Quality by Design

Billions of Freescale products power and connect lives across the globe. From product concept to customer ship, our quality system helps ensure that every solution is safe, cost-effective and reliable.
Quality Policy

At Freescale we are committed to being the finest semiconductor company in the world by providing the highest levels of product quality, delivery and service, as viewed through the eyes of our customers. Freescale is passionate in our relentless pursuit of total customer loyalty by instilling a global high quality culture through the Freescale Way that results in manufacturing excellence and flawless new products.
Quality Pledge

• To see the world through the eyes of the customer with a focus on protecting them from defects

• To shift the paradigm from defect detection and correction to a defect prevention methodology

• To use NPI qualification as validation that quality and reliability have been designed into new products

• To drive continuous improvement in everything we do

• To drive a quality culture through the Freescale Way where all employees believe they own quality

Garic Power
Vice President, Quality
August 2014
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Quality Management, Organization, Responsibilities and Information Systems

Quality Management

Customer expectations drive Freescale Quality. Our management programs and processes are designed to ensure customer satisfaction in every aspect of our relationship. Freescale’s quality leadership team has developed “Freescale Way”, which defines our guiding philosophy for quality strategy, goals and new quality program initiatives. Quality review meetings are held regularly and are chaired by the CEO with the participation of his direct reporting staff and led by the VP of Quality. At these reviews, the CEO reviews key quality results, customer feedback reports and trends, and the status of quality improvement initiatives. These reviews enable the CEO to continually adjust corporate strategy and resources to stay on target to our customer’s needs and expectations.

The Freescale Way

The “Freescale Way”, a corporate-wide continuous improvement effort focused on problem solving and providing the highest level of quality every step of the way. Every problem represents a challenge to quality, and every employee should be engaged in quality improvement. The “Freescale Way” focus is on problem elimination, not reduction, by putting an emphasis on understanding top problems, so that our corrective actions are targeted and efficient. Focus is placed on employee development to teach our team members to be good problem solvers and our managers to be good mentors and coaches. Everyone is empowered in the Freescale Way with an expectation of 100% participation at every level to look for ways to improve the quality of our work and workplace.

Quality Information Systems

Freescale has developed online quality tools and processes to support both operational and customer requirements. They are accessed through our internal “Quality Portal” website. The Quality Portal is the Freescale “homepage” for critical business functions such as, Global PCN, FMEA database, Change Action Boards (CAB), Customer Failure Analysis requests, internal 8D reports, and many other processes which support our Quality Management System. The system enables extensive reporting and data mining capabilities.

Freescale Way Creates an Organization That...

| … has leaders who coach and mentor their employees | Employee Development |
| … has clear, documented standards for the work we do and checks to ensure the standards can be and are followed | Standardized Work and Standardized Work Checks |
| … enables every person to detect problems and drive to closure | Self Diagnosis |
| … hears and acts upon employee ideas at the point of activity | Employee Suggestions |
| … enables every individual to identify problems and develop root cause solutions within their work area | QC Circles |
| … follows systematic, standard problem solving processes focused on root cause identification and elimination | Root Cause Problem Solving |
| … leads the culture by participation and example | Program Management |
Quality Roles and Responsibilities

The Freescale Quality team is a worldwide organization that leads customer-critical functions within the corporation. The responsibilities for these core quality functions include:

- Customer Quality: Drives identification of the root cause of quality issues and execution of product quality improvements through preventive or corrective actions.
- External Quality: Interfaces with final manufacturing subcontractors and foundries for quality-related tasks, audits and incidents. This is the primary quality interface for outsourced products.
- Failure Analysis Lab: Performs electrical and physical product analysis to support new product development, customer issue resolution and manufacturing effectiveness improvements. Provides an expert voice in new product development teams.
- Field Quality: Interfaces with customers for quality-related tasks, audits and incidents and collects and summarizes customer quality data to drive improvement within Freescale.
- Manufacturing Quality: Provides support and the voice of the customer for internal manufacturing sites regarding change management, discrepant material and product qualifications. Overviews and performs quality audit activities, provides expert knowledge with quality tools and methods and helps to ensure quality of manufactured products.
- New Product Introduction (NPI) Quality: Drives quality into product development activities and helps to ensure that new product releases meet customer and standards requirements. These activities focus on the quality and reliability of new products, qualifies new materials and new products and performs reliability engineering for all NPI qualification definitions and new product qualifications.
- Quality Standards and Bodies: Voices Freescale’s position and interests within industry standard bodies such as IEC and JEDEC; Communicates within Freescale industry standard trends and changes (planned or actual).
- Quality Systems: Manages Freescale quality rules, process structure and documents. Coordinates internal and certification audits. Leads continuous improvement activities. Helps to ensure that customer-specific requirements are available and understood.
- Reliability Lab: Operates life and environmental stress labs used to validate long-term reliability of Freescale products.
- Software Quality: Drives quality into software development activities and helps to ensure that new software releases meet customer and standards requirements.
- Supplier Quality: Interfaces with suppliers for Quality related tasks, audits and incidents. Drives supplier quality improvements and handles supplier audits, data collection and analysis and quality related items, including issues and changes.
Quality Certifications

