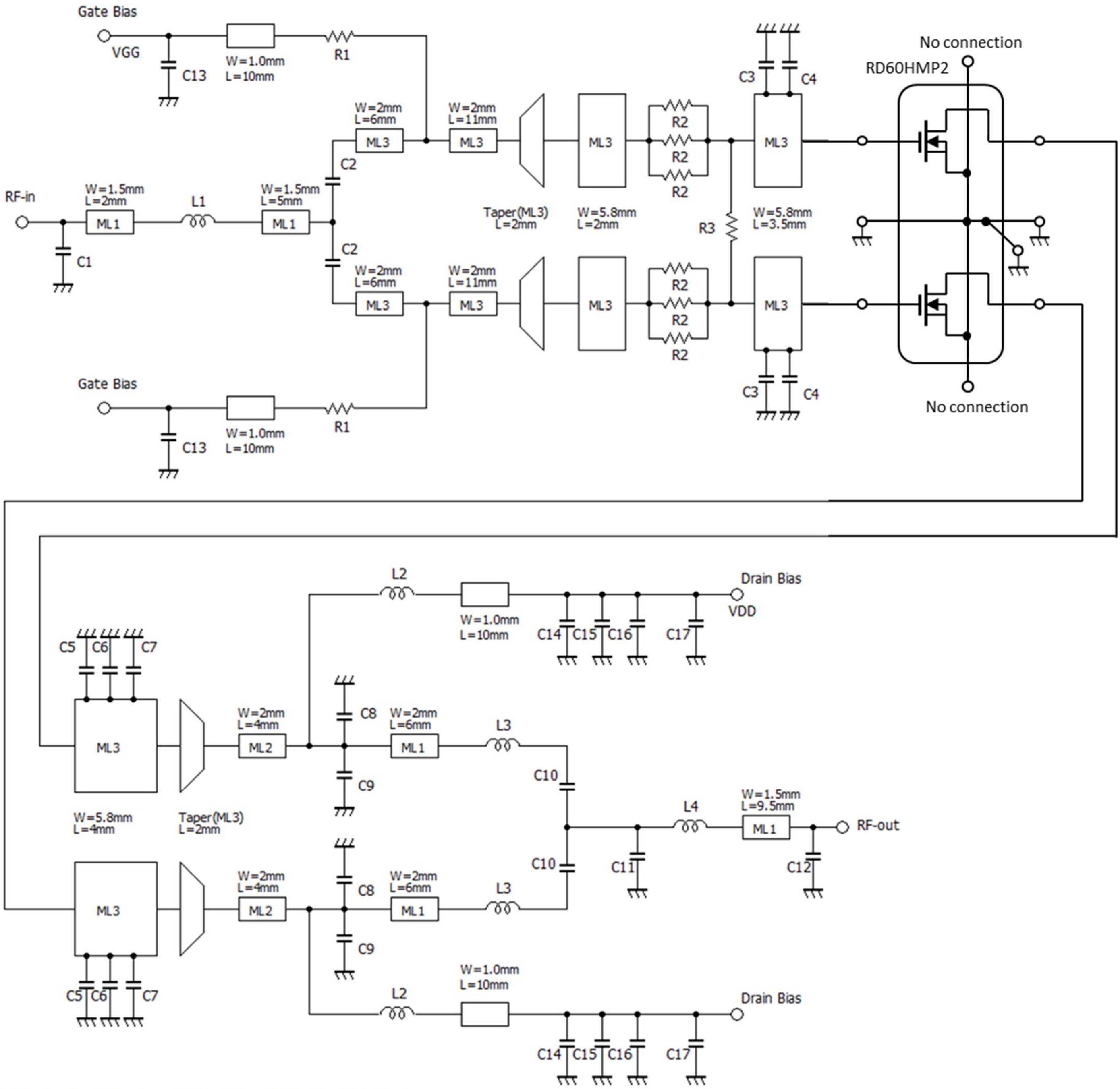








EQUIVALENT CIRCUITRY for 764-870 MHz EVB



Board material : Glass Epoxy Subatrate (εr=4.8, TanD=0.018@1GHz)

