IT3 Thermal Cycling Test Report
(Solder type: Sn63 Pb37)

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CONTENTS

1 OVERVIEW

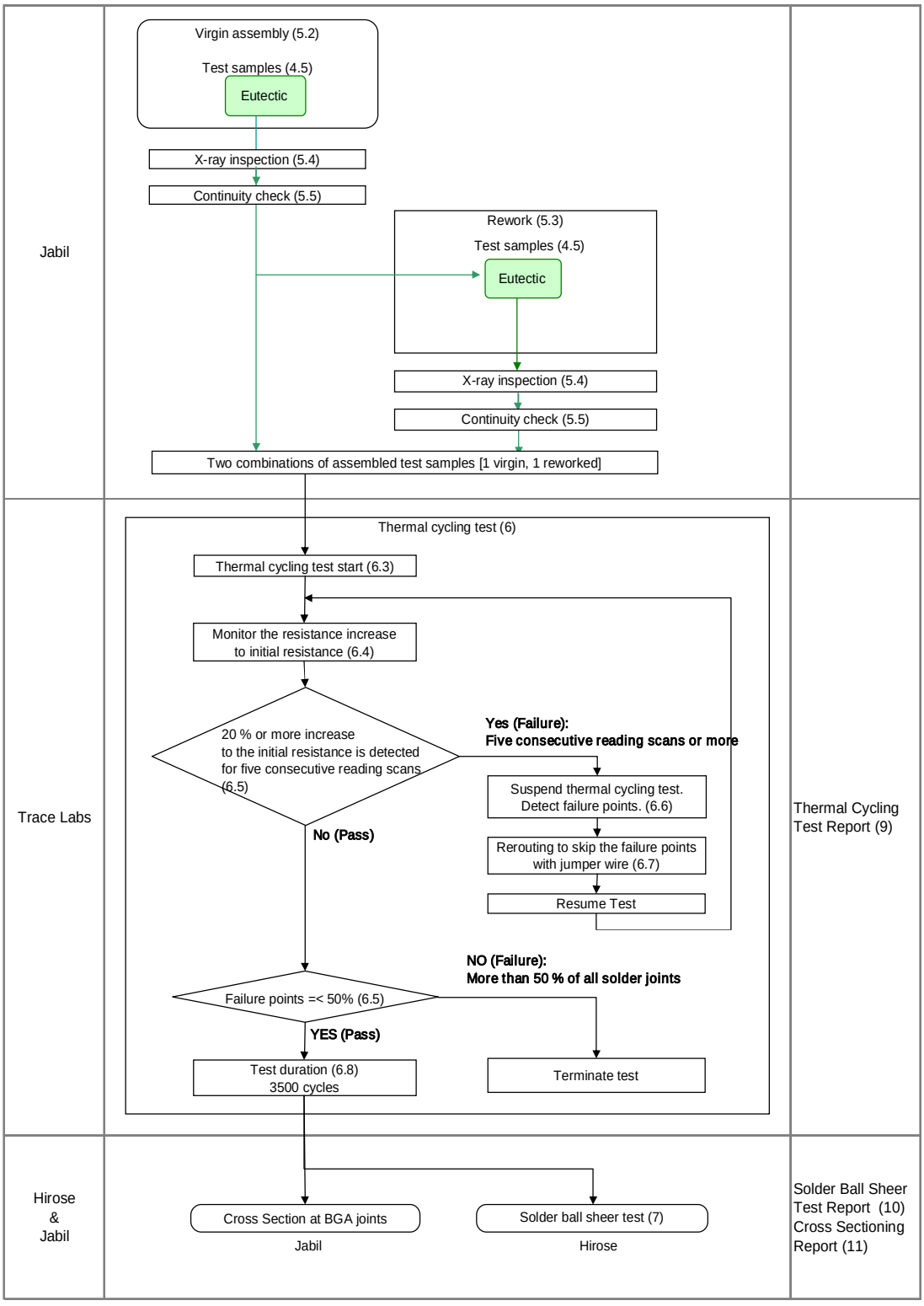
The following test report is to be considered official documentation for results found during thermal cycle testing of the IT3 series BGA connector system. BGA connection is becoming a key technology for current and next generation high-speed transmission. It is crucial to perform accelerated life time testing to both simulate actual applications and prove BGA attachment reliability. All processes described herein, including test board design and thermal cycling test conditions, are based on and conform to IPC-9701.

All assembly and re-work processes were performed by Jabil Circuit, Inc. (San Jose, Ca., hereafter 'Jabil'), and thermal cycling was performed by Trace Laboratories, Inc.(Chicago, Il.). This document includes all processes and test procedures followed, along with who and where they were performed.

2 TEST OBJECTIVES

The test samples and processes were prepared to simulate various applications that included: Both virgin and rework assemblies, connector configurations, and both single and multiple connector mounts.

3 THERMAL CYCLING TEST PROCEDURE



4 TEST VEHICLES

The following parameters were applied to simulate various manufacturing and connector usage situations.

