Explanation of the late President Kanjiro Okada’s motto

“Quality speaks for itself—no matter where you go”

In 1966, Fujitsu began a companywide movement to ensure high levels of quality and reliability. During its preparation, then-president Kanjiro Okada stated that “Suppressing costs and meeting deadlines is important, but these are meaningless if the quality is not good. Quality precedes everything.” This statement summarizes Fujitsu’s unswerving commitment to quality.
By employing leading-edge production technologies, we have earned an excellent reputation in Japan and overseas for the quality and reliability of our semiconductor devices. This reputation has been earned through tireless efforts to ensure the quality and reliability of our products. We concentrate in particular on these three aspects of our people, processes and products.

**The People**

Ensuring Quality through Personnel Training
Not only are our staff members highly skilled in all aspects of process management and control, they are also totally dedicated to achieving the highest standards of quality and reliability.

**The Process**

Paying Attention to Quality at Every Stage
Maintaining optimal conditions throughout the production process is the key to providing semiconductor devices with consistently high yield rates and quality levels. To ensure that we meet our quality goals, we perform stringent quality checks at each stage of manufacturing from product planning through to final delivery.

**The Products**

Guaranteeing Reliability throughout Many Segments of Society
Our extensive expertise as a leading provider of computers and telecommunications equipment enables us to develop products that meet a variety of customer needs. We seek to contribute to diverse segments of society by providing highly reliable products created from highly reliable semiconductor devices.
The Key to High Levels of Quality and Reliability

Personnel Training
At FUJITSU SEMICONDUCTOR, we believe that people are the most important element in our efforts to ensure quality and reliability. To achieve these goals, we provide extensive and continual personnel training at every level and in each department. Our goal is to train people to think creatively and to turn their ideas into products.

Qfinity Activities
The word “Qfinity” is made by combining “Quality” and “Infinity,” and reflects our commitment to pursuing infinite quality. The purpose of our Qfinity activities is to enhance the value of the Fujitsu brand and to further tie the mutual relationship for trust with our customers by undertaking significant improvements to the quality of our products and services. To this end, all employees in the Fujitsu Group make extensive use of IT to obtain data as a basis for reforming processes, and for improving not only the function and reliability of products, but also customer support, delivery, and costs.

Quality Control Education and Training
FUJITSU SEMICONDUCTOR employees receive quality control education and training in which they learn how to improve product quality by employing consistent quality goals. This training also helps to improve overall employee morale. In addition to performing regular quality control checks at each product stage, each employee is given the opportunity to independently apply their training results to perform autonomous self-checks, with the aim of ensuring quality and reliability and of identifying nonconforming products as rejects early on.

Overall Training System

QA Department Training for New Employees

<table>
<thead>
<tr>
<th>Training Type</th>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Training</td>
<td>Company Outline</td>
<td>Organization and Positioning of the QA Division</td>
</tr>
<tr>
<td></td>
<td>Outline of Semiconductors</td>
<td>Operations and Types of Semiconductors, Semiconductor Production Processes, Handling of Semiconductors</td>
</tr>
<tr>
<td></td>
<td>Quality Control (QC)</td>
<td>Concept of Quality Control, Explanation of Quality and Reliability, Explanation of Inspection</td>
</tr>
<tr>
<td></td>
<td>Explanation of Safety and Sanitation</td>
<td>Handling of Chemicals, Points to be Considered During Work</td>
</tr>
<tr>
<td></td>
<td>Qfinity Activities</td>
<td>Outline of Activities</td>
</tr>
<tr>
<td></td>
<td>Explanation of Standardization</td>
<td>Need for Standardization, System of Standardization</td>
</tr>
<tr>
<td></td>
<td>Quality Management Systems</td>
<td>Internal Quality Systems/ISO 9000 series, etc.</td>
</tr>
<tr>
<td></td>
<td>Environmental Management Systems</td>
<td>ISO 14001 Series and Fujitsu Environmental Management Systems</td>
</tr>
<tr>
<td>QIET</td>
<td>Inspection</td>
<td>Basic Knowledge, Inspection Based on Specifications</td>
</tr>
<tr>
<td></td>
<td>Training in Areas Other Than Inspection</td>
<td>How to Summarize Data, Defect Analysis, SPC, Completion Control</td>
</tr>
</tbody>
</table>

