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## Revision History

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<tr>
<td>17.10.20</td>
<td>00</td>
<td>Quality Handbook Rev00</td>
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1. Quality Policy

Samsung Memory Division (“Samsung”) is continuously striving to achieve the best quality in all products and services in order to meet customers’ requirements and expectations. It is Samsung Quality Policy, based on an effective quality management system to ensure delivery of the best products and services.

2. Quality Management System

The Samsung’s Quality Management System (QMS) meets the requirements of ISO 9001, ISO/TS 16949 and also our customers’ requirements. The manager of the quality team sets annual quality goals to execute the quality policy and the activities with respect to the quality policy. Goals are shared with all levels of management involved with the quality management system.

2.1 Certifications

All domestic and overseas semiconductor sites have acquired the ISO 9001 certification. The memory business acquired the QS 9000 in 2002. Samsung has led the industry in quality standards for the semiconductor industry since 1993 when the company first received top-level (ISO 9001) certification of its plants in Korea. To date, Samsung has by far satisfied consumer requirements through its broad range of quality management system certification such as ISO 9001 and ISO/TS 16949.

Certificate Milestones

- 1993 ISO 9001 for semiconductor plants in Korea
- 1999 ISO 9002 for semiconductor plants in Austin, Texas and Suzhou, China
- 1999 QS 9000 for System LSI plants in Korea
- 2001 TL 9000 for semiconductor plants in Korea
- 2002 QS 9000 for memory plants in Korea
- 2004 ISO/TS 16949 for semiconductor plants in Korea → Substituted TS 16949 for QS 9000
- 2005 ISO/TS 16949 for semiconductor plants in Suzhou, China
- 2008 ISO/TS 16949 for semiconductor plants in Austin, Texas
- 2014 ISO 9001 for semiconductor plants in Xian, China

Implementation History

<table>
<thead>
<tr>
<th>ISO/TS 16949</th>
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<tr>
<td>Korea - Kiheung, Hwaseong, Onyang</td>
<td>USA - Austin</td>
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<tr>
<td>Design, Fabrication, Assembly and Test of Memory, System LSI Semiconductor</td>
<td>Assembly and Test of Semiconductor</td>
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<td>China - Suzhou</td>
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<td>China - Xian</td>
<td>Fabrication of Memory Semiconductor</td>
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2.2 Quality Documentation System

The objective of Samsung's quality management system is to establish and maintain a documented quality system which is defined to ensure that the products and process conform to specified requirements and meet the requirements of ISO 9001 and Automotive requirements. All employees are committed to the concept of “No Spec, No Work” and performing all applicable quality improvement activities on a continuous basis. Samsung's quality documentation system is comprised of a document structure hierarchy.

The purpose of the Quality Manual is to specify the requirements of the quality management system of Memory Business in order to satisfy the requirements of ISO/TS 16949, statutory and regulatory requirements as well as customers’ requirements and to ensure that all members of the organization involved in the quality management system implement the quality policy.

Procedure describes role and responsibility and work processes by each department to implement the quality management system components.

Instruction describes skills and methods that are needed to implement the work processes defined by the procedure.

2.3 Audit Program

Samsung has set up and is operating the Audit Program by each manufacturing site, to upgrade the level of the quality management systems by creating a desirable culture of objective diagnosis and improvement.

Memory business has organized quality teams for the purpose of auditing quality management system to insure that the policies and specifications set forth by the company are followed. There are different audits performed at the manufacturing site on a routine and non-routine basis.

Preventive Audit

The preventive audit is performed on a regular basis. The purpose of this type of audit is to insure that major department throughout the division follows the general policies of the company, and the division follows the general policies of the company that concern the quality management system for Memory business. If any problems are found, the department is cited and required to produce a corrective action.

Non-scheduled Audit

This audit is performed on a random basis unannounced to check process areas and their personnel for their conformance to company quality policies and/or specifications. Operators and equipment as well as the process itself will be audited at this time. Typically the audit is requested when a problem arises in a process. If any problems are found, then the department is cited and required to produce a corrective action.

