Chapter 1 Approach to Quality Assurance
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1.1 Approach toward Quality Assurance

1.1.1 Basic Policy

The Sony Group is not content simply to improve product and service quality, and is instead deploying Company-wide activities to realize the world’s top management quality in order to provide the highest level of satisfaction in all aspects to our customers. As a member of the Sony Group, the Semiconductor Business Unit is charged with the development, design, manufacture and sale of semiconductor products.

Within the Semiconductor Business Unit as well, all divisions, related departments and factories aim to realize “No. 1 Quality (No. 1 customer satisfaction in the industry with minimum quality losses),” based on the quality values of “Quality First / giving priority to quality over individual profits.” To achieve this, the Semiconductor Business Unit deploys various quality improvement activities, with attention also given to improving management quality.

1.1.2 Operation of a Quality Management System Based on the ISO 9000 Series

The Semiconductor Business Unit has established and operates a quality management system that conforms to the ISO 9001 Standard, and all divisions, related departments and factories have acquired ISO 9001 certification from the certification body.

The Semiconductor Business Unit’s quality policy has been established as follows, based on achievement of the Unit’s quality values and vision.

Quality policy:  “To build a great relationship of trust with customers, improve the Quality Management System based on the ISO 9001 continually with the concept of making quality the first priority, in effort to achieve No. 1 Quality (No. 1 customer satisfaction and minimizing the quality loss).”

The Semiconductor Business Unit constantly strives to improve the quality of its semiconductor products based on this quality policy, through activities such as maintaining and controlling the quality management system, continuously working to improve the effectiveness of processes, and improving quality through quality engineering and other scientific approaches.

(1) Document system

The Semiconductor Business Unit’s quality management system is classified and documented with quality manuals at the top supported by overall Business Unit standards, individual division standards, procedures, related documents and records.
(2) Quality target management

Every fiscal year the Semiconductor Business Unit sets customer satisfaction and quality loss goals, establishes various improvement indices and targets for achieving those goals, and compiles various improvement measures for achieving the targets into a quality business plan, with the aim of realizing “No. 1 Quality (No. 1 customer satisfaction in the industry with minimum quality losses).” The implementation and progress of this quality business plan are reported at quality meetings held periodically by top management, and the top management themselves review the level of target achievement.

(3) Improvement of process effectiveness

It is expected that the established quality management system is implemented as planned, and that records are maintained as evidence of implementation according to plan. As such, the Semiconductor Business Unit’s quality management system carries out periodic quality assessments to check maturity levels for planning and execution quality and for results quality process by process; and then, extracts themes with the aim of achieving even higher maturity levels, as a part of measures to improve work process performance. These themes are reflected to the quality business plan, and improvement activities are carried out to increase maturity levels.

1.1.3 Scientific Approach

(1) Sony Six Sigma

Sony Six Sigma takes the Six Sigma developed in the U.S. and modifies it to realize a Sony-style Six Sigma that aims to improve not only product quality but also the quality of all work, based on the following three concepts.

- Focusing not only on results but also on processes
- Looking not only at averages but also at variance
- Making judgments based on facts and data
The basic Sony Six Sigma approach is represented by the acronym DMAIC, which stands for Define - Measure - Analyze - Improve (Execute) - Control (Standardize). In this process, “Define” correctly [sets] themes, and “MAIC” [solves] those themes. DMAIC comprises 14 steps as follows.

The Semiconductor Business Unit deploys this Sony Six Sigma technique to carry out activities aimed at realizing the “6σ level management quality.”

- **Define**
  - **Step1** Define important themes for realizing CTQ (Critical to Quality, commitment) from the standpoints of VOC (Voice of Customer, what customers really want) and corporate profit.
  - **Step2** Break down CTQ.

- **Measure**
  - **Step3** Define an index (Y) that numerically expresses CTQ.
  - **Step4** Verify the reliability of the index (Y) measurement system.
  - **Step5** Verify the current status of the index (Y) and determine improvement targets.