Micro Strip Line :
- ML1: T=0.8mm, W=1.5mm(Z=50 Ohm)
- ML2: T=0.4mm, W=2.0mm(Z=25 Ohm)
- ML3: T=0.2mm, W=5.8mm(Z=5.5 Ohm)/W=2.0mm(Z=14 Ohm)

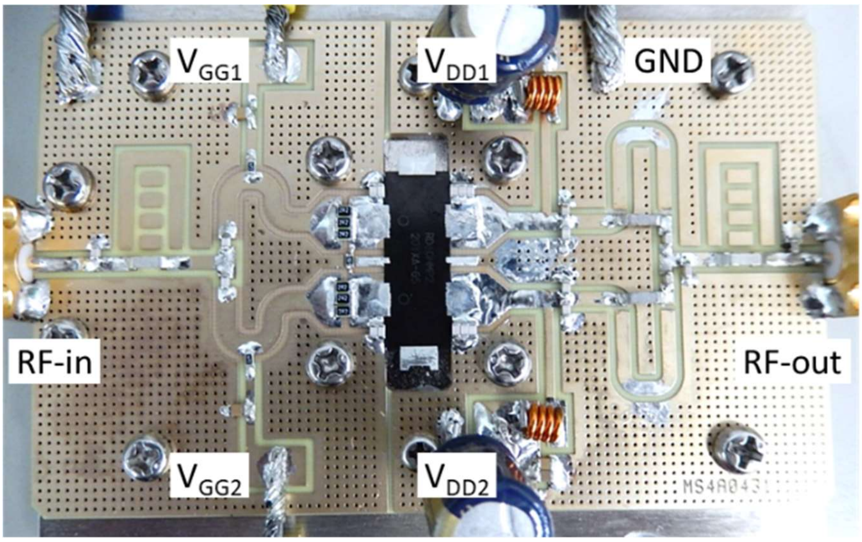
COMPONENT LIST of 764-870 MHz EVB

No.	Description			P/N	Manufacturer
	Capacitance	Size	Remarks		
C1	2.7pF	1608	Hi-Q 250V	GQM1875C2E2R7CB12	MURATA MANUFACTURING CO.
C2	68pF	1608	Hi-Q	GQM1882C1H680JB01	MURATA MANUFACTURING CO.
C3	4.7pF	1608	Hi-Q 250V	GQM1875C2E4R7CB12	MURATA MANUFACTURING CO.
C4	11pF	1608	Hi-Q 250V	GQM1875C2E110JB12	MURATA MANUFACTURING CO.
C5	12pF	1608	Hi-Q 250V	GQM1875C2E120JB12	MURATA MANUFACTURING CO.
C6	10pF	1608	Hi-Q 250V	GQM1875C2E100JB12	MURATA MANUFACTURING CO.
C7	6.8pF	1608	Hi-Q 250V	GQM1875C2E6R8CB12	MURATA MANUFACTURING CO.
C8	4.7pF	1608	Hi-Q 250V	GQM1875C2E4R7CB12	MURATA MANUFACTURING CO.
C9	3.6pF	1608	Hi-Q 250V	GQM1875C2E3R6CB12	MURATA MANUFACTURING CO.
C10	68pF	1608	Hi-Q	GQM1882C1H680JB01	MURATA MANUFACTURING CO.
C11	7.5pF	1608	Hi-Q 250V	GQM1875C2E7R5CB12	MURATA MANUFACTURING CO.
C12	2.7pF	1608	Hi-Q 250V	GQM1875C2E2R7CB12	MURATA MANUFACTURING CO.
C13	1000pF	2012	50V	GRM216R11H102KA01	MURATA MANUFACTURING CO.
C14	1000pF	2012	50V	GRM216R11H102KA01	MURATA MANUFACTURING CO.
C15	22nF	2012	50V	GRM21BR71H223KA01	MURATA MANUFACTURING CO.
C16	0.22uF	2012	50V	GRM21BR71H224KA01	MURATA MANUFACTURING CO.
C17	220uF	-	35V	EEUFC1V221	Panasonic Corporation

