

To: _____**Ref. No. G2K-R-051019-1 B****Prepared S.Kametani/T.Ohkawa****Checked T.Ohkawa****Approved M.Koyama****Date 19th Oct 2005, /Rev B 8th March 2006**

Subject ; RoHS Compliance products for RA & RD series

This document shows the change points for RoHS compliance products for RA & RD series.

1.Specification number

Add the “ 1 “ on the top of specification number.

Examples;

Non RoHS compliance

RoHS compliance

RA07M1317M-01



RA07M1317M-101

RA35H1516M-51



RA35H1516M-151

RD01MUS1-T13



RD01MUS1-T113

RD60HUF1-01



RD60HUF1-101

2. Indication on the products

Add the “ -G ” after Lot number marking on the products.

Examples; Non RoHS compliance

RoHS compliance

Lot No ⇨ Lot No -G

Lot No-51 ⇨ Lot No-G51

Lot No-B ⇨ Lot No-GB

We do not indicate the “ -G ” for small size SMD products of SOT89 package.

3. Changing point of RoHS compliance products.

Page 4-8 shows the changing points of materials and construction.

4. Amount of flange concave.

Page 9 shows the amount of flange concave vs elapsed days for H2 outline module.

Amount of flange concave for RoHS H2 outline is larger about 200-300um than Non RoHS.

We recommend to increase the amount of thermal grease between flange and chassis.

5. RF performance of RoHS compliance products for RF module RA series.

Page 10-22 shows the comparison data between non RoHS compliance and RoHS compliance products.

Results; H46 package delegate module RA07M1317M ⇨ Equal

H11 package delegate module RA13H8891MB ⇨ Equal

H2 package delegate module RA45H4452M ⇨ Equal

6. Surface temperature of RoHS compliance products for RF module RA series.

Page 23-28 shows the comparison data between non RoHS compliance and RoHS compliance products.

Results; H46 package delegate module RA07M1317M	⇒	Equal
H11 package delegate module RA13H8891MB	⇒	Equal
H2 package delegate module RA45H4452M	⇒	Around 7 deg/c up at the first stage MOSFET.(Note)

Note; The temperature of first stage MOSFET is rise the 10deg/c from module flange temperature. The temperature of first stage MOSFET is very low and no problem for around 7 deg/c up.

7. RF performance of RoHS compliance products for RF discrete MOSFET RD series.

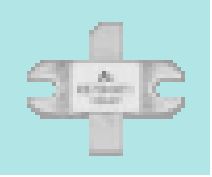
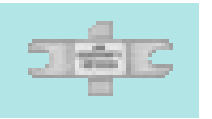



Page 29-37 shows the comparison data between non RoHS compliance and RoHS compliance products.

Results; SOT-89 package delegate MOS FET RD01MUS1	⇒	Equal
SLP package delegate MOSF ET RD07MVS1	⇒	Equal
TO220 package delegate MOSFET RD15HVF1	⇒	Equal

8. Recommended solder condition.



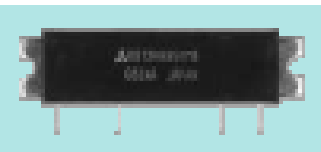
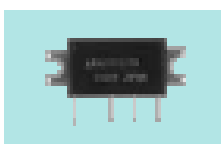

Page 38 shows the recommended solder condition.

Change points of RoHS Compliance For Discrete RF MOS FETs

Outline	Package	Type Number	Metal Finish		D/B Solder
			Current	New	
	Ceramic (T31S T40S)	<i>RD70HVF1</i> <i>RD60HUF1</i> <i>RD45HMF1</i> <i>RD70HHF1</i> <i>RD100HHF1</i>	Ni/Au	Ni/Au	AuSn
		<i>RD30HVF1</i> <i>RD30HUF1</i> <i>RD20HMF1</i>	Ni/Au	Ni/Au	AuSn
	Mold (SLP)	<i>RD12MVS1</i> <i>RD07MVS1</i> <i>RD02MUS1</i>	Ni/Au	Ag	PbSnAg
	Mold (TO220 S)	<i>RD15HVF1</i> <i>RD16HHF1</i> <i>RD06HHF1</i>	PbSn	SnCu	PbSnAg
	Mold (SC-62/SOT-89)	<i>RD00HVS1</i> <i>RD01MUS1</i>	PbSn	SnBi	PbSnAg

Notes: On the above table, PbSnAg solder which is the “High Melting Temperature Solder” having 88% content of Pb is exempted from RoHS.

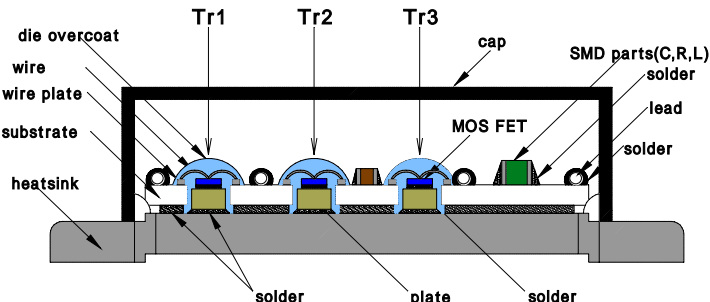
Change points of RoHS Compliance For RF Modules

Outline	Package	PKG#	Type Number	Position	Current 	New
	High Po PKG L	H2S H2RS	RA13H, RA30H RA45H, RA55H RA60H, RA35H RA20H, RA18H Series	Lead Finish	Sn	Sn
				Solder for chip mount	PbSnAg	SnAgCu
				Solder between substrate and flange	InPbAg	SnAgCu
	Middle Po PKG M	H11S	RA13H8891MB RA06H8285M	Lead Finish	Sn	Sn
				Solder for chip mount	PbSnAg	SnAgCu
				Solder between substrate and flange	InPbAg	SnAgCu
	Handy PKG	H46S	RA03M, RA07M RA07N, RA07H Series	Lead Finish	Sn	Sn
				Solder for chip mount	PbSnAg	SnAgCu
				Solder between substrate and flange	PbSnAg	SnAgCu
	Handy PKG SMD	H46 SMD	RA07M1317MS RA07M4047MS RA07M4452MS	Lead Finish	PbSn	SnAgCu
				Solder for chip mount	PbSnAg	SnAgCu
				Solder between substrate and flange	PbSnAg	SnAgCu

Note: PbSnAg solder on the above table contains Pb as about 64% and is not “High Melting Temperature Solder”.

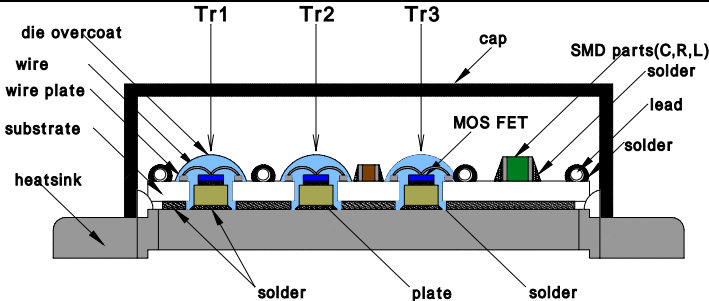
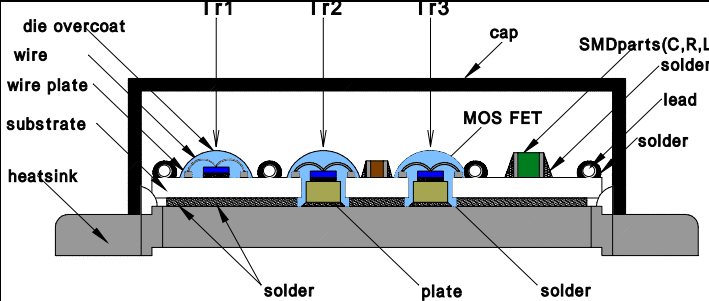
Change points of RoHS Compliance For RF Modules (detail)

Change point for RoHS Compliance @ RA series(H46 style)

		Current	RoHS Compliance
structure			
solder	composition	SnAgSbPb	SnAgCu
	melting temp	solidus : 181 liquidus : 198	solidus : 217 liquidus : 220
solder	composition	PbSnAg	SnAgCu
	melting temp	solidus : 178 liquidus : 192	solidus : 217 liquidus : 220
solder	composition	PbSn	SnAgCu
	melting temp	-	-
change reason ()		change for PbFree solder	
wire plate	material	AL	Fe
	finish plating	-	Ni
change reason ()		countermeasure for wire break	
SMDparts	material	-	-
	electrode	solder plating	Sn
change reason ()		change for PbFree parts	

Change points of RoHS Compliance For RF Modules (detail)

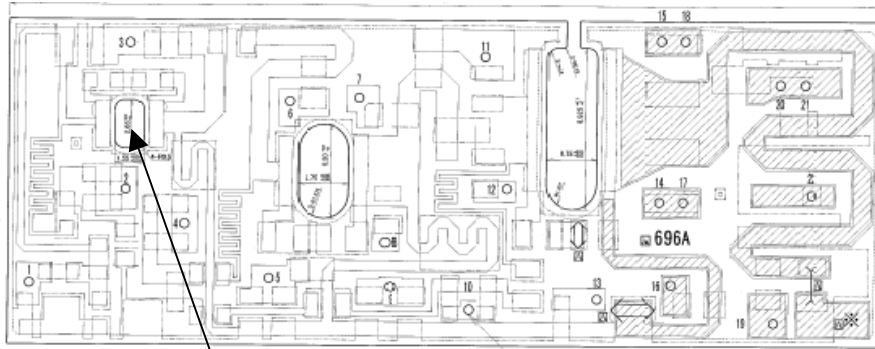
Change point for RoHS compliance @ RA series(H2 &H11 style)

		Current	RoHS Compliance
structure			
solder	composition	InPbAg	SnAgCu
	melting temp	solidus: 167 liquidus: 254	solidus: 217 liquidus: 220
solder	composition	PbSnAg	SnAgCu
	melting temp	solidus: 178 liquidus: 192	solidus: 217 liquidus: 220
solder	composition	PbSn	SnAgCu
	melting temp	-	-
change reason ()		change for PbFree solder	
substrate	structure	Tr1/Tr2/Tr3 area is hollow	Tr1 area is COB structure
change reason ()		countermeasure for substrate crack	
wire plate	material	AL	Fe
	finish plating	-	Ni
change reason ()		countermeasure for wire break	
SMDparts	material	-	-
	electrode	solder plating	Sn
change reason ()		change for PbFree parts	

Change points of RoHS Compliance For RF Modules (detail)

- Change point of inner substrate for H2&H11 outline

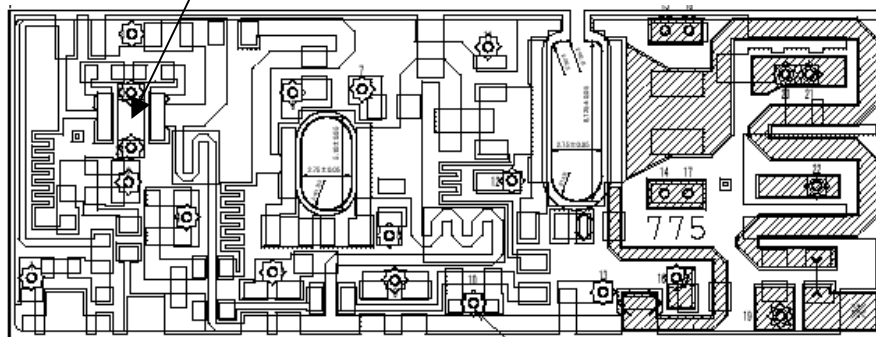
Non RoHS compliance



Hole structure

RoHS compliance

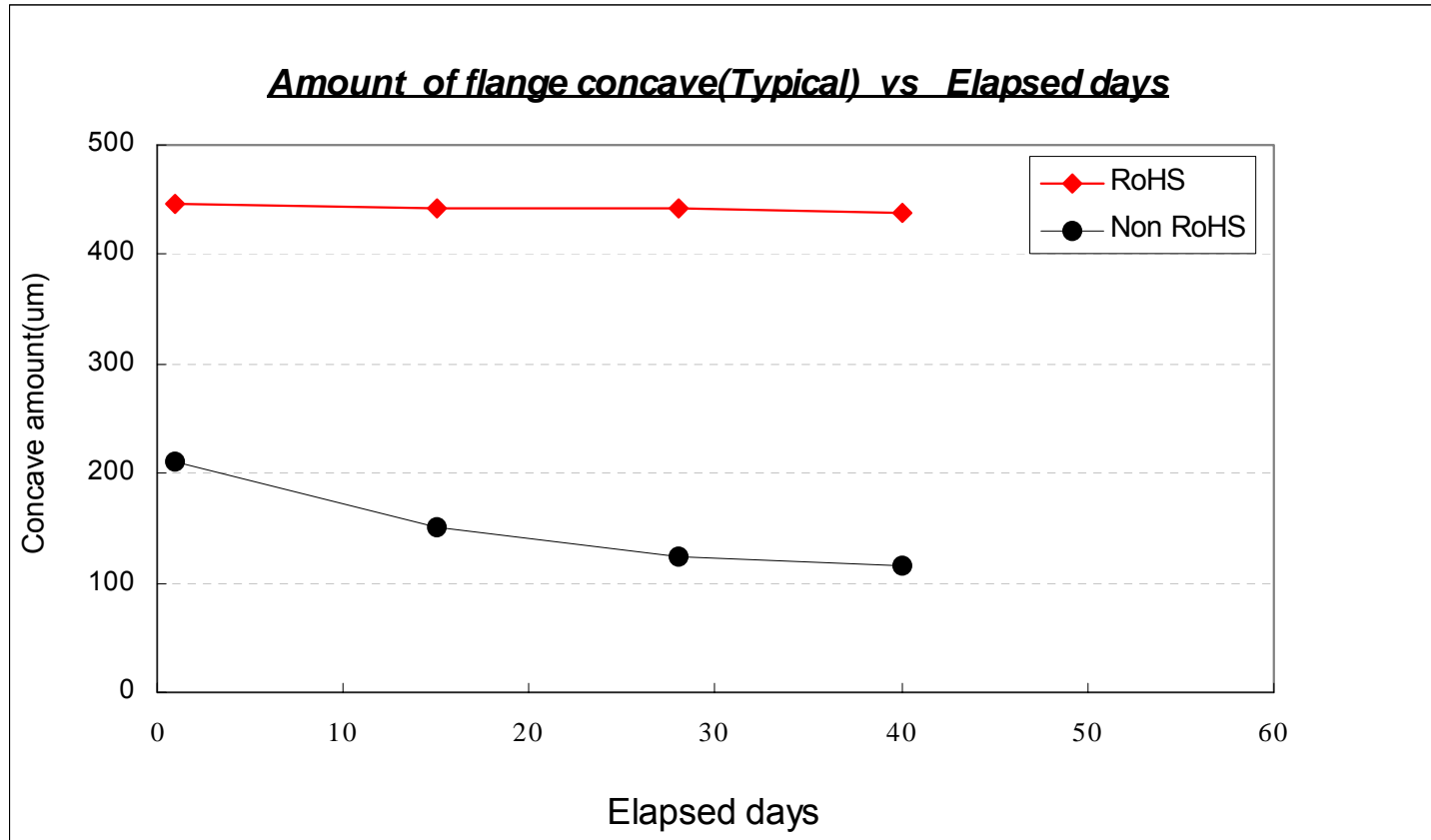
COB structure (This is change point of inner substrate)



