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A publication of the National Electronics Manufacturing Center of Excellence December 2008

Guest Feature: Hesse & Knipps

Process Integrated Quality Control Improves Wire Bonding Reliability

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In This Issue

Traditional methods of monitoring wire bond quality employed during semiconductor IC packaging operations, such as non-destructive pull tests, optical inspection and wire deformation monitoring, fail to find 100% of all possible failure modes of an electronic device. As a result, field failures may occur, resulting in costly recalls. To answer the industry's demand for zero failure rates, quality control (QC) systems must go beyond monitoring wire deformation and current characteristics to ensure good bond quality. A variety of signals must be monitored in parallel to ensure different aspects of the bond meet quality standards.

A new multi-dimensional process integrated quality control (PiQC) system introduced this year from Hesse & Knipps does just that - it monitors a host of the most applicable and significant measures of feedback from the bond process in parallel, achieving 100% quality control. Implemented at the back-end of semiconductor assembly during wire bonding, PiQC utilizes a transducer-integrated sensor and an ultrasonic generator to record all relevant signals for a wire bonding process including wedge tip mechanical oscillation, friction, resonance frequency as well as the wire deformation and ultrasonic current.

Figure 5-1: The Hesse & Knipps Bondjet BJ820.

A sensor added to the transducer provides relevant feedback data for calculating a bond quality value. Because the sensor provides a signal very sensitive to the process acting on the bonding tool tip, this feedback can detect abnormal characteristics typically not obvious during wire bonding that can result in bond failures.

With PiQC, real-time signal feedback for friction and wedge tip mechanical oscillation is mathematically derived, and, along with additional information from the ultrasonic generator, provides indicators for surface contamination. PiQC is the first QC method that enables conclusions about substrate surface conditions.

Unlike other process quality control methods, PiQC acquires data during the bond process without interrupting machine operations or deterring throughput. Recorded in real-time, values are statistically analyzed based on a newly developed mathematical decision model. The tests, themselves, are never based on statistical assumptions. Control algorithms are implemented in a very high-speed integrated circuit hardware description language (VHDL). PiQC allows derivation of extensive quality statements, with signal feedback and processing that allows detailed analysis of the welding process and translation

into a quasi-optimized reference process.

It also calculates a quality index for each bond based on process feedback signals. A quality index value from 0 to 100% is calculated based on multiple input signals compared to multiple reference curves. First, an individual quality index is calculated for each signal, which are then combined to result in an overall quality index. The individual quality indices are obtained by comparing the actual signal characteristic with a reference characteristic learned by the system in a preliminary automated procedure.

During implementation, PiQC learns to recognize deviations in real-time for operator interpretation. The user can put an emphasis on certain individual quality indices or adjust the sensitivity of certain signals in order to tune the system to best detect specific failure modes and react faster on problems with incoming material, contamination, insufficient clamping or other process variables. Without the PiQC system, these problems typically can only be detected after destructive statistical testing that is not conducted in real-time.
Offering a myriad of advanced data acquisition and processing capabilities, PiQC offers superior quality control over the wire bonding process. The user is presented with a maximum of relevant information to ensure optimized process control. Once implemented, existing mechanical non-destructive tests may become obsolete, or can be used on selected conspicuous bonds only, which are indicated by a low quality index from the PiQC test. PiQC is also less time consuming as it acquires data during the bond process. This allows a throughput neutral 100% quality control.

For additional information on this article or to schedule a demonstration at the EMPF of the Bondjet BJ820 featuring the PiQC, contact Ken Friedman, 610-362-1200 extension 279 or via email at kfriedman@aciusa.org.