2.4 Continuous Efforts

Samsung makes every effort to achieve excellent and consistent product quality at fair prices, and at the right time to ensure customer satisfaction. In order to achieve this goal, Samsung continuously improves productivity by controlling the variation in various processes in a stable way. Continuous improvement is implemented by a closed loop methodology consisting of a selection of critical parameters, evaluation of the measurement system, monitoring of critical parameters, process capability improvement, and reaction plan. The main purpose of the CIP activities is minimizing the variation around the target.
Real Time Monitoring (Activities for Special Causes)

**Interlock System**: Products and processes are monitored and controlled by automatic interlock systems throughout the manufacturing process. In FAB, a three stage protection system is working: Process Recipe Interlock (Incoming Materials and Recipe Check), Equipment Parameter Interlock and Process Output Interlock. At wafer sort, wafers are statistically monitored based on various test results and yields before assembly.

**Statistical Process Control (SPC) and Advanced Process Control (APC)**: An advanced SPC system suitable for semiconductor manufacturing processes has been implemented and used for random trend monitoring. It includes small change detecting, particle, and multivariate SPC modules. Also, the APC system including real time control and run-to-run control is successfully used for controlling deterministic process behaviors.

Company-wide Improvement Projects (Activities for Common Causes)

**FAB Equivalency - “Copy Intelligently”**: Samsung Equivalence Test program checks the equivalency and non-equivalency of measurement data of output characteristics from "Copy Intelligently" activities. Its purpose is to lead us to make an action to standardize the output characteristics between lines or equipment.

**Statistical Post Processing**: Statistical analysis of test results at wafer sort not only optimizes test effort but also gives useful information such as potential reliability and yield. With a help of statistical approach, wafers or dies with latent risks can be effectively screened and dies can be binned according to potential risks.

**Virtual Metrology and Modeling**: Virtual metrology is of great interest in semiconductor manufacturing process. The idea is to construct predictive models that can forecast the electrical/physical parameters of wafers based on data collected from processing equipment. In this way, actual measurements from wafers can be minimized or eliminated. Furthermore, the APC combined with virtual metrology will lead to a shift from "Lot-to-Lot control" to "Wafer-to-Wafer control".

**MSA (Measurement System Analysis)**

Measurement System Analysis is performed to quantify statistically the uncertainty of the measurement system (component elements including the measurement environment and sample as well as mechanical devices, measuring methods and people are evaluated. This is to control the stability and integrity of measure of process parameters of product characteristics from both the short and long-term perspective. MSA procedures are as follows:
FMEA (Failure Mode and Effects Analysis)

Failure mode effect analysis is a method used for checking if measures are taken against every possible failure in the design, the manufacturing process, the operating method, etc. For this analysis, factors such as design, manufacturing process, packaging, and operating method are divided into small units, and its functions are clearly defined. All possible failure modes are listed for each item. The effect on the product and the cause of each failure are examined. Each item is then evaluated to clarify the corrective action to be taken. Samsung performs Design FMEA at a stage of design and Process FMEA at a stage of manufacturing stage.

2.5 Nonconforming products control

If nonconforming products (products which deviate from the specified) develop during process, the procedures for handling the nonconforming products and preventing the recurrence thereof require identification, isolation, and corrective actions. The ALPS computer system (ALPS: Abnormal Lots Processing System) is being set up which can handle the notification of nonconforming product occurrence, investigation of the cause, establishment of countermeasures, handling instructions, and approval procedures immediately upon occurrence thereof.
2.6 Calibration

The purpose of calibration is to provide a system whereby, production and test equipment parameters are correlated to Samsung standards via internal and external calibration methods. Calibration of manufacturing and test equipment is the responsibility of the respective process engineering and test engineering departments. It is conducted by either calibration engineering or an external service organization. Equipment used for piece parts, incoming raw material, in-process quality measurement, final acceptance, and batch release of product, require calibration.