- **Analyze**
  - **Step6** List and analyze factors causing index (Y) fluctuation.
  - **Step7** Extract the Vital Few (X, factors that truly influence output) that have a decisive effect on the index (Y).
  - **Step8** Verify the reliability of the Vital Few (X) measurement system.

- **Improve**
  - **Step9** Obtain the relationship between the Vital Few (X) and the index (Y).
  - **Step10** Set the optimum conditions including the Vital Few (X) tolerance.
  - **Step11** Experimentally confirm the optimum conditions in an actual process.

- **Control**
  - **Step12** Construct a Vital Few management system and ensure that improvement effects take root.
  - **Step13** Organize and accumulate the knowledge obtained by the project.
  - **Step14** Share and horizontally deploy the improvement process.

(2) **Deployment of quality engineering**

Quality engineering is a specific technical methodology for simultaneously realizing high quality and high productivity, and centers on methods for evaluating and improving functionality.

Evaluation of functionality does not refer to individually evaluating large numbers of quality characteristics, but instead evaluating the proper function of products and systems. The degree to which operation is unaffected or not subject to variance (functionality) due to differences in customer operating and environmental conditions is expressed by the single measure known as the S/N ratio. Many quality characteristics items are negative items...
(badness) or similar to differences in operating conditions, and occur due to changes or variance from proper operation. The inability to adequately demonstrate functions is a substantial problem. Conversely, good functionality naturally also results in the improvement of multiple quality characteristics.

Next, one tool used to improve functionality is an orthogonal array. When attempting to improve a design, experiments are performed using different design factors (control factors). Generally, in most cases there is no preexisting knowledge about which factors can effectively improve functionality, so many design factors must be investigated. Experiments using an orthogonal array are a method of investigating many factors at once instead of one at a time.

Evaluation and improvement of functionality enables the following.

・The pros and cons of technology to be used in the product can be understood and technical limits can be evaluated in a short time before starting product planning. This vastly increases the development efficiency and helps to greatly shorten the development period.

・Fundamental technical ability is increased, enabling to tackle similar products that use the same technology and future new product development without problem.

・Technology can be made intrinsically resistant to changes or deterioration in operating and environmental conditions. This means that results confirmed in the development stage can be reproduced at the production site or in the market, which greatly reduces the costs for dealing with complaints.

The Semiconductor Business Unit works to spread quality engineering throughout the Unit by conducting quality engineering training and applying quality engineering to specific examples.

(3) SPC

The manufacturing process is controlled using check sheets, graphs, control diagrams and other control tools. In particular, control diagrams are an effective means for continuously monitoring changes in quality for each process, and make it possible to take proper action when trouble occurs.

Control diagrams set control limits indicating the range of normally occurring data based on the variance of process data over a certain range, and enter measurement data onto charts.

When an abnormal factor enters the process variance, the data exceeds the control limit lines, so control charts are effective for quickly detecting process changes. In addition to detecting when the data exceeds the control limit lines, process changes such as rising and falling data trends can also be detected. In this way, the use of control diagrams and other statistical techniques helps to periodically understand and analyze variance that affects quality, and is useful in improving quality.

In addition, important control items are also determined based on characteristic items demanded by customers, items affecting device quality and reliability, and items that correlate with defect mechanisms, etc. Capability measures (Cp, Cpk) are calculated for each process based on these items, and process improvements are then
carried out for items with low process capability measure levels to achieve higher-level values and realize stable quality.

Process capability measures:

The process stability with respect to the standards for that process can be obtained from the process data over a certain period and the standard values.

These are called process capability measures (Cp, Cpk), and are obtained by the following formulas.

\[
Cp = \frac{(Upper\ specification\ limit - Lower\ specification\ limit)}{6\sigma}
\]

Process capability measures in consideration of data (average value) bias toward the standard center:

\[
Cpk = \frac{|Specification\ limit\ closest\ to\ average\ value - Average\ value|}{3\sigma}
\]

The Semiconductor Business Unit works to improve process variance by periodically understanding these process capability measures.

