# Ⅱ. QUALITY ASSURANCE FOR HYBRID ICs, SMALL SIGNAL TRANSISTOR/DIODE

# Ⅱ. QUALITY ASSURANCE FOR HYBRID ICs AND SMALL SIGNAL TARNSISTOR / DIODE

## 1. QUALITY ASSURANCE SYSTEM FOR SEMICONDUCTOR DEVICES

Figure Ⅱ-1 shows our quality assurance system that covers the products' life cycle from development and design to mass production, shipping and field use.

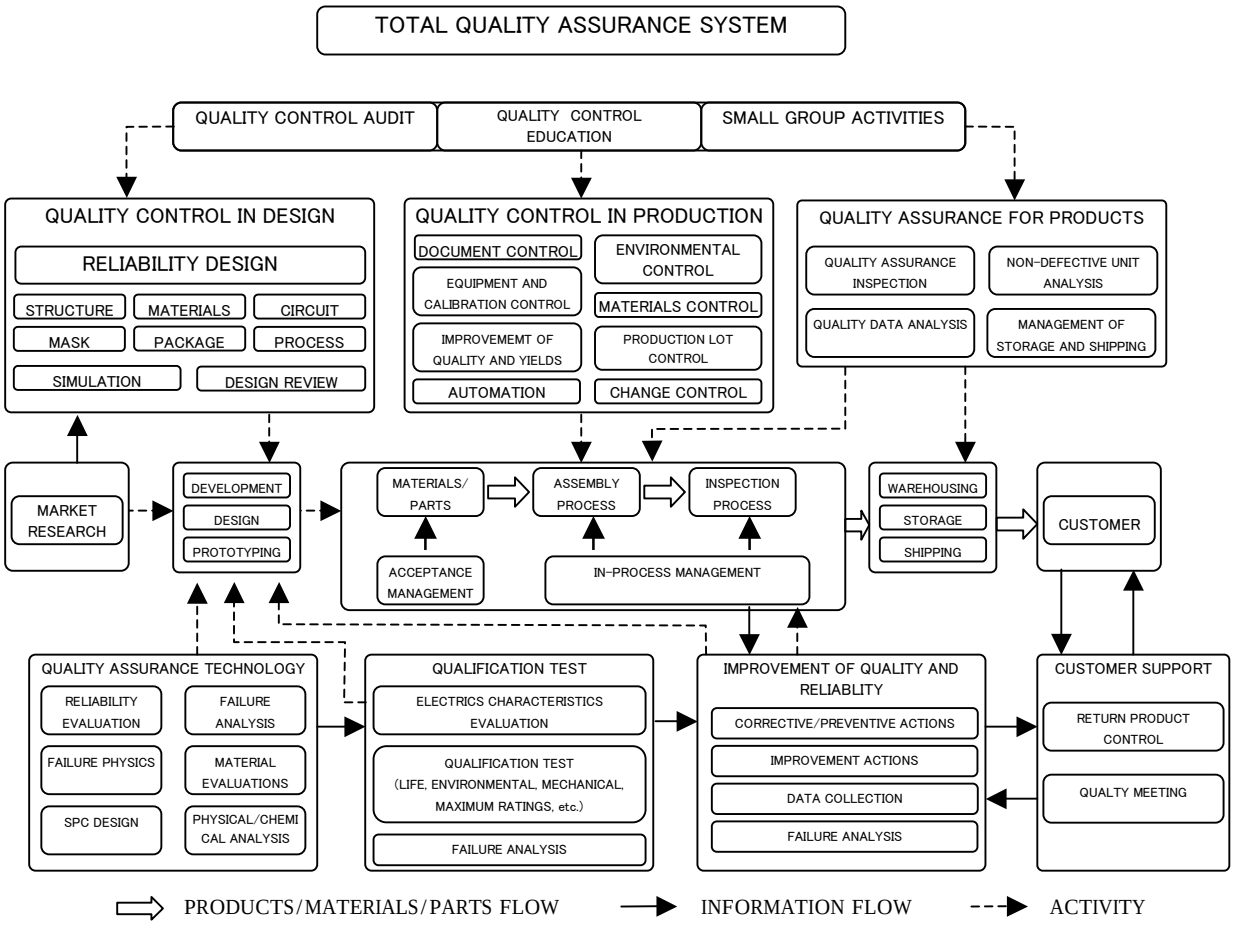


**Figure Ⅱ-1 Quality Assurance System for Semiconductor Devices**

The quality control in design builds the specifications and quality of the product. It focuses on optimization and review of structure, materials, circuit design, packaging and production process. For each device product type, a prototype is fabricated to verify the characteristics and reliability before mass production begins.

The quality control in production builds quality during the production process. It controls the quality of manufacturing equipment, tools, air and water cleanliness, gases, and manufacturing conditions, and product finish. We have established a total quality control system with this quality control information.

The quality control of product includes two activities. The first activity is in-house testing and inspection of individual device, lot, or samples to check whether the product meets the prescribed function and reliability levels. The second activity is customer support through accepting returned products and providing quality control information.

The quality control information is collected in the development, design, production, shipping, and field use stages, it is fed back to each stage to improve quality.
Figure Ⅱ-2 shows the flowchart of the quality assurance program.