Raising the Standards

System certifications are important to our business. We have a long history of quality system improvement and verify the effectiveness and health of our system on a regular basis according to global standards. We’re proud of our certifications, developed by the International Organization for Standardization (ISO), whose standards contribute to improving the development, manufacturing and supply of products and services worldwide. By adopting and adhering to these standards, we raise the levels of quality, safety, reliability, efficiency and adaptability in our products.

Global Impact

Freescale is certified to ISO 9001. Manufacturing operations, automotive business units and support processes are additionally certified to ISO/TS 16949; this technical specification aligns existing U.S., German, French and Italian automotive quality system standards within the global automotive industry.

The Quality Certifications may be viewed at: http://www.freescale.com/webapp/sps/site/overview.jsp?code=QUALITY_CERT

Freescale sites around the world operate under a common EHS management systems framework. All manufacturing sites are registered to ISO 14001, the international standard for environmental management systems, and OHSAS 18001, the Occupational Health and Safety Assessment Series standard for health and safety management systems. These are maintained through an enterprise certification issued by Lloyd’s Registrar Quality Assurance (LRQA).

You can view the entire section at: http://www.freescale.com/webapp/sps/site/overview.jsp?code=EHS_POLICY_MS

Certifications include:

- ISO 9001-2008
- ATMC (Ed Bluestein) Fab
- Oak Hill Fab
- Chandler Fab
- Kuala Lumpur Final Manufacturing
- Tianjin Final Manufacturing
**Process Reliability**

**Employing a Process Certification Strategy**

Freescale considers customer requirements for reliability, cost and schedule a top priority. That’s why we use a process certification strategy to build reliability throughout our product development cycle. Our process certification process directly aligns with our new product introduction process so that quality can be assessed and optimized in each stage of the development cycle. Product reliability can either be screened in after a product has been manufactured or built in from the beginning. A screened approach is not optimal, as there is little reliability input included in the early concept and design phases of the product development cycle. With this screened approach, reliability resources must be focused on the reliability characterization just before the product is shipped and any reliability issues can only be addressed with additional burn-in or other screens at the end of the product development cycle. Freescale has found that building in reliability from the start reduces reliability risks and resources. Reliability expectations are defined during the product concept phase and are used to drive reliability into the design phase of the product development cycle. Reliability testing is focused on early learning to identify important failure modes and to drive reliability improvements during that each phase of the product development cycle. Using this approach, the risk of product qualification is reduced and requires fewer resources to verify reliability that has already been built in. By building in reliability, we have a clear understanding of reliability risks before products are introduced to customers, and we can better address any issues.

**Reliability**

**Screen in Reliability**
- Definition
- Develop Fab/Package Process/Design Layout Rules
- DRC and Simulations (Optional)
- Wearout Characterization/Packaging Interaction
- High Risk Qualification/Characterization/Data Sheet/ATE Developed/Subcontractor Qual

**Design in Reliability**
- Process/Package Definition
- Wearout Characterization
- Design Layout Rules
- Risk Assessment
- DRC Violation Reviews
- Simulation Results
- Product Characterization
- Subcontractor Qual
- Production ATE
- Final Data Sheet
- Apps Checkout

Energy (E) = The focus of resources
Integrating Reliability into New Products

Freescale uses a phased process to manage new technology introduction. Technical and business goals are assessed before moving to a new phase in development. These phase gates also include specific and detailed reliability criteria. The reliability risks for new technology implementation are reduced as the technology progresses through the development cycle. Thus, the reliability risks for a new product can be assessed from the maturity of the underlying technologies. These are real measurements of risk characterized throughout the development cycle and applied to specific product applications.