4.1 Connector Type

Mezzanine Connector: Hirose IT3 series

❑ Receptacle

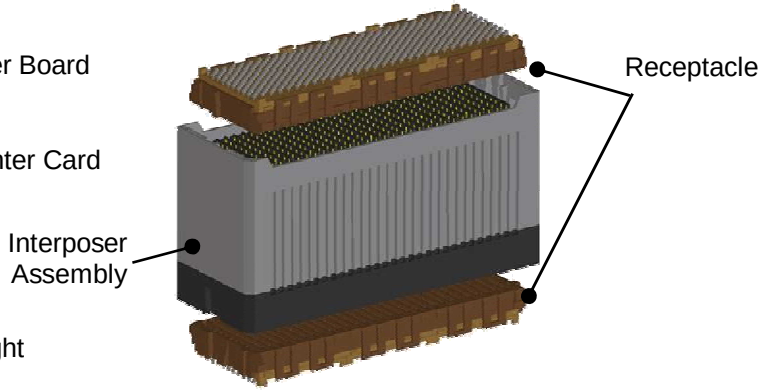
· IT3M-300S-BGA(57)…Mounted on Mother Board

· IT3D-300S-BGA(57)…Mounted on Daughter Card

❑ Interposer assembly

· IT3-300P-17H(03)…17 mm Stacking Height

· IT3-300P-32H(03)…32 mm Stacking Height



IT3 Connector

4.2 Test Vehicle Configuration

Boards were designed to a thickness of 3.3 mm (125 mils) per IPC-9701

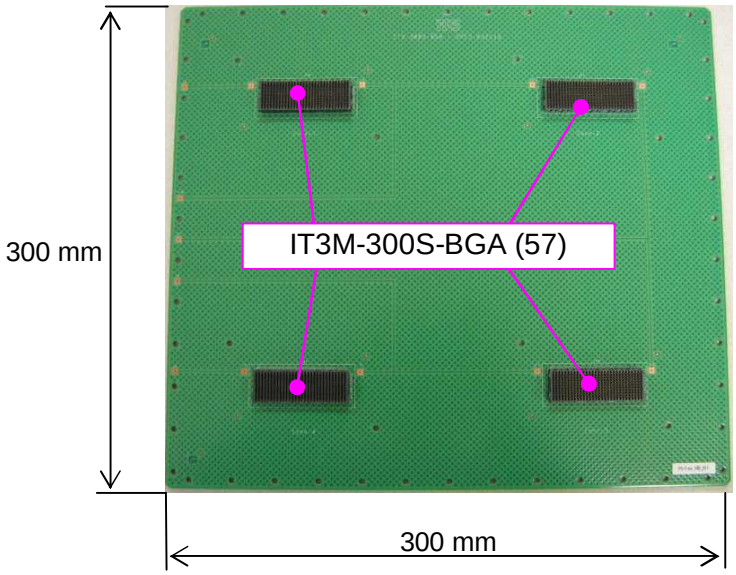
4.2.1 Multiple Connector Mount

In many applications, multiple connectors are mounted on one daughter card which can create potential alignment issues and different stresses on solder joints. This test covers multiple connector mounting in various configurations.

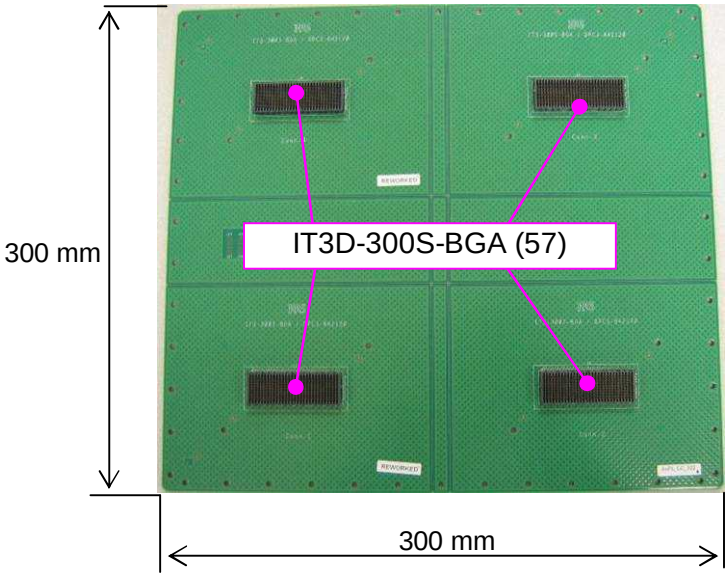
	Config. 1	Config. 2	Config. 3	Config. 4
Numbers of connectors / Daughter card	1	2	2	4
Remarks	Individual	X Direction(2 CN)	Y Direction(2CN)	Quad(4 CN)

4.2.2 Test Board Examples

IT3 mezzanine connectors were assembled to the board and tested . Each test board has four IT3 connectors



