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Solid State Drive End to End Reliability Prediction, Characterization and Control

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Abstract : A flaw or drift from expected operational performance in one component (NAND, PMIC, controller, DRAM, etc.) may affect the reliability of the entire Solid State Drive (SSD) system. Therefore, it is important to ensure the required quality of each individual component through qualification testing specified using standards or user requirements. Qualification testing is time-consuming and comes at a substantial cost for product manufacturers. A highly technical team, from all the eminent stakeholders is embarking on reliability prediction from beginning of new product development, identify critical to reliability parameters, perform full-blown characterization to embed margin into product reliability and establish control to ensure the product reliability is sustainable in the mass production. The paper will discuss a comprehensive development framework, comprehending SSD end to end from design to assembly, in-line inspection, in-line testing and will be able to predict and to validate the product reliability at the early stage of new product development. During the design stage, the SSD will go through intense reliability margin investigation with focus on assembly process attributes, process equipment control, in-process metrology and also comprehending forward looking product roadmap. Once these pillars are completed, the next step is to perform process characterization and build up reliability prediction modeling. Next, for the design validation process, the reliability prediction specifically solder joint simulator will be established. The SSD will be stratified into Non-Operating and Operating tests with focus on solder joint reliability and connectivity/component latent failures by prevention through design intervention and containment through Temperature Cycle Test (TCT). Some of the SSDs will be subjected to the physical solder joint analysis called Dye and Pry (DP) and Cross Section analysis. The result will be feedbacked to the simulation team for any corrective actions required to further improve the design. Once the SSD is validated and is proven working, it will be subjected to implementation of the monitor phase whereby Design for Assembly (DFA) rules will be updated. At this stage, the design change, process and equipment parameters are in control. Predictable product reliability at early product development will enable on-time sample qualification delivery to customer and will optimize product development validation, effective development resource and will avoid forced late investment to bandage the end-of-life product failures. Understanding the critical to reliability parameters earlier will allow focus on increasing the product margin that will increase customer confidence to product reliability.

Keywords : e2e reliability prediction, SSD, TCT, solder joint reliability, NUDD, connectivity issues, qualifications, characterization and control
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