Amount of flange concave vs Elapsed days for H2 outline module

Fig; Amount of flange concave vs Elapsed days

Sample ; RA45H4452M-01/101



Elapsed days; The day of placed by itself at room temperature.

Summary of evaluation result for Module

Summary of evaluation result for Non RoHS & RoHS compliance

	Evaluation items			
	Surface temp.	RF characteristics	Load VSWR Tolerance	Stability
RA45H4452M (H2 outline)	RoHS products is little higher than Non RoHS.(first stage) Note	Equal	Equal	Equal
RA13H8891MB (H11 Outline)	Equal	Equal	Equal	Equal
RA07M1317M (H46 Outline)	Equal	Equal	Equal	Equal

Note; Around 7 deg/c up at the first stage MOSFET.

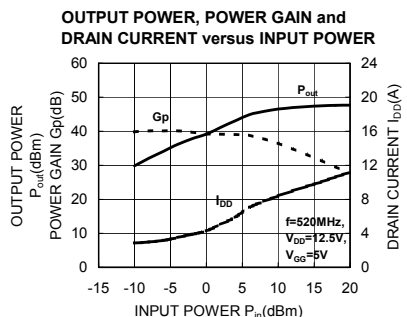
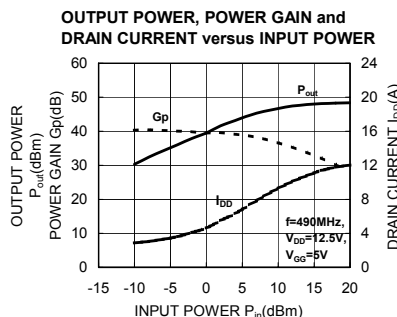
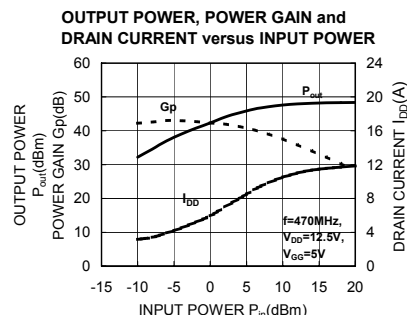
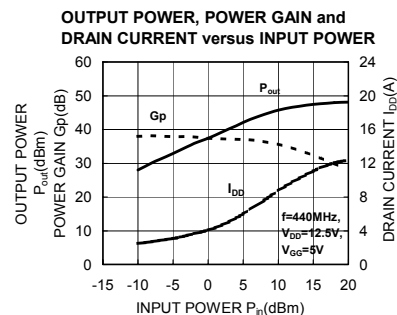
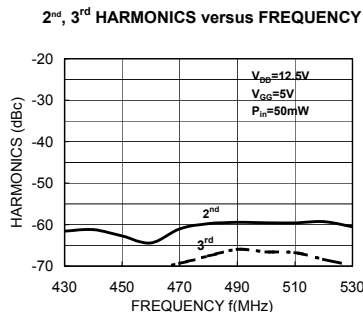
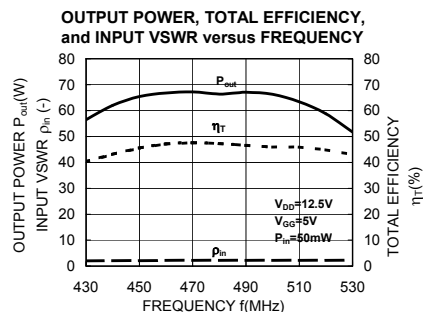
The temperature of first stage MOSFET is rise the 10deg/c from module case temperature.

The temperature of first stage MOSFET is very low and no problem for around 7 deg/c up.

RA45H4452M RF characteristics (Non RoHS vs. RoHS compliance products)

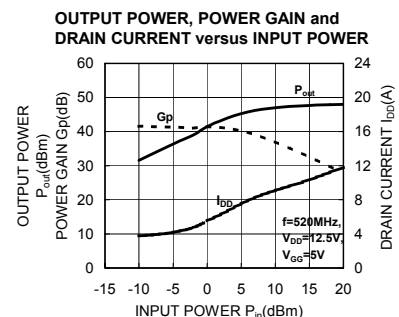
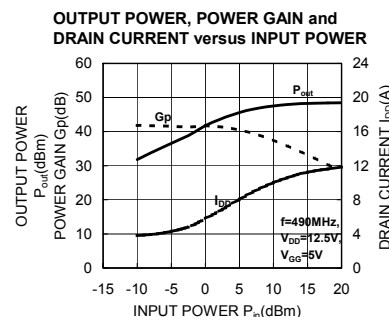
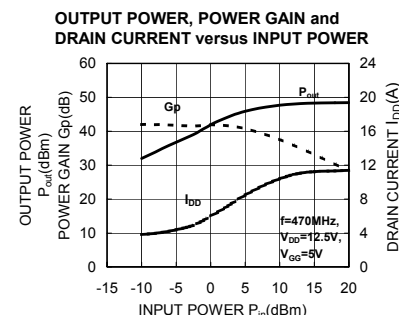
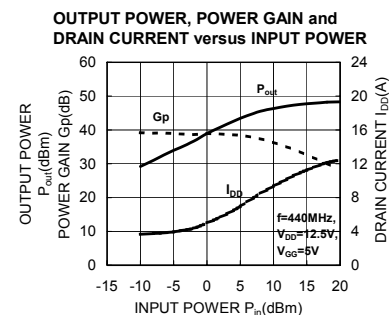
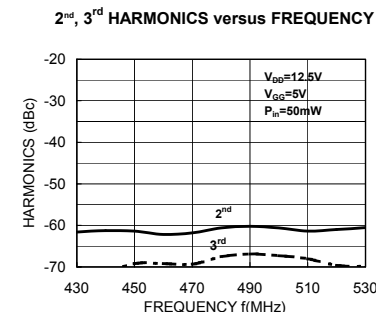
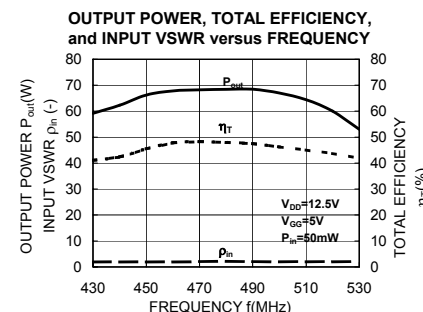
RA45H4452M (Non RoHS)

TYPICAL PERFORMANCE DATA



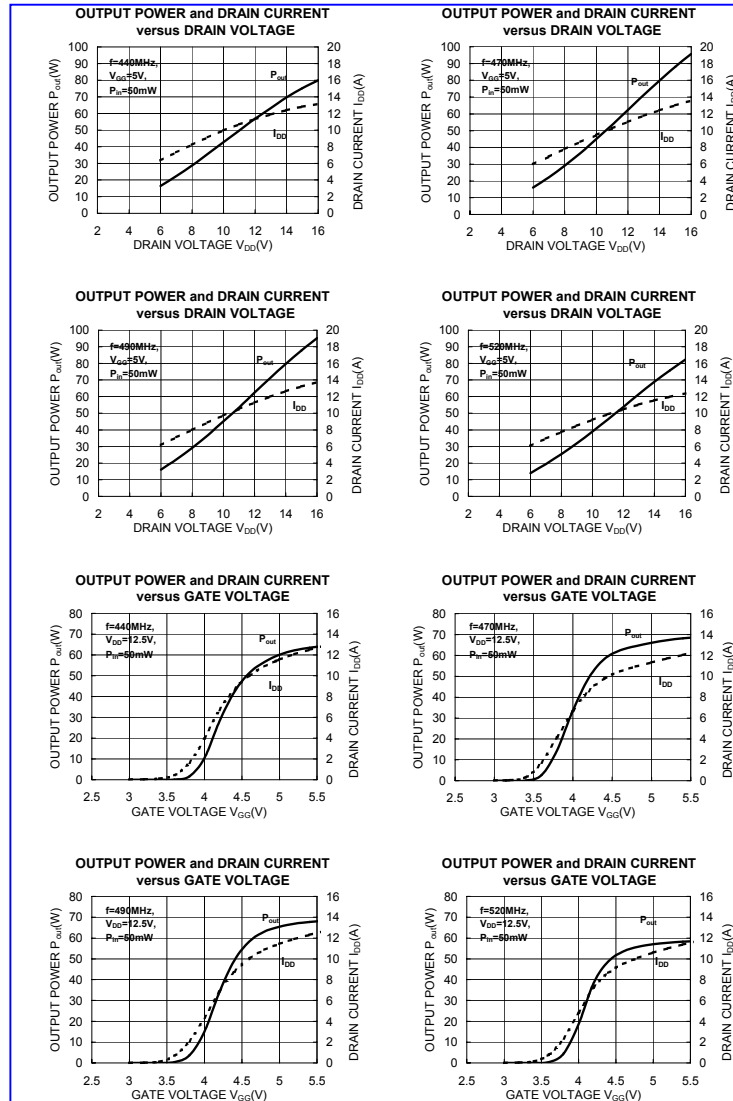
RA45H4452M (RoHS compliance)

TYPICAL PERFORMANCE DATA

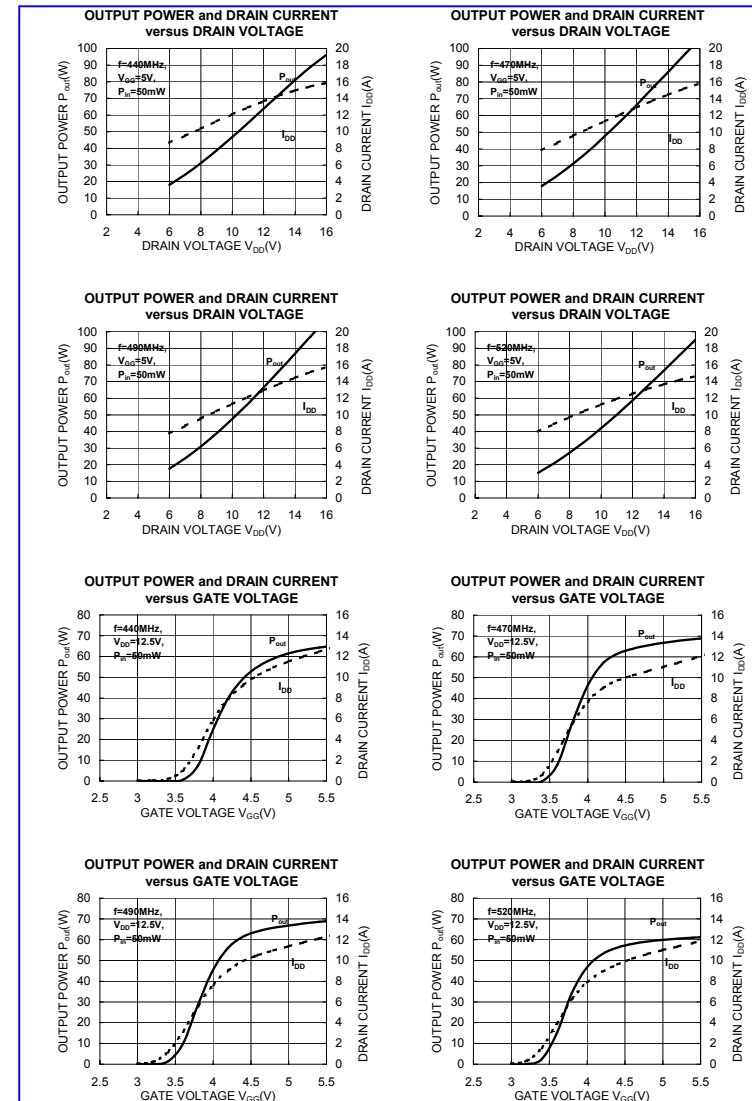


RA45H4452M RF characteristics (Non RoHS vs. RoHS compliance products)

RA45H4452M (Non RoHS)



RA45H4452M (RoHS compliance)



RA45H4452M RF characteristics (Non RoHS vs. RoHS compliance products)

RA45H4452M Input Impedance

condition: V_{dd}=12.5V, P_{in}=50mW, P_o=45W set(V_{gg} adj.), Z_i=50degC.