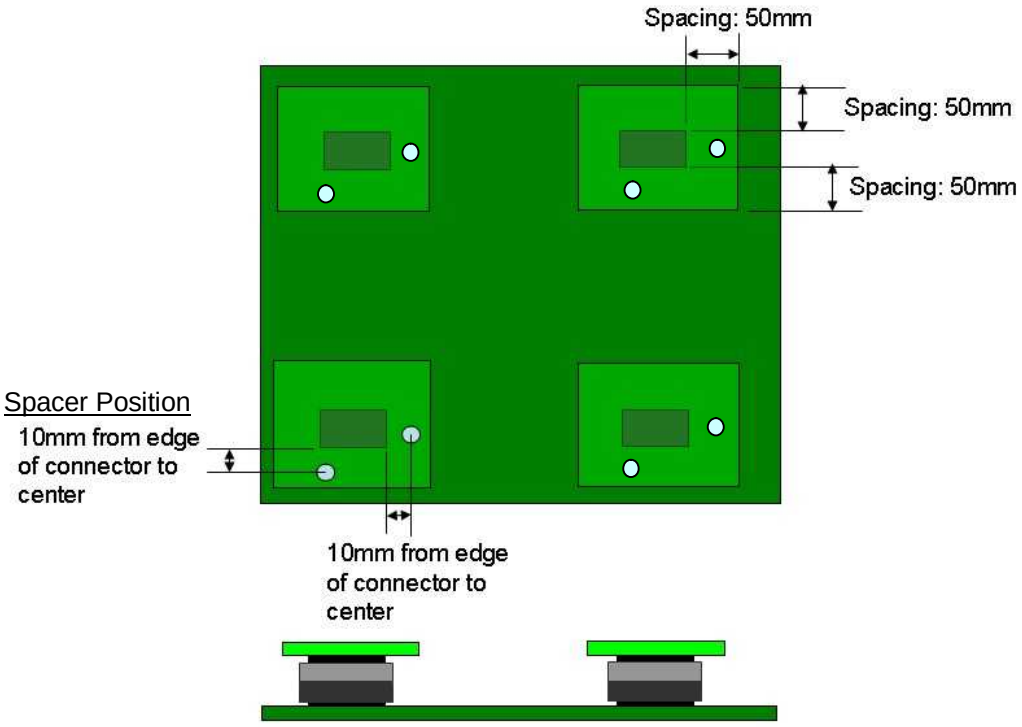
Mother Board



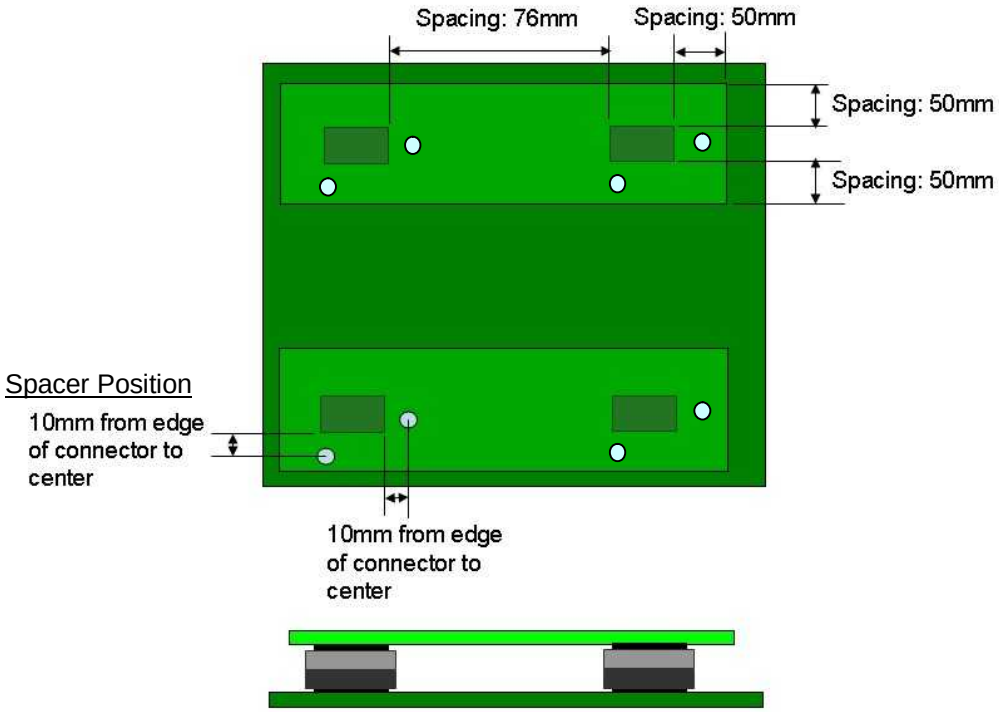
Daughter Card（Config.4）

4.2.3 Test Board Configurations

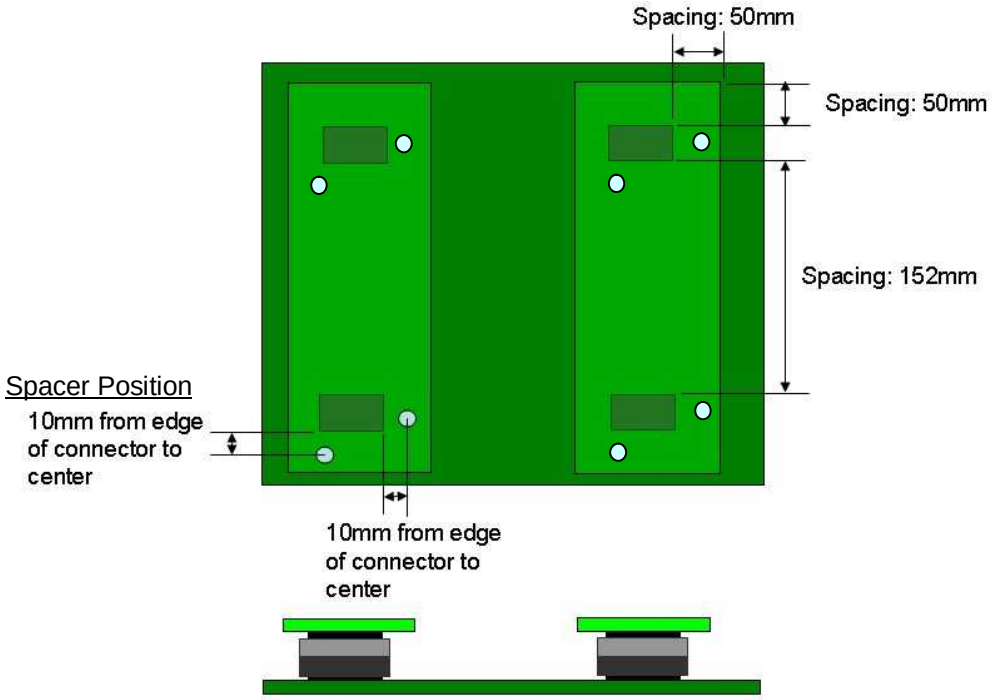
- Config. 1 ---One connector per daughter card