Procedure

1) Calibration is conducted by qualified personnel only. Comprehensive specifications for procedural methods are made available for complex instrumentation systems.

2) A calibration record contains reference to:
   a) Operational and calibration status
   b) Frequency of calibration
   c) Dates applicable
   d) Personnel involved

3) In addition to an individual calibration record for each piece of registered equipment, a display chart showing the current calibration status of all registered equipment is maintained.
2.7 Product Regulation Certification

Declarations of Conformity for Samsung

Samsung has gone to great lengths to achieve and maintain compliance with standards and regulations such as CE marking or CB. By complying with industry standards, we are able to quickly adapt to changes in the industry for our customers.

Regulations covered by region:
European Union - CE marking, CB
USA – EMC, Safety certification
Canada, Australia, New Zealand - EMC certification

Other regions:
Certain countries might require extra certifications that are not listed here. For more details or country-specific approvals applicable to the specific product, consult your regional representative.

3. Supplier/Sub-contractor Quality Management

3.1 Material Qualification

This ensures that materials of good quality are supplied by certifying the quality based on procedures concerning materials. Samsung makes its utmost efforts to secure high-quality raw materials from material suppliers to meet manufacturing requirements. To meet material requirements, Samsung operates a material quality management system to ensure raw material quality. The material must satisfy quality and reliability requirements, specification requirements including validation, and yield targets of Samsung.
Prevention: To prevent material-related quality issues, Samsung operates issue preventative tools. Change control board controls and evaluates intended quality changes from suppliers. Failure Mode and Effect Analysis (FMEA) is used as a tool to define potential causes of quality issues and establish effective counterplans in advance. Samsung performs audits on supplier’s overall quality management system and manufacturing process including SCM capacity, purchasing, and storage management.

Detection: To detect material-related quality issues and to control propagation of issues, Samsung uses tools such as material inspection based on statistical process control (SPC), and advanced metrology system. Suppliers are requested to support these process control actions and Samsung offers consultation and training including seminars to suppliers if necessary.

Reaction: Suppliers are responsible for corrective actions following material-related quality issues. Samsung operates Material Review Board to find the true cause of the issues and set-up preventative action plans.
Supplier Qualification
To qualify as a new supplier of Samsung, the certification supervising department evaluates the engineering capability, product stability, and R&D capability by reviewing the documents and may request the necessary supplementary materials from the supplier. Samsung quality audit is carried out based on the vendor quality audit procedures.

Supplier Evaluation
Samsung evaluates quality, technology and purchasing performance of suppliers and vendors in the transaction of primary subsidiary materials. Evaluation department apply Penalty & Incentive rule to Suppliers as negotiation with procurement and quality team.

3.2 Sub-contractor quality assurance (Quality/Engineering)

Sub-contractor Qualification
The System under which a Qual Plan is established when the events requiring subcontractor Qual occur Subcontractor changes requiring Qual are new PKG/new equipment/process/raw materials. The conformity of subcontractor mass production process is subjected to technical review conducted by the Engineering Dept.. The Subcontract Quality Dept. supervises the activities required for evaluation qualification, and approval of a Subcontractor production process.

![Diagram of Qualification Process]

- Qual Required (New PKG/PCN)
- Contents Received & Plan
- Notification of Established Qual Plan
- Prior Technical Review
  - Decision: Pass
- Qual Implementation
  - Decision: Pass
- Reliability Test Conducted
  - Necessary
  - Decision: Pass
- New/Change Applied

[ Figure 3-2 Sub-contractor qual procedure ]
Subcontractor Nonconformity Products Control
Nonconformity product handling (Subcontractor part): Procedure for taking corrective actions for the Lots with yield below the standard due to Device characteristics are established. Test is conducted at Onyang after Assembly of subcontractor semi-finished products. Product which can affect the reliability, quality and Field due to defect caused when process characteristics quality is evaluated.