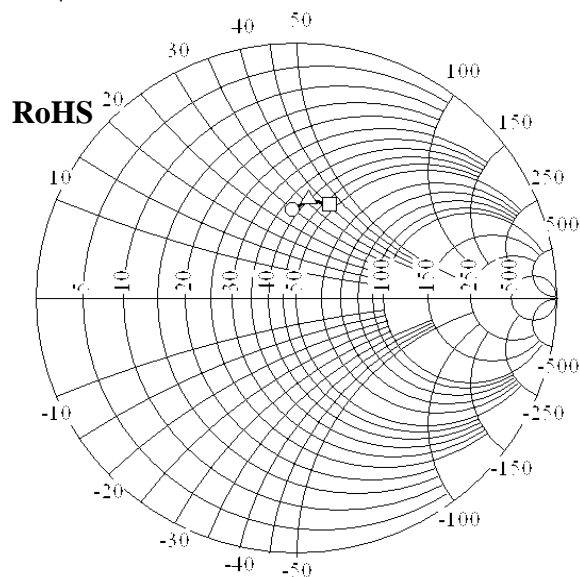
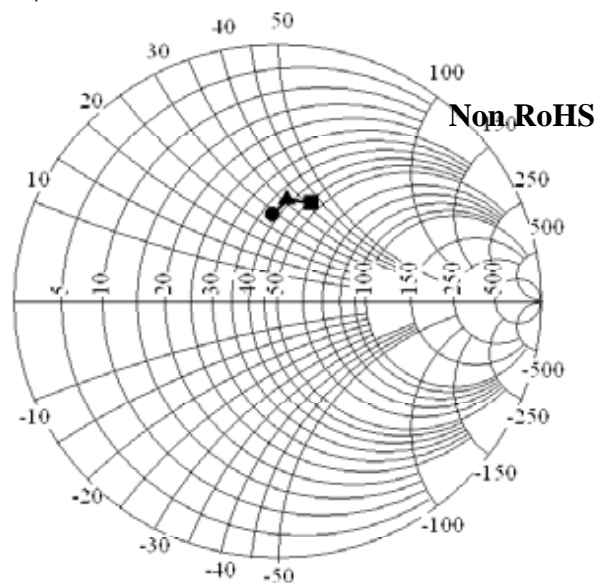
f(MHz)	440M				480M				520M			
	Po(set)	Id(set)	input impedance(Ω)		Po(set)	Id(set)	input impedance(Ω)		Po(set)	Id(set)	input impedance(Ω)	
			Re.	Im.			Re.	Im.			Re.	Im.
Non RoHS No.1	45.04	7.20	38.162	29.270	45.07	6.60	38.547	36.252	45.00	6.25	45.904	42.176
No.2	45.08	7.50	38.773	29.803	45.04	6.75	38.600	35.941	44.95	6.35	45.758	41.639
No.3	45.00	7.20	38.271	29.395	45.07	6.55	38.424	35.768	45.05	6.30	45.588	41.314
No.4	45.04	7.15	38.488	29.883	44.98	6.35	38.525	37.674	45.05	6.10	45.965	41.693
No.5	45.07	7.60	38.352	30.051	45.05	7.20	38.893	36.316	45.03	7.00	46.223	42.176
AVE.	45.05	7.33	38.409	29.680	45.04	6.69	38.598	36.390	45.02	6.40	45.888	41.800
RoHS No.1	45.04	7.45	38.258	30.166	45.09	6.90	39.707	36.508	54.01	6.50	47.381	40.900
No.2	45.07	7.30	38.941	30.549	45.06	6.70	39.752	37.127	45.08	6.50	47.975	41.705
No.3	45.05	7.90	39.605	31.320	45.06	7.65	40.207	36.561	44.99	7.60	48.908	43.006
No.4	45.04	7.10	38.021	30.908	44.98	6.50	38.982	37.566	44.99	6.35	46.404	41.895
No.5	45.02	7.40	38.684	29.879	44.97	6.90	39.883	37.158	45.05	6.70	47.613	41.564
AVE.	45.04	7.43	38.702	30.564	45.03	6.93	39.706	36.984	46.82	6.73	47.656	41.814

Case in point: RoHS No.1

:440MHz, :480MHz, □:520MHz

Case in point: Non RoHS No.1

:440MHz, :480MHz, :520MHz


○ 38.258+j30.166, 0.947∠92.400[deg]
△ 39.707+j36.508, 0.392∠83.600[deg]
□ 47.381+j40.900, 0.388∠70.880[deg]

● 38.162+j29.270, 0.340∠93.650[deg]
▲ 38.547+j36.252, 0.397∠85.270[deg]
■ 45.904+j42.176, 0.404∠71.810[deg]

RA45H4452M RF characteristics (Non RoHS vs. RoHS compliance products)

Load VSWR Tolerance

CONDITIONS

f=440/480/520MHz, Vdd=10/12.5/15.2V, $p_l < 20:1$ (All Phase)

P_{in}=50mW, P_o=45W (V_{gg}:adj.)

result

* OK : No degradation or destroy

Specification	sample No	y (MHz) Vdd(V)	440			480			520		
			10	12.5	15.2	10	12.5	15.2	10	12.5	15.2
RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK
Non RoHS	No.1		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK

Load VSWR Tolerance

Stability

CONDITIONS

f=440/480/520MHz, Vdd=10/12.5/15.2V, $p_l = 3:1$

P_{in}=25/50/70mW, P_o=55.0/27.5/5.5W (V_{gg} adj.)

result

* OK : No parasitic oscillation at 55.0/27.5/5.5W

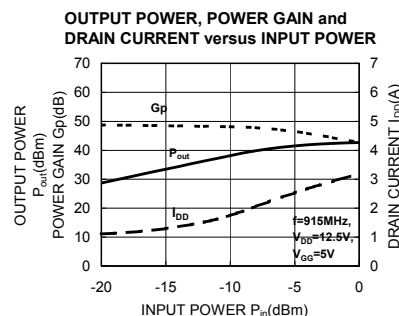
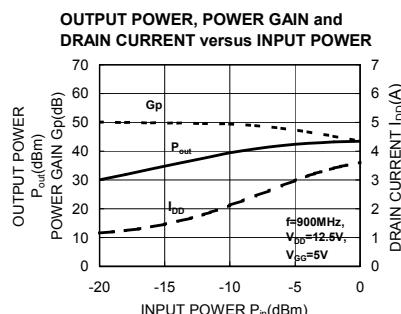
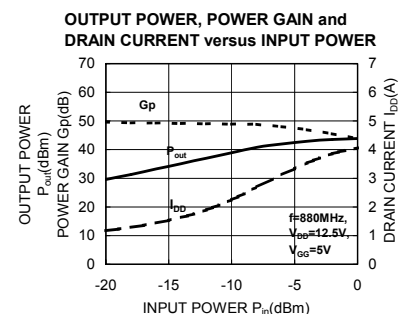
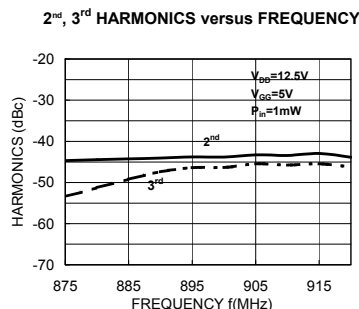
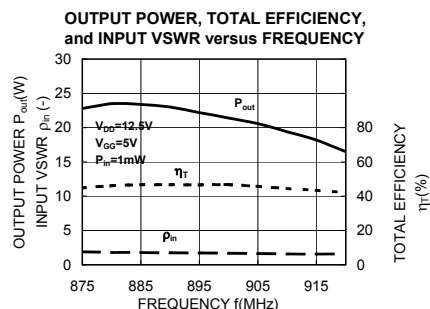
Specification	sample No	y (MHz) P _{in} (mW) Vdd(V)	440/480/520			440/480/520			440/480/520		
			25			50			70		
			10	12.5	15.2	10	12.5	15.2	10	12.5	15.2
RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK
Non RoHS	No.1		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK

Stability

RA13H8891MB RF characteristics (Non RoHS vs. RoHS compliance products)

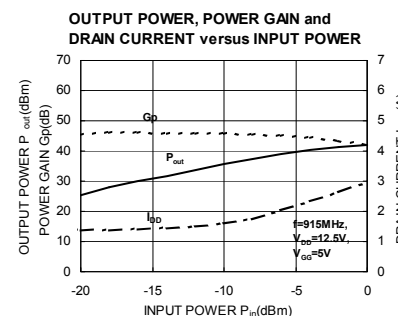
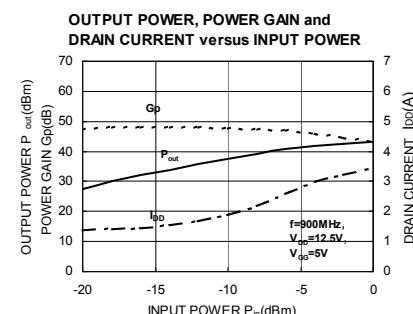
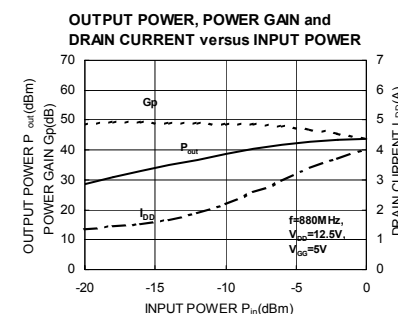
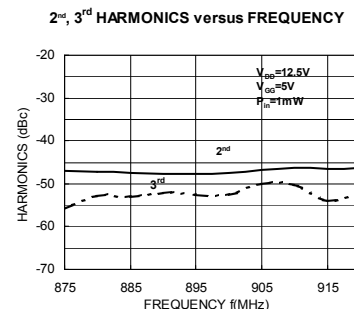
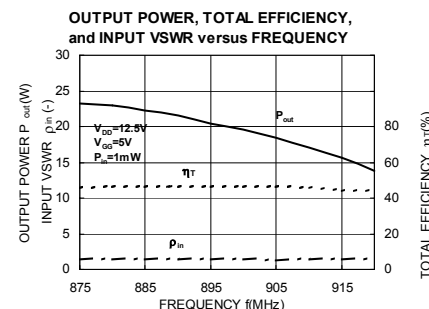
RA13H8891MB (Non RoHS)

TYPICAL PERFORMANCE DATA



RA13H8891MB (RoHS compliance)

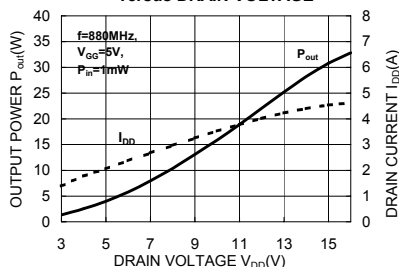
TYPICAL PERFORMANCE DATA



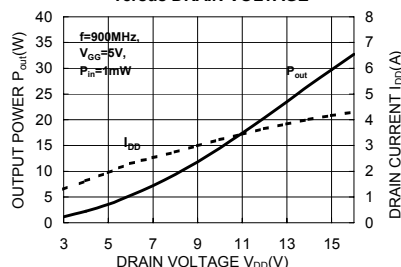
RA13H8891MB RF characteristics (Non RoHS vs. RoHS compliance products)

RA13H8891MB (Non RoHS)

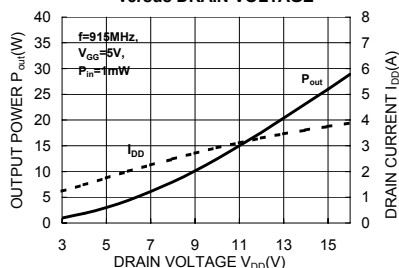
OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE



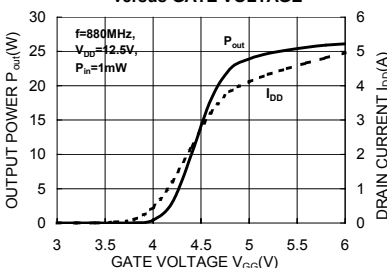
OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE



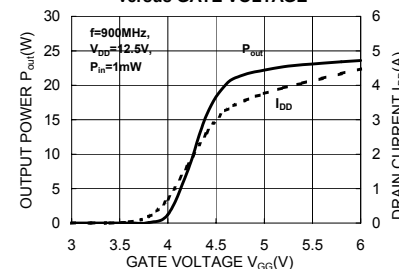
OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE



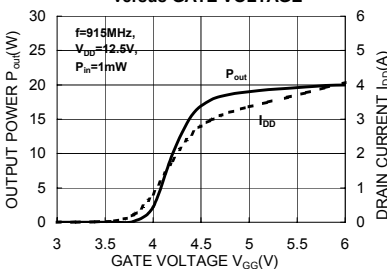
OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE



OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE

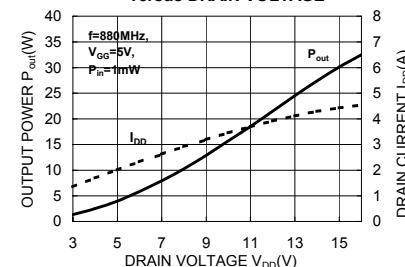


OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE

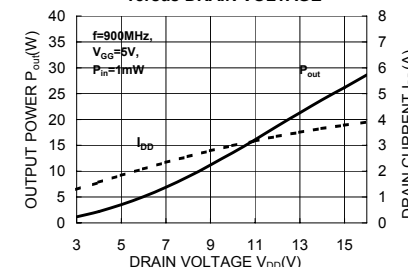


RA13H8891MB (RoHS compliance)

