Atmel Quality Handbook

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Quality Policy and General Information

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Atmel Quality Policy

Atmel® will provide a competitive advantage to its customers through timely, innovative, and defect-free products with outstanding service driven by a culture of systematic continuous improvement.

Company Overview

Atmel is a leader in microcontrollers and touch solutions. Headquartered in San Jose, CA, Atmel (NASDAQ: ATML) has 40 local sales offices worldwide. Atmel is a worldwide leader in the design and manufacture of microcontrollers, capacitive touch solutions, advanced logic, mixed-signal, nonvolatile memory and radio frequency components. With wafer fabrication locations in Colorado Springs, CO, and third party foundries, Atmel is able to provide the electronics industry with complete system solutions focused on industrial, consumer, security, communications, computing, and automotive markets. In addition, the company has test and assembly facilities in the Philippines and subcontractors, employing nearly 5600 employees worldwide.

Atmel Technology

The broad product portfolio services the fast-growing segments in all of the major application areas such as industrial, consumer electronics, automotive, wireless communications, computing, storage, printing, security, military and aerospace. Atmel products consist primarily of microcontrollers (Atmel AVR®, Atmel QTouch®, Atmel maXTouch™, ARM, and 8051), advanced logic, mixed-signal, nonvolatile memory (Serial and Parallel EEPROMs DataFlash, Flash, and EPROMs), radio frequency and system-level integration semiconductor solutions.

Corporate Strategy

A key element of our business strategy includes expansion through the acquisition of businesses, assets, products or technologies that allow us to complement our existing product offerings, expand our market coverage, increase our skilled engineering workforce or enhance our technological capabilities. Atmel's direction is to offer touch and microcontroller value added solutions that enable companies to lead the markets they serve through the design, manufacture and marketing of differentiated, cost-effective systems. These solutions encompass innovative products, technology, complete portfolio of products and development tools, quality and manufacturing, and accelerated time to market.

Continuous Quality Improvement Overview

Continuous Quality Improvement Overview

From the early stages, Atmel's philosophy of continuous improvement has ensured that our customers receive products with not only the highest levels of quality and reliability, but that every group within the company operates with the same customer expectations in mind. Atmel's improvement process consists of mid-term improvement programs that require employee involvement at all levels.

Atmel's Quest for Continuous Improvement

2008 and Beyond
- Achieve and Maintain World Class Excellence
- Global Change Management
- Configuration management
- Enhanced Manufacturing Process Control
- Maverick Lot Control
- Zero Defects-CIP
- New Product Introduction

1999 - 2007
- QS 9000 and TS-16949
- Environmental Policy and Lead-Free Programs
- Corporate Quality Web Site Deployment
- Abnormal Lot Control Initiative
- Customer Satisfaction Surveys
- Quality Councils

1997 - 1998
- Customer Satisfaction Program
- Corporate Q & R Standardization
- 10X Improvement Program
- Enhanced Quality Business System

1995 - 1996
- Zero Defects Initiative
- Quality Tools Training
- Product Development Methodology Enhancement

1994
- ISO-9001 Certification Team Driven Problem Solving

Before 1993
- Mil-Std-883
- DESC Certification
- Statistical Process Control Proliferation

Continuous Quality Improvement Overview

These programs keep employees continuously updated on the latest requirements and standards: Training in Quality Systems, advanced quality tools including DOE and FMEA as well as customer requirements.

Continuous Improvement

Atmel Continuous Improvement program are driven by following major areas:

- Management Commitment and Employee Involvement
- Customer Satisfaction Program
- Robust Quality Business System
- Employee Training and Skill Enhancement

Throughout this handbook, each of these four major areas will be covered in more detail.

Management Commitment and Employee Involvement

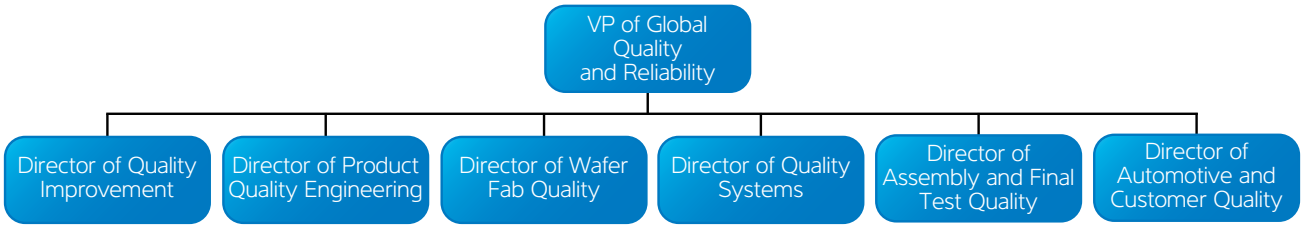
Atmel's worldwide quality and reliability organization has been chartered and empowered by Atmel executive management to spearhead the corporation's continuous quality improvement effort. Employees take part in this effort by being part of targeted continuous improvement teams as well as participating on an individual level. The progress of this effort is continually monitored by management through regularly scheduled reviews at corporate, site, and group levels. This information is also disseminated to all employees through group meetings, newsletters, and bulletin boards.

Global Quality and Reliability Organization

Atmel's Global Quality and Reliability Organization is the executive arm of the quality at the corporate, business unit, and site levels. It is responsible for ensuring that Atmel has the most competitive systems, processes, and programs in place to drive the strategic quality improvement goals. It maintains, analyzes, and reports all internal and external quality and reliability data. As the customer advocate, it also has the overall responsibility for Atmel's Customer Satisfaction Program, which includes scorecard and customer survey management. Atmel's Global Quality and Reliability structure is outlined in Figure 2-1.

The Global Quality and Reliability Team meets periodically to develop major goals, initiatives, and programs based on internal and external data. Each initiative has a defined champion or owner that is responsible for the successful implementation of the initiative. Quality metric goals have owners that are responsible for measuring, analyzing and driving improvements toward defined targets.

These goals and initiatives are closely monitored by the global quality and reliability team with progress reported at all levels of the organization.



External Certifications

Certification to external standards is one example of how Atmel strives to meet the needs of its worldwide customers. Atmel design and manufacturing sites, as well as our major subcontractors, are certified to prestigious internationally recognized quality standards. Each site goes through third-party periodic recertification audits.