Reliability First and Foremost

Reliability certification is used to demonstrate the reliability of a technology even before the first product is built. Before a product enters the design phase, we use test vehicles to try out critical library elements and bit cell designs. Reliability stresses are performed on these test vehicles, and failures are fully analyzed using the same criteria as actual product. This allows us to gather information and to identify key reliability issues that must be addressed for product qualification. Precertification uses a subset of full reliability stresses to assess risks even earlier in the technology development cycle. We also employ models based on technology maturity and product parameters to determine the manufacturing, test and burn-in conditions that will be required to meet reliability requirements for a specific product. By using rigorous criteria for process certification, and aligning design and manufacturing maturity, we ensure that our reliability learning applies directly to our customers’ product reliability. Building in reliability allows us to better understand reliability expectations and to appropriately define test vehicles and stress criteria for process.

New Product Introduction Milestones

Milestone 0: Specification Defined
Market Analysis, Concept and Feasability

Milestone 1: Ready for Design
Process and Design Development

Milestone 2: Ready for Prototype
Process and Design Solidification, Certification

Milestone 3: Technology Certified
Certification, Prepare for Production

Milestone 4: Ready for Product
Ready for Full Production

Production Ramp

Lower Risk, Big Gains

Building in reliability also creates a substantial database of findings that can be applied to many products. After product qualification, test results are fed back into our reliability models to refine them. Each subsequent qualification then builds upon the learning of previous certifications and qualifications. We continually update our reliability processes and techniques to more accurately quantify reliability risks and improve product reliability early in development. The end result is a reliability verification that is simpler, more cost-effective and better focused on customer satisfaction.
Product Qualification

Reliability is the probability that a product (e.g., semiconductor device) will perform its specified function in a given environment for a specified period of time. At Freescale, we are not only focused on quality as our products leave our doors, but are also concerned about product reliability as our products are used in specific environments over time.

Application Based Qualification

Requirements for product qualification are based on application operating conditions (speed, power, temperature, field lifetime, duty cycle, etc.). To assess product reliability over a range of product applications, we identify field life expectations, and set test conditions to simulate typical use conditions for the most stringent application. Tiers are defined for standard life (~5 years application life), long life (~10 years application life) and automotive (~10-20 years application life) applications, based on industry standards set by the Joint Electron Device Engineering Council (JEDEC).

Automotive products must also meet the requirements set by the Automotive Electronics Council. In response to specific customer requests, custom reliability requirements may also be considered.

Put to the Test

Semiconductor failure rates, based on the standards previously mentioned follow a bathtub curve with an initially decreasing failure rate followed by a long, low-level failure rate and then eventual wear out. We perform stresses to characterize each part of this curve. Test and burn-in are used to screen infant mortality (or early product failures), and thus, reduce the early failure rate. Extended life tests and intrinsic reliability are performed to verify the start of wear out.

To simulate application life in a reasonable amount of time, the industry uses accelerated reliability testing. During accelerated tests, elevated stress conditions such as voltage and temperature are used to produce, in a shorter period of time, the same failure mechanisms as would be observed under normal use conditions. The objective is to identify failure mechanisms and eliminate them as a cause of failure during the useful lifetime of a product (such as those described in JEP122, a JEDEC standards publication).

Freescale product reliability rests on a strong foundation of proven validation principles. Our prequalification efforts including designing, modeling, testing and test vehicle investigations drive low-risk manufacturing processes. We use industry standard testing to help ensure our customers have reliable products optimal for their specific application.

Typical Freescale accelerated stress tests performed during product qualification are shown in the tables and are based on JEDEC standard JESD22 methods specified in JESD47, another JEDEC standards publication.

Product Failure Behavior

![Bathtub Curve Diagram]

- **Failure Rate \( \lambda(t) \)**: [#parts/time]
- **Early Life Mortality Failures**:
- **Low-Level, Long-Term Failure Rate**:
- **Parts Wear Out**
- **Time**
With the failure rate of semiconductor devices being inherently low, the industry uses accelerated testing to assess semiconductor reliability. During accelerated tests (such as those described in JEP122, a JEDEC standards publication), elevated stress conditions such as voltage and temperature are used to produce, in a shorter period of time, the same failure mechanisms as would be observed under normal use conditions. The objective is to identify failure mechanisms and eliminate them as a cause of failure during the useful lifetime of a product. Freescale product reliability rests on a strong foundation of proven validation principles. Our prequalification efforts, including designing, modeling, testing and test vehicle investigations, drive low-risk manufacturing processes. We use industry-standard testing to help ensure our customers have reliable products optimal for their specific application. Typical Freescale accelerated stress tests performed during product qualification are shown in the tables and are based on JEDEC standard JESD22 methods specified in JESD47, another JEDEC standards publication.