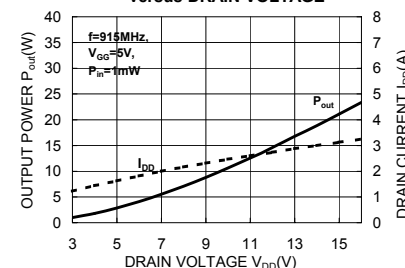
OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE



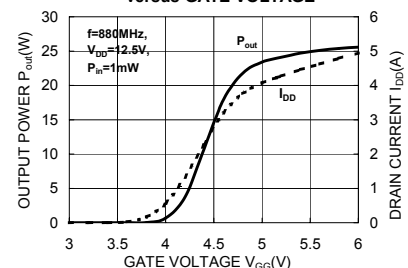
OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE



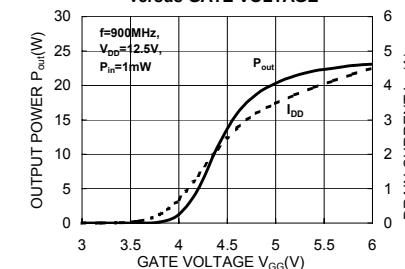
OUTPUT POWER and DRAIN CURRENT versus DRAIN VOLTAGE



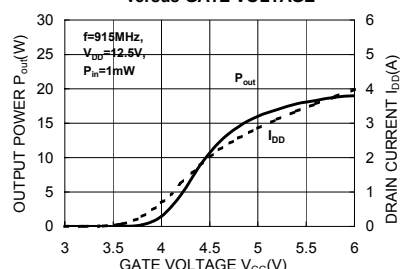
OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE



OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE



OUTPUT POWER and DRAIN CURRENT versus GATE VOLTAGE



RA13H8891MB RF characteristics (Non RoHS vs. RoHS compliance products)

RA13H8891MB Input impedance

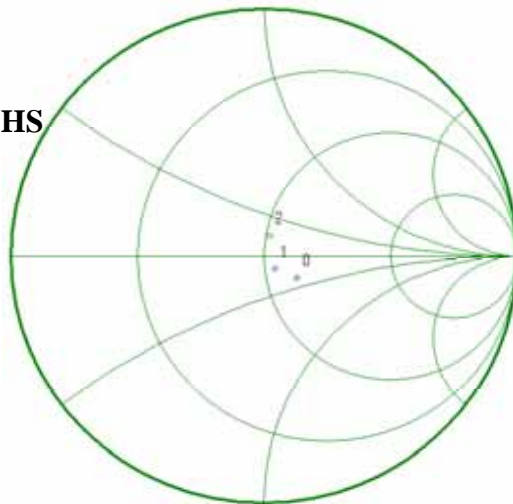
condition: Vdd=12.5V, Pin=1mW, Po=13W set(Vgg adj.), Zi=50degC.

f(MHz)	880M				897.5M				915M			
	Po(set)	Id(set)	input impedance(ohm)		Po(set)	Id(set)	input impedance(ohm)		Po(set)	Id(set)	input impedance(ohm)	
			Real	Imaginary			Real	Imaginary			Real	Imaginary
Non RoHS No.1	13.00	2.90	64.152	-35.484	13.30	2.80	40.195	-23.611	13.00	2.60	37.473	6.400
No.2	12.90	2.90	67.891	-32.750	13.30	2.70	43.963	-25.400	12.90	2.50	36.000	2.672
No.3	13.20	2.85	61.015	-36.471	12.90	2.70	39.297	-24.934	13.00	2.50	35.633	7.170
No.4	13.00	2.90	59.086	-37.070	13.30	2.80	36.727	-21.150	12.90	2.60	37.832	9.565
No.5	13.30	3.05	67.496	-32.125	13.30	2.85	45.676	-27.045	13.40	2.70	36.264	1.775
AVE	13.08	2.92	63.928	-34.780	13.22	2.77	41.172	-24.428	13.04	2.58	36.640	5.517
RoHSNo.1	13.20	2.95	63.516	-11.291	13.10	2.80	54.041	-5.459	13.00	2.60	51.393	8.838
No.2	13.10	3.00	64.961	-12.664	13.20	2.85	54.746	-6.967	12.90	2.70	51.051	7.063
No.3	13.10	3.05	62.740	-8.996	13.20	2.80	54.078	-2.535	13.00	2.70	51.666	8.522
No.4	13.30	2.95	59.146	-9.049	13.00	2.80	51.984	-0.200	13.00	2.80	51.551	11.633
No.5	13.10	2.85	65.934	-11.070	13.40	2.80	53.320	-4.016	12.90	2.70	50.135	8.795
AVE	13.16	2.96	63.259	-10.614	13.18	2.81	53.634	-3.835	12.96	2.70	51.159	8.970

Example : RoHS No.1

0:880MHz
1:897.5MHz
2:915MHz

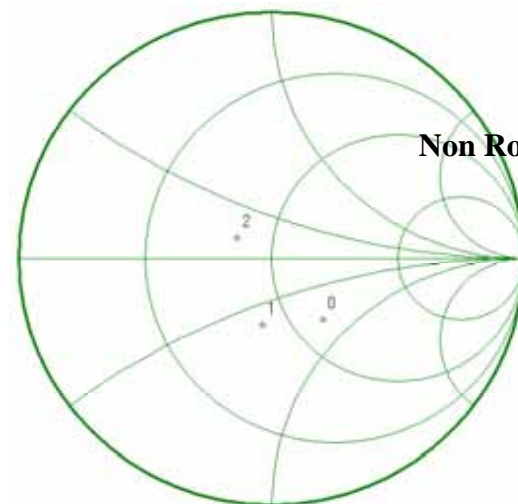
RoHS


0 : 63.516+j(-11.291),1.365 -34.19[deg.]
1 : 54.041+j(-5.459),1.139 -50.486[deg.]
2 : 51.393+j(8.838),1.1927 76.06[deg.]

Example : Non RoHS No.1

0:880MHz
1:897.5MHz
2:915MHz

Non RoHS


0 : 64.152+j(-35.484),1.934 -50.99[deg.]
1 : 40.195+j(-23.611),1.756 -97.88[deg.]
2 : 37.473+j(6.400),1.382 148.75[deg.]

RA13H8891MB RF characteristics (Non RoHS vs. RoHS compliance products)

Load VSWR Tolerance

CONDITIONS

f=880/897.5/920MHz,Vdd=10/12.5/15.2V,rl=20:1(All Phase)

Pin=1mW,Po=13W(Vgg:adj.),

Result

* OK : No degradation or destroy

Specification	sample No	y (MHz)	880			897.5			920		
			10	12.5	15.2	10	12.5	15.2	10	12.5	15.2
RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK
Non RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK

Load VSWR Tolerance

Stability

CONDITIONS

f=880/897.5/920MHz,Vdd=10/12.5/15.2V,rl=3:1

Pin=0.5/1/2mW,Po=20.0/10.0/1.0W(Vgg adj.)

result

* OK : No parasitic oscillation at Po=20.0/10.0/1

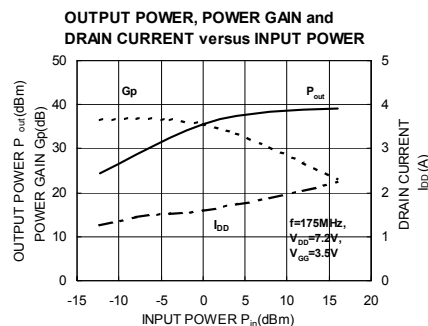
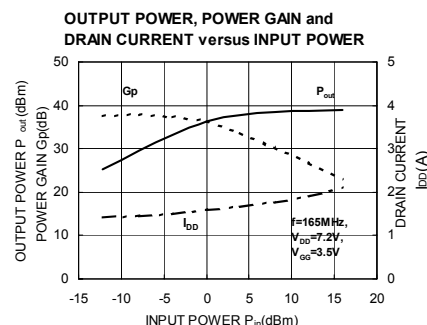
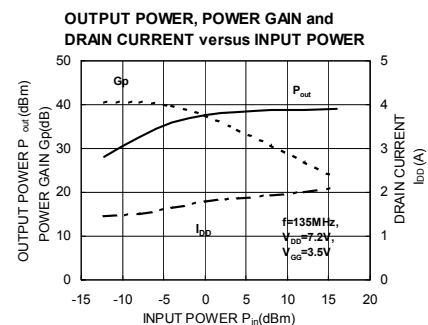
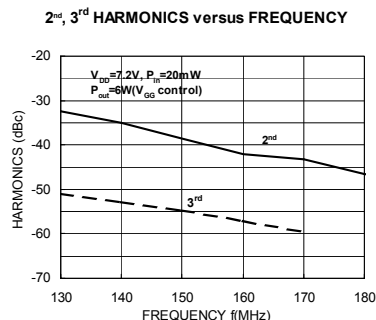
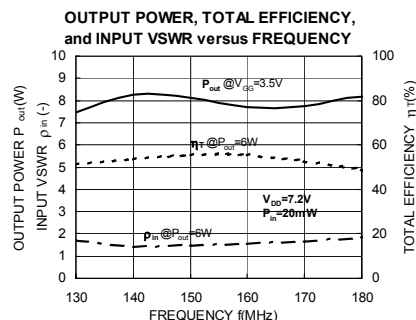
Specification	sample No	Frequenc y (MHz)	880/897.5/920			880/897.5/920			880/897.5/920		
			0.5			1			2		
RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK
Non RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK

Stability

RA07M1317M RF characteristics (Non RoHS vs. RoHS compliance products)

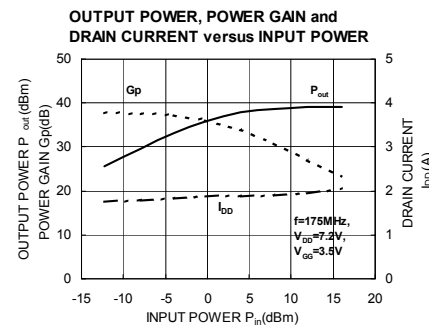
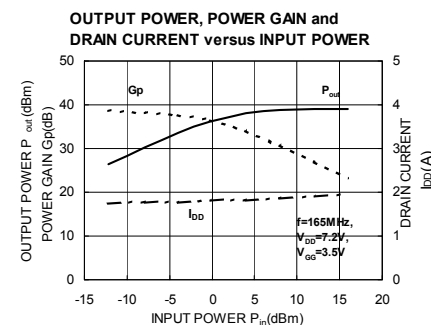
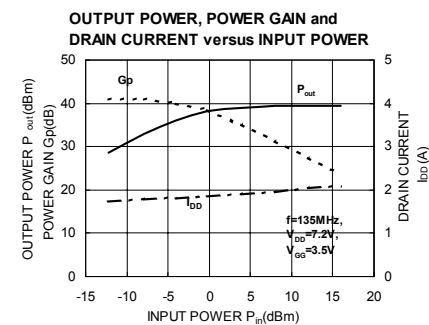
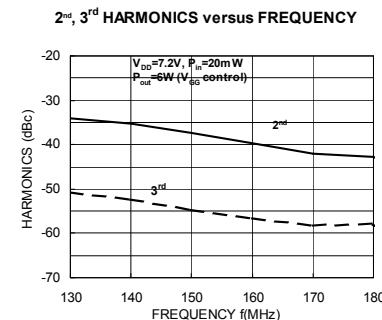
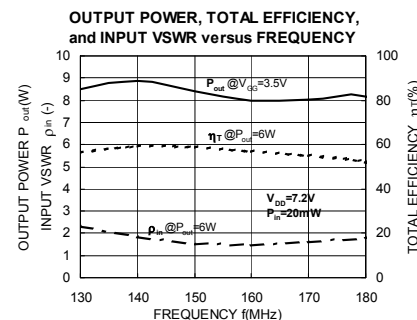
RA07M1317M (Non RoHS)

TYPICAL PERFORMANCE DATA



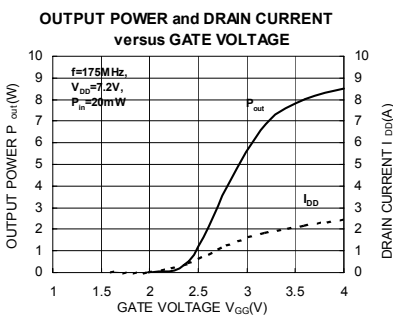
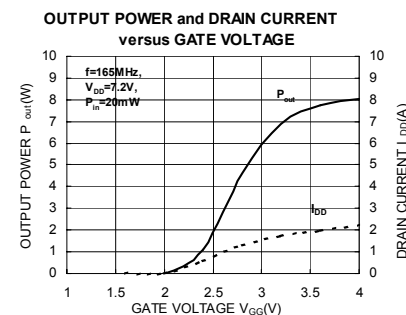
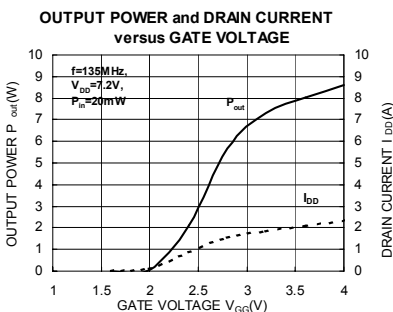
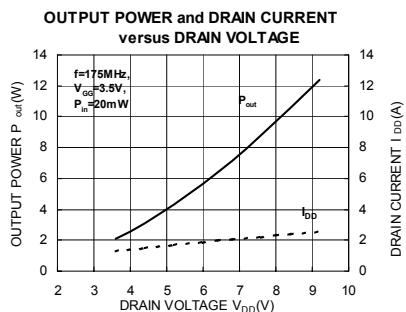
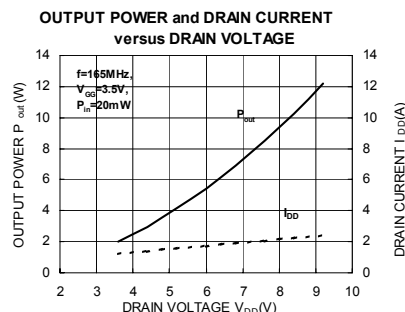
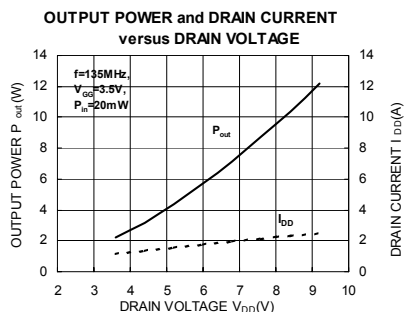
RA07M1317M (RoHS compliance)