Atmel has continued its Quality excellence path by undertaking major certification programs: ISO 9001(2008), TS 16949 (2009), and ISO 14001(2004).

All of Atmel's current registration certificates can be downloaded from our web site (http://www2.atmel.com/about/quality/default.aspx, select "Quality and Environmental Certificates").

Employee Training and Skill Development

Achieving our strategic objectives as a corporation requires that we not only focus on continuous improvement of systems, equipment, and processes, but most importantly on continuously improving the knowledge base of our employees. Atmel emphasizes the importance of the training and re-training of our personnel at all levels of the organization to maintain a total quality culture and ensure that we stay competitive in our marketplace.

Training is provided by subject matter experts who may be Atmel employees or external contractors. This training is targeted towards all employees; some material is mandatory. Contents and the level of detail vary with the target audience.

Quality Improvement Planning

Identification of Key Improvement Programs

Atmel has developed a systematic quest for improvement opportunities. These are derived from various inputs including:

- Periodic Customer Satisfaction Surveys
- Routine Customer Feedback
- A Formal Review of the Efficiency of the Overall Quality Metrics.

Key Initiatives

From all derived actions, the following initiatives are of the highest priority and are sponsored by Atmel's senior management. These global, cross-functional teams are comprised of representatives from business units, manufacturing, quality, and other pertinent areas. Progress is reviewed on a periodic basis. Listed are some of the initiatives that have been implemented since 2008.

- Automotive Quality Initiative: Implement best practices across all Atmel locations for manufacturing, APQP and Sales
- Global Change Management Process: Define and implement a standard change review process for all changes in the manufacturing process (process, testing, design, and supplier)
- Configuration Management: Standardization of processes and controls for definition and creation of products into Atmel manufacturing and planning systems.
- Asia Center of Excellence (ACOE): Establish a reliability and failure analysis lab support activity in Asia to better support Atmel and Atmel customers.
- Global CIP/Zero Defect Program: Process where a CIP step-down plan is implemented for repeat defects in order to reduce or eliminate occurrence.
- New Product Introduction: Standardized process that utilizes multiple gates (control points) to drive new products quickly and safely to market. Process has ability to identify weaknesses and drive improvements.
- Assembly Improvement Initiatives: Implementation of standardized practices for in-line monitoring, qualification, maverick, supplier improvement and other assembly controls.

Quality Monitoring

The efficiency of the overall system is continuously monitored by a set of quality metrics. Each metric goal has an owner defined that is responsible for the measurement across all of Atmel.

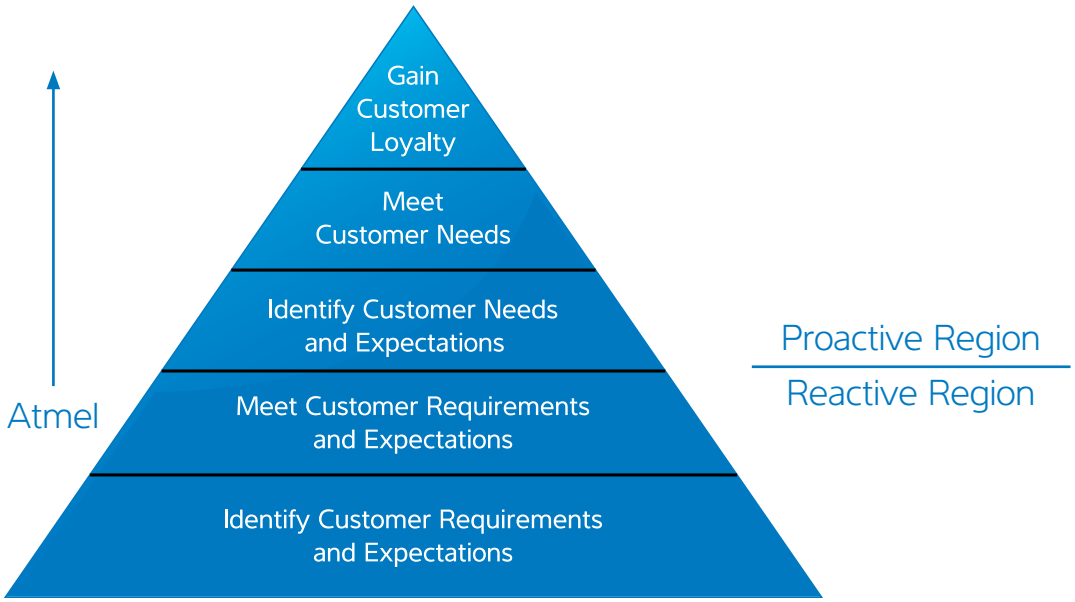
Customer Satisfaction Program

Customer Satisfaction Program

Atmel Strategy to Achieve Customer Satisfaction

Since its inception, Atmel® has prided itself on providing outstanding service to its customers. Customer service teams have always been in existence in all areas throughout the company including wafer fabs and final test areas. Atmel has an outstanding track record in customer service and has historically been recognized with service awards from many of its major customers.

The root of this success is a well-defined Customer Satisfaction Program with the objective of achieving preferred supplier status for its top global customers without diminishing its focus on serving its entire customer base. Many of these top global customers impose the most stringent requirements in the industry. Many improvements made to achieve preferred supplier status at a particular customer have been applied across all sites to benefit all Atmel customers.
Following is a model of the Atmel Customer Satisfaction Program:



Quality Champions and Customer Satisfaction Teams

Atmel assigns cross-functional customer teams for all strategic customers. Typically, these teams include the account manager, marketing manager or director from the primary Atmel business unit, sales manager, and a quality champion from the Quality and Reliability organization.

The overall objective of each customer satisfaction team is to proactively engage with their assigned customer and achieve preferred supplier status for Atmel. Atmel believes that if we meet the needs of our customers, we will achieve their loyalty and provide a mutually beneficial business impact. Teams set specific annual goals to meet the overall objective. This proactive approach requires frequent communication and formal customer feedback.

Based on customer input, the teams develop an action plan with short-term and long-term objectives that are set to specifically address customer needs. However, each team is given the flexibility to use whatever processes and methods are most desirable to their assigned customer.