**Tiered Qualification**

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<th>Typical Use Conditions (Duty Cycle, Temperature)</th>
<th>Product Field Life</th>
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<tr>
<td>Long Life</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td></td>
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</table>

Tiered Qualification
Freescale Stress Test

Freescale performs accelerated stress testing during process certification to identify potential failure mechanisms and eliminate their root causes prior to product development. Stress tests are also performed during qualification of a product to check for potential failure mechanisms associated with integration of product design and process technologies. The following table outlines the major stress tests performed during process and product introduction. Other tests may be required for particular product types.

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<th>General Notes</th>
<th>Qualification Readpoint</th>
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<td>High-Temperature Operating Life Test (HTOL)</td>
<td>JESD22-A108</td>
<td>Acceleration factors are determined per JEP122; typically performed at 125°C</td>
<td>Standard Life 5-year equivalent use time, Long Life 10-year equivalent use time, Automotive 1008 hours (125°C) or 406 hours (150°C)</td>
</tr>
<tr>
<td>Electrostastic Discharge (ESD)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Human Body Model (HBM)</td>
<td>ANSI/ESDA/JEDEC JS-001-2012</td>
<td>Typically characterized at various voltages</td>
<td>Standard Life +/–200V (or classification), Long Life +/–200V (or classification), Automotive +/–200V or MM (or classification)</td>
</tr>
<tr>
<td>Machine Model (MM)</td>
<td>JESD22-A115</td>
<td>Optional test +/–200V (or classification)</td>
<td></td>
</tr>
<tr>
<td>Charged Device Model (CDM)</td>
<td>JESD22-C101</td>
<td>+/–500V (or classification)</td>
<td></td>
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<tr>
<td>Latch-up (LU)</td>
<td>JESD78</td>
<td>Class I for Comm/Ind, Class II for Auto</td>
<td>Standard Life +/–100 mA (or classification), Long Life +/–100 mA (or classification), Automotive +/–100 mA (or classification)</td>
</tr>
<tr>
<td>Preconditioning (PC)</td>
<td>J-STD-020</td>
<td>For surface mount plastic packages only</td>
<td>Performed prior to THB, HAST, T/C and AC</td>
</tr>
<tr>
<td>Temp and Humidity Bias (THB)</td>
<td>JESD22-A101</td>
<td>For surface mount plastic packages only, PC is performed prior to this test</td>
<td>Standard Life 504 hours (or biased HAST), Long Life 1008 hours (or biased HAST), Automotive 1008 hours (or biased HAST)</td>
</tr>
<tr>
<td>Highly Accelerated Stress Testing (HAST)</td>
<td>JESD22-A110</td>
<td>If PC is required, PC is performed prior to this test 48 Hours at 130°C / 132 hours at 110°C (or THB)</td>
<td>Standard Life 200 cycles (-65°C to +150°C) or equivalent cycles at other temps per JESD94, Long Life 500 cycles (-65°C to +150°C) or equivalent cycles at other temps per JESD94, Automotive 500 cycles (-65°C to +150°C) or 1000 cycles (-50°C to +150°C)</td>
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<tr>
<td>Temperature Cycling (T/C)</td>
<td>JESD22-A104</td>
<td>For surface mount plastic packages only, PC is performed prior to this test</td>
<td>Standard Life Optional test 48 hours, Long Life Optional test 96 hours, Automotive 96 hours (or 96 hours unbiased HAST)</td>
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<tr>
<td>Autoclave (AC)</td>
<td>JESD22-A102</td>
<td>For surface mount plastic packages only, PC is performed prior to this test</td>
<td>Standard Life Optional test 504 hours (150°C) or 240 hours (175°C), Long Life Optional test 1008 hours (150°C) or 504 hours (175°C), Automotive 1008 hours (150°C) or 504 hours (175°C)</td>
</tr>
<tr>
<td>High Temperature Storage Life (HTSL)</td>
<td>JESD22-A103</td>
<td>No bias</td>
<td>Standard Life Optional test 504 hours (150°C) or 240 hours (175°C), Long Life Optional test 1008 hours (150°C) or 504 hours (175°C), Automotive 1008 hours (150°C) or 504 hours (175°C)</td>
</tr>
<tr>
<td>Write/Erase Cycling</td>
<td>JESD22-A117</td>
<td>Non-volatile memory only</td>
<td>Standard Life Performed prior to Data Retention Bake, Qualification readpoint determined per data sheet requirement</td>
</tr>
<tr>
<td>Data Retention Bake</td>
<td>JESD22-A117</td>
<td></td>
<td>Standard Life 504 Hours (150°C), Long Life 1008 Hours (150°C), Automotive 1008 Hours (150°C)</td>
</tr>
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</table>
Product Analysis

Detectives in a Nanotech World

Freescale Product Analysis Labs provide the expertise and analytical capabilities necessary to help develop high performance and high quality new products and technologies. Additionally, the labs provide the primary forensic analysis for Freescale's aggressive continuous improvement efforts and for analyzing customer reported issues.