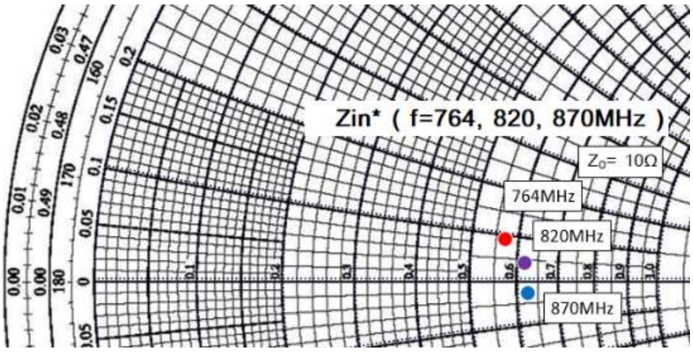
No.	Description				P/N	Manufacturer	Remarks
	Inductance	Diameter					
		Wire Φ	Inside Φ	T/N of coils			
L 1	1.1 nH				Cu Bridge H01	OISHI INDUSTRIES,Ltd.	Bridge inductor
L 2	17 nH *	0.8 mm	3.86 mm	4	8004C	YC Corporation Co.,Ltd.	Enameled wire
L 3	1.1 nH				Cu Bridge H01	OISHI INDUSTRIES,Ltd.	Bridge inductor
L 4	1.1 nH				Cu Bridge H01	OISHI INDUSTRIES,Ltd.	Bridge inductor

No.	Description		P/N	Manufacturer
	Resistance	Size		
R 1	4700 Ω	1608	RPC05T472J	TAIYOSHA ELECTRIC CO.
R 2	2.2 Ω	2012	RPC10T2R2J	TAIYOSHA ELECTRIC CO.
R 3	10 Ω	1005	RPC05T100J	TAIYOSHA ELECTRIC CO.