Customer Feedback

Scorecards

Atmel® relies heavily on formal feedback from our customers to identify opportunities for continuous improvement. This feedback is usually received through periodic scorecards from key customers who provide useful information about our performance in areas most important to them. Typically, this criteria includes technology, delivery, cost, support, and quality performance. This process has resulted in several continuous improvement initiatives at Atmel.

Surveys

Atmel has complemented the results obtained via scorecards with our 3-annual customer satisfaction survey process. Atmel conducts the survey via direct customer contact and our web site on the following topics:

- Q and R Improvements Over the Past 12 Months
- Web Site (Content and Ease of Use)
- Technical Hotline
- Technical Documentation
- Feasibility Requests
- Commercial Policy
- Flexibility
- Product Technology
- Overall Responsiveness
- Change Notification Process
- Quality and Reliability
- Sales Department Availability and Support
- Shipping Accuracy
- Overall Performance Over the Past 12 Months
- Service Improvements Over the Past 12 Months
- Field Application Engineering Support
- Development Tool Offering
- Product Offering
- Early Warning System
- Sample Availability
- Design-in Support
- Failure Analysis Responsiveness
- Manufacturing Line Fall-out Rate
- Product Availability
- Product Lead Times
- Delivery Performance

For each topic, we ask customers to rate our performance in comparison to their other suppliers. Every comment is carefully analyzed by our Worldwide Quality and Reliability Team. All results are subsequently communicated to Atmel Executive Management and Sales personnel.

Further feedback is obtained by conducting a questionnaire of our sales force in order to solicit direct input on Atmel performance based on direct customer contact.

The results from both sources are analyzed and used to generate opportunities for improvement through our annual Corporate Quality Goals and Initiatives. It also serves to help in the mutual understanding and exchange of information about product and technology roadmaps and helps align Atmel with our customers' immediate and future needs.

Business Review

Atmel promotes regular business reviews with its major accounts as a formal forum for feedback in various business aspects including product and technology strategy, logistics, systems, and quality.

Field Quality Organization

Atmel has appointed field quality support personnel in all major global regions, including North America, Europe, Japan, and Asia to ensure timely support to our worldwide customers. These field quality managers act as our customers' first point of contact and are responsible for tracking and following up all issues to closure. They are also responsible for facilitating communication through customer meetings covering quality, reliability, and service.

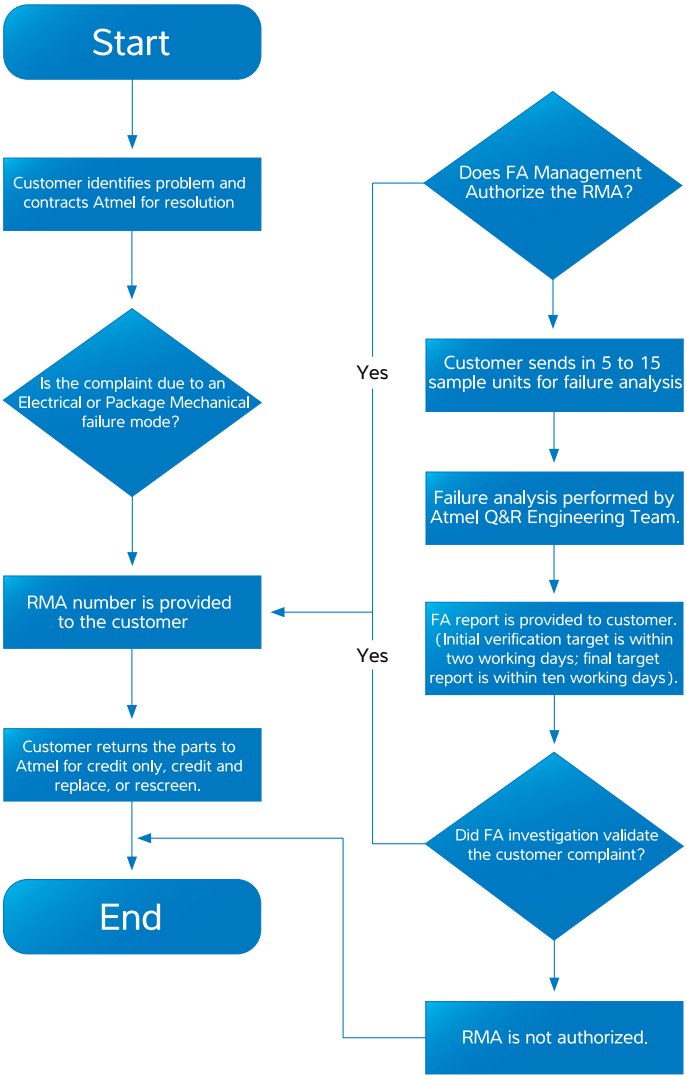
Customer Specification Review Process

Atmel has a system for the formal review for all customer documents specifications and information requests. These requests are generally submitted through your Atmel Sales Representative or Atmel Distributor. The response will be prepared by subject matter experts including product and design engineering, manufacturing, customer service, business planning, logistics and quality. Exceptions to customer requirements will be taken via a Supplier Addendum. Any exceptions to customer requirements must be negotiated with and approved by the customer before an order can be placed.

Returned Material Authorization (RMA) and Failure Analysis (FA) Process

Atmel strives to supply defect-free products with the highest levels of quality and reliability. Should a product not operate according to the customer expectations in their systems, investigation and analysis is handled by our Failure Analysis (FA) and Returned Material Authorization (RMA) system. Atmel field sales and applications groups work closely with the customer to determine the root cause of failures at the customer site. However, if further analysis is required, the Atmel Online FA procedure should be used and the suspect parts to be analyzed are returned to the corresponding Atmel site. We ask our customers to provide detailed information on any product returned for analysis in order to facilitate the fastest response and closure. Atmel places top priority on providing containment within 24 hours and quick initial feedback to our Key Accounts and Key customers (within 48 hours after the parts are returned). Target to provide a final report identifying containment, root cause, and corrective action is provided within ten working days. When the FA takes longer, the customer will receive a target date or will be regularly informed.

RMA and FA Process Flowchart



Any material returned for credit or replacement must be processed through the appropriate Atmel sales office or sales representative using our RMA/FA system. Standard request forms are used to ensure completeness of information and quick response. For technical returns, authorization will not be granted unless the initial failure analysis verification has been completed and validated. Both forms are available on our web site: (http://www2.atmel.com/about/quality/default.aspx, select "RMA & FA Information") along with shipping instructions.