Subcontractor Rating & Ranking (S.R.R)
Purpose
To conduct a periodic and an objective evaluation of all activities of subcontractors related to the quality to ensure efficient and systematic control of all subcontractors of Samsung, thereby improving the quality level of subcontractors through actions for business and follow-up control based on the rating & ranking by quality evaluation.

Evaluation method
Absolute evaluation by 5 Ratings & Rankings (A-E) weighted per item by category of items related to the quality activities.
Items: Quality audit, Process nonconformity, Customer complaint, CIP, CPK etc.

Follow-up actions per rating & ranking by evaluation
Depending on the rating and ranking by evaluation (A-E), follow-up actions including but not limited to adjustment of subcontract volume for the next year’s subcontract agreement, extension of agreement duration, and support for quality improvement would be taken to encourage subcontractors to make continuous quality level improvement.

4. Customer Service

4.1 Customer Satisfaction
For customer satisfaction, Samsung regards interactions with our customer as the highest priority and performs a variety of technical and proactive quality collaborations such as Qualification Support, Quality Improvement, and Problem and Requirement Management. Having its newest long-term master plan for “Quality Design” in place, Samsung will create a symbiotic business environment to ensure the Highest Quality of Customer Service.

VOC Management
Samsung actively listens to the voices of customers using various channels, including R&R, periodic quality review meetings, or surveys or interviews on specific customers, and analyzes the obtained data in an effort to provide customers with products and services of the highest quality by driving a sustainable quality innovation movement.
4.2 Claim Management
This flow demonstrates the failure analysis procedures for maximization of customer satisfaction which starts from receiving quality claims, analyzing them, devising countermeasures to taking corrective actions by exactly identifying customer dissatisfaction with the products and thus effectively handling claims and preventing the recurrence of the same problem, thereby securing good product quality and credibility.

4.3 RMA
(Return Material Authorization)
This is a series of steps by which problems that may occur with Samsung’s products that have already been shipped to customers or warehoused for shipping are being identified and handled promptly. The objective is to minimize quality issues by responding to customer’s quality-related requests quickly and timely.
Recall

This refers to a process by which Samsung notifies its branches or customers of any quality issues found by its internal quality monitoring system. In rare cases, Samsung will have its branches or customers to return products with quality issues to the designated places to take care of such quality issues effectively.

4.4 PCN (Process Change Notification)

Product/Process changes allow Samsung to improve product quality and manufacturing efficiency as well as customers‘ flexibility. These changes can include new or different types of materials, designs or processes. Samsung has a PCN procedure for any major or critical changes to its process. By following this procedure, the customer is able to be notified before any major or critical change is made to the process.

![PCN Procedure Diagram]

[Figure 4-4 PCN Procedure]
<table>
<thead>
<tr>
<th>Terminology or Abbreviations</th>
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<td>QMS</td>
<td>Quality Management System</td>
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<tr>
<td>SPC</td>
<td>Statistical Process Control</td>
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<tr>
<td>MSA</td>
<td>Measurement System Analysis</td>
</tr>
<tr>
<td>FMEA</td>
<td>Failure Mode and Effects Analysis</td>
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<td>ALPS</td>
<td>Abnormal Lots Processing System</td>
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<td>NIST</td>
<td>National Institute of Standard Technology</td>
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<tr>
<td>IAA</td>
<td>Industrial Advancement Administration</td>
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<tr>
<td>KRISS</td>
<td>Korea Research Institute of Standards &amp; Science</td>
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<td>APC</td>
<td>Advanced Process Control</td>
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<td>TRM</td>
<td>Technical Review Meeting</td>
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<td>OQC</td>
<td>Outgoing Quality Control</td>
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<td>IQC</td>
<td>Incoming Quality Control</td>
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<td>CAR</td>
<td>Corrective Action Request</td>
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<td>SRP</td>
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<td>FA</td>
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<td>RMA</td>
<td>Return Material Authorization</td>
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<td>Product/Process Change Notification</td>
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