APPEARANCE of 764-870 MHz EVB

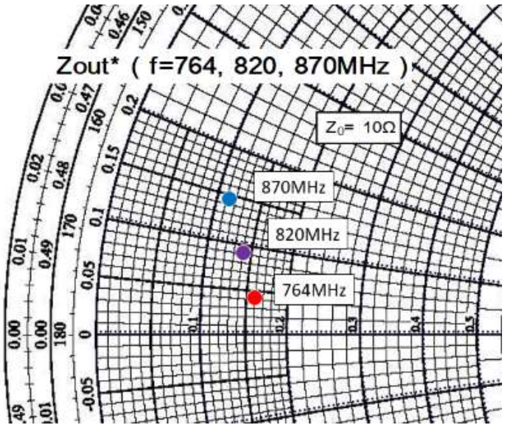


Input / Output Impedance of 764-870 MHz EVB



f (MHz)	Zin* (Ω)
764	5.70 + j 0.82
820	6.17 + j 0.34
870	6.25 - j -0.35

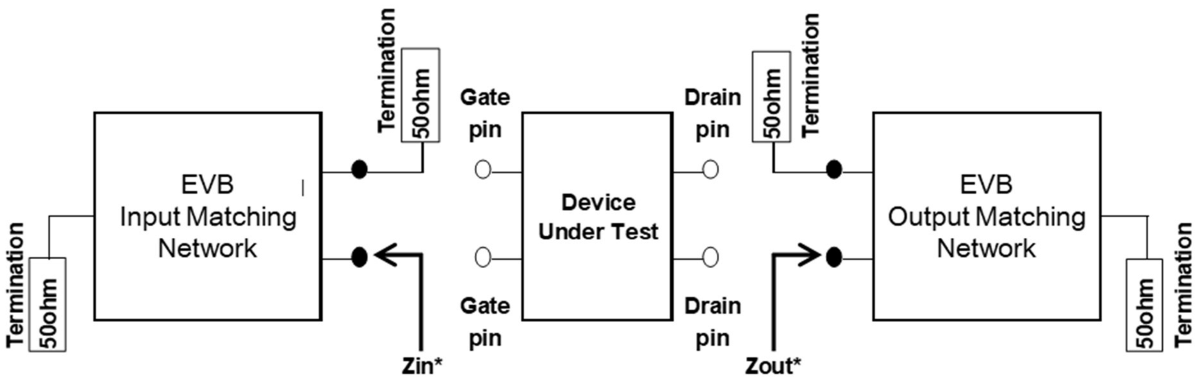
Zin*:Complex conjugate of input impedance



f (MHz)	Zout* (Ω)
764	1.60 + j 0.38
820	1.41 + j 0.88
870	1.14 + j 1.43

Zout*:Complex conjugate of output impedance

Measurement Method



● : Edge of a footprint pad placed for a pin

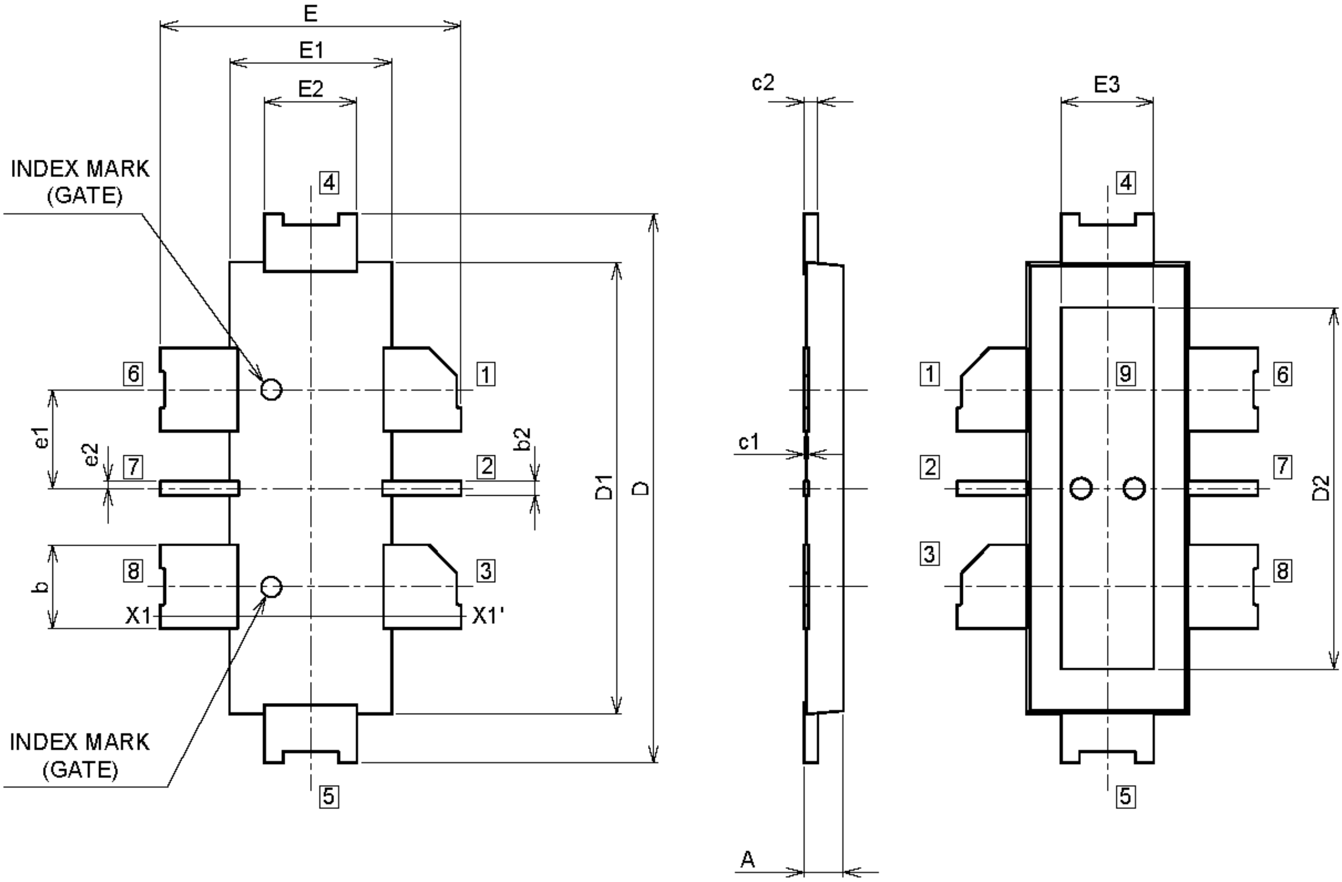
○ : Boundary surface between a pin and package plastics