Change Notification and Product Obsolescence

Atmel relies heavily on continuous improvements to enhance our products. In our fast moving technology, Atmel must also stay cost competitive. These factors result in changes to our products after they are released for mass production. Atmel has a comprehensive system to manage such changes including inventory management and customer notification when required. Customers are notified through a change notice prior to the implementation of a major change.

In some cases, change notices will result in product obsolescence. In these instances, specific details on the last time buy (LTB) date, last time ship (LTS), and replacement part information will be widely distributed. The Atmel Quality Web Site includes a product obsolescence query screen that allows customers to easily search our database: (http://www2.atmel.com/about/quality/default.aspx, select "Obsolescence Information").

Atmel Quality and Reliability Web Site

Atmel has made a focused effort to utilize our web site as the primary vehicle for quality and reliability data dissemination. It is our intent to continuously improve and enhance the site so that customers can have immediate access to all relevant quality and reliability information. Items that are available at: http://www2.atmel.com/about/quality/default.aspx include:

- Quality Inquiry
- Quality Handbook
- Green Packaging
- Environmental Information
- Quality and Environmental Certificates
- RMA and FA Information
- Reliability Information
- Obsolescence Information
- FAQ Response Summary

Quality Business System

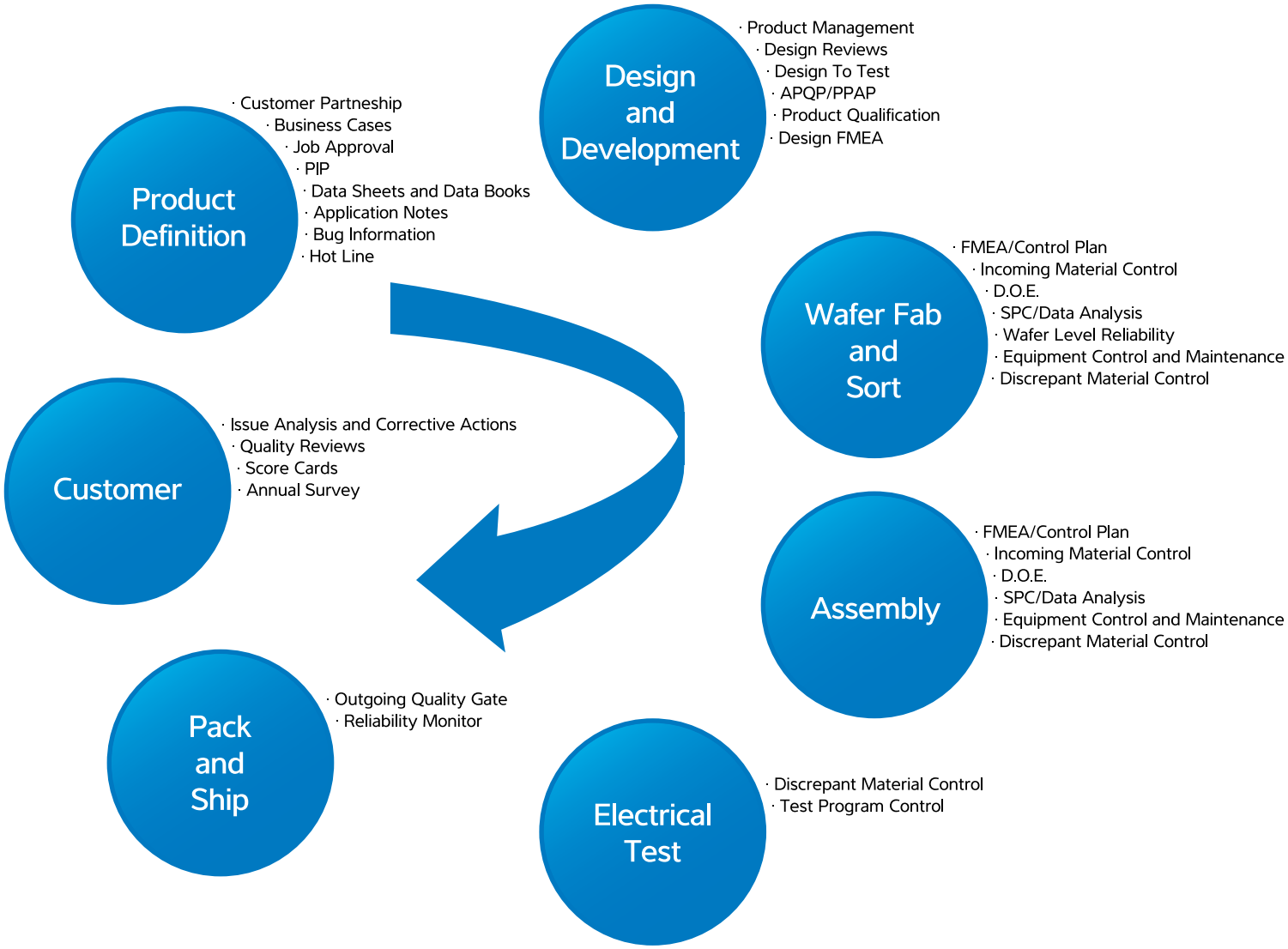
Quality Business System

Quality Business System Model

Our core business is to design, develop, manufacture, and deliver IC products based on its memory, logic, and analog technologies. These products range from commodity memory devices such as Serial EEPROMs, Flash PEROMs, and microcontrollers to system-level solutions requiring custom ASICs. For these system-level solutions, customer interaction is required from the product definition stage to the time the product goes into high volume production and obsolescence.

The entire process to define, develop, manufacture, and deliver products starts and ends with the customer. At each of these steps, Atmel® has clearly defined corporate systems and procedures to guarantee that our products meet or exceed customer requirements. All design and manufacturing groups must comply with the corporate level systems and requirements to ensure product consistency regardless of the original design and manufacturing site.

Major Quality Systems Elements



All major corporate level systems and procedures are identified in this model. This model is used as a basis to identify opportunities for improvements and enhancements in the system as well as for training and communication.