* LTC: LSI Technical Center
* HR: High Reliability
* VE: Value Engineering
* CF: Customer Focus

FUHITSU Development of Fujitsu Brand
Qfinity

Conventional Activities
*HR, VE, CF, etc.
Existing System
Goal Management, Education, Knowledge Management, etc.
New System
New Business Model
- New Manufacturing -

High Level Customer Liaison

4 Quality & Reliability

5 Quality & Reliability
Integrated Manufacturing Management to Ensure Quality Semiconductor Devices

Organization to Ensure Quality and Reliability

FUJITSU SEMICONDUCTOR’s system for ensuring the overall reliability of semiconductor devices involves the allocation of responsibility to every department engaged in a product’s development and manufacture, including technologies and manufacturing processes and the control of materials. The Quality Assurance Division controls this overall system. Quality assurance departments at each of FUJITSU SEMICONDUCTOR’s manufacturing plants interact with the Quality Assurance Division which functions as the overall center for assuring quality and reliability.

Areas of Responsibility

To assure high levels of reliability, the department is charged with the following responsibilities.

Table of task assignments by division

<table>
<thead>
<tr>
<th>Task</th>
<th>Development</th>
<th>Design, Process, Assembly and Testing Department</th>
<th>Design Review Department</th>
<th>Manufacturing Process Control</th>
<th>QA Engineering and Reliability Department</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reliability Design</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Process Development</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Design Review</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Mass-Production Engineering Approval Testing</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Production</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Quality Assurance Department</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>QA Department</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Manufacturing Department</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>QA Department</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Facility Engineering Department</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>QA, Manufacturing and Testing Departments</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>Reliability Warranty and QA Departments</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
<tr>
<td></td>
<td>All Departments</td>
<td>Design, Process, Assembly and Testing Department</td>
<td>Design Review Department</td>
<td>Manufacturing Process Control</td>
<td>QA Engineering and Reliability Department</td>
</tr>
</tbody>
</table>

Organization of the Quality Assurance Division

- Quality Assurance Division
  - Reliability and Quality Management Department, Akiruno Technology Center
  - Quality Assurance Department, Mie/Aizuwakamatsu Subsidiary Company Quality Assurance Departments
    - FUJITSU INTEGRATED MICROTECHNOLOGY LTD.
    - FUJITSU SEMICONDUCTOR TECHNOLOGY INC.

Legends

- Basic route
- Assist route
- Information route

Quality Assurance System Structure

- Customer
- **Sales Department
- Development/Technology
- Design, Process, Assembly and Testing Department
- Design Review Department
- Engineering and Reliability Department
- Manufacturing Process Control
- QA Engineering and Reliability Department
- QA Department
- Manufacturing Department
- QA Department
- Facility Engineering Department
- QA, Manufacturing and Testing Departments
- Reliability Warranty and QA Departments
- All Departments

- Quality Assurance System Structure
  - Process Planning
    - Development
      - Reliability Design
      - Process Development
      - Design Review
      - Mass-Production Engineering Approval Testing
    - Production
      - Purchasing and QA Departments
      - Manufacturing Department
      - QA Department
      - QA Department
    - QA Department
  - Design Verification
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Technical Review
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Field Evaluation
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Establishing Engineering Standards
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Mass Production Review (DR4)
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Establishing Manufacturing Standards
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Initial Shipping Control
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Mass Production Stability Review (DR5)
    - Design, Process, Assembly and Testing Department
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Component and Material Information
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Quality Assurance Information
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - Quality Assurance Information Related to Manufacturing
    - Manufacturing Department
    - QA Department
    - Facility Engineering Department
    - QA, Manufacturing and Testing Departments
    - QA Department
    - Manufacturing Department
  - **Sales Department

*Sales Department of FUJITSU ELECTRONICS INC.
Ensuring the Quality and Reliability of Semiconductor Devices

Quality and Reliability Management Program

We are responding to developments such as increasing degrees of integration with a shortened development time for our semiconductor circuits. In addition to reducing development time at each stage, we are also committed to bolstering quality and reliability. Semiconductor product quality efforts begin at the planning stages. Customer requirements identified by market surveys are incorporated into product planning and reflected in product quality efforts. Compiling this information enables us to begin development with clearly established quality and reliability standards, schedules and systems for development.

