Some Observations on the Role of Component Size in Solder Joint Degradation under Thermal Cycling Environments

A paper for consideration for presentation at the International Intersociety Electronic Packaging Conference, March 26-30, 1995, at the Westin Maui, Lahaina, Hawaii.

by
J.W. Winslow
JPL/Caltech
Pasadena, CA

Experimental results will be presented from a continuing investigation into the influence of component size and configuration on thermal cycling lifetimes, in a set of quadpak electronic component packages. Observed data will be presented from three sizes of Leadless Chip Carriers (LCCs) and from one size of j-leaded components.

Results to date display qualitative agreement with the generally expected inverse relationship between cycles to joint failure and size of the component, for large components (68 pin quadpaks) and for intermediate sized components (28 pin quadpaks). The number of cycles to failure for the large quadpaks is approximately 1/7 of its counterpart for the 28 pin quadpaks, which have a size ratio of 2.4. However, the cycles to failure for 20 pin quadpaks are indistinguishable from those of the 28-pin quadpaks, despite the factor of 1.4 between their dimensions.

The experimental investigation subjected samples of test articles to the same thermal cycle, namely (1) starting from room temperature and cooling to a minimum temperature of -55 °C, at a ramp rate of about ? °C per minute, (2) followed by a low temperature dwell at -55 °C for about 30 minutes, (3) followed by heating at the ramp rate of about 2 °C per minute to a maximum temperature of 100 °C, (4) followed by a high temperature dwell at 100 °C for about 30 minutes, and then (5) finishing with a cooling to room temperature, again at a ramp rate of about 2 °C per minute. Allowing for the thermal lag of the test articles behind our ovens of about 15 minutes on each leg, this resulted in a thermal cycle of period 246 minutes, allowing ample time for creep.

The first sample consisted of 30 specimens of 86-pin quadpak LCCs. These dummy packages had corner lead pads separated by approximately 33 mm between pad centers (diagonally). Specimens were reflow soldered to footprints on G1 O PWBs. No conformal coating was applied to these specimens.

Package leads of each specimen were partially daisy-chained. Failure was defined by loss of electrical continuity along the daisy chain of the specimen. Failure statistics are shown by the Weibull plots of Fig. 1.

The second sample consisted of 31 specimens of 28-pin quadpak LCCs. These dummy packages had corner lead pads separated by approximately 14 mm between pad centers (diagonally). Specimens were reflow soldered to footprints on G1 O PWBs. No conformal coating was applied to these specimens.

Package leads of each specimen were partially daisy -chained. Failure was defined by loss of electrical continuity along the daisy chain of the specimen. The 68 pin packages are approximately 2.36 times the size of the 28-pin packages. Failure statistics for the 28-pin quadpak LCCs are shown also in the Weibull plots of Fig. 1.