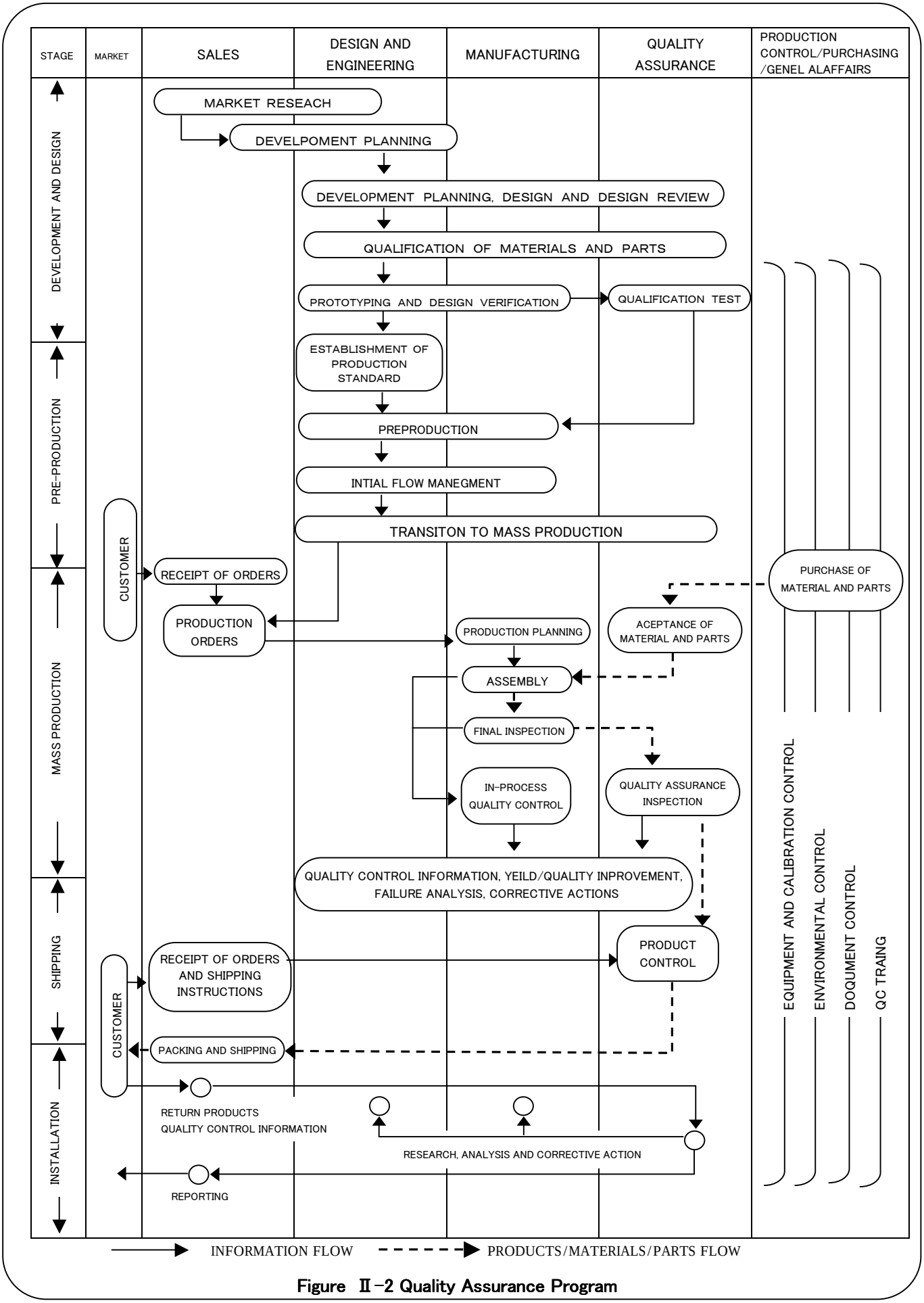


**Figure Ⅱ-2 Quality Assurance Program**

## 2. QUALITY ASSURANCE AT DEVELOPMENT STAGE

We use the following procedure to ensure the target quality and reliability in product development. Using the demand estimate based on market research, we plan development considering the required levels of quality, functionality, reliability and production issues.

Then new theories, technology and ideas are adopted to design and development. For this purpose, we have defined three development levels:

Level Ⅰ: Developing products with new design rules, materials, and process technologies

Level Ⅱ: Modifying the design to mass-produced products, or partially modifying processes, packages, materials, and equipment

LevelⅢ: Using the current processes and packages or those of similar or slightly modified quality levels

After we review the design validation, a prototype is fabricated. Then the prototype undergoes a qualification test that checks whether their electrical characteristics, maximum ratings, and re liability meet the quality target.

The Design and Engineering Department and Quality Assurance Department carefully review the results of qualification test. When they find any inconsistencies, they investigate the causes using failure analyses and improve the prototype.

When the new device passes the qualification test, a pre-production meeting is held to check any problems concerning design, production, or quality. After all problems have been resolved, the device is ready for pre-production.

At the pre-production stage, initial period management is carried out to check the quality of manufactured products. The initial period management refers to a special management system that applies for a certain period after the production starts. An increased quantity of information is collected during this period. Immediate corrective