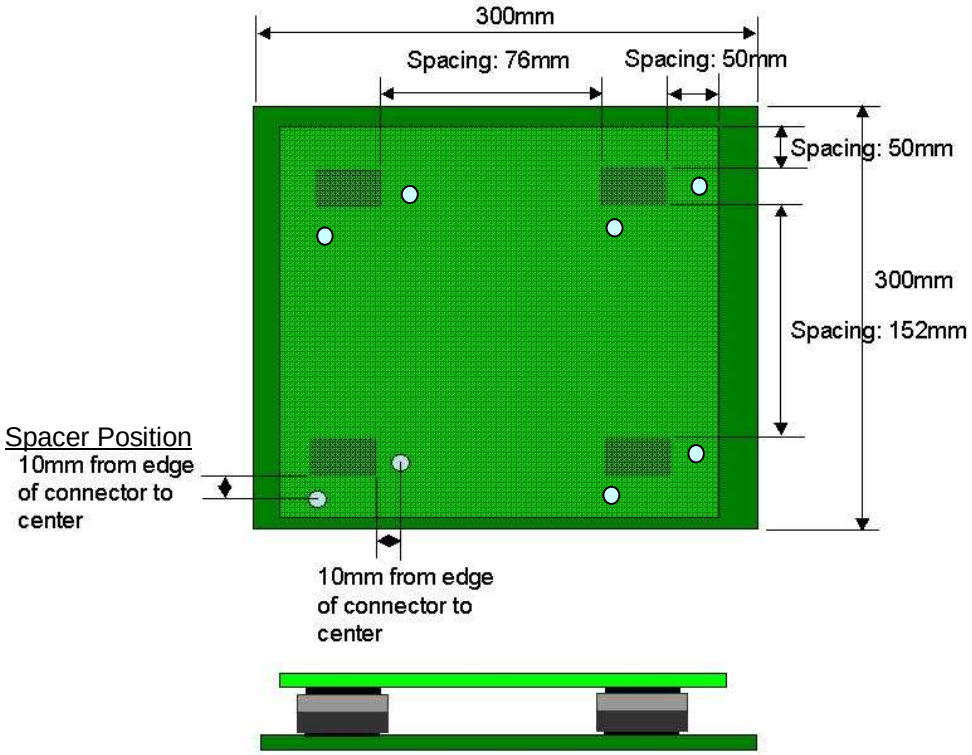
- Config. 2 ---Two connectors per daughter card (X direction)



- Config. 3 ---Two connectors per daughter card (Y direction)



- Config. 4 --- Four connectors per daughter card



4.3 Virgin or Reworked

To simulate the actual assembly process, both “Virgin” and “Reworked” board samples were tested. Assembly was done by Jabil, using industry standard assembly /rework equipment and processes.

	Virgin	Reworked
Test Board	Virgin	Reuse after connector removal
Connector	Virgin	Virgin

4.4 Type of Solder

	Virgin	Reworked
Solder Ball on Connector	Eutectic	Eutectic
Solder Paste	Eutectic	Eutectic

4.5 Number of Test Vehicles and Connectors

For 3.3mm (125 mil) thick test boards, the following number of connectors were used.

	Height	Config 1	Config 2	Config 3	Config 4	Total # of Connectors
IT3-300S	17H	6/2	6/2	6/2	6/2	24/8
	32H	6/2	6/2	6/2	6/2	24/8
Totals		12/4	12/4	12/4	12/4	48/16