(4) Failure Mode and Effects Analysis (FMEA)

Failure Mode and Effects Analysis (FMEA) consists of confirming and evaluating the risks posed by the failure modes that are latent in devices or processes. Confirming these risks makes it possible to systematically discover what is necessary to eliminate or reduce decisive trouble and achieve an optimum design.

1.2 Quality Assurance System for Semiconductor Products

To ensure quality and reliability and to supply products that meet customer needs in a timely manner, all Sony Semiconductor Business Unit departments carry out activities based on a consistent quality assurance system, from the product planning conception stage through development, design, manufacture of prototypes, evaluation, mass production, shipping, and after-sale service.

Fig. 1-1 shows the Sony Semiconductor Business Unit’s quality assurance system diagram.
1.2.1 Quality Assurance in the Development Design Stage

The Semiconductor Business Unit establishes rules for the development and design process and performs work according to those rules in order to provide customers with homogeneous and attractive products that meet the items demanded by customers and the marketplace.

(1) Product planning

Market research activities are performed to ascertain the intended applications, operating conditions, and the product quality and reliability levels demanded by each customer, and also to understand technical trends, required performance, delivery periods, prices, quality, reliability and other demands on products in the general marketplace. This information is used to formulate product development plans that are used for product planning.

(2) Planning conception

The product planning results and various data obtained within the Semiconductor Business Unit from accumulated quality and reliability results and fundamental research on reliability technology are used to set quality and reliability targets that are appropriate for product applications and operating environments, and to formulate development plans. In addition, this quality and reliability information is compiled into quality concepts, which are a part of the design specifications, and used as input for design.
(3) Design

Design is an extremely important process for ensuring high reliability in semiconductor devices. Design is performed as follows based on the design requirements (quality concept, design specifications, related laws and regulations, cases of past trouble), with sufficient design leeway to tolerate variance in the manufacturing process.

- **Understanding the latest requirements**
  
The latest requirements are understood, and any necessary changes from the plan formulation stage are clarified, visualized (compiled into documents) as the latest requirements, and shared with related parties. In addition, past review analysis results are also understood as requirements.

- **Plan formulation**
  
The requirements are broken down into specific plans. When there are changes to the requirements or other specifications, the need for plan revision is verified. When revision is necessary, the plans are updated as appropriate, and the latest version of the plans is visualized (compiled into documents) and shared with related parties. In addition, risk countermeasures are also included in the plans.

- **Execution**
  
Work is executed in accordance with each plan until the targets are achieved.

- **Progress control**
  
Plan progress is controlled, achievement conditions are reviewed to ensure that the expected results are obtained, and any problems are dealt with as appropriate.

(4) Evaluation and verification

The design results are checked to make sure they satisfy the product requirements (verification) and that the intended applications and purposes are achieved (validity check). This validity check includes reliability certification tests performed by the Quality Assurance Department of the Semiconductor Business Unit, and reliability is checked from the standpoint of the customer. Shipment of products to customers cannot start until these verification and validity checks are complete.

(5) Design review

The design results and observance of the design specifications used as the design inputs are checked as the design review. Design review is carried out partway through the design work, if necessary, and these results fed back to the design to improve design quality.

In design review, during circuit design, layout design, wafer process design and assembly process design, whether the design standards that are the rules to be followed are being observed is checked and design contents are thoroughly investigated by technical experts. In addition, experts from related departments review design contents from the viewpoint of cases of past trouble or each technology. These design reviews aim to avoid
trouble after prototype manufacture and mass production, and build the target performance, quality and reliability into products in line with demands.

1.2.2 Quality Assurance in the Mass Production Stage

(1) Process quality control in manufacturing

In order to supply the high quality and high reliability products demanded by customers, related departments perform capacity verification with respect to production, shipping and material purchasing plans that have been created based on the latest sales plan, and then operations shift to the production stage.