Design Review Flowchart

The following flowchart illustrates our processes for evaluating and verifying our semiconductor devices:

1. Market Research
   - Product Definition & Development Planning
2. Product Design
   - Technology/Basic Design Verification
3. Pilot Circuit Fabrication
   - FMEA
4. Pre-Mass Production
   - Design FMEA
5. Mass Production
   - Fabrication
   - Pre-Mass Production
   - Mass Production

Verification of Product Planning

Before mass production, product evaluations and product qualification tests are conducted on the new product. Methods of application, required characteristics, target quality, and target reliability are all determined on the basis of this survey. The planning and development planning of a product determined through this process is evaluated in DR0.

Verification of Technology and Basic Design

The technology used for a new product is evaluated using basic product designs and pilot circuits. These basic product designs and pilot circuits are ultimately evaluated in DR1.

FMEA (Failure Mode and Effects Analysis)

Through the incorporation of FMEA in product design and processes, the generation, detection, and effects of all possible failures and their causes are evaluated under ten items. A risk index is formed by combining the values recorded for each item. Corrective measures are then undertaken starting with the item with the highest value. FMEA is both a corrective and preventative process used to confirm the implementation of measures designed to deal with anticipated faults.

<table>
<thead>
<tr>
<th>Example of FMEA Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Failure Mode</strong></td>
</tr>
<tr>
<td>Hardware malfunction</td>
</tr>
<tr>
<td>Software error</td>
</tr>
<tr>
<td>Power supply failure</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Design Review

In each step of the design review, we objectively evaluate product quality including functionality, cost, marketability, reliability, form, packaging and delivery time. A specialized team identifies potential problems in each phase of development, and makes changes accordingly.

The Design Review that is part of FUJITSU SEMICONDUCTORS’ Quality Assurance Program consists of five steps:
1. Developing Planning Review (DR0)
2. Technical Review (DR1)
3. Product Review (DR2)
4. Mass Production Review (DR3)
5. Mass Production Stability Review (DR4)

Example of FMEA Sheet

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Possible Failure Effects</th>
<th>Failure Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware malfunction</td>
<td>System failure</td>
<td>High</td>
</tr>
<tr>
<td>Software error</td>
<td>Process error</td>
<td>Medium</td>
</tr>
<tr>
<td>Power supply failure</td>
<td>Memory failure</td>
<td>Low</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example of FMEA Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Failure Mode</strong></td>
</tr>
<tr>
<td>Hardware malfunction</td>
</tr>
<tr>
<td>Software error</td>
</tr>
<tr>
<td>Power supply failure</td>
</tr>
</tbody>
</table>
Reliability Test
Process Qualification
To ensure the reliability of newly developed technologies, we conduct process qualification using TEGs (Test Element Group)*. A group of elements used to identify and measure specific failure modes.

These tests are categorized as process technology qualifications.

Engineering Tests
At the early stage of pilot production, reliability assessments are performed as necessary. TEGs that resemble the actual product are used to identify technical problems and provide feedback prior to mass production.

Moisture Sensitivity Level
In general, when resin components of plastic packages that have absorbed moisture are subjected to heat stress during mounting, cracks can develop in the packaging. For plastic surface mount devices, we examine moisture-induced stress sensitivity tests as necessary. Based on the results of these assessments, packages are classified by moisture sensitivity, and customers are notified of recommended mounting conditions to counter heat stress during mounting.