Note: 12/4 represents 12 Virgin and 4 Reworked

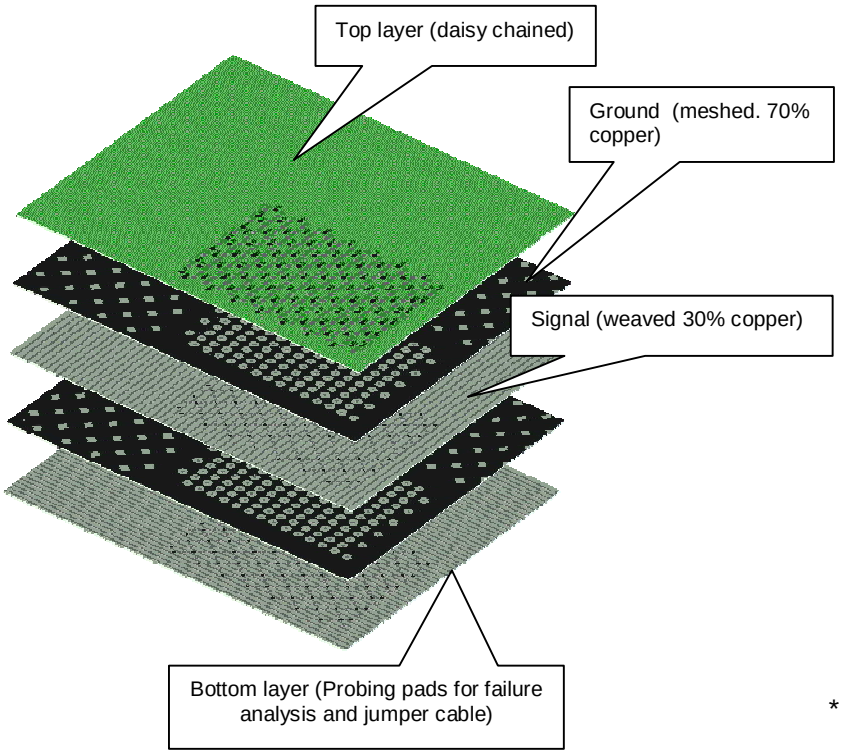
5 ASSEMBLY CONDITIONS

5.1 Test Board Design Detail

❑ Test Board Design Details per IPC-9701

	Item	Requirement	Remarks
1	Thickness	3.3mm (125 mils) per IPC-9701	—
2	# of Metal Layers	16 layers	—
3	Layer Structure	See Fig. 1 on the next page	—
4	PCB Material	High Tg FR-4	IS-410/NP-150TL
5	Ground Layer	Remaining 70% copper mesh	Ground plane on even # layers
6	Signal Layer	Remaining 30% copper weave	Signal traces on odd # layers
7	Daisy Chain	On top layer only	—
8	Pad and Via	Pads for probing on the bottom layer through via	For failure analysis purposes, pads are connected by jumper cable to continue rest of the cycles if any failure is found. Simulate mechanical strength of actual PCBs with vias.
9	Surface Finish	High Tg OSP (Organic solderability preservative)	Passed IPC-S-804B solderability test IPC-TM-650 insulation resistance test IPC-6012(0.75%) warp and twist test
10	Pad Type	NSMD (Non-solder mask defined)	—
11	Copper Thickness	Outer layer: 35 microns Inner ground: 35 microns Inner signal: 18 microns	—
12	Trace Width	200 microns (8 mils)	150 microns (6 mils) minimum (IPC-9701)
13	# of Connectors	10 connectors per board maximum	—

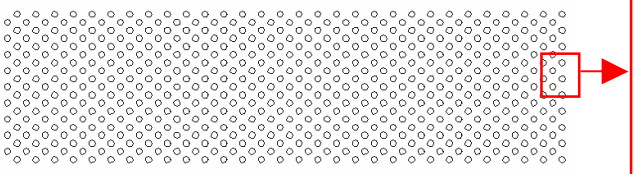
Note: Test boards were designed to measure electrical continuity using the daisy chain circuit only. Vias were not connected to any specific signal or ground layers. Neither ground contacts nor ground layers are connected anywhere.



Layer	Footprint type
Top	Daisy chain
2nd	Ground layer
3rd	Signal layer Type A
4th	Ground layer
5th	Signal layer Type B
6th	Ground layer
7th	Signal layer Type A
8th	Ground layer
9th	Signal layer Type B
10th	Ground layer
11th	Signal layer Type A
12th	Ground layer
13th	Signal layer Type B
14th	Ground layer
15th	Signal layer Type A
Bottom	Via test points

* 16 Layers in Total

Fig. 1 PCB Layer Structure



IT3* – 300S-BGA Foot Pattern

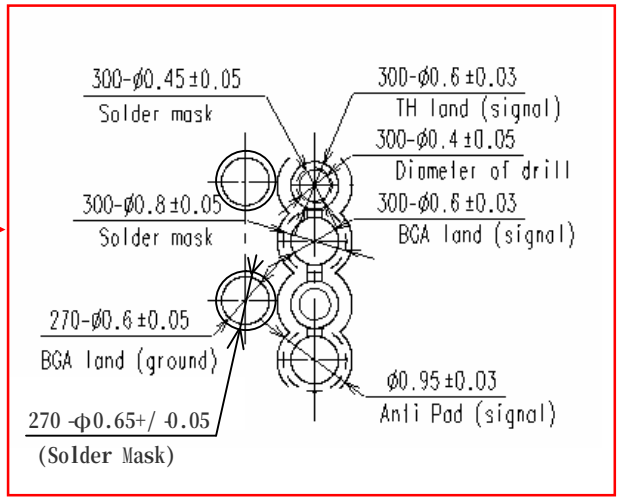


Fig. 2 BGA Land Design

5.2 Test Vehicle Assembly

Hirose provided assembly/rework process information, that was then adapted by Jabil to conform to industry standard practices. All connectors were assembled / reworked at Jabil.

5.2.1 Virgin Assembly Parameters

Process parameters followed for testing.

Items	Requirements
Type of Reflow Equipment	Mass-reflow conveyor furnaces
Pre Conditioning	Dry package
Stencil	Thickness = 0.127 mm (0.005'') Frame size X= 736.6 mm, Y= 736.6 mm (29'' x 29'') Open area ratio : 90% aperture size by area
Solder Ball Composition	Sn63 : Pb37
Solder Paste Composition (Supplier Part Number)	Sn63 : Pb37 (Kester EP 256 no-clean Eutectic solder paste)
Process Parameters	DEK-265GSX Automatic screen printer · Printing speed = 1''/second · Stencil snap off = 0
Reflow Temperature Profile	See details on the next page.
Reflow Atmosphere	Nitrogen

5.3 Rework

"Rework" consists of a series of processes, such as removal of connector by using rework equipment (i.e., SRT), PCB cleaning and placement/reflow of a new connector using rework equipment.