TYPICAL PERFORMANCE DATA

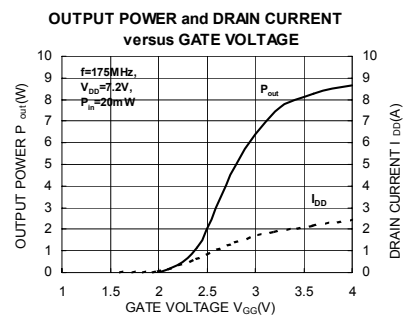
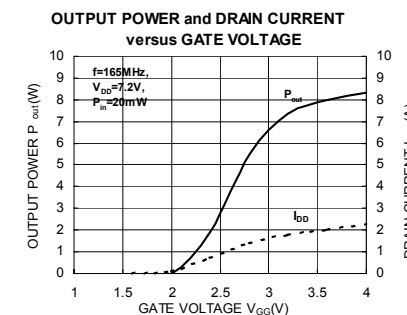
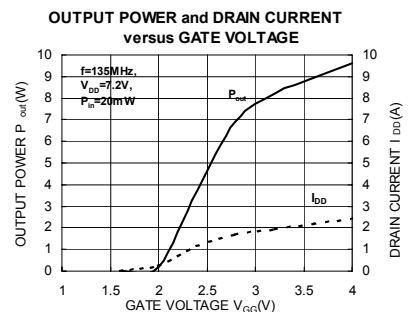
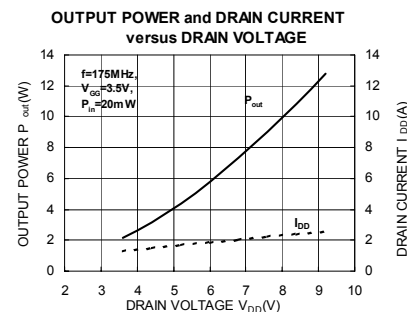
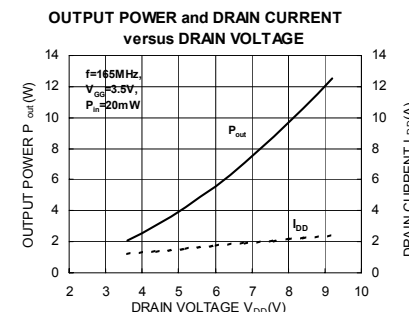
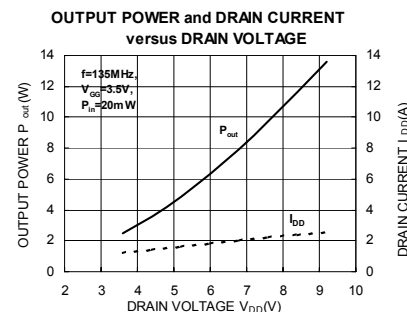


RA07M1317M RF characteristics (Non RoHS vs. RoHS compliance products)

RA07M1317M (Non RoHS)



RA07M1317M (RoHS compliance)



RA07M1317M RF characteristics (Non RoHS vs. RoHS compliance products)

RA07M1317M Input impedance

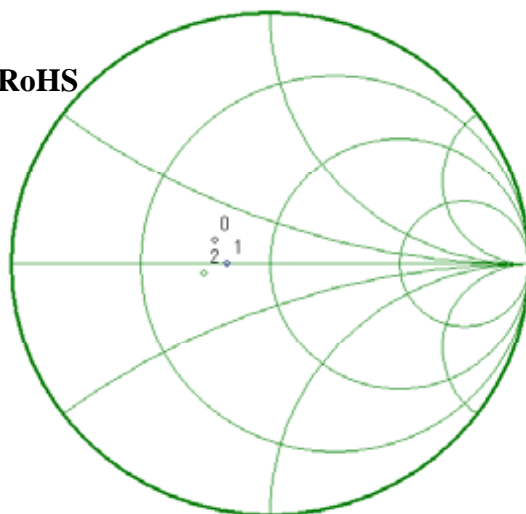
condition:Vdd=7.2V,Pin=20mW,Po=6W set(Vgg adj.),ZI=50degC.

f(MHz)	135				155				175			
	Po(set) (W)	Id(set) (A)	input impedance(ohm)		Po(set) (W)	Id(set) (A)	input impedance(ohm)		Po(set) (W)	Id(set) (A)	input impedance(ohm)	
			Real	Imaginary			Real	Imaginary			Real	Imaginary
Non RoHS No.1	7.03	1.85	30.973	7.739	7.05	1.75	36.134	1.516	7.03	1.80	30.024	-1.565
No.2	7.03	1.75	29.362	8.228	7.03	1.70	35.453	3.055	7.02	1.85	30.338	-0.081
No.3	7.03	1.70	30.425	7.739	7.06	1.75	35.494	1.988	7.00	1.90	29.858	-0.610
No.4	7.03	1.75	31.427	8.757	7.02	1.75	36.160	2.484	7.03	1.80	30.045	-0.490
No.5	7.04	1.72	32.223	6.602	7.01	1.70	35.543	0.676	7.00	1.90	29.842	-1.053
AVE	7.03	1.75	30.882	7.813	7.03	1.73	35.757	1.944	7.02	1.85	30.021	-0.760
RoHS No.1	7.04	1.70	31.849	6.531	7.05	1.75	35.760	0.400	7.00	1.90	29.652	-2.184
No.2	7.00	1.70	31.975	6.064	7.03	1.70	35.516	0.389	7.05	1.90	29.313	-1.592
No.3	7.01	1.70	31.120	6.657	7.04	1.75	35.510	1.270	7.01	1.90	29.570	-1.297
No.4	7.01	1.70	31.879	5.716	7.03	1.70	35.299	0.051	7.00	1.85	29.152	-1.788
No.5	7.00	1.70	31.169	7.303	7.05	1.70	35.898	1.629	7.02	2.00	29.726	-1.314
AVE	7.01	1.70	31.598	6.454	7.04	1.72	35.597	0.748	7.02	1.91	29.483	-1.635

Example : RoHS No.1

0:135MHz
1:155MHz
2:175MHz

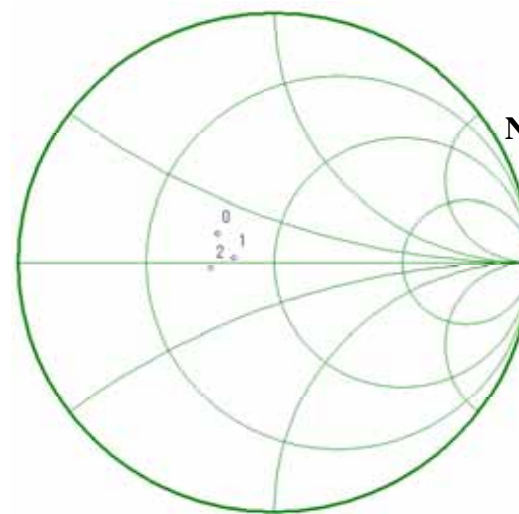
RoHS


0:31.849+j(6.531),1.614 155.65[deg.]
1:35.760+j(0.400),1.398 178.12[deg.]
2:29.652+j(-2.184),1.691 -172.30[deg.]

Example : Non RoHS No.1

0:135MHz
1:155MHz
2:175MHz

Non RoHS


0:30.973+j(7.739),1.676 152.41[deg.]
1:36.134+j(1.516),1.386 172.75[deg.]
2:30.024+j(-1.565),1.668 -174.40[deg.]

RA07M1317M RF characteristics (Non RoHS vs. RoHS compliance products)

Load VSWR Tolerance

CONDITIONS

f=135/155/175MHz,Vdd=4/7.2/9.2V,pl<20:1(All Phase)

Pin=20mW,Po=7W(Vgg:adj.),

result

* OK : No degradation or destroy

Load VSWR Tolerance

Specification	sample No	y (MHz)	135			155			175		
		Vdd(V)	4	7.2	9.2	4	7.2	9.2	4	7.2	9.2
RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK
Non RoHS	No.1		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK

Stability

CONDITIONS

f=135/155/175MHz,Vdd=4/7.2/9.2V,pl=4:1

Pin=10/20/30mW,Po=8.0/4.0/0.8W(Vgg adj.)

result

* OK : No parasitic oscillation at Po=8.0/4.0/0.8W

Stability

Specification	sample No	Frequency y (MHz)	135/155/175			135/155/175			135/155/175		
		P _{in} (mW)	10			20			30		
		Vdd(V)	4	7.2	9.2	4	7.2	9.2	4	7.2	9.2
RoHS	No.1	r e s u l t	OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK
Non RoHS	No.1		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.2		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.3		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.4		OK	OK	OK	OK	OK	OK	OK	OK	OK
	No.5		OK	OK	OK	OK	OK	OK	OK	OK	OK

Surface temperature of Module Non RoHS VS. RoHS compliance products

- RA45H4452M(H2 Outline)

- Conditions ; VDD=12.5V,Pin=50mW,Po=45W, with silicon compound

ΔTemp. (RoHS compliance parts - Non RoHS)

freq.	Temp. of FET1(deg.C.)			Temp. of FET2(deg.C.)			Temp. of FET3(deg.C.)			Temp. of C119(deg.C.)			Temp. of C120(deg.C.)		
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc		
	60°C	90 ° C	110 ° C	60 ° C	90 ° C	110 ° C	60 ° C	90 ° C	110 ° C	60 ° C	90 ° C	110 ° C	60 ° C	90 ° C	110 ° C
440	6.6	6.6	6.6	-2.0	-2.0	-2.0	-3.0	-3.0	-3.0	-3.5	-3.5	-3.5	2.6	2.6	2.6

freq.	Temp. of C121 ()			Temp. of C122 ()			Temp.C124 ()			Temp. of C125 ()			Idd	Po	
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc					
	60°C	90 ° C	110 ° C	60°C	90 ° C	110 ° C	60°C	90 ° C	110 ° C	60°C	90 ° C	110 ° C			
440	-5.9	-5.9	-5.9	-2.3	-2.3	-2.3	1.6	1.6	1.6	2.0	2.0	2.0	(A)	(W)	

freq.	Temp. of FET1(deg.C.)			Temp. of FET2(deg.C.)			Temp. of FET2(deg.C.)			Temp. of C119(deg.C.)			Temp. of C120(deg.C.)		
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc		
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110
480	0.7	0.7	0.7	-4.0	-4.0	-4.0	-2.3	-2.3	-2.3	-4.6	-4.6	-4.6	6.3	6.3	6.3

freq.	Temp. of C121 ()			Temp. of C122 ()			Temp.C124 ()			Temp. of C125 ()			Idd	Po	
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc					
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	(A)	(W)	
480	2.5	2.5	2.5	-2.6	-2.6	-2.6	0.9	0.9	0.9	0.7	0.7	0.7			

freq.	Temp. of FET1(degC.)			Temp. of FET2(degC.)			Temp. of FET3(degC.)			Temp. of C119(degC.)			Temp. of C120(degC.)		
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc		
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110
520	1.5	1.5	1.5	1.8	1.8	1.8	2.9	2.9	2.9	-5.0	-5.0	-5.0	0.6	0.6	0.6