Electromigration
- Wiring material, structure, current density
- Constant density, temperature

Stress migration
- Wiring material, structure, current density
- Temperature, stress

Hot carrier injection
- Transistor structure, distribution of impurities
- Temperature, stress

Gate oxide integrity
- Structure, oxide film characteristics
- Electric field, temperature

NBTI
- Transistor structure, oxide film characteristics
- Electric field, temperature

Table: Production Qualification Tests
<table>
<thead>
<tr>
<th>Test Item</th>
<th>Purpose of the test</th>
<th>Related standards</th>
<th>Launching of new process technologies</th>
<th>Circuit technology</th>
<th>Conformance to international standards and packaging technology</th>
<th>Test executes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSO* 125°C</td>
<td>Evaluates the resistance property of the device after electric and thermal stresses are applied to the device for a long time.</td>
<td>MIL-STD-883  1005, 40017C</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>HSO* 85°C, 85%RH</td>
<td>Evaluates the resistance property of the device when the device is operated in a high temperature, high humidity environment.</td>
<td>EIAJ ED-4701/00, JESD22-A114</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>T-Cycling* -45°C to 155°C</td>
<td>Evaluates the resistance property of the device under high-temperature and low-temperature stress.</td>
<td>MIL-STD-883  1010, 1011</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>PCT-Bias 121°C, 100%RH</td>
<td>Evaluates the resistance property of the device under high-temperature and high-humidity environments.</td>
<td>JEITA C6174, JESD22-A115</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>PCT-Bias 121°C, 100%RH</td>
<td>Evaluates the resistance property of the device under high-temperature and high-humidity environments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTH* -55°C</td>
<td>Evaluates the resistance property of the device under low-temperature and high-humidity environments.</td>
<td>MIL-STD-883  1010, 1011</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>HST 150°C</td>
<td>Evaluates the resistance property of the device under high-temperature stress.</td>
<td>MIL-STD-883  1010, 1011</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>Thermal shock 0°C to 100°C</td>
<td>Evaluates the resistance property of the device under rapid thermal changes.</td>
<td>MIL-STD-883  1005, 1011</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>Mechanical Sequence (Vibration, shock, constant acceleration)</td>
<td>Evaluates the resistance property of the device under mechanical environments.</td>
<td>MIL-STD-883  1005, 1011, 40017C</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>ESD-1 (HBM)</td>
<td>Evaluates the resistance property of the device under electrostatic discharge damage handling.</td>
<td>MIL-STD-883  3015, 40017C</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>ESD-2 (MM)</td>
<td>Evaluates the resistance property of the device under electrostatic discharge damage handling.</td>
<td>MIL-STD-883  3015, 40017C</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>Latch-up</td>
<td>Evaluates the resistance property of the device in latch-up conditions.</td>
<td>MIL-STD-883  1005, 1011</td>
<td></td>
<td></td>
<td></td>
<td>0 ≤ E1 ≤ E3</td>
</tr>
<tr>
<td>Thermal Characterization</td>
<td>Evaluates the resistance property of the device in extreme temperature, room temperature, and high temperature.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For surface mount devices, thermal stress is applied prior to testing.

Qualification Family Representative Assessments
The following technical items are taken into account in determining qualification families and representative products:

- Process technologies
- Design rule
- Materials used
- Structure
- Assembly technologies
- Design rule
- Materials used
- Structure
- Circuit technology
- Process technology and packaging technology combinations

The sample size and items test for reliability are determined according to the newness of the technology and testing purposes (refer to table below).
Screening
As illustrated in Figure 1 (p13), the failure rates for LSIs follow a ‘bathtub curve.’ Even though ensuring quality at each stage of the production process and a range of tests and inspections eliminate most causes of failure, it is possible that some may persist. FUJITSU SEMICONDUCTOR’s reliability screening eliminates potential early faults. Conducted prior to shipping, it involves the application of stress at a level that will not damage the product in question.

Burn-in
Burn-in is effective as a reliability screening to reject the early failures. In our factories, we strive for improvement in the everyday quality of our products. When the burn-in failure rate has been reduced to a certain level, we reduce the time required for burn-in, and eventually, eliminate it all together. Even after burn-in has been eliminated, products will be periodically sampled for burn-in to assure product quality.

Reliability Monitoring Tests
Once mass production begins, products are periodically monitored to confirm the uniformity of quality and reliability. Tests to monitor reliability are performed on representative samples from each production line.