Major elements that are covered by this system include:

- New Product Introduction System
- New Technology Introduction Methodology
- Reliability Qualification and Monitor Methodology
- Product Characterization and Test Methodology
- Product and Technology Transfer Methodology
- Statistical Process Control System
- Incoming Material Control System
- Equipment Control, Calibration, and Maintenance
- Product Quality Monitoring System
- Product Traceability System
- Subcontractor Selection, Monitor, and Control System
- Customer Specification Review System
- Customer Change Notification System
- Customer Failure Analysis and Returned Material System
- Document Control System
- Audit and Review System
- Training Methodology

Statistical Process Control

Atmel has a well-established Statistical Process Control (SPC) system in all of our manufacturing areas, including wafer fabs. We also require all major subcontractors to meet this requirement. Atmel is continuously pursuing tighter control over its processes. Achieving Six Sigma Control (a measure of tight process control) over our manufacturing processes is a strategic continuous improvement goal. Each manufacturing site continuously monitors the performance of each critical process parameter. Corrective actions are taken if a parameter falls out of control.

In addition, a system to identify abnormal lots and trigger corrective action is utilized throughout all wafer fabs, assembly, and test areas. This ensures the shipment of consistent products to our customers at all times.

Product Traceability System

All Atmel products are traceable to the source wafer fab lot number. In addition, date code traceability allows quick identification of the test/assembly and fab time periods. Product traceability information is also provided on the inner and outer package boxes in addition to the reel, tube, and tray bundles.

Supplier Selection, Monitor, and Control

All direct material used in the manufacture of Atmel products must be procured from approved and certified suppliers. Suppliers are evaluated by a team consisting of representatives from procurement, engineering, logistics and quality. Decisions to approve or certify a supplier are based on the team's evaluation of the supplier's control systems and their ability to meet all Atmel requirements in key areas of the supply chain processes.

Verification of the procured material may occur in the form of acceptance inspection by Atmel, acceptance inspection by the supplier, or a review of process and other relevant data. Periodic supplier audits are performed to ensure continued conformance to Atmel requirements. In addition, formal business reviews are held with key suppliers where scorecards and/or key performance indicators are discussed for the identification of improvements needed and business allocation.

Document Control System

Atmel utilizes a hierarchical document control system. All documents are driven by the Atmel Corporate Quality Manual which is in conformance with ISO 9001/ TS 16949 quality standards. The next level in hierarchy is the global quality policy documents. The third level includes site specifications that are driven by the higher-level policies. Within each site, a local hierarchical structure exists to facilitate communication, training, and utilization of these documents. This system gives the desired level of control at the corporate level without sacrificing site level flexibility.

All documents managed within the Document Control System are under formal revision control. Changes to the documents can be initiated by anybody in the company. However, all changes must be evaluated and approved by all functions affected at the appropriate level.

Audit and Review System

Atmel maintains a system of internal and external audits to ensure compliance with our specifications. The main purpose of these audits is to assure management that Atmel's Quality Management System is effective, adequate, and suitable in satisfying the requirements of Quality Management System standards, Atmel's Quality Policy, and objectives. These audits are augmented by the periodic annual ISO 9001/ TS 16949 quality system audits which are conducted by certified third-party auditors. All issues and improvement opportunities are reviewed and followed up with appropriate corrective actions.

New Product Development and Introduction

New Product Development and Introduction

Overview

In order to meet our customer and market needs, it is imperative that Atmel® develop and introduce new products in a timely manner with minimal design rework. To achieve this goal, Atmel uses a comprehensive product development and new product introduction methodology (NPI). This methodology defines development stages, milestones, and deliverables in the development process. This ensures consistency across the design, development, and product business groups located worldwide. It also serves to guarantee participation in the development process by all stakeholders at the earliest possible opportunity. In addition, most major business divisions have developed specific checklists suitable for their specific business needs.

The new product introduction flow is introduced in order to improve engineering project execution, improve effectiveness of product launches and to increase customer satisfaction by:

- Increasing Project and Program Predictability
- Establishing a Common NPI Terminology thus Enabling Clear and Concise Internal and External Communication
- Well Defined Responsibilities, Interfaces and Deliverables Between Business Units and Other Atmel Units and Corporate Functions (quality, technology development, planning, wafer production, back-end operations, ...)
- Clear Communications to Sales, and One Face to the Customer
- Setting a Stronger Focus on Product Quality
- Special Consideration of New Packages and Technologies
- Safe Launch
- Improved Learning Between Product Lines and Leveraging Best Practices

Major Milestones and Criteria

- World Class Benchmarked Methodology
- Phase Gated Approach: Checks and balances at each phase of development
- Risk Management Applied Throughout: Focus on 'first time right'
- Senior Management Oversight: Regular process and Key Performance Indicators (KPI) reviews
- Continuous improvement Methods Used to Drive NPI Process Excellence

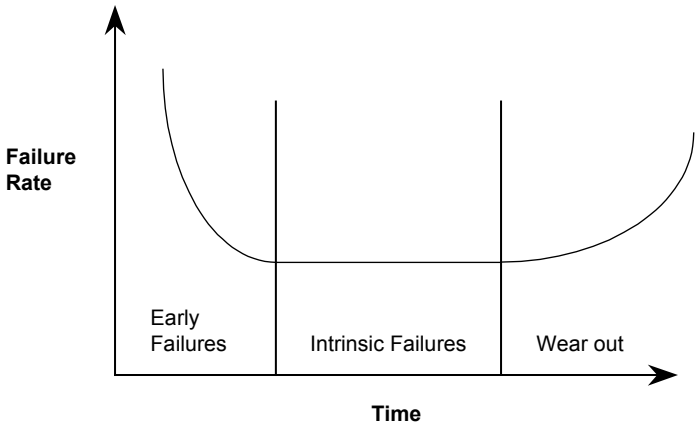
Reliability Qualification and Monitoring

Reliability Qualification and Monitoring

Overview and Philosophy

Reliability is the ability of a product to perform under stated conditions for a specified period of time. Generally, reliability levels are expressed as the probability that a part will fail to function after a specified time interval. The same part will have different probabilities of failure under different use conditions. For example, a part which may last for thirty years in a desktop computer in an air-conditioned office building may last for only ten years in an underhood, automotive application where temperature and humidity conditions are extreme.

In the electronics industry, this failure rate over time exhibits characteristics that, when summed, are commonly referred to as the "Bathtub Curve". This curve is typically divided into the three regions depicted below (Early Failure Rate, Intrinsic Failure Rate, Wear Out Failure Rate).