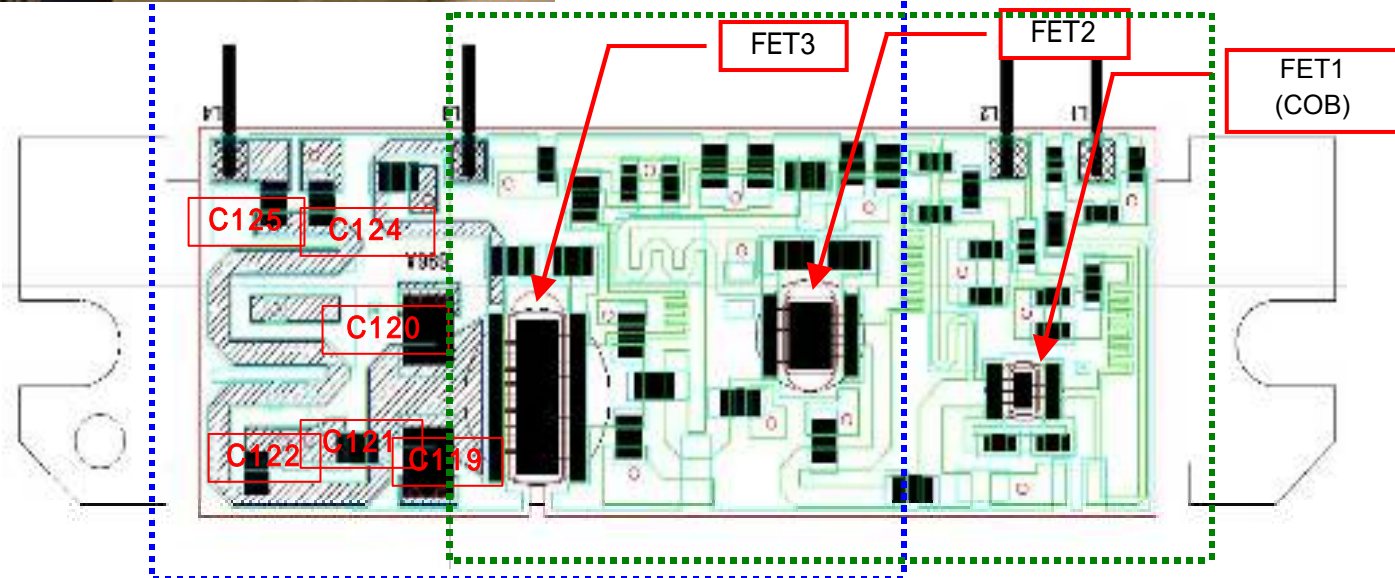
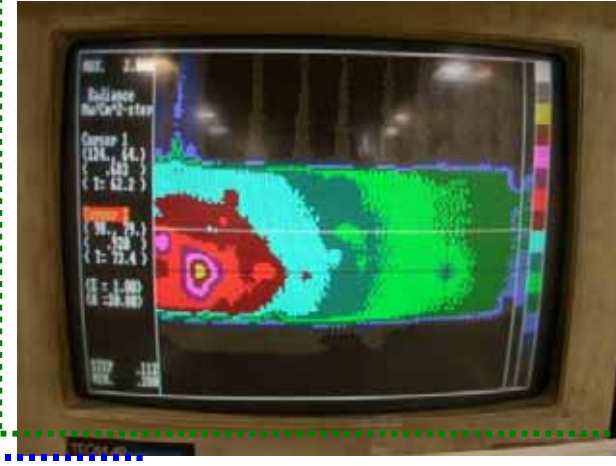
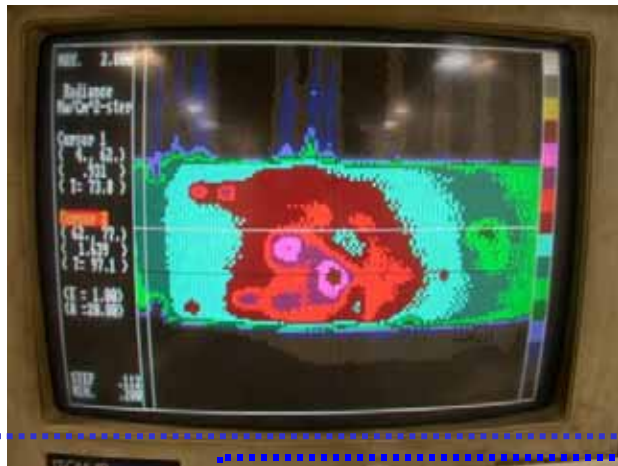
freq.	Temp. of C121 ()			Temp. of C122 ()			Temp.C124 ()			Temp. of C125 ()			Idd	Po	
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc					
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	(A)	(W)	
520	-7.9	-7.9	-7.9	0.0	0.0	0.0	2.3	2.3	2.3	2.7	2.7	2.7			

Result ; FET1's temperature is little higher, but no problem

absolute temperature is low (Tc+10)

Surface temperature of Module RoHS compliance products (example)

- RA45H4452M(H2 Outline)
- Conditions ; VDD=12.5V, Pin=50mW, Po=45W, with silicon compound



Surface temperature of Module Non RoHS VS. RoHS compliance products

- RA13H8891MB(H11 Outline)

- Conditions ; VDD=12.5V,Pin=1mW,Po=13W, with silicon compound

ΔTemp. (RoHS compliance parts - Non RoHS)

freq. (MHz)	Temp. of FET3 ()			Temp. of R215 ()			Temp. of C117 ()			Temp. of C118 ()			Temp. of Tr1 ()			Idd @13W (A)	Po (Full) (W)
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc				
	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110		
880	-0.1	-0.1	-0.1	0.3	0.3	0.3	1.3	1.3	1.3	2.2	2.2	2.2	0.8	0.8	0.8		

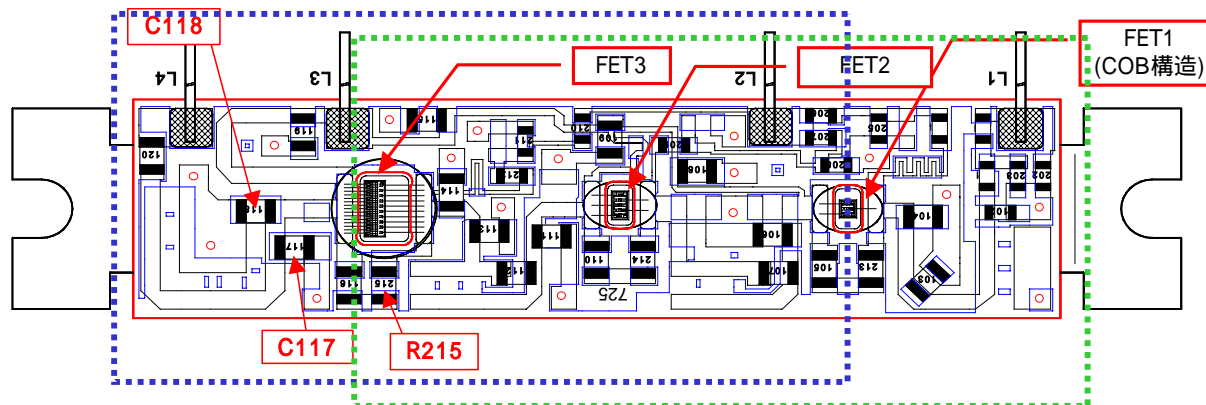
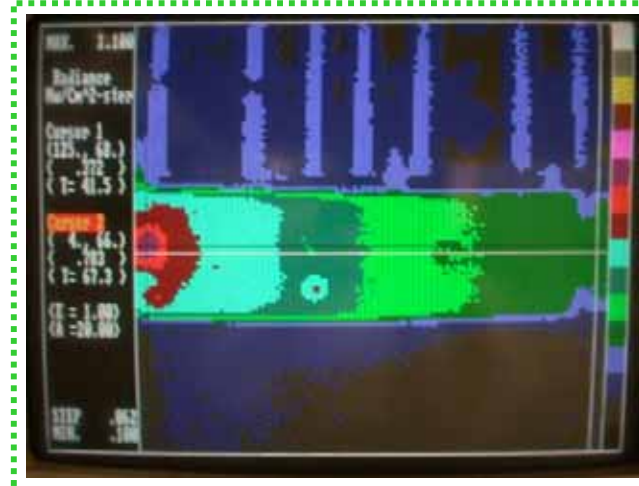
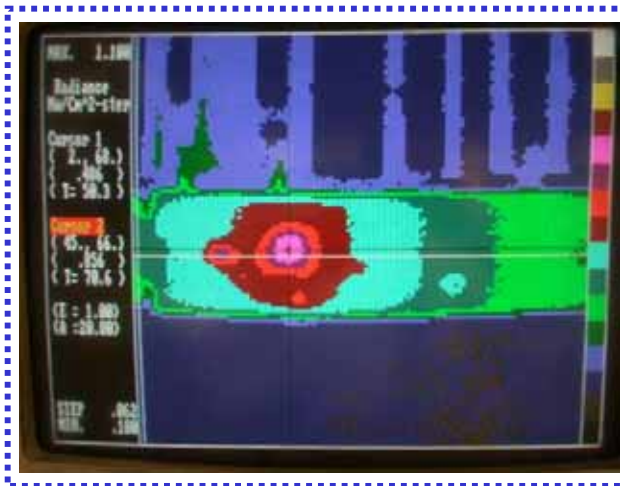
freq. (MHz)	Temp. of FET3 ()			Temp. of R215 ()			Temp. of C117 ()			Temp. of C118 ()			Temp. of Tr1 ()			Idd @13W (A)	Po (Full) (W)
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc				
	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110		
900	1.1	1.1	1.1	0.5	0.5	0.5	1.6	1.6	1.6	2.2	2.2	2.2	1.8	1.8	1.8		

freq. (MHz)	Temp. of FET3 ()			Temp. of R215 ()			Temp. of C117 ()			Temp. of C118 ()			Temp. of Tr1 ()			Idd @13W (A)	Po (Full) (W)
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc				
	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110		
915	-3.6	-3.6	-3.6	-1.2	-1.2	-1.2	-1.3	-1.3	-1.3	-2.8	-2.8	-2.8	0.1	0.1	0.1		

Result ; almost Same temperature for RoHS compliance and Non RoHS.

Surface Temperature of Module RoHS compliance products (example)

- RA13H8891MB(H11 Outline)
- Conditions ; $V_{DD}=12.5V$, $P_{in}=1mW$, $P_o=13W$, with silicon compound



Surface temperature of Module Non RoHS VS. RoHS compliance products

- RA07M1317M(H46 Outline)

- Conditions ; VDD=7.2V,Pin=30mW,Po=7W, with silicon compound

Temp. (RoHS compliance parts - Non RoHS)

freq.	Temp. of FET1()			Temp. of FET2()			Temp. of K303()			Temp. of C107()			Temp. of C106()		
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc		
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110
135	2.1	2.1	2.1	-2.8	-2.8	-2.8	0.6	0.6	0.6	-1.5	-1.5	-1.5	-1.1	-1.1	-1.1

freq.	Temp. of K301()			Temp. of K302()			Temp. of C105()			Temp. of R205()			Idd	Po
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc				
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	(A)	(W)
135	1.3	1.3	1.3	-0.7	-0.7	-0.7	1.5	1.5	1.5	0.7	0.7	0.7		

freq.	Temp. of FET1()			Temp. of FET2()			Temp. of K303()			Temp. of C107()			Temp. of C106()		
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc		
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110
155	-0.8	-0.8	-0.8	-2.8	-2.8	-2.8	2.6	2.6	2.6	-2.8	-2.8	-2.8	-1.9	-1.9	-1.9

freq.	Temp. of K301()			Temp. of K302()			Temp. of C105()			Temp. of R205()			Idd	Po
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc				
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	(A)	(W)
155	-0.9	-0.9	-0.9	-2.8	-2.8	-2.8	-0.7	-0.7	-0.7	-2.1	-2.1	-2.1		

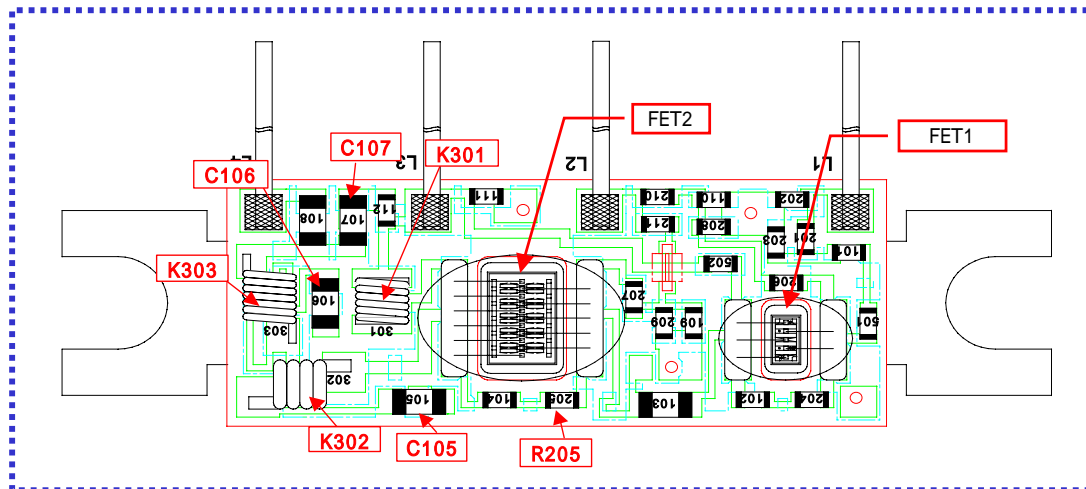
freq.	Temp. of FET1()			Temp. of FET2()			Temp. of K303()			Temp. of C107()			Temp. of C106()		
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc		
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	60	90	110
175	2.4	2.4	2.4	0.8	0.8	0.8	1.9	1.9	1.9	-0.3	-0.3	-0.3	0.6	0.6	0.6

freq.	Temp. of K301()			Temp. of K302()			Temp. of C105()			Temp. of R205()			Idd	Po
	conversion at Tc			conversion at Tc			conversion at Tc			conversion at Tc				
(MHz)	60	90	110	60	90	110	60	90	110	60	90	110	(A)	(W)
175	1.6	1.6	1.6	-0.5	-0.5	-0.5	2.3	2.3	2.3	-1.6	-1.6	-1.6		

Result ; almost Same temperature for RoHS compliance and Non RoHS.