FIT Rate
A failure rate is defined as ‘The rate at which an item which has been operated up to a particular point in time will bring on a failure within a specific unit of time’ in the JIS Z8115.F26. The Figure 1 shows it as a bathtub curve. The time process of failure is divided into 3 periods; Early Failure Period, Random Failure Period, and Wearout Failure period. The failure rate of LSIs is in general described in the random failure period. The forecasted failure rate is obtained by the formula in Figure 2, using accelerated test data taken from qualification tests and reliability monitoring tests.

Example of Reliability Monitoring Tests (Test Items and Test Samples)

<table>
<thead>
<tr>
<th>Test Conditions</th>
<th>Wafer Process</th>
<th>Assembly (Plastic Package)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTOL 150°C</td>
<td>46</td>
<td>—</td>
</tr>
<tr>
<td>THB 85°C, 85%RH or PCT Bias 121°C, 100%RH</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td>3-Cycling: 45°C/95°C</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>PCT 121°C, 100%RH or PCT 134°C, 85%RH</td>
<td>46</td>
<td>46</td>
</tr>
</tbody>
</table>

Figure 1: Reliability Bathtub Curve

Figure 2: Failure Rate Calculation Method

\[
\lambda = \left( \frac{\gamma}{n \times t \times Kt \times Kv} \right) \times 1 \times 10^9 \text{ [fit]}
\]

\[
Kt = \exp\left[\frac{Ea}{k} \left( \frac{1}{T1} - \frac{1}{T2} \right) \right]
\]

\[
Kv = 10^{(E1-E2/Ea)}
\]

<table>
<thead>
<tr>
<th>Table 1:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Failures</td>
<td>0</td>
</tr>
<tr>
<td>Coefficient γ</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Ensuring the Quality of Semiconductor Devices

Quality Programs
To ensure the quality of our semiconductor devices, we perform inspections of each manufacturing process. We perform a broad range of efficient process controls and inspections of the manufacturing process to assure that all products achieve the quality and reliability levels established at the design stage. The results of these tests are evaluated using statistical methods, and feedback is provided to the manufacturing process.

Example of Quality Control Flowchart

Incoming Inspection
Quality assurance departments perform incoming inspection of materials at the time of procurement. This inspection helps guarantee the quality of products that we purchase.

In-Process Inspections
Quality assurance departments perform these inspections to set control items and standards for each manufacturing process. Prompt feedback maintains and improves the quality consciousness throughout the groups. Inspections occur regularly for each lot and/or production line.

In-Process QA Inspection
The Quality Assurance Groups perform inspections at the end of each manufacturing phase. Using the sampling standards, the groups confirm the level of quality before the products proceed to the next phase.

Statistical Process Control (SPC)
SPC is performed for especially important parameters in the manufacturing processes. Engineering groups set the major quality parameters and their specified values for the manufacturing processes to assure proper quality. The manufacturing groups determine control values for production process equipment and conditions. Once mass production begins, the manufacturing groups implement control plans to check and improve the product capability of each process. Some important parameters are critical dimensions, monitor characteristics, bonding strength, electrical characteristics and yield. Computer software checks each parameter automatically.

Note: The quality control flowchart uses a plastic package as a representative sample. Some tests and inspections may not be applicable to all product categories.
Maintaining the Quality and Reliability of Semiconductor Devices

Quality and Reliability Support

Inspection and testing are vital parts of semiconductor production. Yet they cannot guarantee absolute quality and reliability. Control of environment and equipment in the manufacturing process is equally important.

Equipment Maintenance

The maintenance of the manufacturing equipment is another important aspect of maintaining product quality. At FUJITSU SEMICONDUCTOR, each piece of production equipment is regularly inspected according to stringent control standards. Each plant’s equipment maintenance group regularly calibrates all instruments used for measurements and inspections. Control ledgers record the results of the calibrations. Each piece of production equipment bears a label showing the deadline for the next calibration. Only experienced specialists calibrate the measuring instruments. The standard equipment used for the calibration is calibrated with a traceability system based on Japanese government standards.

Measurement Standards Traceability System

- National Institute of Information and Communications Technology
- National Institute of Advanced Industrial Science and Technology
- FUJITSU Facilities Measuring Device Service
- Fujitsu Electric Meters Inspection Corporation
- Japan Electric Meters Inspection Corporation
- Manufacturers
- Factory Weights and Measures Control Office
- On-site Measuring Devices

Measurement System Analysis (MSA)

Control of inspection and testing equipment. Measurement and testing equipment are used for tests and inspections that verify that semiconductor devices meet the required specifications. From the time of introduction, equipment is controlled daily and also undergoes regular calibration.

