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Application News

Electromagnetic Force Micro Testing System Microservo MMT-250NV-10

Durability Evaluation of Solder Joints for Surface-Mount Devices (SMDs)—Measurement of Electrical Continuity Resistance during Cyclic Bend Tests—

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User Benefits

- The durability of solder joints under cyclic bending can be evaluated in with reference to JEITA ET-7409/105A and JIS C 62137-1-4.
- By using the Microservo MMT electromagnetic force micro testing system and a resistance measurement unit, changes in the continuity resistance of the solder joint can be continuously measured.
- The Servo Controller 4830 can perform high accuracy dynamic control.

■ Introduction

Electronic devices have become smaller with higher functionality. This has enabled surface-mount devices (SMDs) to be mounted at high densities on printed circuit boards. However, during the manufacturing process or in the operating environment, circuit boards may be subjected to repeated mechanical loads, such as bending or vibration. This can cause cracks to form at solder joints, leading to contact failures. To address this, the durability of solder joints can be evaluated through cyclic bend tests, which are useful for examining solder alloys, component designs, terminal structures, and mounting conditions, as well as for improving joint reliability (Fig. 1).

In this article, testing was conducted with reference to JEITA ET-7409/105A and JIS C 62137-1-4. Under cyclic bending loads, the electrical continuity of a solder joint changes as damage progresses, and the continuity resistance tends to increase. By using a resistance measurement unit, continuity resistance can be measured continuously during testing, enabling the state of degradation to be quantitatively determined up to failure.

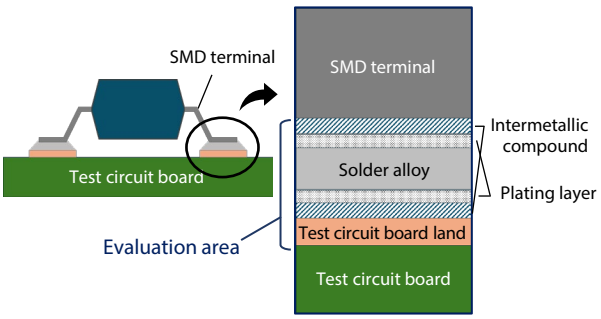

Fig. 1 Schematic Diagram of Cyclic Bend Test Evaluation Area

■ Measurement System

Table 1 shows the equipment configuration, and Fig. 2 shows views of the test. In this test, the Microservo MMT electromagnetic force micro testing system and a resistance measurement unit were used. A three-point bending fixture that complies with the relevant standards was used for the tests. The indenter has a structure that sandwiches the center of the test circuit board from both the top and bottom sides. This structure prevents the test circuit board from deforming excessively toward the indentation side as the cyclic bend test progresses. It also enables it to be accurately pulled back to the position it had at the start of the test. The supports also have a structure in which both ends of the base plate are sandwiched between the top and bottom sides by the support fixtures. A swiveling roller mechanism is provided at the top to ensure that the test base plate is not excessively constrained by the support fixture. In addition, by connecting a resistance measurement unit to the fatigue testing machine, continuity resistance can be measured continuously, and the test can be stopped the moment a loss of continuity due to fracture is detected.

Table 1 Equipment Configuration

Instrument:	Microservo MMT electromagnetic force micro testing system
Jig:	Test Circuit Board 3-Point Bending Jig
Load Cell:	250 N
Actuator Stroke:	±10 mm
Controller:	Servo Controller 4830
Software:	Windows Software for 4830
Resistance Measurement Device:	Resistance Measurement Unit for Servopulser
Resistance Measurement Range	0 to 100 Ω

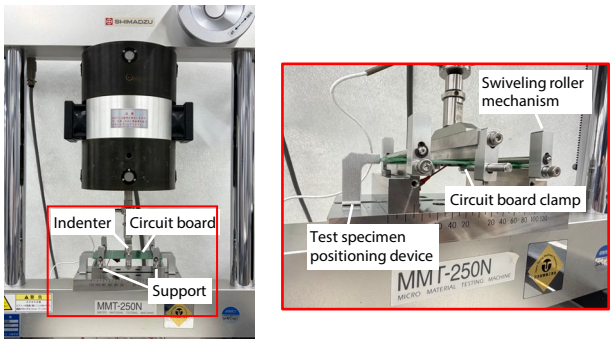

Fig. 2 Views of the Test

■ Test Specimen Information

Fig. 3 shows the test specimen and the resistance measurement locations. A printed circuit board with SMDs was used as the test specimen. The devices were positioned in the center of the board, the area where devices are most susceptible to the effects of board deformation. A resistance meter was connected to the terminals corresponding to the resistance measurement points, and the continuity resistance was measured.

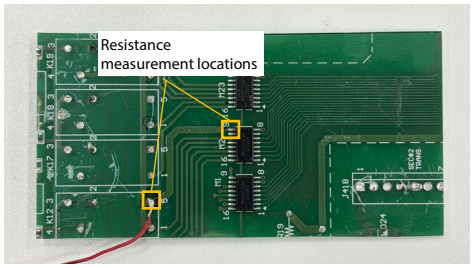

Fig. 3 View of the Test Specimen

■ Test Conditions

The fatigue test conditions are shown in Table 2. A triangular waveform was used for the control. The test speed was 0.5 mm/s, and the maximum stroke was 4 mm. The test was terminated when the continuity resistance reached 100 Ω, and the number of cycles at that point was recorded as the number of cycles to fracture.

