

## IST History,

Interconnect Stress Testing (IST) technology was originally developed from the electrical stress testing concept called "power cycling", developed by Rama Munikoti (et. al.) at Northern Telecom (Nortel) in the mid 80's. The present IST developers were also working at Nortel, with the responsibility of developing various test vehicles, with known good and bad levels of plated through hole (PTH) quality. The different quality conditions were used to support the determination of the viability for the power cycling concept.

The initial results showed great promise and a white paper was written to discuss the results. In 1989, we left Nortel and joined Digital Equipment Corporation of Canada (DEC), and soon after established a joint R&D program between Nortel and DEC. Our intentions were to duplicate the same capability at DEC, to establish the repeatability and reproducibility of the power cycling methodology. The results identified lower than expected/acceptable correlation. Nortel elected to discontinue further R&D funding, and DEC "went it alone", to understand how to achieve excellent repeatability and correlation with industry standard test methods (Air to Air thermal cycling).

During the early 90's, DEC developed new principles and a new name (IST), new coupon designs, and totally automated the IST test method. Our internal motivations were to develop a faster, cheaper, more repeatable accelerated stress test method to quantify the integrity of our VAX 9000 backplanes, produced at one of our internal PWB facilities. The VAX9000 was the DEC entry into the super computer market, and measured 48" x 36", 24 layers, .250" thick, with blind and buried vias, with a nickel/gold finish over the total board surface. We were mounting 16 MCM's, which required 68 separable interconnect flex on the surface of each backplane. IST was developed as the tool to characterize the manufacturing process and quantify the integrity of the total PTH interconnect.

We started working with IPC in 1992, and have been involved with various round robin test plans to determine the correlation of our test methods to thermal ovens and liquid to liquid testing (basically a repeat of the IPC-TR-579). In addition to IST, other new technologies including 2 similar electrical stress test methods and an accelerated fluidized sand bath method were compared.

In the interim IST was made available to the PWB industry through a testing service. Customers would submit products to the DEC failure analysis labs. IST was completed, in conjunction with Mil Std Thermal cycling. Excellent correlation was achieved and identical failure modes and mechanisms were found between the different methods.

In 1994, new IST principles were developed to establish the capability to detect inner-layer to PTH barrel (post) separations. Working with the PWB industry and various chemical suppliers, we were able to re-create numerous types and levels of post separations within the interconnect. IST was able to consistently detect the separations and achieved a .98+ correlation coefficient with microsection analysis.

The IST system electrically stresses and monitors both the PTH and post interconnects independently, creating 2 "dimensions" of failure. The system clearly identifies whether the PTH or the post interconnect are degrading as individual failure mechanisms, or whether there are interactions between the different failure mechanisms.

We have received extensive interest for this capability, generally related to evaluating the integrity of direct metallizations when compared to traditional electroless coppers. We completed a study that compared the performance of 25 different metallizations using both IST testing and microsection analysis (completed by Robisan Labs). The results showed excellent correlation between the two methods, a white paper is included as an attachment (and was partially described in the January/97 issue of Circuitree).

The requirement for our testing service has concentrated on the performance of plated PTH interconnect and the detection of foil cracking or post separations, at the PWB manufacturing base. An increased number of PWB manufacturers and customers are experiencing various degrees of interconnect quality issues like post separations in their products. The defects range from fine line separations to "gross" separations, the gross levels are being uncovered during the assembly operations, where they are measured as intermittent opens. We are involved with many companies throughout the industry, that are working to troubleshoot the problem at the vendor base, we supply immediate feedback that determines the manufacturers ability to turn

the problem on and off.

The PWB manufacturers are frustrated with the traditional microsection analysis method because of the randomness and inconsistency of their test results. IST is supplying timely information that not only determines the presence of interconnect quality issues, but also determines the severity of the problem.

In 1996, we received approval from the IPC as an official test method. The methodology is designed to replace/support traditional accelerated stress testing and microsection analysis. The methodology will be released in the next version of the IPC TM-650 test methods manual.

Our most recent activities include working with the Aerospace, Avionics, and Automotive industries to correlate with their 1000 hour (-65C - +125C) thermal cycling test. Multiple studies have been completed on chemical and material DOE's. A copy of a recent IPC Expo presentation by Delco Electronics is included as an attachment. IST technology is also becoming established as the preferred method for quantifying the integrity of microvias (our test vehicle measures 3" x 0.5" and contains 2,000 microvias).

There has been a strong demand from companies that are required to meet extensive long term reliability testing, they are using our service as a prescreening tool, to determine their ability to pass the extended tests. Our testing requires 1 day to give assurances of passing the 1000 hour (41 days) test.

Using IST as an electrical test delivers a capability to remove the human factor from the decision making process of product acceptance or rejection. The test rapidly quantifies whether any "flaw" within the interconnect has a detrimental impact on the total interconnect integrity. We are starting to understand the "hierarchy of failure", the test method will demonstrate which are dominant and which are latent failure mechanisms.

In 1996 PWB Interconnect Solutions Inc. received the exclusive licensing rights for IST Technology, from DEC. Our company portfolio includes selling IST systems, IST test services, failure analysis and consulting to the PWB Industry. The technology is now being deployed to multiple PWB

manufacturers and users across North America and Europe, at this time Viasystems has purchased 3 systems, Merix Corporation has purchased 1 system, Electrochemicals has purchased 1 system, Hewlett Packard (Germany) will receive delivery shortly. We have sent several quotations to mid and large size independent PWB manufacturers, Chemical and Material suppliers, and also received strong interest from the larger corporations that are dependent on their external PWB supply base.

The majority of our business is related to our IST test services, we have customers from all segments of the industry. The service activity usually works with some or all of the following activities:

1. Discussions on specifically what is to be achieved through the testing services, i.e. process characterization, material/chemistry evaluations, process monitoring, trouble-shooting, correlation studies, reliability studies, etc.
2. Establishing the test vehicle design attributes, this is a critical stage, to ensure that we include or re-create the products conditions, that are needed to be quantified.
3. Select or design (if not already available) test vehicle.
4. Release test vehicle design file to customer.
5. Work with PWB vendor to ensure coupons are produced correctly, to deliver the maximum return of information.
6. Construct test vehicles.

Send coupons to IST test lab, for accelerated stress testing and failure analysis, generate test report with references to baseline data, conclusions/ recommendations.

The service side of the business is an excellent, cost effective introduction to the technology, the customer has the opportunity to use the technology without capital investment. Once the customer has utilized the services, they have an ability to determine the ROI, and justify the potential future purchase of an IST system.

Our primary customer base is in North America, although we have completed testing services for both European and Far East customers, the logistics of sending coupons is made easy by using the international courier services (Fed-Ex etc.). Most of our communications are completed through email.

We are presently expanding the service business, to include independent PWB test companies, we have received strong interest from several of the recognized test houses (Trace labs, Delsen Labs, Mircotek Labs and Robisan Labs), who have offered to deliver a complete IST testing service, including full failure analysis capability.

We have initiated an IST user group, that will compile a data base of information on product reliability/performance. This information can be used to establish whether existing standards (usually visual) are effective at specifying realistic acceptance/rejection criteria, with regard to the "total" performance of the interconnect.