actions are then taken for any failures detected and the results are checked. Also at this stage, we prepare standard forms for mass production and train workers. And we set up materials and parts supply system and provide equipment and tools required for production. The new device is now ready to enter the mass production stage.

## 3. QUALLTY ASSURANCE AT MASS PRODUCTION STAGE

At the mass production stage, the device is put into continuous production based on the production plan. The Manufacturing Department controls the materials, parts, production process, environments and equipment conditions. They also perform in-process inspections, final inspection and quality assurance tests on both semi-manufactured and manufactured products to check quality levels. Figure II-3 shows the quality assurance system for mass-produced products.

Building in quality at this stage is very important for manufacturing high quality products economically. To do this, the Manufacturing/Engineering Department provides operating instructions and defines control items for critical production conditions.

Operation proceeds in accordance with the instructions. Check sheets are used to control manufacturing conditions that affect the quality and some specific product/process data is controlled to maintain or improve quality level.

Periodical inspections and accuracy adjustments are performed for early detection of abnormalities and for preventive maintenance.

The in-process quality control consists of workmanships checking of product finish and measurement values of quality data. The quality control information is fed back to earlier processes to improve quality levels.

At the final inspection, all products undergo electrical characteristic testing. For detecting defective products and rejecting marginal products, screening is performed. The resulting data is used for improving quality.