Table 2 Fatigue Test Conditions

Control Waveform:	Triangular wave
Minimum Stroke:	0 mm
Maximum Stroke:	4 mm
Test Speed:	0.5 mm/s
Distance between Supports:	90 mm
Indenter/Support:	R3
Test Termination Condition:	When 100 Ω was reached

■ Test Results

The number of cycles to failure is shown in Table 3. The control waveform is shown in Fig. 4, and Fig. 5 shows the test force-stroke relationship. They indicate that the tests using the triangular waveform were effective. Fig. 6 shows the relationship between the number of cycles and the continuity resistance. Under repeated bending loads, the resistance gradually increased. After showing a sharp rise at around 4,500 cycles, it reached 100 Ω. This indicates that the resistance increased as damage to the solder joint progressed due to cyclic loading, with the joint eventually becoming non-conducting. Also, Fig. 7 shows the time, stroke, and continuity resistance value for each cycle. No change in resistance was observed during the pressing action in the 10th cycle, whereas an increase in resistance was observed during the pressing action in the 4,500th cycle.

Table 3 Number of Cycles to Failure in the Soldered Joint

Number of Cycles to Failure (Cycles)	:	4798

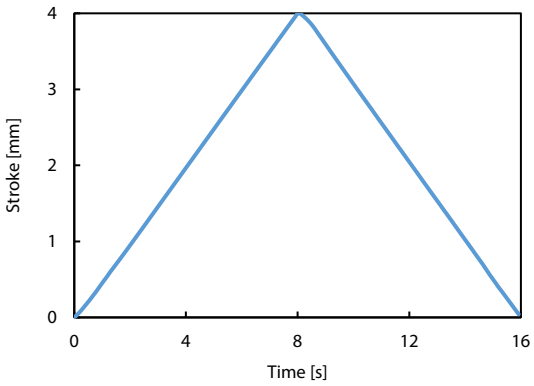

Fig. 4 Control Waveform

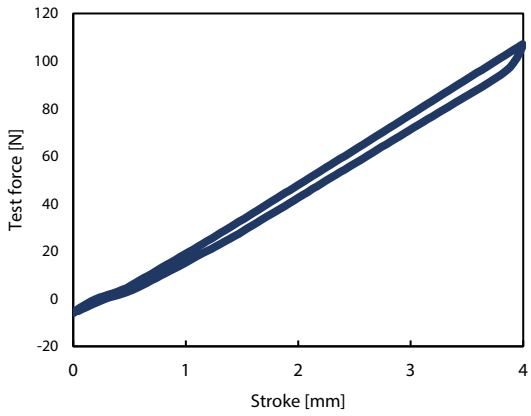

Fig. 5 Test Force - Stroke Diagram

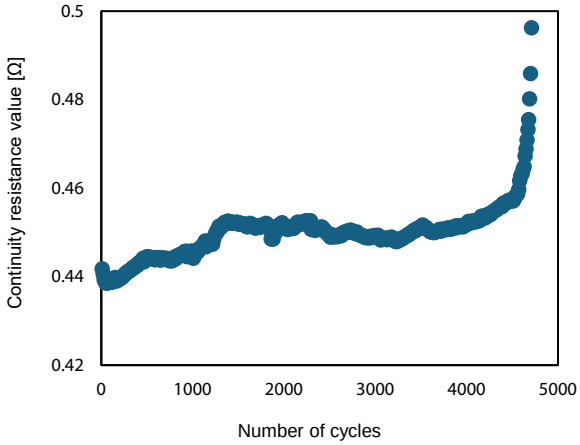

Fig. 6 Relationship Between Continuity Resistance and Number of Cycles

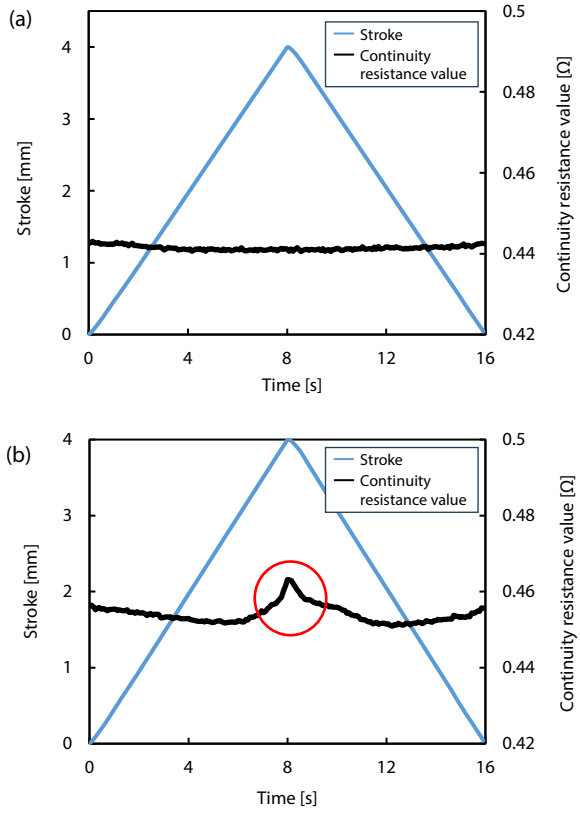

Fig. 7 Time - Stroke - Continuity Resistance Relationships
(a) 10th cycle, (b) 4,500th cycle

■ Conclusion

This article describes a cyclic bend test on a printed circuit board in which the continuity resistance was continuously measured. It was conducted with reference to JEITA ET-7409/105A and JIS C 62137-1-4 using the Microservo MMT electromagnetic force micro testing system and a resistance measurement unit. The test confirmed that the continuity resistance gradually increased with the application of cyclic bending loads, and it showed a sharp rise immediately before fracture. In the latter stages of the test, changes in continuity resistance were also observed that corresponded to the applied indentation force.

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