Freescale Product Analysis teams are located throughout the world and have decades of product analysis experience. The rich expertise of the lab staff combined with industry-standard techniques and internally developed tools enable product analysts to locate sub-micron defects among hundreds of millions of transistors on a silicon IC. This formula is instrumental in providing an accurate understanding of a failure's root cause, which enables rapid corrective action and prevents similar defects moving forward.

The product analysis flow employs the following six steps:

Step 1: Reproducing the Failure

One of the first steps required to determine the root cause is to reproduce the IC's failure mode in a laboratory environment. Product analysts use evaluation boards, digital testers and other tools for this critical step. Special care, such as the use of ESD protection, is taken during this step and throughout the product analysis flow to help ensure that new defects are not introduced during the analysis process.

Step 2: Package Analysis

The IC package is carefully inspected to determine if the physical defect is associated with the package that surrounds the die. The product analyst can employ an array of package analysis tools and techniques, such as optical inspection, scanning acoustic microscopy or X-ray. If the defect is found to be located in the package, a package analyst will carefully isolate and characterize it using techniques described below.

Step 3: Defect Spatial Localization

If there is no defect in the package, the analysis moves on to the silicon IC itself. The product analysts use advanced localization techniques to identify a subset of transistors that may explain the observed failure mode. The device package is first carefully removed to expose the silicon die. Localization techniques are then employed to narrow down the area within the die that may contain the defect causing the observed failure mode. The tools available for this step range from equipments that can detect visible and infrared lights to software developed by Freescale for product analysis. The key commonality of the localization tools and techniques is the ability to narrow down the area of interest in a non-destructive manner. Light emission microscopy, thermal detection techniques, and diagnostic fault simulation are just a few of the techniques available to an analyst for defect spatial localization.

Step 4: Advanced Electrical Analysis

Once a small area within the IC has been identified, advanced analytical techniques are employed to pinpoint the individual transistor or component that may be causing the observed failure mode. Typically, a product analyst starts with non-destructive techniques, such as micro-probing, to further reduce the number of potentially defective components. Destructive techniques, such as atomic force probing, might be used subsequently to identify the single component that is causing the observed failure mode and to characterize the defective component electrically. If the defective area has been isolated to the device package, then a package analyst probes between the package layers to further pinpoint the component that is causing the observed failure mode. The analyst starts by probing the top two package layers. If a defective signal is not detected, then the analyst removes the top layer that was just probed and proceeds to probe the next two package layers. This iterative process is performed until a defective signal is found.
Step 5: Physical Analysis

The goal of physical analysis is to identify the physical defect that correlates, without ambiguity, to the electrical signature of the failing component. A variety of physical analysis techniques are available for this step. A common physical analysis technique is to selectively remove each layer of the integrated circuit or package layer followed by inspection with an electron or optical microscope. Cross-sectioning is another common technique typically employed when the defect is located between two layers. When physical and spatial characteristics of the defect are not sufficient, material analysis can be used to gather more information. Energy dispersive spectroscopy (EDS) and transmission electron microscopy (TEM) are two examples of material analysis techniques available in Freescale Product Analysis Labs.

Step 6: Documenting the Analysis

The product analysts will use the results from both the electrical analysis and the physical analysis to arrive at a coherent failure mechanism that explains the observed failure mode. Once the analysts reach a conclusion, the failure root cause along with the analysis process steps are documented in a report. The report is then forwarded to the appropriate groups outside the product analysis team, such as product engineering, manufacturing engineering, assembly, test engineering or design engineering, so that corrective action can be rapidly implemented.