The specific shape and position of the bathtub curve is dependent on the product design, material, processing and defect density for both die and package. When considering the overall reliability of the product, the intended application(s) and the board/system level manufacturing processes will contribute to the observed reliability. As the knowledge and understanding of all these factors grows, designs and processes can be implemented and improved to ensure a robust and reliable product.

As products can operate in a system for more than thirty years without failing, any test designed to accurately evaluate reliability must utilize accelerated use conditions. This acceleration is achieved through the use of extreme environmental (temperature, humidity, pressure) and operating (voltages, currents) conditions that serve to shorten the overall test times to more manageable levels. Even under accelerated conditions, these tests may take several months to complete.

Long cycle times and high qualification costs have resulted in the emergence of techniques to evaluate reliability in wafer form where even higher temperatures, voltages and currents can be applied for greater acceleration. These techniques are referred to as Wafer Level Reliability (WLR).

Atmel® supplies the most reliable product to our customers by developing highly reliable technologies and design rules in our wafer fab areas. Further reliability enhancements are made by using packages and assembly subcontractors with proven reliability and by qualifying these processes as well as products in packaged and finished forms before high volume production release. Atmel's Reliability Methodology consists of early evaluation and short-loop monitoring of its technologies using wafer-level reliability (WLR), end-of-line reliability qualification of new products and technologies using a battery of stress tests, and monitoring the reliability of production released products by periodically repeating these stress tests on an ongoing basis. These three programs are referred to as Wafer Level Reliability (WLR), Reliability Qualification Methodology, and Reliability Monitor Program.

Highly Accelerated Stress Test (HAST)

The purpose of this test is to evaluate a plastic packaged component's ability to withstand harsh environmental conditions with extreme temperature and humidity levels. The parts are stressed to high temperature (130°C) and relative humidity (85%RH) conditions in a biased state to achieve maximum acceleration.

Wafer Level Reliability

WLR involves the reliability evaluation of new technologies during development and an ongoing monitor of these technologies on wafers to provide the earliest possible feedback. Special test structures have been developed for various technologies to evaluate the fundamental reliability of design rules and technologies. Wafer Level Test structures are designed to assess the reliability of the materials and fabrication processes such as thin oxides, metalization and dielectric structures, and the basic transistor ruggedness. Structures are designed for the following tests:

- Gate Oxide Integrity (GOI)
- Time Dependent Dielectric Breakdown (TDDB)
- Gate Oxide Charge Retention (Qbd)
- Hot Carrier Injection (HCI)
- Negative Bias Temperature Instability (NBTI)
- Metal and Plug Step Coverage
- Metal Electromigration (EM)
- Ionic Contamination
- Interlayer Dielectric Integrity
- Transistor Latch Up
- Transistor Performance and Ruggedness
- Process Induced Charging

Appropriate structures are identified for new technologies and used to evaluate the robustness and reliability. Most structures are used to monitor reliability and process performance on an ongoing basis. These structures are also used to perform the initial assessment of major improvement changes.

Reliability Qualification Methodology

Wafer Level Reliability Tests, though very comprehensive and useful, have not achieved universal acceptance to replace reliability tests performed on the finished product due to the less known interactions between die, package, and assembly processes. For this reason, Atmel maintains a stringent reliability qualification methodology for new products, technologies, and packages on packaged product according to established standards of JEDEC (JESD47), AEC (AEC-Q100) and MIL (MIL-STD-883).

These reliability tests are designed to accelerate potential failure mechanisms due to process technology, package and die interaction, and worst-case environmental conditions. Each test and its purpose are described below.

Data Retention Bake (DRB)

This test is used to measure a device's ability to retain a charge for extended periods of time without applying voltage bias. Stressing at high temperatures (150°C for plastic packages) accelerates any discharge causing the memory state to change.

Electrostatic Discharge (ESD)

This test is conducted in order to evaluate a device's Sensitivity to ESD charges. Human Body (HBM) and Charged Device (CDM) models are used to replicate the handling environment.

Endurance Test (END)

This test is performed in order to evaluate a device's ability to be programmed, erased, and verified repeatedly for a pre-determined number of cycles. This test is used for products that are used in applications requiring multiple programming and erase cycles.

Latch Up (LU)

The purpose of this test is to evaluate a device's susceptibility to Latch Up at high current and voltage conditions.

Steam Pressure Pot (SPP)

The test is used to evaluate a plastic packaged component's ability to withstand severe conditions of pressure (15 psig), temperature (121°C), and humidity (100%RH).

Temperature Cycle (TC)

This test is used to measure a product's sensitivity to thermal stresses due to differences in expansion and contraction characteristics of the die and package materials by repeated alternating temperature dwells between high (typically 150°C) and low (typically –65°C) temperature extremes.

Reliability Modeling

Failure rates for Atmel product and processes are typically calculated based on test data with acceleration factors based on the Arrhenius Model for thermal acceleration and/or the Eyring Model for voltage acceleration. Other models, such as Coffin-Manson (temperature cycling) may be used for specific applications or customer concerns.

Thermal Acceleration

where,

$$TAF = e^{\frac{e_a}{k}\cdot\left[\frac{1}{T_f + (P_f \cdot \theta_{JAf})} - \frac{1}{T_s + (P_s \cdot \theta_{JAs})}\right]}$$

TAF	=	Thermal Acceleration Factor
ea	=	Activation Energy (eV)
k	=	Boltzman's Constant (8.617 x 10-5 eV/°K)
T	=	Temperature (°K)
f	=	Field Conditions
s	=	Stress Conditions
P	=	Power Dissipation (W)
JA	=	Thermal Resistance Coefficient - Junction to Ambient (°C/W)

Voltage Acceleration

Voltage acceleration is only used for failure mechanisms, which are known to be accelerated by the presence of an electric field (i.e., gate oxide defects, charge gain, etc.). The generic Voltage acceleration model has been published as:

where,

$$VAF = e^{Z\cdot[V_S - V_n]}$$

VAF	=	Voltage Acceleration Factor
Vs	=	Stress Voltage (V)
Vn	=	Nominal Voltage (V)
Z	=	Voltage Acceleration Constant (usually, 0.5 < Z < 1.0)

