

1.Substrate Crack Mechanism

1.Module flange and substrate have a bend by bimetal effect.



2.RF Power transmitting,

The temperature of flange and chassis is increase by loss.

The flange are extending by thermal at first and the amount of bend is drop away.



3.RF Power transmitting and the amount of bend to Zero.

After the amount of bend reach to Zero, the substrate have a tensility to both side. When the tensility over the limit of substrate tensile, the substrate occur the crack.







Measurement result of the stress



Simulate the good flatness

Simulate the poor flatness

Simulate the poor screw cramp



The example of thermal stress analysis



When heat is applied, a crack will spread.

Hot Po test can reject the crack by measuring the RF Power.

<u>The Example of</u> <u>Thermal Stress Analysis</u>



The check results of crack place

This is a typical substrate crack by high temperatures. There are no signs in which have a small crack that is latent in the substrate.



Expansion next page A

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Expansion photo



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Hot Po measurement equipment

The purpose of Hot Po

Hot Po test can reject the micro crack & another poor soldering by heat stress.

Operation

1.PA s are put on the pre heart stage. The temperature of PA becomes 100 degrees C.

2. PA is moved to the RF test stage.

3. PA is hold down to the RF test jig and test is started. RF power is checked.



The outline of the test equipment







The outline of RF out put tester (Auto tester)



Stress limit VS temperature rise

	Substrate coefficient of variation		0.1
		Reliability R	
The result of Calcuration by FEM	Sterss limit (kgf/mm)	99.9%	8.8
		99.99%	8.0
		99.999%	7.3
The result of Mesurement	Generated Thermal Stress (kgf/mm)	dT/dt=A	7.8
		dT/dt=B	6.0
		C <u>C=th\Th</u>	50



MITSUBISHI ELECTRIC HF&Optical Semiconductor Div. (MIYOSHI ELECTRONICS)



4. THERMAL DESIGN

In order to keep high reliability of the equipment, it is better to keep the device temperature low. The case temperature of the module is recommended to keep lower than 90 deg. C under all conditions, and to keep lower than 60 deg. C under standard conditions.

For discrete transistor, keep the operating junction temperature of Transistors Tj(op) less than specified temperature.

Ceramic substrate in the module may crack by excessive stress such as foreign object between Fin and chassis or expansion by thermal force.

For foreign object between Fin and chassis, recommendation is written in next item 5. Concerning expansion by thermal force, MITSUBISHI recommend to design the ramp-up speed of module case temperature as below.

Customer needs to design the heat sink size and control the output power of the module in order to keep safety ramp-up curve.



Application Note for Mitsubishi RF Power Semiconductors

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Example of Poor Flatness







Example of the Flatness improvement





Before Substrate crack occurred

After Substrate crack No issue



The RF on /off results with RoHS compliant ver.

RoHS model will be stronger than existing Pb Model.

Test sample RA45H4452M

RF on/off test result at extreme test condition

RoHS ver. r/n=0/16

(No substrate crack over 3000 cycles)

Existing ver. r/n=8/8

(All substrate crack at few cycles)