- Daily inspection and regular calibration.
- The cycle for regular calibration is determined separately for each piece of equipment and ranges from every six months through to every 24 months. Equipment is calibrated with a traceability system based on international standards.
- Daily inspection cycles are also determined separately for each piece of equipment.

- Measurement System Analysis
- At FUJITSU SEMICONDUCTOR, we conduct measurement system analysis in order to analyze potential variations in measuring devices. We also ensure that gage repeatability and reproducibility and measurement system analysis correspond to process capabilities.

Examples of Procedures to Control ESD

- **Floors**: Use antistatic flooring materials with a surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω or antistatic mats.
- **Bench tops**: Use work surfaces with a surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω.
- **Chairs**: Use chairs with a resistance to ground of $1 \times 10^{5}$ to $1 \times 10^{8}$ Ω.
- **Storage shelves**: Store wafers in boxes. Shelves are either grounded or have charge voltage of less than $300$ V.
- **Work clothes, dust proof clothes**: Use antistatic clothes with surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω.
- **Antistatic shoes**: Use antistatic shoes that meet the following specification: Surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω.
- **Wafer process**: Use antistatic mats to shelves and ground to floor (resistance to ground of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω).

Environmental Control

The manufacturing environment greatly affects the quality and reliability of semiconductors. To maintain consistent product quality, we strictly control temperature, humidity, dust levels and water purity at every phase of manufacturing. We impose rigorous standards on each item and regularly monitor every aspect of the environment. We also impose control standards for product storage.

Electrostatic Discharge (ESD) Controls

The structure of semiconductors makes them extremely sensitive to static electricity. At FUJITSU SEMICONDUCTOR, we design our integrated circuits to be as resistant to static electricity as possible. We also take extensive measures to reduce static electricity throughout the manufacturing process.

Shipment Control (Moisture Absorption Control)

We use moisture-protective packing for our semiconductor devices according to moisture sensitivity level, because resins are highly subject to moisture damage during the mounting process of surface-mounted packages. Labeling provides information about the moisture sensitivity level of each product.

- **Equipment**: For electrically powered equipment, use grounded equipment.

Environmental Control (Central Surveillance Center)

**Wafer Process**

- Apply antistatic mats to shelves and ground to floor (resistance to ground of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω).

**Assembly Process**

- Use grounded shelves with a surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω.

**Test Process**

- Use antistatic shoes that meet the following specification: Surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω.

**Examples of Procedures to Control ESD**

- **Floors**: Use antistatic flooring materials with a surface resistance of $1 \times 10^{10}$ to $1 \times 10^{11}$ Ω or antistatic mats.
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Control of Components, Materials and Suppliers
The quality of our products begins when we select the raw materials and components. Our raw material control follows the three steps below:
1. The engineering group performs the basic examination of the products for their physical and chemical characteristics.
2. QA groups perform reliability evaluation.
3. Audit component manufacturers’ factories and certify those having good quality. This is followed by regular auditing for maintaining and improving quality.

In-Process Troubleshooting
Whenever a problem arises that might affect the quality and reliability of the manufacturing process, the Quality Assurance Division immediately investigates the cause and implements countermeasures to correct the problem. The Division also confirms the effectiveness of countermeasures.

Design and Process Changes
We maintain controlled specifications that define the procedures for process changes and notifications to customers. The proposed process changes should follow the internal PCN specifications, and be reviewed by a committee formed of members from the quality assurance department, the department where the change originated and any other related departments. Changes are classified by the specific categories, and a major change should be reviewed and approved by the manager of QA division before the implementation of the change. We always customer notification in advance of changes affecting form, appearance, function, quality or reliability.