Summary

Freescale Product Analysis Labs play a critical role in the journey to zero defects. The Product Analysis teams use their analysis experience, industry standards and internally developed tools and techniques to identify a physical defect that clearly explains the observed failure mode in an integrated circuit or in the package that surrounds the IC device. The analysis steps, results and conclusion are communicated to the appropriate groups within Freescale for quick implementation of a solution that will eliminate the cause of the failure. Freescale Product Analysis Labs also work closely with research and development teams to create the next generation of products that meet customers’ needs and exceeds quality expectations. By identifying potential problems early in the product development phase, these labs help accelerate the availability and quality of new products to all Freescale customers.
Continuous Improvement

Continuous improvement is part of what we do every day at Freescale. It is utilized in manufacturing and the business operations to assure that Freescale meets or exceeds our customers’ expectations. Be it a large process re-engineering project or a manufacturing employee realizing that their particular production tool is not running as it should, continuous improvement is part of our culture and everyone’s responsibility. Continuous improvement means constantly adapting. It starts by defining the objective, obtaining data, analyzing it to derive information and making decisions to implement changes. Finally, the changes are evaluated to ensure their effectiveness and controls evaluated to ensure the gains are maintained.

Freescale employs a high level process, AMAG, a proven framework to help organize and assess the importance of various continuous improvement projects and then drive those activities through to a successful completion.

Align | Mobilize | Accelerate | Govern

We employ the following tools in our continuous improvement process:

- Six Sigma
- Fault Tree Analysis
- FMEA
- 3L5Y
- 8D
- Lean production
- Kaizen
- 5S
- VSM
- Internal Audits
- Customer Audits
- Business Process re-engineering
- Customer focused team input
Zero Defects

Building Better Products from Start to Ship

The Zero Defects methodology provides an elevated level of excellence, enabling the highest quality required by Freescale customers. In using it, we ensure that products receive optimum attention to detail in every phase of production, including design, wafer fabrication, assembly and test. As demonstrated in the graphic, our Zero Defects methodology comprises a balanced set of quality processes.

### Manufacturing Continuous Improvement

**Part Average Testing and Statistical Bin Limits**

Statistical methods are applied at both unit probe and at final test. Part average testing (PAT) is a die-level screen that establishes the typical limits of a historical distribution of some of the electrical measures contributing to unit probe and/or final test. Any die that registers an electrical measure outside of a PAT limit is inked out and defined as an outlier. Statistical bin limits (SBL) is a wafer-level screen that employs a statistical method to determine the typical fallout level of each bin at unit probe.

**Outlier Detection**

Along with PAT and SBL, there are other screening methods applied at unit probe in our processes. The good die in bad cluster (GDBC) methodology identifies a working/passing die that may be surrounded by failing die. These good die are then eliminated as a precaution. Wafer fabrication and die final manufacturing statistical process control (SPC) limits identify processes that are out of control so they can be adjusted as necessary. Specification limits are used as the gauge to determine if the product has been manufactured as per the design. An advanced method establishes inline process limits at median +/- 6 Sigma to identify “typical” product. Capability (CpK) studies are regularly performed on various inline processes and class probe (electrical) parameters.

### Product Improvement

**Design for Manufacturing**

Design for manufacturing (DFM) is a design methodology with the aim of optimizing process operating windows in our manufacturing processes and incorporating many modules that address potential manufacturing marginalities and therefore prevent faults materializing. It helps to ensure optimum quality, reliability, cost, time to market and customer satisfaction. DFM builds in quality and incorporates it into the technology Freescale is known for.

**Application/Test Correlation**

This is a systematic effort and methodology to identify, classify and eliminate issues due to application or product test differences. The correlation effort is an iterative process. It involves collaborating with our customers to share application schematics and methods for Freescale to implement testing that mirrors the customer application.
Quality Systems Intelligence Quotient (QSIQ)

The QSIQ portal is a Freescale intranet site and is the official repository for Freescale Quality Systems processes. This is the way a “Process” approach (also called “Business Process Management” or “BPM”) has been adopted and deployed within Freescale.

This portal has been designed to give all Freescale employees access to the Quality Systems processes of the company, as well as to their attributes (applicable documents, requirements, tools, training, data) in a user friendly way.

The QSIQ portal provides any Quality Systems process owner the capability to own, manage and improve their process. This understanding and clarity is essential when facing new initiatives and future challenges, and helps to achieve best-in-class quality for complete customer satisfaction.

The process framework has been designed around standard process categories shown above, such as Metrics, Record Retention, Process Flow, Training. Freescale employee can drill down into each category and find the information needed.
Process Mapping

Each process is mapped using the simple concept described in the figure below. The different arrows have hyperlink capability, which allows linking to the right information, document, data or repository.