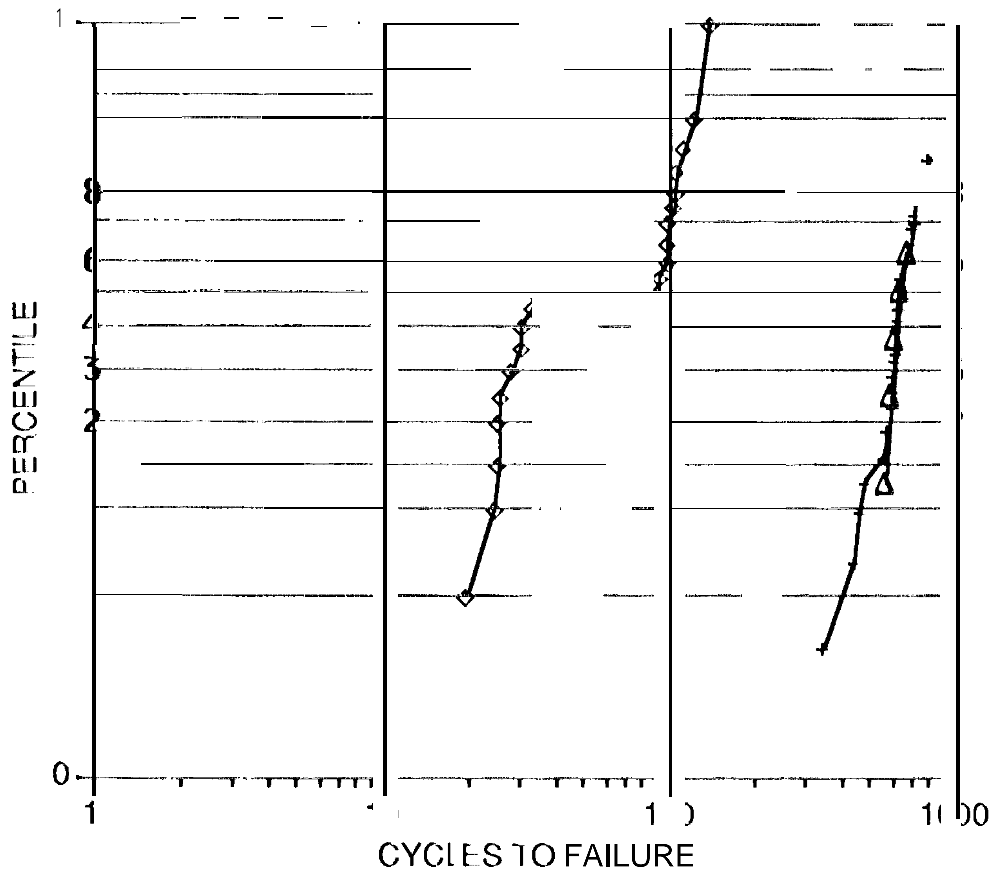
The third sample consisted of 8 specimens of 20-pin quadpak LCCS. These dummy packages had corner lead pads separated by approximately 10 mm between pad centers (diagonally). Specimens were reflow soldered to footprints on G1 O PWBs. No conformal coating was applied to these specimens.

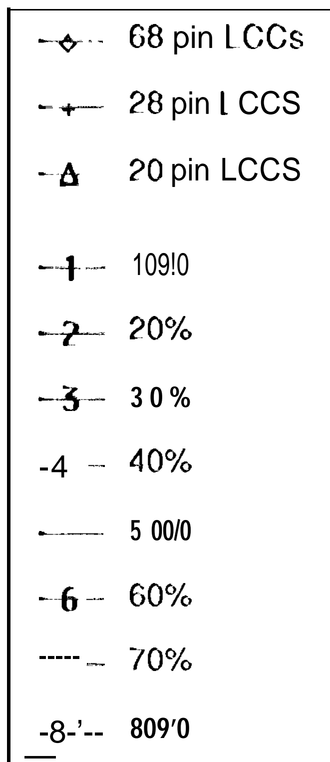
Package leads of each specimen were partially daisy -chained. Failure was defined by loss of electrical continuity along the daisy chain of the specimen, The 28-pin packages are larger than the 2(I pin packages by a factor of about 1.4 times. Failure statistics for the 20-pin quadpak LCCS also are shown in the Weibull plots of Fig. 1. It will be noted that the Weibull plot for the 20-pin 1 CCS is indistinguishable from that for the 28-pin specimens.

The fourth sample consisted of 36 specimens of 68-pin j-leaded dummy packages. These dummy packages had corner lead pads separated by approximately 33 mm between pad centers (diagonally). Specimens were reflow soldered to footprints on G1O PWBs. No conformal coating was applied to these specimens.

Package leads of each specimen were partially daisy-chained. Failure was defined by loss of electrical continuity along the daisy chain of the specimen.

At this writing, this sample has survived 197 thermal cycles, with only one failure. It would appear that the thermal cycling lifetimes will be somewhat longer than for the 68-pin LCC sample, but not so long as for the 28-pin LCCs.


PERCENTILE
CYCLES TO FAILURE
1
10
100
1000
0
1


68 pin LCCs
28 pin LCCS
20 pin LCCS
10%
20%
30%
40%
50%
60%
70%
80%