Supplier Management Flow
- Select suppliers
- Evaluate technologies
- Evaluate quality
- Certification judgement
- Mass production
- SPI (Supplier Performance Review)
- • Organization finance status
  • Supply capacity
  • Cost + DI
- • Technological evaluation
- • Reliability evaluation
- • Certification audit
- Judgment of technological evaluation, reliability experimental results, and certification audit results
- • Quality
  • Cost and productivity
  • Confidentiality and environment

Traceability
We maintain complete records for incoming material and components that cover all processes through to shipment to allow identification and traceability in the event of a quality-related problem occurring on the market or during processing. An integrated database enables traceability from wafer process through to assembly, testing, and shipment. All products are marked with lot numbers at time of shipment, allowing their production history to be traced.

Document Management
FUJITSU SEMICONDUCTOR’s standards govern all specification sheets. The group responsible for specifications prepares and revises each document. The Document Management Group is responsible for registering, distributing and maintaining specification sheets. This workflow and the responsible group, which has the overall control over documents, keep the spec sheets updated.

Ensuring Continuous Improvement
We set objectives for continuous improvement in quality, cost and delivery. Joining forces to enhance quality and reliability, we meet customers’ demands through a comprehensive quality improvement campaign.
1. Improvement with in-process data
2. Customer’s feedback
When implementing improvement plans, we use statistical and QC techniques. In addition, we regularly measure customer satisfaction and incorporate the findings into our future improvement plans. Furthermore, we set and strive to achieve goals for continuous improvement plans.

Flowchart of Design Changes and Process Changes
Failure Analysis and Identification of Root Causes
Each of our factories not only monitors for faults during the production process, but also monitors the results of wafer probing tests and final testing of completed products, and analyzes the causes of defective products. These results are then used as feedback to the production process. Furthermore, the results of analysis of defective products that are actually returned from our customers are essential for preventing the malfunctions that occur for customers. The measures are also distributed to areas where similar problems may occur.

Internal Quality Auditing
At each plant, the following three types of audits are carried out periodically by the Quality Assurance Department.
- **Quality Management System (QMS) Audit**
  Conducted with the purpose of verifying the compatibility with QMS requirements and validity of rating requirements, department-specified requirements, customer requirements, legal regulation requirements that apply in relation to the product, etc.
- **Manufacturing Process Audit**
  Conducted to inspect the validity of the manufacturing process based on the documentation at the production factory such as control plans, process flowcharts, work standards, process FMEA, etc.
- **Product Audit**
  Conducted with the aim of verifying that the product meets the requirements at the appropriate stages during production and handover.

Third Party Certifications
In relation to third party certifications of the quality management system, the following support is given for ISO9001 and for automobile-related ISO/TS16949 to support European automotive customers.

![Third Party Certifications](image)

<table>
<thead>
<tr>
<th>Plant name and Office</th>
<th>Certification obtained</th>
<th>Registration date</th>
<th>Certification number</th>
<th>Certifying institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akiruno Technology Center *2</td>
<td></td>
<td>(2) June 19, 2012 (August 29, 2009)*3</td>
<td>(3) 491647-TS09</td>
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<tr>
<td>(1) Aizuwakamatsu Plant</td>
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<td>(2) Mie Plant</td>
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<tr>
<td>(3) Fujitsu Semiconductor Technology, Inc.</td>
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<tr>
<td>(5) Miyagi Plant</td>
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<td>(5) October 31, 2008</td>
<td></td>
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<td>(6) Kyushu Plant</td>
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<td>(6) October 23, 2009</td>
<td></td>
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</tr>
</tbody>
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*1) *2) ISO/TS16949: The head office (Shinysokohama) and Akiruno Technology Center are included in the certification as the support sections.
*3) Registration date of former certifying institute

Investigation of Causes due to Fault Analysis

<table>
<thead>
<tr>
<th>Process History</th>
<th>Defect Analysis</th>
<th>Outcome of the Case</th>
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<tbody>
<tr>
<td>Status of complaints that occur</td>
<td>Customer information</td>
<td></td>
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</table>

Approach to Analysis and Technology Improvements

Direct contact with SAWA unit by nano-probe

Cross-sectional photo of gate unit (90 nm)
For Standard Applications

Providing Customized Products

Today, semiconductors are used in a variety of fields, resulting in a diverse range of customer demand. FUJITSU SEMICONDUCTOR has established quality grades for its LSI offerings to ensure that all products meet the required quality grade. We also provide customized products that satisfy the various shipping requirements of our customers.