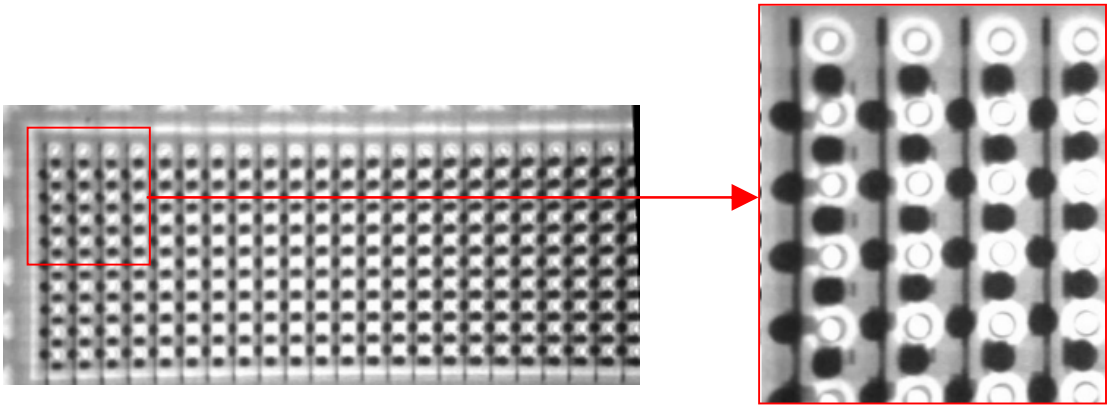
5.3.1 Rework Parameters

Items	Requirements
Type of Reflow Equipment	Hot air rework station
Stencil	Thickness = 0.127 mm (0.005") Open area ratio : 90% aperture size by area
Solder Ball Composition	Sn63 : Pb37
Solder PasteComposition	Sn63 : Pb37 (Kester EP 256 no-clean Eutectic solder paste)
Rework Atomosphere	Nitrogen

5.4 X-ray Inspection Test Board Design Detail

· X-ray inspection after assembly was conducted.

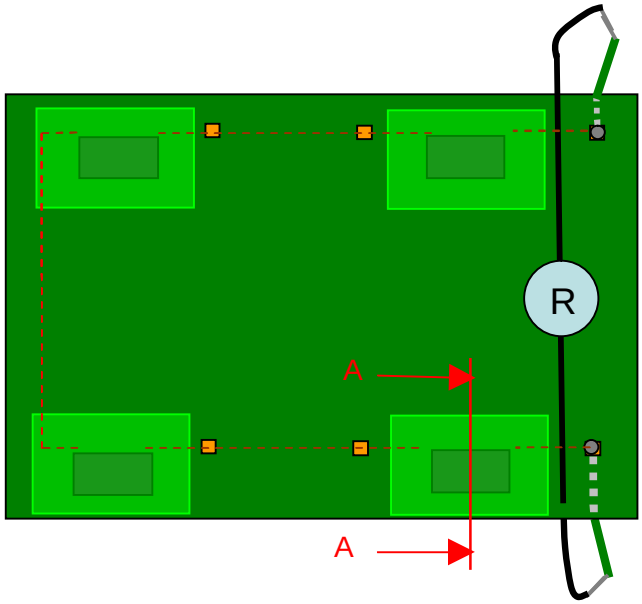
· All connectors passed the X-ray inspection before thermal cycling.

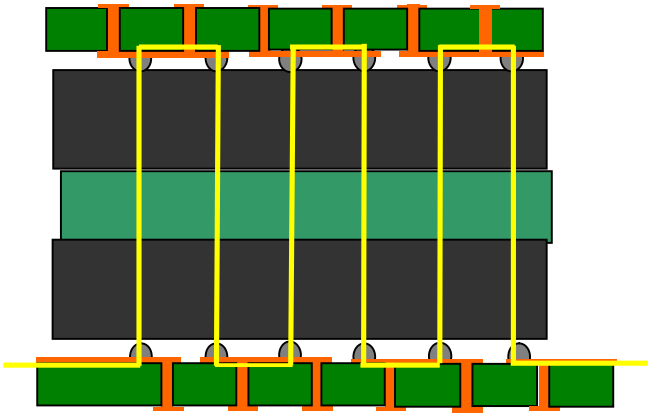


X ray Photo： IT3D-300S-BGA (57)

5.5 Continuity Check

Final assembly, including mounting interposer assembly / daughter cards and board spacers, was performed to complete the daisy-chain circuit prior to performing the continuity check.





Cross section _ AA

❑ Resistance Per Connector Chain

IT3 Interposer Height	Resistance
17 mm height	25 to 29
32 mm height	38 to 42

Unit : Ohm

* Resistance includes one connector assembly plus PCB trace.

