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 (Taking Charge of Silicon RF by
 Miyoshi Electronics)

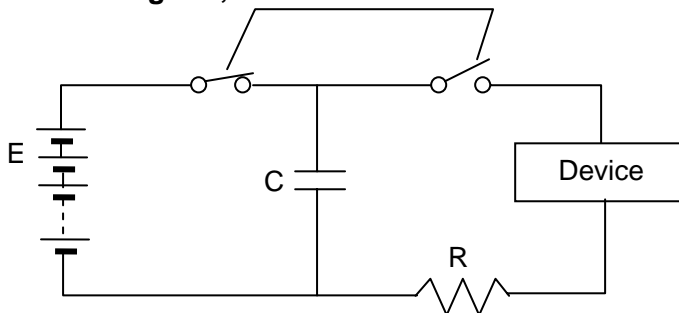
SUBJECT: ELECTRO STATIC SENSITIVITY FOR RF POWER MODULE RA**** series

GENERAL:

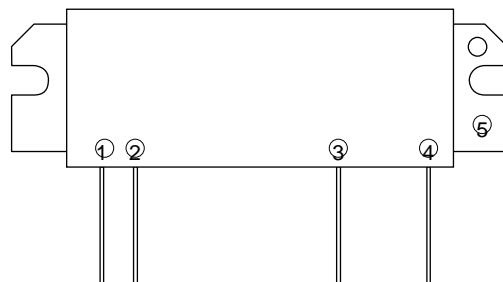
MITSUBISHI ELECTRIC RF Power Modules RA**** series products use MOS FET device. MOS FET devices have lower surge endurance compared with silicon bipolar devices. And there is a possibility of burn-out when static electricity or surge is added to devices. This application note shows the test results of the electro static discharge level for MITSUBISHI RF Power Modules RA**** series products.

1. ELECTRO STATIC DISCHARGE TEST RESULTS:

-1. Test Block Diagram;



-2. Pinning;

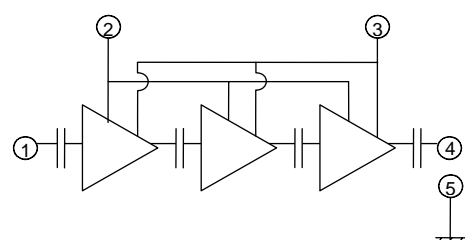
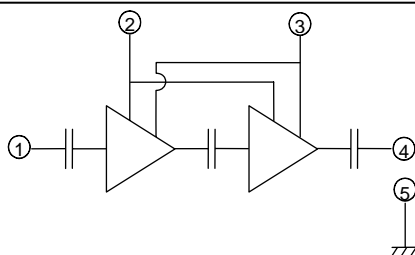


- 1 RF Input (P_{in})
- 2 Gate Voltage (V_{GG})
- 3 Drain Voltage (V_{DD})
- 4 RF Output (P_{out})
- 5 RF Ground (Flange)

(Block Diagram)

RA13H1317M/ RA30H1317M/ RA35H1516M/
 RA03M8087M/ RA13H3340M/ RA13H4047M/
 RA13H4452M/ RA07H3340M/ RA07H4047M/
 RA07H4452M

RA30H4452M/ RA13H8891MB
 RA60H1317M1



-3. Human Model Test Results;

[Type number: RA13H1317M (Po>13W @135-175MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times discharge for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2500	-	1	-3400
		2	2500		2	-3400
		3	2500		3	-3600
Vgg to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000

[Type number: RA30H1317M (Po>30W @135-175MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times discharge for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2300	-	1	-3100
		2	2200		2	-3300
		3	2200		3	-3400
Vgg to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	4900	-	1	-4500
		2	4900		2	-5000
		3	4900		3	-5100

[Type number: RA35H1516M (Po>40W @154-162MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times discharge for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2500	-	1	-3400
		2	2500		2	-3400
		3	2400		3	-3600
Vgg to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	4500	-	1	-3800
		2	4500		2	-4500
		3	4500		3	-4000

[Type number: RA30H4452M (Po>30W @440-520MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2000	-	1	-2600
		2	2000		2	-2600
		3	2000		3	-2600
Vgg to Flange	+	1	4400	-	1	Over -6000
		2	4900		2	Over -6000
		3	4700		3	Over -6000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000

[Type number: RA03M8087M (Po>3.6W @806-870MHz, Vdd=7.2V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Vgg to Flange	+	1	3200	-	1	-3800
		2	3200		2	Over -6000
		3	3200		3	-4500
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000

[Type number: RA13H8891MB (Po>13W @880-915MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	1300	-	1	-1700
		2	1300		2	-1800
		3	1400		3	-1700
Vgg to Flange	+	1	2900	-	1	Over -6000
		2	2900		2	Over -6000
		3	2900		3	Over -6000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000

[Type number: RA60H1317M1 (Po>60W @136-174MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	6000	-	1	Over -6000
		2	6000		2	Over -6000
		3	6000		3	Over -6000
Vgg to Flange	+	1	4500	-	1	Over -6000
		2	4500		2	Over -6000
		3	4500		3	Over -6000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000