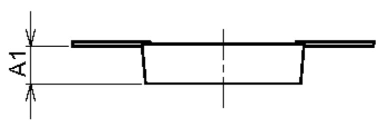
S-PARAMETER DATA of DEVICE (One side characteristics of 2 FETs)

V_{DD} = 12.5V, I_{dq} = 0.5A, T_a = 25deg.C,

Freq.	S11		S21		S12		S22	
(MHz)	(mag)	(ang)	(mag)	(ang)	(mag)	(ang)	(mag)	(ang)
100	0.86	-167	13.95	60	0.008	-28	0.70	-153
150	0.90	-170	7.90	46	0.006	-40	0.79	-158
200	0.93	-173	5.03	36	0.005	-48	0.85	-163
250	0.94	-176	3.43	28	0.004	-52	0.89	-167
300	0.96	-178	2.47	22	0.003	-55	0.92	-170
350	0.96	-179	1.85	18	0.002	-55	0.94	-172
400	0.97	179	1.42	14	0.002	-52	0.95	-175
450	0.97	178	1.12	11	0.001	-42	0.96	-176
500	0.98	176	0.91	8	0.001	-16	0.96	-178
550	0.98	175	0.74	6	0.001	21	0.97	-179
600	0.98	174	0.62	3	0.001	48	0.97	179
650	0.98	173	0.52	2	0.001	61	0.97	179
700	0.98	173	0.44	0	0.001	67	0.98	177
750	0.99	172	0.38	-1	0.002	70	0.98	177
760	0.99	172	0.37	-2	0.002	71	0.98	176
800	0.99	171	0.33	-3	0.002	71	0.98	176
820	0.99	171	0.32	-3	0.002	72	0.98	176
850	0.99	170	0.29	-4	0.002	73	0.98	175
870	0.99	170	0.28	-5	0.002	73	0.99	175
900	0.99	170	0.26	-5	0.002	73	0.98	175
950	0.99	169	0.23	-6	0.003	73	0.99	174
1000	0.99	169	0.20	-7	0.003	74	0.99	174
1100	0.99	168	0.17	-9	0.003	74	0.99	173
1200	0.99	167	0.14	-10	0.004	74	0.99	173
1300	0.99	166	0.13	-12	0.004	73	0.99	173
1400	0.99	165	0.12	-13	0.005	72	0.99	173
1500	0.99	164	0.11	-14	0.006	72	0.99	173