Overall Acceleration

The overall acceleration factor (AF) is computed as the product of the thermal and Voltage acceleration factors. In cases where Voltage acceleration is inapplicable, a default value of 1.0 is assigned.

$$AF = TAF \cdot VAF$$

Failure Rate

where,

$$\lambda = \frac{\chi^2_{\left(1-\frac{\alpha}{100},\, 2\cdot n+2\right)}}{2\cdot AF\cdot DH}\cdot 10^9$$

	=	Failure Rate (Failure UnITs = Failures/109 Device Hours)
2	=	Failure Estimate
	=	Confidence Level (60% or 90%)
n	=	Number of Failures
DH	=	Device Hours

Example Calculation

HTOL (High Temperature Operating Life) testing at 125°C for 1,000 hours on a particular device results in 1 failure (charge gain) out of a sample size of 500 units. The corresponding activation energy for charge gain is known to be 0.5 eV (Voltage Acceleration constant = 1.0). The power dissipation for the device is identical under field and stress conditions (.15W). The junction temperature rise for the package is 20°C/W. The stress and nominal Voltage levels are 6.5 V and 5.0 V respectively. The field operating temperature is known to be 55°C.

The thermal and Voltage acceleration factors are computed as follows:

$$TAF = e^{\frac{0.5}{8.617\cdot 10^{-5}}\cdot\left[\frac{1}{328+(0.15\cdot 20)}-\frac{1}{398+(0.15\cdot 20)}\right]} = 21.3$$

$$VAF = e^{1.0\,\cdot\,[6.5-5.0]} = 4.5$$

Therefore,

$$FA = 21.3\cdot 4.5 = 95.9$$

The failure rate in FITS (with 60% confidence) is calculated as:

$$\lambda = \frac{4.04\cdot 10^9}{2\cdot(95.9)\cdot(1{,}000)\cdot(500)} = 42\ FITS$$

Chi-Square Failure Estimate Reference

Number of Failures	Chi-Square (60% Conf.)	Chi-Square (90% Conf.)
0	1.83	4.61
1	4.04	7.78
2	6.21	10.64
3	8.35	13.36
4	10.47	15.99
5	12.58	18.55
6	14.69	21.06
7	16.78	23.54
8	18.87	25.99
9	20.95	28.41

Reliability Monitor Program

Each quarter, Atmel's reliability group subjects a set of representative products to the stress tests previously used for reliability qualification. These products are selected using criteria that include volume, complexity, fab area, assembly source, and specific customer requirements. This testing is performed to ensure that the reliability of a technology continues to meet the assigned goals since its initial qualification. This data is accumulated over several quarters to determine reliability trends in fab technologies, design rules, and assembly processes. Additionally, this data allows customers to predict the expected reliability performance of their overall system. The data is also used to identify continuous improvement opportunities and appropriate corrective actions. Quarterly reliability monitor reports are available on our web site (http://www2.atmel.com/about/quality/default.aspx, select "Reliability Information")

Failure Analysis and Corrective Action

In order to continuously improve reliability, it is imperative to understand the root cause of failures and prevent their recurrence. A systematic approach is necessary to ensure that the more prevalent failures are eliminated first. Atmel has a policy to analyze every reliability failure for root cause identification. Sources of failures include customer returns and internal reliability evaluations. A summary and Pareto distribution of all failure mechanisms is used to target the most common, recurring mechanisms for elimination. This has helped Atmel focus its resources on eliminating or reducing several failure mechanisms in recent years.

Reliability Targets

Results of the reliability monitor and qualification programs are used to determine the average failure rates for each technology and major product family. Specific targets are set for technologies based on customer requirements and maturity level.

Subcontractor Monitor and Control

Subcontractor Monitor and Control

Overview

Almost all large corporations rely on subcontractors to provide specialized services. This reduces any exposure to the changes in the business climate and eliminates the need to invest heavily in plant and equipment. Downside risk of unit costs, capacity, and cycle times can be minimized by entering into strategic partnerships with subcontractors and by implementing a clearly defined system of checks and balances.

Atmel® made a strategic decision to utilize subcontractors for assembly; many of these sites have also been qualified to perform final electrical testing.

Subcontractor Selection, Assessment, and Control

We must ensure that services provided by our subcontractors meet both internal and external requirements. Consequently, we have implemented a comprehensive system to select, assess, and control our subcontractors.

The selection process relies on a cross-functional team, which typically consists of representatives from the relevant engineering, procurement, quality, reliability, and manufacturing groups. All subcontractors are subjected to a qualification process in order to verify the quality of their work prior to the commencement of production part processing. After a subcontractor passes qualification and is deemed to be approved, a single quality or reliability incident may result in subsequent disqualification.

Also, we utilize a detailed subcontractor assessment questionnaire in order to identify gaps between Atmel and subcontractor quality system requirements. All gaps must be addressed prior to the utilization of a new subcontractor.

Each group using a subcontractor defines its requirements for cost, cycle time, and delivery. Subcontractors must also meet Atmel's Global Quality and Reliability requirements that include:

- Monthly SPC Report
- Continuous Improvement System
- Abnormal Lot Control
- Process Change Notification For All Changes
- Process Change Approval On All Major Changes
- Yield and In-line Monitor Data
- Annual Facility Audit
- ISO-9001 (2000) Certification
- Reliability Monitor Program
- Storage and Handling Precautions
- FA System that Meets Atmel Requirements
- Equipment Calibration and Preventive Maintenance
- Record Retention
- Traceability
- Dedicated Quality Contact

Subcontractor Performance Tracking

All major subcontractors are evaluated through the use of periodic standardized scorecards. Established programs are in place at each site to drive continuous improvement in each of these areas.

SQ-BREP (Subcontractor Monitor and Control Selection)

SQ-BREP is designed to form synergies among our employees and encourage continuous improvement among all the Atmel Assembly and Test Suppliers. It uses a 'win-win' approach between Atmel and its supplier which facilitates in optimizing Atmel productivity that leads to its competitive edge to be the market leader. Subcontractor's performance tracking helps to discover and remove hidden waste and cost in the supply chain, facilitate suppliers' performance improvement, increase competitiveness among suppliers and provide necessary information in making sound business decisions.

SQ-BREP will be conducted quarterly globally among all the Atmel Tier 1 Assembly and Test Suppliers via the model called 'WINNER'. The average scores of the Quarterly SQ-BREP will be used for rating the suppliers yearly. Based on these ratings, the suppliers will be ranked and selected accordingly to support current business growth.