Based on the concept of building in quality in the manufacturing process, the manufacturing conditions that have been determined according to the various drawings presented from the Development Design Department are prescribed in control plans (descriptions or systemization of the process flow, equipment used, equipment handling procedures, work conditions, work methods, parts and materials used, parts and materials handling methods, various QC items and control criteria, inspection criteria, and definitions and methods of dealing with trouble). These control plans are then compiled into documents and used as guides for performing each manufacturing work. In addition, SPC method and other tools are used to understand changes for important control items that have a significant effect on quality, and efforts are made to stabilize quality and to discover and prevent trouble.

Also, all necessary information concerning quality, from materials and parts purchasing to quality control in manufacturing process, inspections, warehousing and quality information for customers, is controlled and analyzed by a data collection system and used to make quality improvements. In addition, this information is also used to quickly determine the affected range in the event that trouble occurs.

When trouble occurs in the manufacturing process, a trouble report is issued, the Technology Department in charge investigates the matter, and necessary corrective action is taken to prevent recurrence of the trouble.

In this manner, whether manufactured products satisfy product specifications and customer demands is checked during a final inspection process, and only passing products are shipped to customers.

(2) Process quality control for outsourced items

Even when outsourcing part of the manufacturing process, quality assurance activities are promoted for outsourced production lines based on the same approach as our in-house line. These activities include product quality, process control, quality improvement activities and measures when trouble occurs, and efforts are made to maintain and improve product quality and to prevent the occurrence of trouble.

- Certification of product reliability

Outsourced production items undergo the same reliability evaluations as in-house production items as “Certification of product reliability” to make sure there are no problems.
• **Line certification audits**

  Manufacturing line audits are conducted by specialists, including Quality Assurance Department members as main members, when starting outsourced production to make sure there are no problems.

• **Measures when trouble occurs**

  When trouble occurs in outsourced production processes, product and corrective actions are carried out according to the decisions of related in-house departments based on information provided from the outsourcing supplier.

• **Periodic quality meetings**

  Periodic quality meetings are held with outsourcing suppliers, and problems such as trends for process control items and inspection passing rates are extracted. Quality improvement activities are promoted through correction and prevention of problems.

(3) **Quality assurance for purchased products (materials and parts)**

As semiconductor devices move toward higher reliability and higher density, design demands on purchased products are also becoming higher-level. It hardly needs mentioning that purchased products’ quality is important for assuring the quality of semiconductor devices. The Semiconductor Business Unit compiles the purchased parts system into documents, covering from evaluation, selection and registration of suppliers, to line certification, exchange of specifications, incoming inspections, materials and parts inventory and control, and so on, and promotes quality assurance activities based on these documents.

• **Evaluation, selection and registration**

  “Management conditions,” “CSR (Corporate Social Responsibility including observance of laws and regulations),” “environmental considerations (application of the Sony Green Partner System),” “technical capability,” “cost,” “quality” and “supply capability” are evaluated mainly by the Purchasing Department, with the cooperation of the Technology and Quality Assurance Departments, based on the functions and performance required of the purchased parts. These results are then used to select new suppliers, and suppliers meeting the criteria are registered.

• **Line certification**

  “Quality management systems,” “process quality control” and "technology support capability" are reviewed mainly by the Purchasing, Quality Assurance and Technology Departments, and the lines of suppliers that have come up to the prescribed standards are certified.

• **Exchange of specifications**

  After completing evaluation (function characteristics, quality and reliability) of the purchased parts, the Technology Department creates specifications. The Purchasing Department exchanges these specifications with the suppliers, and then assigns individual numbers to each purchased part, and
registers and controls this data.

- **Incoming inspections**
  These inspections are performed by the Material Quality Assurance Department based on the data sheets.

- **Inventory and control**
  This is performed by the Purchasing Department based on the data sheets.

- **Monitoring and control of suppliers**
  The Purchasing Department obtains information on QDCS results from related departments for suppliers with whom there are ongoing transactions, and periodically evaluates these suppliers. Appropriate guidance is provided to suppliers based on these evaluation results to accelerate the quality improvement activities of suppliers.