Surface Temperature of Module RoHS compliance products (example)

- RA07M1317M(H46 Outline)
- Conditions ; VDD=7.2V,Pin=30mW,Po=7W, with silicon compound



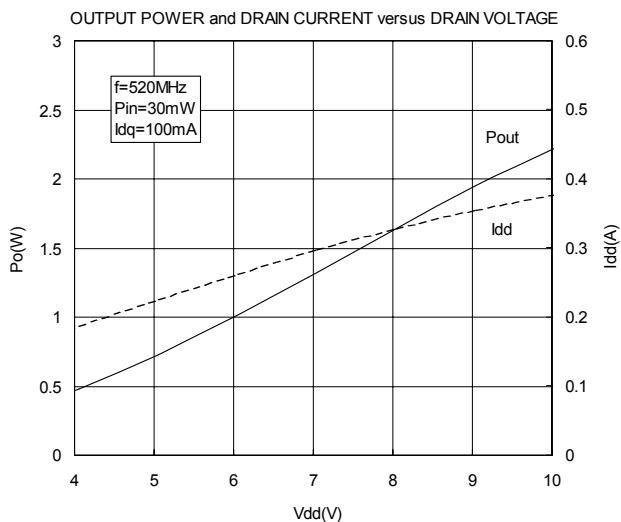
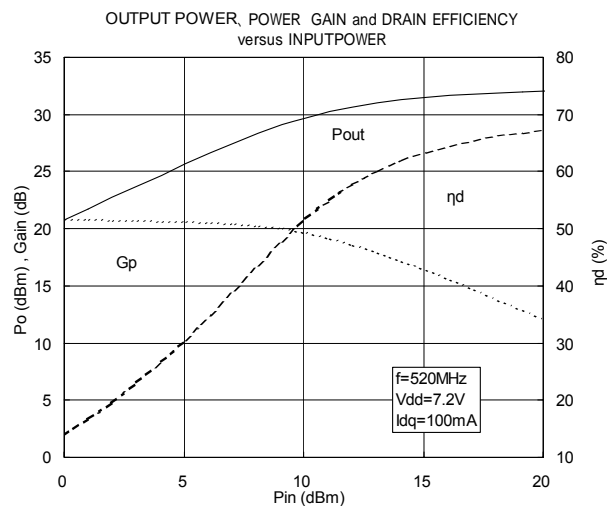
Summary of evaluation result for discrete

Summary of evaluation result for Non RoHS & RoHS compliance

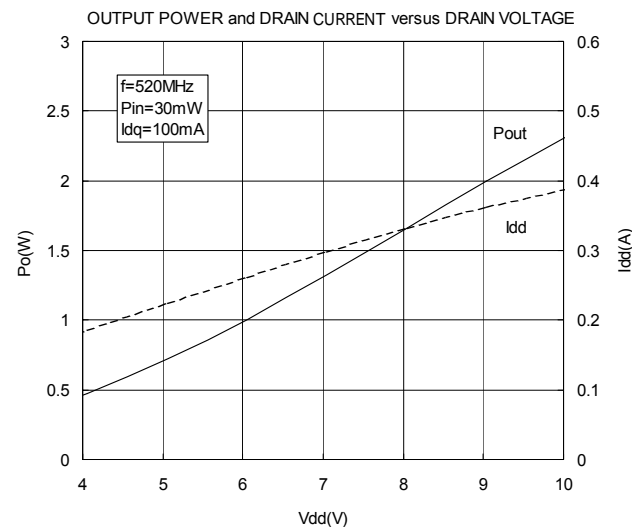
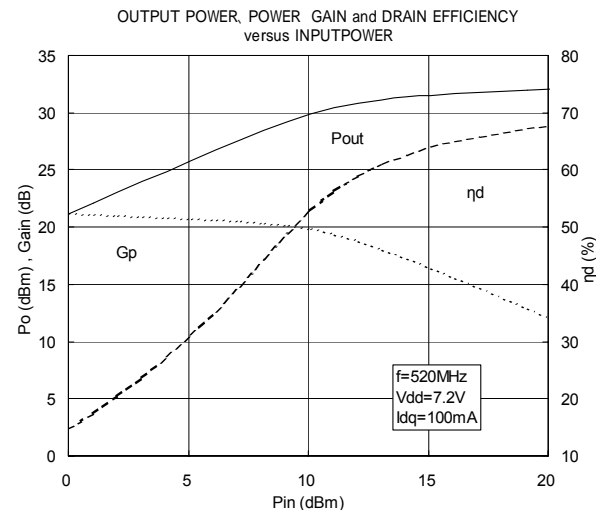
	Evaluation items		
	RF characteristics	Load VSWR Tolerance	Thermal resistance
RD01MUS1 (SOT89 outline)	Equal	Equal	
RD07MVS1 (SLP Outline)	Equal	Equal	Equal
RD15HVF1 (To220 Outline)	Equal	Equal	

RD01MUS1 RF characteristics (Non RoHS vs. RoHS compliance products)

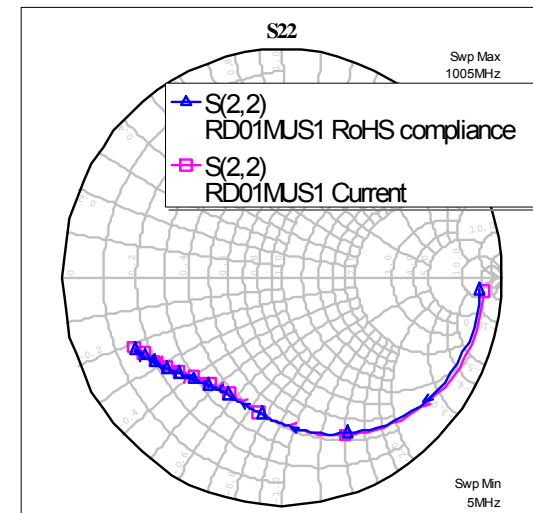
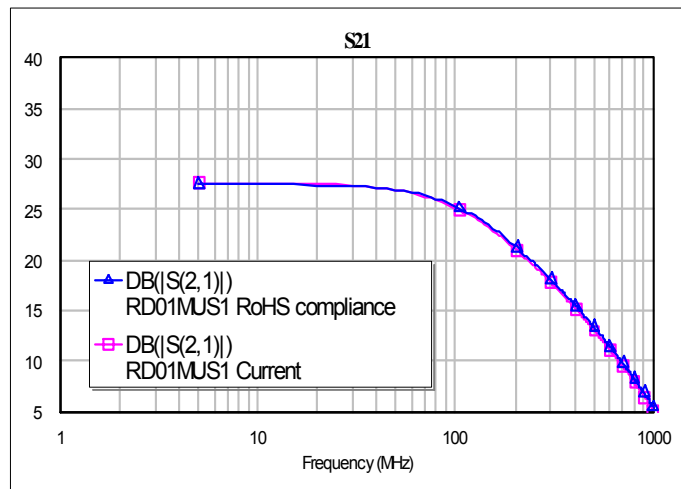
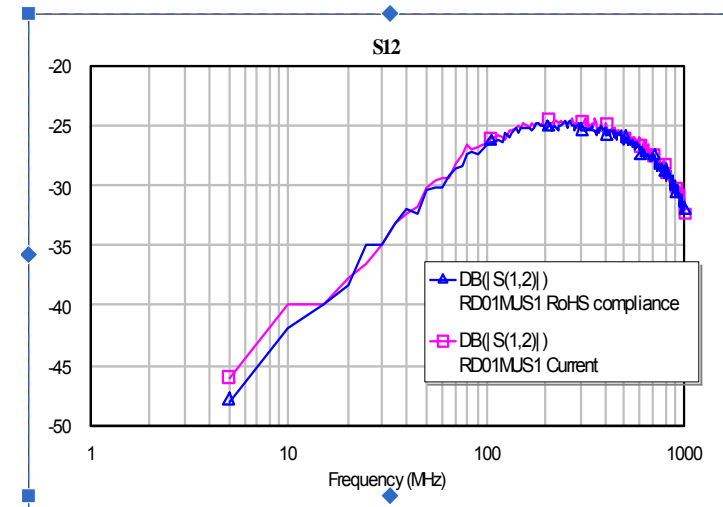
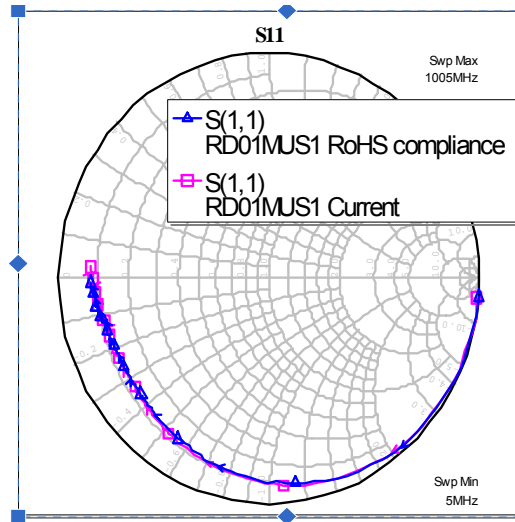
RD01MUS1 (Non RoHS)



RD01MUS1 (RoHS)

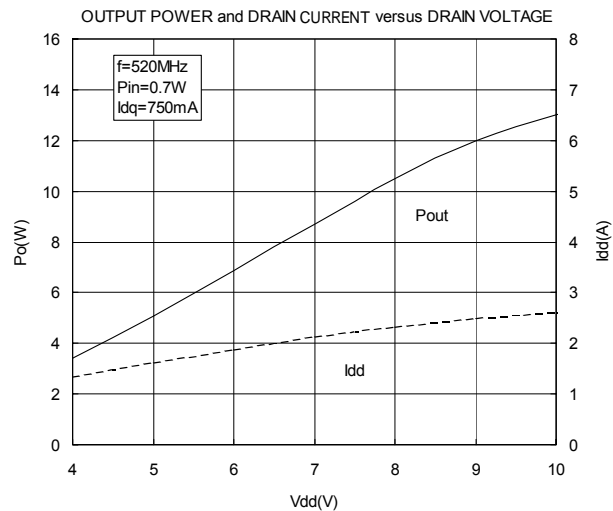
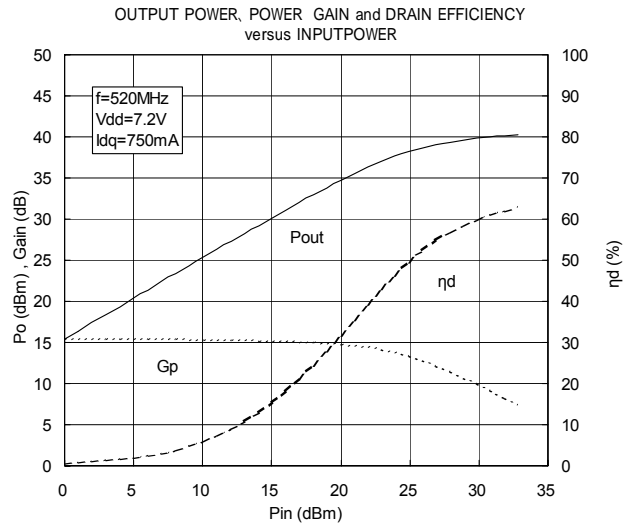


RD01MUS1 RF characteristics (Non RoHS vs. RoHS compliance products)

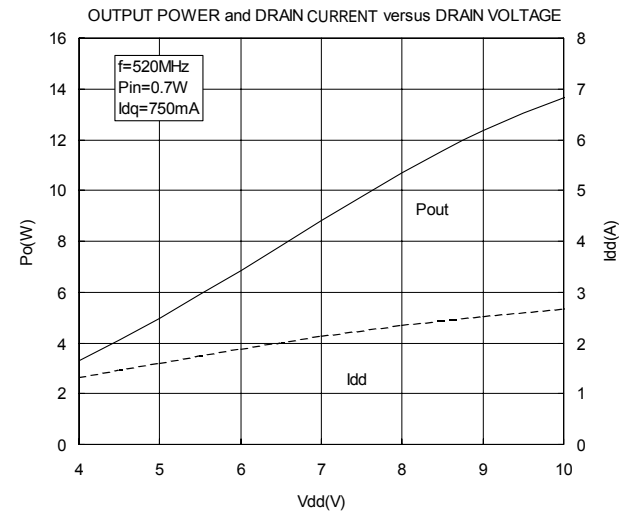
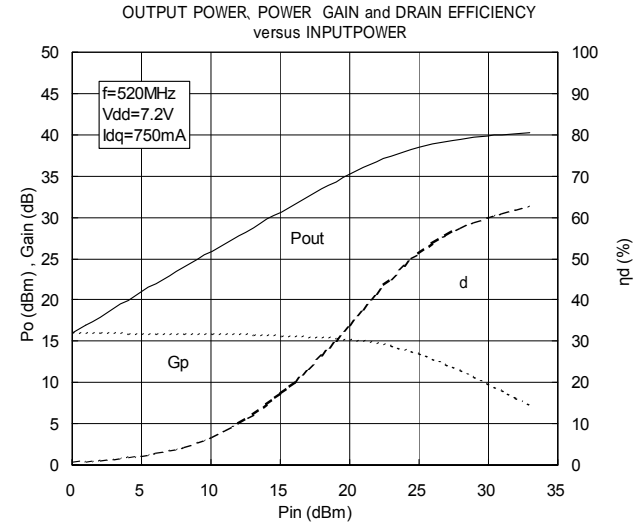


RD07MVS1 RF characteristics (Non RoHS vs. RoHS compliance products)