OUTLINE DIMENSIONS





X1-X1' SECTION

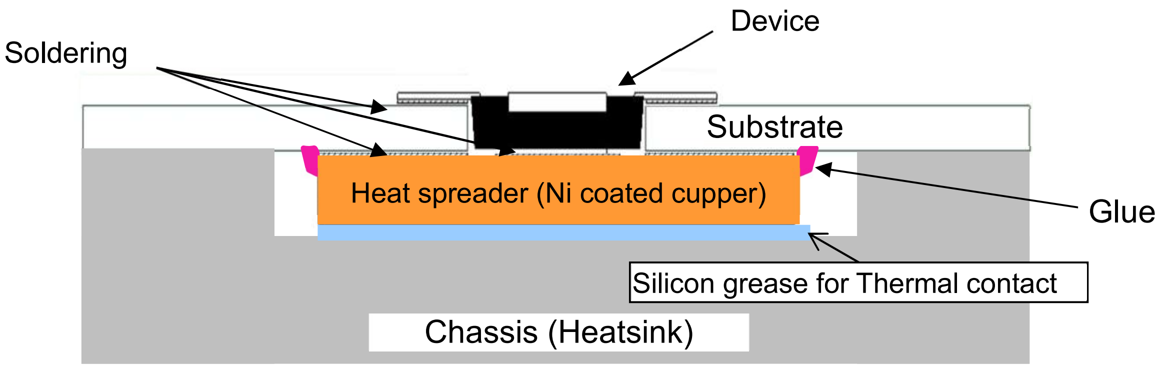
PIN NO;
1 DRAIN
2 SOURCE (COMMON)
3 DRAIN
4 SOURCE (COMMON)
5 SOURCE (COMMON)
6 GATE
7 SOURCE (COMMON)
8 GATE
9 SOURCE (COMMON)

DIM	MILLMETERS	
	MIN	MAX
A	1.60	1.80
A1	1.42	1.52
D	23.60	23.80
D1	19.40	19.60
D2	15.45	15.75
E	12.90	13.10
E1	6.90	7.10
E2	3.95	4.10
E3	3.85	4.15
b	3.55	3.70
b2	0.55	0.70
c1	0.17	0.27
c2	0.55	0.70
e1	4.15	4.35
e2	-	0.40

NOTES;
1. UNIT IS A MILLIMETER.
2. b2 is the width of Pin 2 & 7
3. e2 is the offset of Pin 2 & 7 (from the center to the edge of Pin)

RECOMMENDED DEVICE MOUNTING METHOD

Please consider the thermal design to prevent destruction due to overheat. Recommended mounting structure is shown below. The thermal pad in the back of the device should be soldered directly to a heat sink or heat spreader.



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.

PRECAUTIONS FOR THE USE OF MITSUBISHI SILICON RF POWER 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. A series products (RF power amplifier modules) and RD series products (RF power transistors) 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 and In the application, which is base station applications and fixed station applications that operate with long term continuous transmission and a higher on-off frequency during transmitting, please consider the derating, the redundancy system, appropriate setting of the maintain period and others as needed. For the reliability report which is described about predicted operating life time of Mitsubishi Silicon RF Products , please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor.

3. RD series products use MOSFET semiconductor technology. They are sensitive to ESD voltage therefore appropriate ESD precautions are required.

4. In the case of use in below than recommended frequency, there is possibility to occur that the device is deteriorated or destroyed due to the RF-swing exceed the breakdown voltage.

5. 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 channel temperature for RD series products lower than 120deg/C(in case of Tchmax=150deg/C) ,140deg/C(in case of Tchmax=175deg/C) under standard conditions.

6. Do not use the device at the exceeded the maximum rating condition. In case of plastic molded devices, the exceeded maximum rating condition may cause blowout, smoldering or catch fire of the molding resin due to extreme short current flow between the drain and the source of the device. These results causes in fire or injury.

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 its 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 avoid use in the place where water or organic solvents can adhere directly to the product and the environments with the possibility of caustic gas, dust, salinity, etc. Reliability could be markedly decreased and also there is a possibility failures could result causing a serious accident. Likewise, there is a possibility of causing a serious accident if used in an explosive gas environment. Please allow for adequate safety margin in your designs.

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

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.

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