- **Change control**
  Applications for changes are received by the Purchasing Department and verified in advance by the Technology and Quality Assurance Departments and other related departments. Changes are made only when the verification results indicate that there are no problems, and steps are taken to ensure traceability related to the changes.

(4) **Measuring instrument control and environment control**

During the course of semiconductor development design and production, product performance and quality are assured and improved by having measuring instruments constantly operating in the normal condition and within the required accuracy. Measuring instrument accuracy is controlled by establishing a preventative maintenance system. Incoming inspections are carried out when instruments are purchased and periodic checks are carried out during use to check accuracy and instruments are periodically calibrated, enabling prevention of malfunctions and drops in accuracy.

The environment has a significant effect on semiconductor device quality reliability. Therefore, control items, control methods and control standards for temperature, humidity, dust and other items are set according to the manufacturing process and micro-machining level, and the environment is maintained and controlled by installing centralized monitoring systems, etc. In addition, quality is also maintained and controlled by monitoring the specific resistance, purity and other characteristics of the deionized water, gases and chemicals used in manufacturing in-house lines.

(5) **Change control**

Changes are made to products or manufacturing processes in order to improve semiconductor product functions, quality reliability and also to improve productivity. The feasibility of these changes is judged after confirming that these changes will not produce any negative effects. In addition, when a change is planned, all related departments review the change. The necessary and ideal evaluation of items thought to have a technical
effect is planned, and these effects are confirmed by manufacturing prototypes, etc. If these changes have a significant effect on the product, these results are conveyed in advance to customers to confirm that there is no effect at the customer.

After all check items are completed, change instructions are issued and initial control of floating data is performed as necessary.

(6) Product traceability

Traceability of products shipped to customers uses the mark lot number printed on the final product as the key, and this mark lot number is tied with the parts and materials lots used and the manufacturing history. In addition, the product name and mark lot number of the enclosed products are noted on the label affixed to the outside of the packing carton, so the manufacturing history can be traced even in the packed state.

1.2.3 Handling Customer Complaints

When a customer experiences trouble, these complaints pass through Sony’s sales company and are received by the Quality Assurance Department. Investigation and analysis of complaint items and feedback of these results are both a duty and a service to customers, and at the same time provide valuable information for improving product quality.

Results of investigations of complaint items and the contents of countermeasures are reported to customers in document form and efforts are made to obtain understanding. According to the situations, customers may be visited to report these results directly.

(1) Complaints information

The more accurate information that can be provided, the easier the investigation and analysis can proceed in order to provide a swift and accurate response when trouble occurs. Therefore, when investigation of complaint items is requested, customers are requested to present detailed information on the trouble contents, the process in which the trouble occurred, the electrical, mechanical and thermal stress application history, lot dependency, occurrence rate, surrounding circuit conditions, applications, etc. Particularly with lead bending and packing defect (incorrect items or mixing of different types), detailed information at the time of occurrence is required.

(2) Return of complaint samples

Complaint items are required to be returned as much as possible in the condition in which the trouble occurred. When returning samples, appropriate measures should be taken to avoid external stress (electrical, thermal and mechanical) so that the effects of stress during handling and transport do not change the trouble conditions.

(3) Return of analyzed samples (items for which the trouble cannot be reproduced)

Items judged as acceptable and for which the complaint symptoms cannot be reproduced as a result of analysis by the Sony Semiconductor Business Unit are returned to the customer for reconfirmation. Even after
that, if the complaint symptoms can be produced, investigation should be requested again together with detailed information.

(4) Corrective action

After determining the cause from the complaint item investigation and analysis results, countermeasures are implemented and corrective action is also taken for the quality management systems in the applicable process to prevent recurrence.
1.3 Environmental Approaches

In early recognition of the importance of environmental issues, Sony presented an environmental conservation policy and established an Environmental Conservation Committee in 1990. In 1993, Sony formulated the Sony Global Environmental Policy and Environmental Action Program, and in 2000, Sony instituted the Sony Group Environmental Vision consisting of a “Philosophy” and “Principles” as the global environmental policy for the entire Sony Group, with the aim of contributing to the realization of a sustainable society.