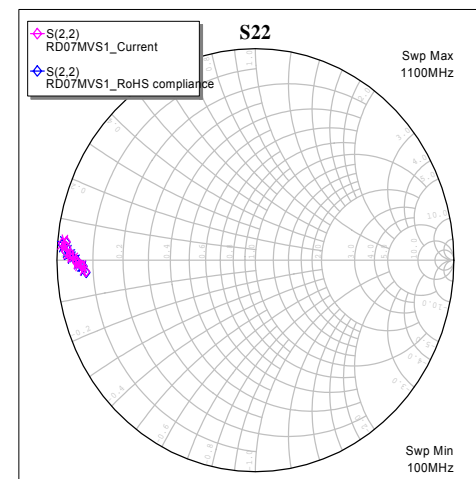
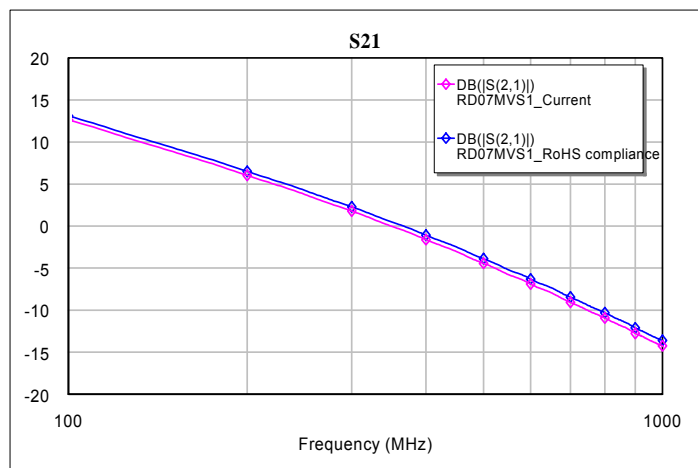
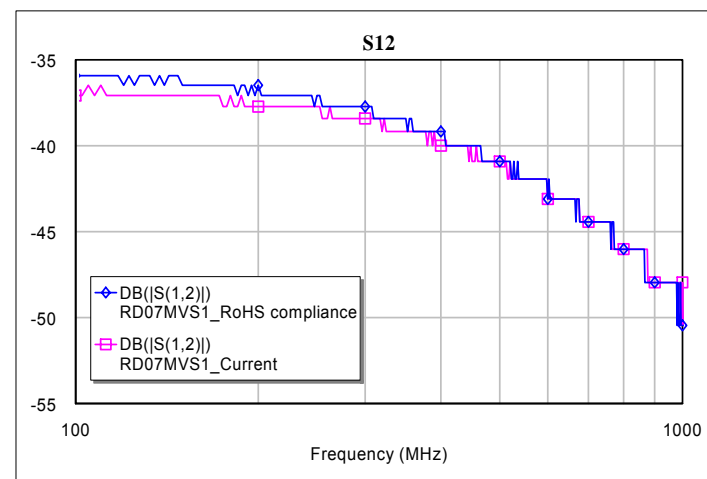
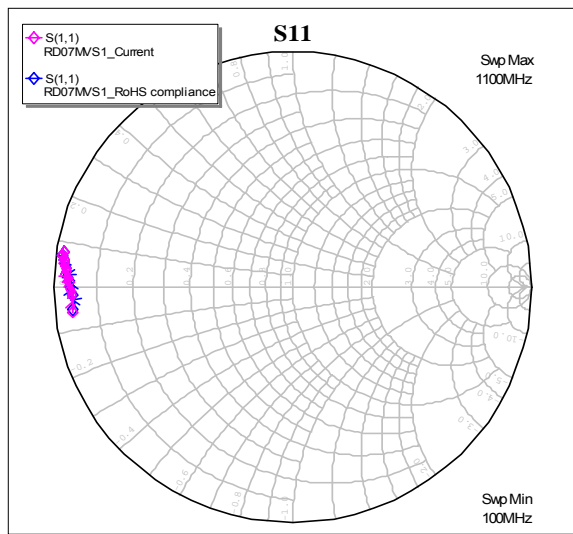
RD07MVS1 (Non RoHS)



RD07MVS1 (RoHS)



RD07MVS1 RF characteristics (Non RoHS vs. RoHS compliance products)



RD07MVS1 RF characteristics (Non RoHS vs. RoHS compliance products)

Load VSWR Tolerance

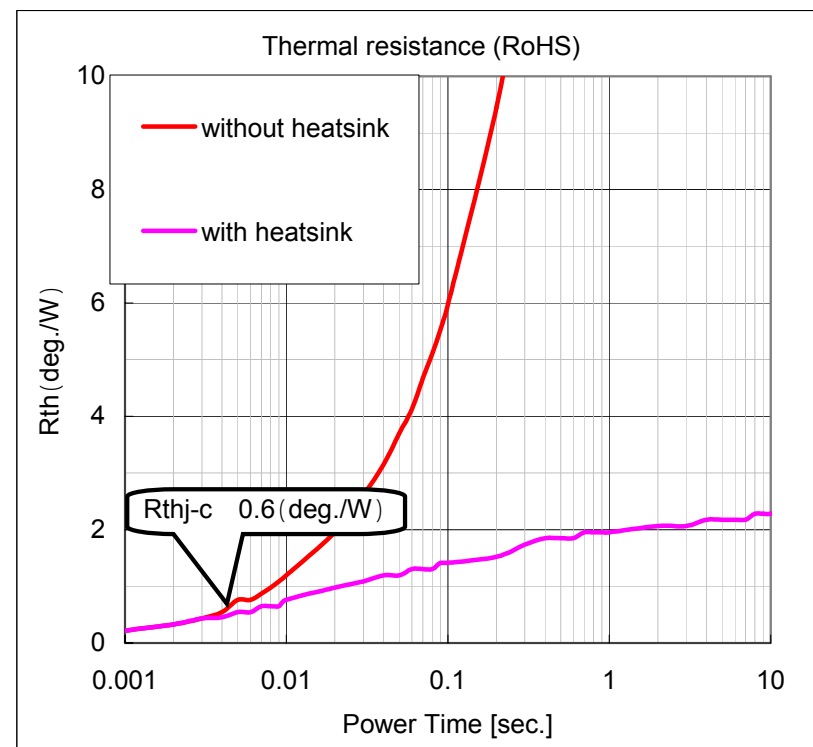
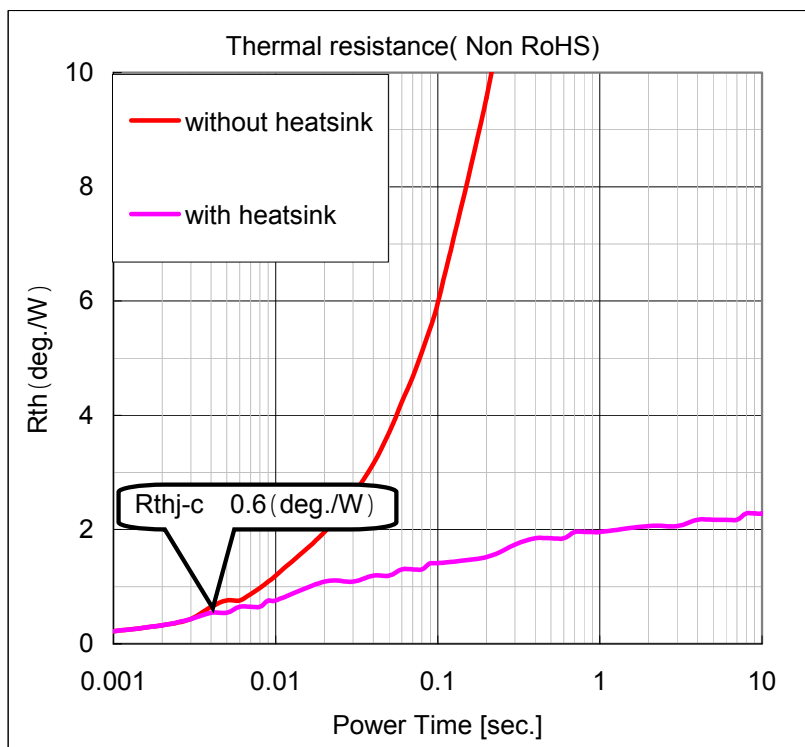
Conditions : f=135/527MHz,Vdd=9.2V,Idq=750mA (Vgg cor
Po(Pincontrol),Zg=50ΩZl=20:1 all phase

Result note: shows no destroy

sample No		7.5W	9W	10W
RoHS	No.1			
	No.2			
	No.3			
	No.4			
	No.5			
	No.6			
	No.7			
	No.8			
	No.9			
	No.10			
Non RoHS	No.1			
	No.2			
	No.3			
	No.4			
	No.5			
	No.6			
	No.7			
	No.8			
	No.9			
	No.10			

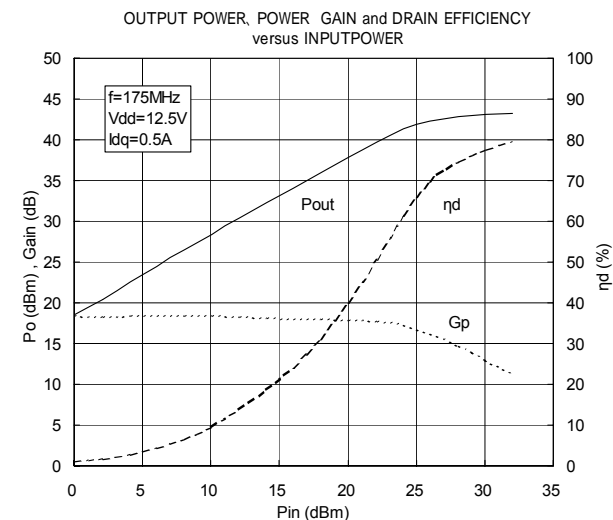
RD07MVS1 RF characteristics (Non RoHS vs. RoHS compliance products)

Conditions: $V_{DS}=7V$ $I_{DS}=0.6A$ $I_M=2mA$ Thermal Coefficient of Si $=2.2mV/deg.C$
 heatsink size : 40x90x10mm (AL)

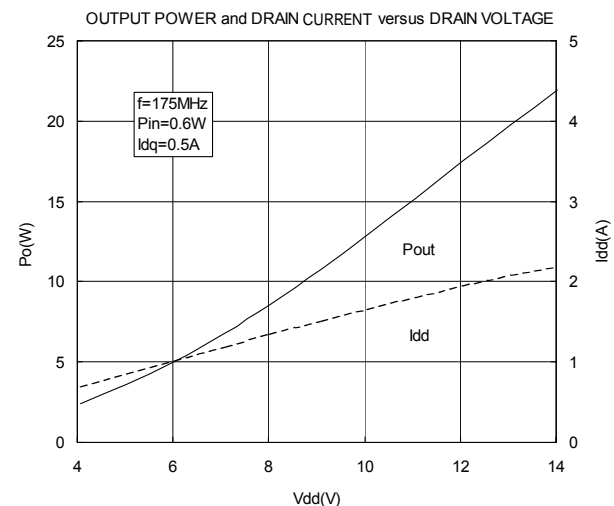
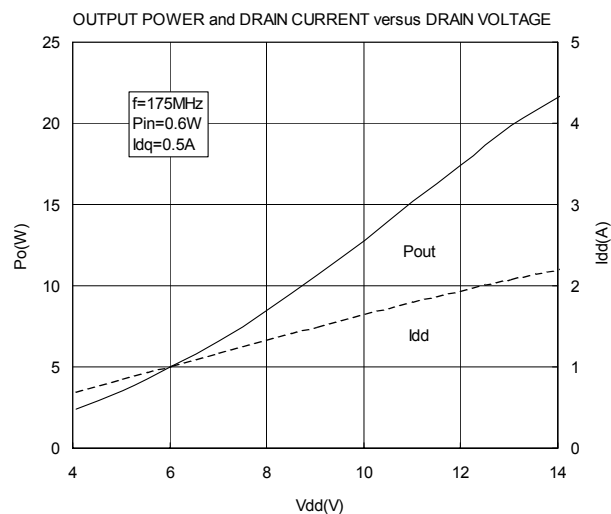
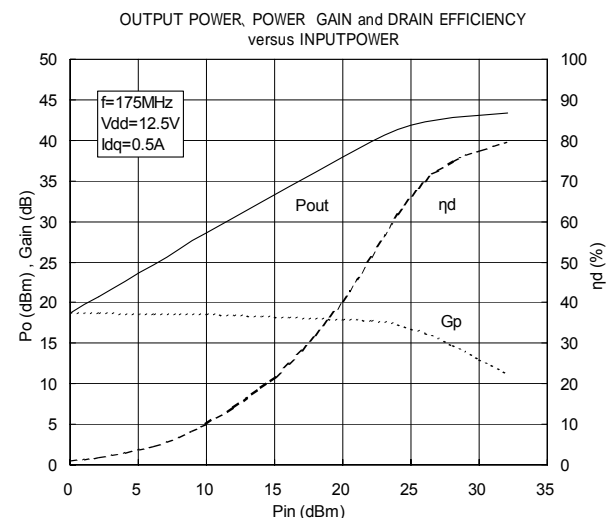


RD15HFV1 RF characteristics (Non RoHS vs. RoHS compliance products)

RD15HVF1 (Non RoHS)



RD15HVF1 (RoHS)



RD15HVF1 RF characteristics (Non RoHS vs. RoHS compliance products)

Load VSWR Tolerance

Conditions: $f=175\text{MHz}$, $V_{dd}=15.2\text{V}$, $I_{dq}=0.5\text{A}$ (V_{gg} con
Po(Pincontrol), $Z_g=50\Omega$, $Z_L=20:1$ all phase

Result note: shows no destroy

sample No		16W	17W	18W
RoHS	No.1			
	No.2			
	No.3			
	No.4			
	No.5			
	No.6			
	No.7			
	No.8			
	No.9			
	No.10			
Non RoHS	No.1			
	No.2			
	No.3			
	No.4			
	No.5			
	No.6			
	No.7			
	No.8			
	No.9			
	No.10			

Recommended Solder Condition

❑ Manual Solder

350deg/C ; Lower than 3sec.

❑ Reflow temperature profile for SMD

