CDC Division
FCI USA, Inc.

FCI

Report EL-2002-02-046 CR
Lead-free BGA Process Development Testing
2006 Jun 27

PURPOSE:

This report summarizes the testing performed on the FCI MEG-Array® Ball Grid Array (BGA) connector during development of a lead-free solder ball to contact attach process. Testing consisted of 3-point bend testing (with dye penetrant), contact to solder ball tensile testing, and solder joint reliability testing (accelerated temperature cycling).

CONCLUSIONS:

All samples successfully met the product specification requirements for all tests. None of the samples exhibited penetrating dye in either of the solder ball interfaces following 3 point bend testing. All samples were above the specification minimum 2.2 lbs. for tensile strength. All samples successfully completed accelerated temperature cycling. Only one sample exhibited an increase in resistance from its initial value.

SAMPLE DESCRIPTION:

Samples consisted of FCI MEG-Array 400 position plug connector PN 84739-002 and mating receptacle PN 74220-002. Thirty pairs were assembled to FCI continuity test boards SK39872 (plug) and SK39875 (receptacle) by Product Engineering. Connector samples were received 2/15/02 and determined to be suitable for testing after visual examination by a member of the product test lab staff.

TESTS

All tests were performed in accordance with FCI MEG-Array product specification GS-12-100, Rev. C, 2/28/01. All results reported herein apply only to samples from FCI Lead-free Design of Experiment (DOE) 79. Product Engineering further defined these samples as SnAgCu solder balls processed in a nitrogen atmosphere, a peak reflow temperature of 251C, and a 55 second time above 217C.

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3 POINT BEND TEST

This test provides a visual assessment of the effects of stresses imparted to the MEG-Array solder ball joints during printed circuit board assembly. Fifteen plug and 15 receptacle connectors were soldered to test boards by Product Engineering. Testing was performed in accordance with FCI procedure BUS-19-125, rev. B, 7/5/00. Each sample was fixtured and deflected 0.020"/inch of board support distance using a compression/tensile tester. Samples were supported at a distance of 3 inches and therefore deflected 0.060". Dye penetrant was then applied around the solder ball array and dried. The connectors are pried from the test board and visually inspected for fractures that may have occurred during deflection. The presence of dye in any of the solder ball interfaces is not permitted.

3 Point Bend Results

None of the 15 plug or 15 receptacle samples exhibited any dye in the solder ball interfaces. In most cases, the solder pad was removed from the laminate indicating the solder ball strength was greater than the solder pad adhesion. There was no solder ball separation from the terminal in any of the samples. Three receptacle and 6 plug samples exhibited solder ball to pad separation. However, no dye was visible in this interface.

TENSILE TEST

The tensile test assesses solder ball to contact solder joint strength. Testing was performed in accordance with the product specification and FCI test procedure BUS-19-124, rev. B, 7/5/00. Five randomly chosen contacts from each of 10 plugs and 10 receptacles were tested.

Tensile Test Results

Table 1 summarizes the test results for both receptacles and plugs. All samples met the specification minimum tensile strength of 2.2 lbs. Minimum observed tensile force was 2.38 lbs. on one receptacle sample. Average tensile force for receptacles and plugs was 3.48 lbs. and 4.08 lbs. respectively.

Table 1 – Tensile Force (lbs.)

	RECEPTACLES	PLUGS
AVERAGE	3.48	4.08
MINIMUM	2.38	3.35
MAXIMUM	4.88	5.31
STD. DEV.	0.42	0.45
COUNT	50	50

SOLDER JOINT RELIABILITY (ACCELERATED TEMPERATURE CYCLING)

This test examines the reliability of the solder ball-to-contact and solder ball-to-pad interface. Accelerated temperature cycling was performed in accordance with the product specification using a thermal shock chamber. Resistance of each sample was recorded at 5 minute intervals throughout the test. Test conditions were –40C to +85C, 15 minute dwell at each temperature for a total of 1000 cycles.

Accelerate Temperature Cycling Results

All samples successfully completed the 1000 cycles. None of the samples exhibited an increase in resistance of 100%. Only one sample exceeded its initial value recorded in the hot temperature. Sample # 24 exhibited a 31% increase in resistance at cycle # 374. The resistance of this sample returned to normal for the remainder of the test. The remaining 29 samples never exceeded their initial value.

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EQUIPMENT:

ITEM NAME	MANUFACTURERS NAME	ID NUMBER	CALIBRATION DUE DATE
Compression/Tensile Tester	Instron	VG6461	8/02
Load Cell	Instron	VG6457	CBU
Calibration Weight	Instron	VG6251	5/02
Housing Retention Fixture	FCI	SF373	N/C
Terminal Grasping Tool	FCI	MF373	N/C
Thermal Shock Chamber	Thermotron	VG6931	5/9/02
Chart Recorder	Molytek	VG6983	5/9/02
Micro-ohmmeter	Keithley	VG6905	7/22/02
Channel Switchbox	Keithley	VG7891	N/C
N/C = Not calibrated CBU = Calibrate Before Use			

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REVISION RECORD

Rev. #	Revision Date	Page(s)	Description
–	2006 June 27	All	Original Issue of CR report.

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