[Type number: RA13H3340M (Po>13W @330-400MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2500	-	1	-3600
		2	2500		2	-3600
		3	2500		3	-3800
Vgg to Flange	+	1	2100	-	1	-4500
		2	2100		2	-5000
		3	2200		3	-5000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	4000	-	1	-3600
		2	4000		2	-3400
		3	3600		3	-3600

[Type number: RA13H4047M (Po>13W @400-470MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2200	-	1	-3400
		2	2300		2	-3800
		3	2300		3	-3000
Vgg to Flange	+	1	2100	-	1	-4000
		2	2100		2	-4000
		3	2100		3	-3800
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	4500	-	1	-3800
		2	4500		2	-3200
		3	4000		3	-3600

[Type number: RA13H4452M (Po>13W @440-520MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2200	-	1	-3400
		2	2200		2	-2800
		3	2200		3	-3600
Vgg to Flange	+	1	2100	-	1	-5500
		2	2100		2	-6000
		3	2200		3	-4500
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	3200	-	1	-3800
		2	3200		2	-3800
		3	3000		3	-3400

[Type number: RA07H3340M (Po>7W @330-400MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2200	-	1	-3200
		2	2200		2	-3400
		3	2200		3	-3000
Vgg to Flange	+	1	3000	-	1	-4000
		2	3000		2	-5000
		3	2900		3	-5000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	5000	-	1	-4500
		2	4500		2	-3600
		3	4500		3	-4500

[Type number: RA07H4047M (Po>7W @400-470MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2200	-	1	-3400
		2	2300		2	-4000
		3	2200		3	-3800
Vgg to Flange	+	1	2600	-	1	-5000
		2	3000		2	-3800
		3	3200		3	-4000
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	5500	-	1	-3600
		2	5000		2	-3200
		3	4500		3	-4000

[Type number: RA07H4452M (Po>7W @440-520MHz, Vdd=12.5V)]

Test Conditions are;

C=100pF, R=1.5KΩ, 3 times for one Voltage,

E=100V step increasing (Max. 6000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	2200	-	1	-3200
		2	2200		2	-3200
		3	2200		3	-2800
Vgg to Flange	+	1	2900	-	1	-4500
		2	2800		2	-4500
		3	2900		3	-3800
Vdd to Flange	+	1	Over 6000	-	1	Over -6000
		2	Over 6000		2	Over -6000
		3	Over 6000		3	Over -6000
Pout to Flange	+	1	5000	-	1	-4000
		2	5000		2	-3800
		3	5500		3	-3000

-4. Machine Model Test Results;

[Type number: RA30H1317M (Po>30W @135-175MHz, Vdd=12.5V)]

Test Conditions are;

C=200pF, R=0Ω, one time discharge for one Voltage,

E=100V step increasing (Max. 3000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	500	-	1	-700
		2	400		2	-500
		3	400		3	-600
Vgg to Flange	+	1	Over 3000	-	1	Over -3000
		2	Over 3000		2	Over -3000
		3	Over 3000		3	Over -3000
Vdd to Flange	+	1	Over 3000	-	1	Over -3000
		2	Over 3000		2	Over -3000
		3	Over 3000		3	Over -3000
Pout to Flange	+	1	2400	-	1	-2400
		2	2500		2	-2300
		3	2400		3	-2500

[Type number: RA35H1516M (Po>40W @154-162MHz, Vdd=12.5V)]

Test Conditions are;

C=200pF, R=0Ω, one time discharge for one Voltage,

E=100V step increasing (Max. 3000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	340	-	1	-600
		2	340		2	-550
		3	340		3	-600
Vgg to Flange	+	1	Over 3000	-	1	Over -3000
		2	Over 3000		2	Over -3000
		3	Over 3000		3	Over -3000
Vdd to Flange	+	1	Over 3000	-	1	Over -3000
		2	Over 3000		2	Over -3000
		3	Over 3000		3	Over -3000
Pout to Flange	+	1	3000	-	1	-2200
		2	2500		2	-2200
		3	2200		3	-2200

[Type number: RA30H4452M (Po>30W @440-520MHz, Vdd=12.5V)]

Test Conditions are;

C=200pF, R=0Ω, one time discharge for one Voltage,

E=100V step increasing (Max. 3000V)

Terminal	Polarity	Sample NO.	Destroyed Voltage(V)	Polarity	Sample NO.	Destroyed Voltage(V)
Pin to Flange	+	1	600	-	1	-700
		2	700		2	-700
		3	500		3	-700
Vgg to Flange	+	1	2300	-	1	Over -3000
		2	2600		2	Over -3000
		3	2600		3	Over -3000
Vdd to Flange	+	1	Over 3000	-	1	Over -3000
		2	Over 3000		2	Over -3000
		3	Over 3000		3	Over -3000
Pout to Flange	+	1	2500	-	1	-2300
		2	2500		2	-2300
		3	2500		3	-2300