6 THERMAL CYCLING TEST PROCESS

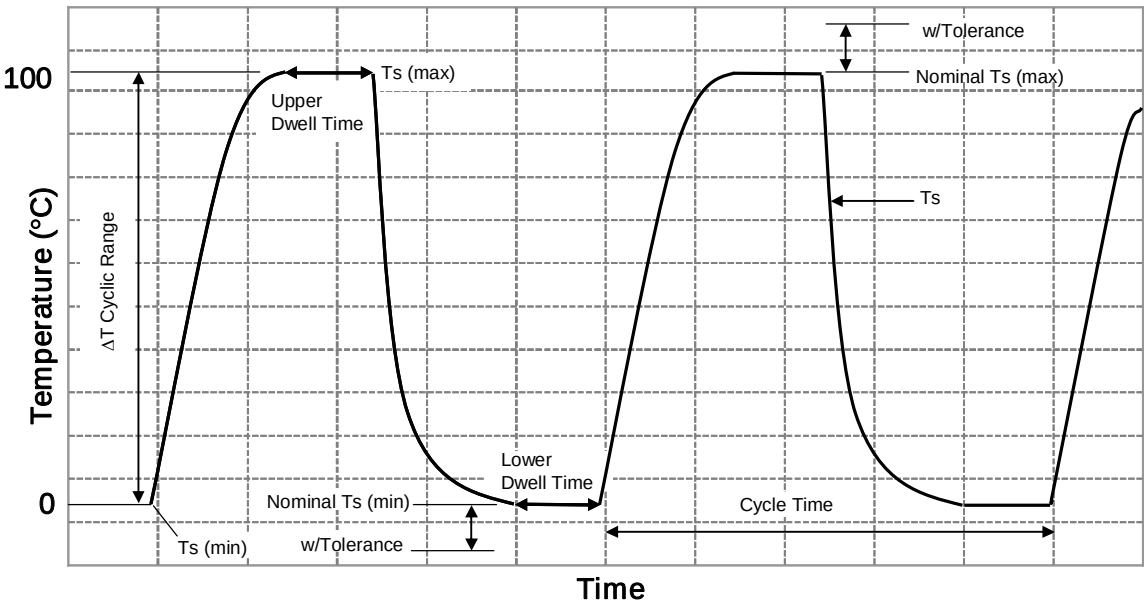
Thermal cycling test performed conforms to IPC-9701 (JESD22-A-104-B).

6.1 Preconditioning by Isothermal Aging

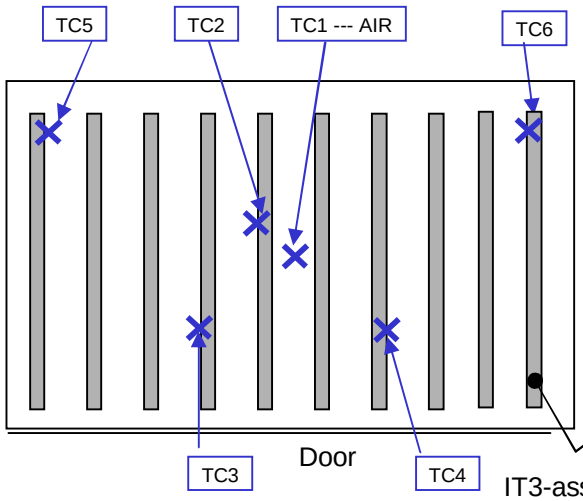
Test specimens were subjected to an accelerated thermal aging (e.g. 24 hours at 100 ◦C (-0/+5 ◦C)) in air to simulate a reasonable use period and to accelerate such possible processes as solder gain, growth, intermetallic compound growth or oxidation. Test specimens were stored at room temperature following the artificial aging process and before commencing the thermal cycling test.

6.2 Thermal Cycle Chamber Profile

- ❑ Dummy boards and connectors were employed to simulate expected thermal mass
- ❑ A minimum of 4 thermal couples near connectors on at least 2 boards
- ❑ Thermal cycle profile
  - · T_{max} = 100 ^{o}C (+10 / 0 ^{o}C)
  - · T_{min} = 0 ^{o}C (0 / -10 ^{o}C)
  - · Ramp rate = Approximately 10 ^{o}C/min (10% to 90% of test temperature range)
  - · Dwell time = 5 to 10 min (Holding time of maximum and minimum temperature)
- ❑ 5 successful cycles were performed before commencing test.

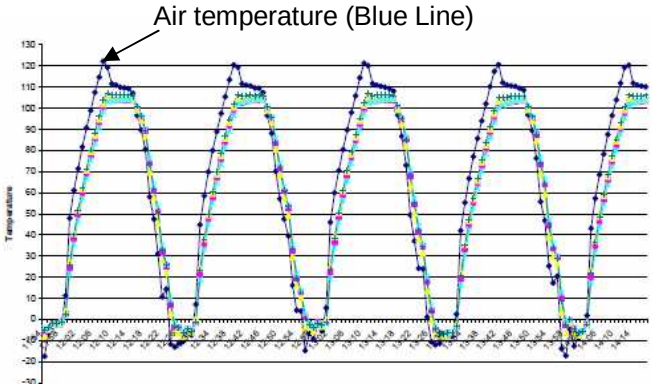


6.3 Thermal Cycling Test Execution

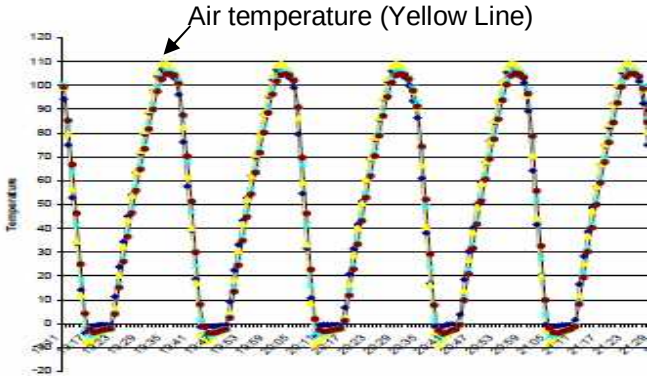


IT3-assembled test board
(Refer to 4.2.2 Test board example
for test board details.)