The “HOW” symbols correspond to:

- Drilling down to next level (the “arrow”)
- Information that is attached to the activity, including documents or files (the “paper clip”)

Process Flow Example

Other Functionalities

In addition to facilitate process execution, this software solution offers additional capabilities to facilitate process management and improvement. Each QSIQ process is structured in multiple views:

- By process, displaying the standard categories by process
- By employee job function, e.g., I am a Product Engineer—what Quality Systems processes apply to me
- By process task, e.g., I want to initiate a Change Action Board—not to learn the entire CAB process, these are the steps to execute just the initiation
Change Management and Customer Communication

Freescale operates a global change management system documenting changes in business and manufacturing operations and processes. This system is governed by a company-wide specification which drives compliance and control. Each change request is considered individually and the risks associated with its adoption are determined by a change action board (CAB) composed of senior engineers and managers. Formal review and acceptance of the risk analysis, the plans for mitigation of the risks and the criteria proposed for a successful evaluation outcome are required by the board before any material is committed to evaluation. When a material is committed to evaluation, the team will begin to generate the customer communication. Communication with the customer occurs when a change affects form, fit, function or reliability of the affected material. After formal acceptance of the evaluation plans, limited engineering material is used to evaluate the effects of the change and helps to ensure identified risks incorporating the change did not occur. When success criteria are met, the change will be taken to an implementation phase. An implementation review of the results associated with evaluation (qualification) data and the implementation of the change are then undertaken by the CAB. If the change is approved by the CAB, the CAB will determine the appropriate customer notification type (e.g., product change notification, product bulletin, device migration, product discontinuance notification or customer alert), if any, and ensure that the notification is sent. Freescale is committed to communicate to customers any changes which may affect the fit, form, function or reliability of a product through our product change notices (PCNs) 90 days prior to implementation. Our notification emails contain a summary of the change and a Web link to access the complete notification and another to submit a service request which may be used to acquire further information, or obtain clarification or object to the PCN. According to JEDEC Standard JESD46, lack of acknowledgment of the PCN within 30 days will be considered acceptance of change. Access to the full notification is done at a secure site and requires a user ID and password for login.

Supplier Quality Support Model

The Freescale Global Product Change Notification (GPCN) system and CAB system are directly linked, creating a closed-loop change management process. The product or process change cannot be implemented without the notification reaching the effective date, having any service requests addressed and receiving the appropriate customer feedback.

The Freescale GPCN system also includes:

- Access to customer copies and generic copies of distributed notifications at freescale.com for customers
- Ability to track customer acknowledgement

Final completion of all notifications and implementation of the change is followed by a verification step to help ensure no difference in the expected outputs is noted in the first production material before the change is formally closed.

Product Obsolescence Policy: We are also committed to providing notification of product obsolescence and offer a lifetime buy (LTB) opportunity. We allow a minimum of six months, after the notification issue date, for an order to be placed and an additional six months for delivery of the ordered product.
Freescale has deployed a global infrastructure to support customer problem resolution, including field quality engineering, field quality laboratories, customer quality engineering and product centers of excellence in all regions. This infrastructure provides technical support close to the customer location to achieve rapid resolution of problems, and specialist expertise centers where required. Freescale uses systematic problem solving methods to investigate and provide a detailed response (including corrective action) for customer product returns and complaints. The problem resolution process is supported by the customer quality incident (QSIQ) management system, which provides incident status tracking and reporting throughout the overall process flow. The system also provides a complete record of the investigation, including failure analysis, corrective action reports and incident cycle time. Freescale also takes advantage of the capability of the QSIQ system and its built-in data mining capabilities to provide failure rate reports and to drive continuous product quality improvement.

The Supplier Quality Support Model referenced below is a typical Freescale flow that does not necessarily include all possible actions. Freescale reserves the right to traverse the process map in a manner most expedient to resolving a given issue.

### Supplier Quality Support Model

1. Customer notifies Freescale of a quality incident
2. Perform field failure verification (FFV)
3a. Perform field failure analysis in field lab
3b. Perform application correlation exercise
4. Send samples to center of excellence
5a. Perform electrical verification and investigation
6. Perform product analysis
7. Perform problem solving investigation
8. Review findings with customer
9. Close CQI incident

- Problem verified?
- Product analysis?
- Corrective action?