Quality Grades

Our quality assurance program assures the quality of FUJITSU SEMICONDUCTOR’s LSI products and is divided into three grades. Please consult the Sales Division to find out more about products used for special applications.

<table>
<thead>
<tr>
<th>Quality Grades</th>
<th>General applications</th>
<th>Special applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fujitsu standard specification</td>
<td>Customer specific applications</td>
<td>Safety applications</td>
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<tr>
<td>Special applications</td>
<td>Safety applications</td>
<td>Enhanced Reliability</td>
</tr>
<tr>
<td>Customer requirement specification</td>
<td>Special applications</td>
<td>Enhanced Reliability</td>
</tr>
</tbody>
</table>

Quality & Reliability

Foundry Services

Many of our customers have benefited from our LSI technologies via the wafer process foundry services.

Bare Chips

Our regular LSI products are packaged for easy handling, but in response to customer requests for size and weight reductions, we also ship “bare chips,” that is, chips without any packaging. There is a greater possibility of in-transit damage to these chips, so extreme care should be taken when handling them. Customers are encouraged to conduct quality and reliability screening and testing for defects after mounting.

Note:

Custom specifications may not be possible on some products. Please make specific inquiries when ordering.
Failure Analysis

We carefully analyze all returned products that we receive from customers, take suitable measures to prevent recurrence and provide analytical feedback to the concerned groups. Because this feedback can directly improve reliability, it is our policy to give customer complaints full attention and to do everything possible to resolve problems.

Customer complaints are first directed to the Sales/Customer Support Departments. Information is then passed on to the Reliability & QA Departments for electronic and physical analysis to determine the cause of the failure. Related divisions take appropriate measures based on the results of these analysis. Furthermore, in order to fully correct the problem, similar measures are taken at all our manufacturing facilities.

1. Presentation of Information related to Defective Products

For analysis of defective products, the more information there is about the defects, the more accurate failure analysis is possible. For this reason, we elicit as much detailed information from the customer as possible when receiving the customer complaint.

2. Returning Defective Goods

Customers are requested to send defective products in the original defective state, preventing exterior defect condition change, so that proper analysis may be performed.

3. Customer Complaints

Handling Period (Standard)

Whenever a customer complaint arises, the Reliability and Quality Assurance Department responds with an interim report within two days of receipt of the customer complaint. The Department produces a final report within two weeks of receipt of the customer complaint.
Environment Issues

At our company, the environment is an extremely important management issue, and environmental activities are promoted based on the environmental action plan of the Fujitsu Group. The Fujitsu Semiconductor Group will focus on five environmental issues in the future:

- Improve the environmental value of products and services, and enhance the development and delivery of green ICT
- Enhance efforts to reduce the Fujitsu Group’s environmental road
- Strengthen environmental governance
- Promote environmental contributions to society
- Promote efforts to preserve biodiversity

As a member of the Fujitsu Group, each of our employees strives to continue environmental activities in their workplace and local regions, and works to reduce the load on the environment and improve our environmental efficiency.

Preventing Global Warming

Measures to Reduce CO₂ Emissions from Energy Consumption

The Fujitsu Semiconductor Group reduced FY2011 CO₂ emissions from energy consumption to about 30% below the FY2007 level. This was achieved through operations improvements beginning with optimization of production equipment operations, together with the introduction of high-efficiency turbo refrigeration equipment, the introduction of inverters, the optimization of heat sink systems, and other energy conservation measures. We are also advancing additional energy conservation efforts such as priority operation of high-efficiency equipment and optimization of air conditioning air flow.

Measures to Reduce Emissions of Greenhouse Gases other than CO₂

The Fujitsu Semiconductor Group achieved the semiconductor industry voluntary action program targets of a 10% reduction from FY1995 levels (1250,000 tons-GWP) by 2010 through the introduction of gas-abatement equipment and other measures. We are continuing these efforts to reduce greenhouse gas emissions from FY2011 through process conditions optimization, the introduction of additional gas-abatement equipment, and switching over to gas with a low global warming coefficient.