SQ-BREP is designed to support the vision of participating in high-growth markets and the company's desire to take early advantage of the tremendous emerging opportunity within the business domain. SQ-BREP is the Atmel global standardized assessment tool to conduct a consistent and unbiased quarterly review to measure how suppliers' pursuit for continuous improvement and provide quick and actionable recommendations.

Rating Steps

SQ-BREP Coordinator/Quality Assurance collects, monitors and analyzes rating for suppliers in the following order:

- SQ-BREP Coordinator Sends Scorecards to the Respective Scorer.
- SQ-BREP Coordinator Collects Back the Scorecards and Analyzes the Scores.
- SQ-BREP Coordinator Presents the Summary to the Assembly and Test Operational Team.
- SQ-BREP Coordinator Sends the Scores to the Respective Business Unit for Their Inputs.
- SQ-BREP Coordinator Communicates the SQBREP Scores to Suppliers.
- SQ-BREP Coordinator Follows Up on the Improvement Map and Reviews it in the Following SQ-BREP.

Elements Being Rated

The elements that are being rated in the SQ-BREP are:

- Quality (20%)
- Delivery (20%)
- Engineering (15%)
- Service and Support (15%)
- Cost (15%)
- Business (10%)
- Green Program (5%)

Score Range

The table below shows the score range for SQ-BREP. Suppliers meeting 3.0 and above qualify for WINNER.

Number of Failures	Chi-Square (60% Conf.)	Chi-Square (90% Conf.)
≤ 2.0	Below	Will be placed under probationary period. Detail Improvement Roadmap required within 7 working days.
2.0 <x ≤3.0	Meeting	Sustain volume. Detail Improvement Roadmap required within 14 working days.
3.0 <x ≤4.0	Good	Qualify for WINNER. Detail working plan needed for new project within a stipulated time.
4.0 <x ≤5.0	Exceeding	Qualify for WINNER. Preferred supplier for future projects. Detail working plan needed for new project within a stipulated time.

Quality Assurance and Monitoring

Quality Assurance and Monitoring

Through Statistical Process Control (SPC), In-Line Quality Control (QC), and other statistical techniques, Atmel® is able to achieve a high level of control over product quality in our manufacturing processes. Atmel's Outgoing Quality Assurance monitor program is geared towards ensuring that the product being shipped is of the highest quality. Any failures detected at the outgoing quality test require the identification of the root cause and its subsequent prevention. This results in continuous improvement of product quality levels to achieve our ultimate goal of providing our customers with products that are free of electrical, mechanical, or visual defects.

In-Line Quality Assurance

A variety of methods are utilized throughout the testing process as a means of ensuring product quality. Atmel's abnormal lot control program is heavily entrenched in the flow as statistical data is continuously updated and used to identify rogue lots. Once an abnormally yielding lot has been identified, product engineering conducts a thorough investigation in order to determine the root cause. Statistical correlation analysis is conducted between final test yields and wafer fab parameters in order to track and eliminate any undesirable process influences.

Quality Assurance Inspection

Final Quality Assurance Inspection is being conducted at the end of the process to ensure product quality. This is through document verification to ensure that the lot or product passed through the required processes. Likewise, Visual/Mechanical Inspection is performed to check that the product is in conformance with the visual and mechanical requirements. The Quality data like Average Outgoing Quality (PPM) from the results of Final Quality Assurance inspections are use to identify and implement corrective actions and to drive continuous improvement.

Shipping Quality Inspection

Shipping or Outgoing Quality Inspection is being performed when there is a customer order. Quality Inspector verifies that the parts marking, quantity and shipping labels correspond with the information contained on the delivery note. Also, special instructions, if any, are being checked to ensure that they were followed prior shipment.

Global Quality Policies

Global Quality Policies

Purpose

To ensure that stringent product quality and reliability expectations are integrated throughout the company, Atmel® has established global-wide quality policies. Each policy serves as the governing document within each site's local document control system. The following policies are currently in effect:

Quality Manual

This document is patterned after the ISO and TS Quality Systems Standards and provides detailed information about Atmel implementation.

Reliability Qualification Methodology

This document defines the tests and procedures that are used for reliability qualification of products, fab process technologies, and assembly/packages.

Reliability Monitor Program

This standard defines the requirements for monitoring the reliability of Atmel products, process technologies, and assembly/packages after release to production.

Return Material Authorization (RMA) and Failure Analysis(FA) Request Policy

This policy applies to all complaints, failure analysis, and return material authorizaiton request from the field.

Product Change Notification and End-of-Life Policy

This policy outlines the Atmel Customer Notification Policy for Product/Process Change Notification (PCN) and Product End-of-life.

Date Code

This policy outlines the minimum acceptable topside date code requirements for shipping product to end customers or distributors.

Customer Document Review

This document specifies the global policy and procedure for customer document review.

Business Recovery

This policy outlines requirements for a Business Recovery Plan that will mitigate effects to our customers of an unforeseen emergency or disaster.

Automotive Product Requirements

This document defines the policies, methodologies, quality, and reliability systems requirements for all Atmel products targeted for the automotive market.

Wafer Foundry Quality Assurance Agreement

This document defines the policies, methodologies, systems, and practices for any wafer foundry engaged by Atmel.

Change Management Policy

This policy defines the processes, responsibilities, and approval rules for change management.

Going forward, this list of policies will continue to grow as we strive to standardize best practices across all Atmel facilities.

Atmel Corporation
2325 Orchard Parkway
San Jose, CA 95131
USA
Tel: (+1)(408) 441-0311
Fax: (+1)(408) 487-2600
www.atmel.com

Atmel Asia Limited
Unit 01-5 & 16, 19F
BEA Tower, Millennium City 5
418 Kwun Tong Road
Kwun Tong, Kowloon
HONG KONG
Tel: (+852) 2245-6100
Fax: (+852) 2722-1369

Atmel Munich GmbH
Business Campus
Parkring 4
D-85748 Garching b. Munich
GERMANY
Tel: (+49) 89-31970-0
Fax: (+49) 89-3194621

Atmel Japan
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
JAPAN
Tel: (+81)(3) 3523-3551
Fax: (+81)(3) 3523-7581