(1) Philosophy

Sony recognizes the importance of preserving the natural environment that sustains all life on the earth for future generations and thereby ensuring that all humanity can attain a healthy and enriched life. In order to realize such a sustainable society, Sony strives to achieve a zero environmental footprint throughout the lifecycle of our products and business activities.

(2) Principles

Sony reduces our environmental footprint and prevents environmental pollution throughout the lifecycle of our products and business activities by complying with all applicable environmental regulations and also by continuously improving our global environmental management systems. Sonyformulates the following goals in four key environmental aspects and takes proactive actions to achieve these goals.

- **Climate change**
  Sony reduces energy consumption and strives to achieve zero emissions of greenhouse gases generated throughout the lifecycle of our products, services and business activities.

- **Resource conservation**
  In order to minimize resource inputs for our business activities, Sony identifies “Key Resources” and strives to achieve zero usage of these virgin materials. Sony also uses water efficiently, minimizes wastes from sites, and maximizes our efforts for take back and recycling of products from markets.

- **Chemical substances**
  Sony minimizes the risk of chemical substances that we use causing serious harm to human health and the environment. Sony maintains strict control over the substances we use, while, in line with our precautionary approach, taking steps wherever possible to reduce, substitute and eliminate the use of substances that have potentially significant impacts on the environment, even in the cases where scientific evidence is not fully proven.

- **Biodiversity conservation**
  Sony protects and utilizes ecosystem services in a sustainable manner, while actively promoting maintenance and recovery of biodiversity through our business and local contribution activities.
1.3.1 Environment in Factories

Sony conducts activities to improve the site environment at all Semiconductor Business Unit-related factories with the aim of achieving mid-term reduction targets for CO₂ emissions, waste recycling rates, water usage, and usage and emissions of volatile organic compounds (VOCs).

1.3.2 Environment in Products

The Semiconductor Business Unit works to reduce CO₂ emissions from product use and actively promotes the reuse of resources. In addition, we also promote reduction of the use of hazardous chemical substances.
1.4 Product Liability (PL) Act

1.4.1 Purpose of Activities

Sony Group carries out product liability (PL) activities under the name “Safety and Peace of Mind.”. Customer expectations toward safety and peace of mind are “to provide safe products and work together with customers to establish an environment in which products can be used with peace of mind,” and Sony Group’s mission is to realize customer satisfaction. To fulfill this mission, Sony Group has prescribed the following basic guideline and policy for promoting safety and peace of mind, and the Semiconductor Business Unit has further established its own basic policy based on these.

**Basic guideline**

Sony will supply safe products and “make Sony the world reference” in the field of safe use by customers.

**Basic policy**

Sony recognizes that one of its most important management requirements is to conduct business activities aimed at realizing a “society where people can live safely and with peace of mind,” and will work to prevent accidents in all corporate activities. Furthermore, in the unfortunate event that accidents do occur, the Sony Semiconductor Network Company will handle these incidents in a fair and swift manner.

1.4.2 Management Structure for Promoting Safety and Peace of Mind

The Sony Semiconductor Business Unit promotes safety and peace of mind from the following starting points of PS, CS and PL.

(1) **PS (Product Safety): Supplying safe products**

The possibility of semiconductor products being the direct cause of death, injury or damage to property is extremely rare. However, semiconductor product trouble in set products that use semiconductor products may trigger accidents in the final market.

The Sony Semiconductor Business Unit feels that improving the quality and reliability of semiconductor products is the most important part of preventing PL accidents in set products, and works constantly to improve quality and reliability.

(2) **CS (Customer Satisfaction): Realizing safe use**

Product data sheets, catalogs, user manuals and other materials contain clearly marked notes on operation in order to prevent PL accidents resulting from improper use by customers, such as use at voltages exceeding the absolute maximum rating.
(3) PL (Product Liability): Fair and swift redress

In the event that quality or reliability of a semiconductor product causes a set product PL accident in the final market, efforts are made to respond swiftly to clarify the cause and prevent the damage from spreading.