**Field**

**Reception Center**

### CQI System Key Features

- Single world-wide database where all customer product returns or complaints are entered
- Web-based tool using pull-down menus, shortcuts and more
- Tracking through eight distinct phases that incident flows through (depending on nature of the incident)
- Event tracking showing status of the incident in the process
- Storage and facilitation of email reporting of investigation progress
- Storage of corrective action (in 8D format) and failure analysis reports
- Data mining capabilities for analysis and reporting
Product Traceability

Product traceability provides the ability to locate and follow a material’s history from its manufacturing start to the point of shipment. Detailed history of each manufacturing lot is available for product research and containment. Freescale traces each product by manufacturing lot through the wafer fabrication, assembly and test manufacturing processes. At Freescale, traceability data for all products is retained in a central storage/reporting database and is available 24/7. Manufacturing execution systems send a trace signal at each main process step. Multiple types of events are recorded during the product build and shipping. Markings on each unit, called the Marked Trace Code, correspond to Trace Code information stored in the central database, enabling matching of marked materials to their manufacturing lots. Trace data includes location, manufacturing lot, material number, date/time stamps and quantities. Freescale can trace forward, backward and bi-directionally starting from any manufacturing record. Powerful IT tools allow us to initiate traceability for a specific unit using material number, manufacturing lot number, shipping lot number, traceability marking, shipping date intervals, customer information and/or a combination of criteria to further focus results. These tools enable us to quickly identify and contain all impacted material in case of an issue.
Supplier Quality Support

Material suppliers play a vital role in helping Freescale achieve customer zero defect quality expectations. The Supplier Quality team is made up of supplier development and supplier quality engineers, managing over 480 supplier locations worldwide and driving them to proactively meet Freescale’s quality requirements. In partnership with Global Procurement, Freescale’s Supplier Quality team works closely with material suppliers to drive systematic and ongoing product and process capability improvements. This helps to ensure the supply of robust raw materials that enable Freescale to manufacture products with consistent performance, while meeting customer application requirements. By utilizing supplier quality system assessment tools developed to audit to the ISO/TS standards, Freescale deploys a rigorous supplier assessment process to understand supplier capability and drive continuous improvement. At a minimum, Freescale requires the following from our material suppliers:

- ISO9001 Quality Systems Certification with critical material suppliers developed to meet the additional requirements of TS16949
- Absolute conformance to Freescale specification requirements
- Zero supply interruptions
- Minimal changes and required Freescale approval prior to implementation of all changes
- Rapid response to all quality incidents with 24 hours containment and 10 days root cause identification and provide Permanent Corrective Action Plan
- Thorough root cause analysis utilizing 5Why, 8D, FTA and drill deep/drink wide methodologies

Commitment from senior leadership to build a zero defects culture in the organization
Comply with Freescale EPP requirements per 12MWS00047B specification

Supplier Quality Support Model

As a component of our zero defect quality commitment, Freescale is currently deploying a supply quality management (SQM) tool which includes a “ship to control” or “receipt to control” module. SQM requires electronic submittal of Material Supplier’s Certificates of Analysis (CoA). This enables the utilization of statistical process control (SPC) methodologies to automatically monitor material supplier’s electronic CoA submittals. If a material is detected to be outside of the pre-determined control limits, it is automatically rejected.

Freescale’s relentless drive towards zero defects is built around a model of predict, prevent, protect which enables a proactive problem-solving approach to supplier-quality development and management.
Software Quality

The Freescale software quality model is a systematic set of activities that enable quality to be built directly into our software. We strive to ensure every system, component and process meet specified requirements and customer expectations. The Software Quality Team drives quality assurance, compliance to software standards, improvement programs and more throughout all Freescale divisions and products. By employing quality control activities throughout the development lifecycle, we rigorously test products to detect and eliminate software defects at critical points in the process—before products are shipped to customers. Ongoing quality management enables continuous process improvement across software products, development lifecycle and defect prevention.

Software Quality Process Handling

- Software Standards: Freescale strives to consistently meet industry standards and our own quality standards.
- Compliance to Standards: Internal quality assurance audits and capability gap assessments are performed.
- Customer Interface: We work with customers to resolve released software issues, discuss software process improvement and enhance support.
- Improvement Programs: Process evaluation, assessments/audits and gap analysis of quality programs are in place throughout the company to ensure process optimization.
Environmentally Preferred Products

Freescale Environment, Health and Safety Policy Statement

It is the policy of Freescale to conduct all business activities in a responsible manner, free from recognized hazards, and to respect the environment, health and safety of our employees, customers, suppliers, partners and the community.

We will comply with all applicable environmental, health and safety legal requirements and with other requirements to which we subscribe, related to EHS aspects and risks. We will implement programs to achieve greater protection, where appropriate. We expect employees to report environmental, health and safety concerns, to continuously maintain a safe work environment, and to actively participate in helping Freescale to achieve our EHS goals.

We are committed to the prevention of pollution and will strive to conserve the earth’s natural resources through the development of sustainable products and manufacturing processes. We are working to be an industry leader in reducing, reusing and recycling wastes.

We are committed to the implementation, maintenance and continuous improvement of our EHS Management Systems.