Thermocouple Locations



Chamber_1_TL 544



Chamber_2_TL 745

Measured Thermal Cycle Profile

6.4 Measurement

- ❑ Chamber temperature profile was continuously monitored and recorded during the test.
- ❑ Electrical resistance was monitored and recorded continuously. Maximum scan interval of all chains was one minute during test.

6.5 Failure Criteria

Failure was claimed when a 20% resistance increase to initial resistance was monitored for five consecutive reading scans. Failure points could not exceed 50 %.

6.6 Identifying Failed Connector(s) and Failure Point(s)

Failed connectors or failed points were identified by probing connector and specific test points and daisy chain test points located on the bottom of all test boards.

Failure point(s) and number of cycles were recorded, when failure(s) occurred.

6.7 Rerouting with Jumper Wire

Once failure and location was detected, rerouting of the effected area was required.

Jumper wires (AWG32, 60mm in length, pre-stripped and tinned) provided by Hirose were inserted approximately 2 mm into the appropriate through-holes and then soldered to complete the bypass.

6.8 Test Duration

3500 cycles

6.9 Test Result

See attached document "07-29834-R1 PRINTED CIRCUIT BOARDS TEMPERATURE CYCLE" prepared by Trace Laboratories, Inc. for more details.

No failure was observed up to 3,500 temperature cycles.

Board #	Initial Resistance	Final Resistance	Failure cycle & Resistance	Configuration	Conn-1	Conn-2	Conn-3	Conn-4
MB-001	40.9	40.1	No failure	Config-1	Virgin	Virgin	Virgin	Virgin
MB-002	26.5	25.8	No failure	Config-1	Virgin	Virgin	Virgin	Virgin
MB-003	40.2	39.7	No failure	Config-2	Virgin	Virgin	Virgin	Virgin
MB-004	26.0	25.6	No failure	Config-2	Virgin	Virgin	Virgin	Virgin
MB-005	39.9	39.6	No failure	Config-3	Virgin	Virgin	Virgin	Virgin
MB-006	25.7	25.2	No failure	Config-3	Virgin	Virgin	Virgin	Virgin
MB-007	40.2	39.8	No failure	Config-4	Virgin	Virgin	Virgin	Virgin
MB-008	26.5	26.1	No failure	Config-4	Virgin	Virgin	Virgin	Virgin
MB-009	41.1	40.1	No failure	Config-1	Virgin	Virgin	Reworked	Reworked
MB-010	27.5	26.5	No failure	Config-1	Virgin	Virgin	Reworked	Reworked
MB-011	41.0	40.4	No failure	Config-2	Virgin	Virgin	Reworked	Reworked
MB-012	26.0	26.6	No failure	Config-2	Virgin	Virgin	Reworked	Reworked
MB-013	39.8	41.1	No failure	Config-3	Reworked	Virgin	Virgin	Reworked
MB-014	26.9	27.5	No failure	Config-3	Reworked	Virgin	Virgin	Reworked
MB-015	40.6	41.5	No failure	Config-4	Reworked	Virgin	Virgin	Reworked
MB-016	26.4	26.9	No failure	Config-4	Reworked	Virgin	Virgin	Reworked

Unit：ohm

Measurement Result

7 SOLDER BALL SHEAR TEST

Ball shear qualification conforms to IPC-9701.

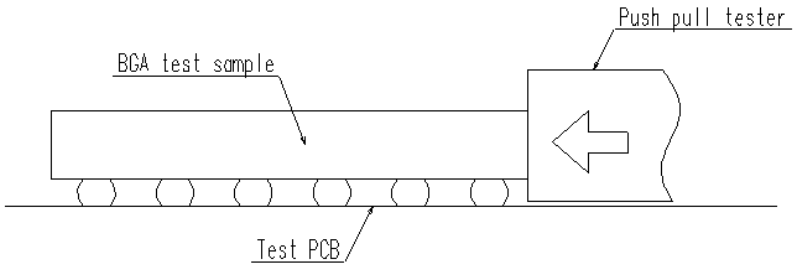
The minimum shear force is defined as the mean minus 3 sigma, for a minimum of three connectors

7.1 Measurement Method

Force is applied to the edge of the connector so that the balls receive the shearing force.

The height of shearing tool should exceed the height of the connector surface of 50µm minimum.

Test speed: 500 micrometer / second



7.2 Failure Mode

The failure mode for the sheared balls is defined as either a bulk solder failure or copper pad lift-off.

An intermetallic failure between contacts and balls is unacceptable.

7.3 Test Result

See the attachment "TR0636E-20027 : IT3D(M)-300S-BGA (57) BGA shearing force test report"

No intermetallic failure between contacts and balls was observed in both Initial and Post 3500 cycles specimens.

8. REVISION RECORD

Revision no.	Description (Major changes)	Date
	Initial release	June. 23rd , 2008