Completed products that have passed the final inspection are subjected to quality assurance tests to check whether they meet the customer requirements. The quality assurance test consists of a lot-by-lot test and a periodical test. The lot-by-lot test judges whether a lot should be accepted or rejected. It includes visual, electrical characteristics, thermal and mechanical environment, and maximum rating tests. The periodical test checks reliability by sampling at a regular interval. It includes electrical characteristics, thermal, mechanical, and operating life tests. The test results are immediately fed back to relevant departments to improve quality. They are also used to estimate the reliability in field use.

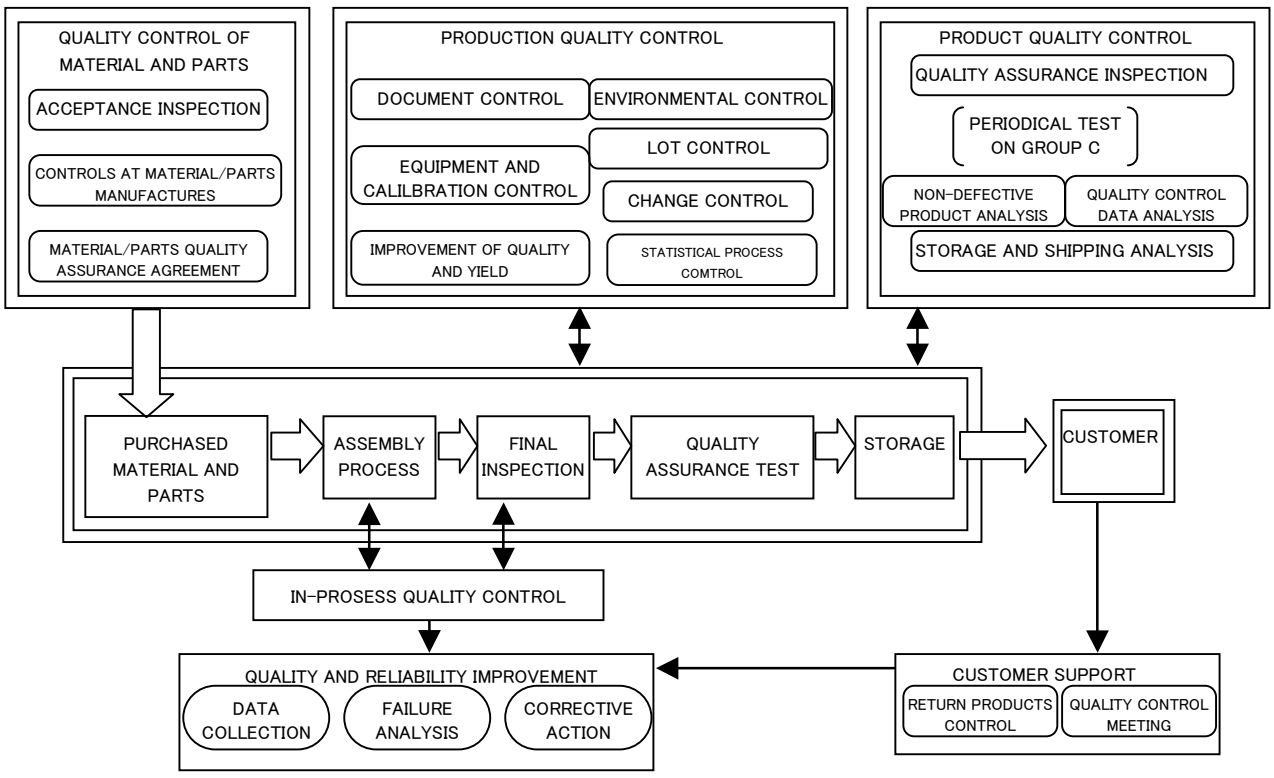


**Figure Ⅱ-3 Quality Assurance System at Mass Production Stage**

The quality information from the purchasing of materials and parts to the production, inspection, shipping, and field use is controlled.
The information is analyzed using statistical quality control methods. The result of analysis is fed back to the Manufacturing/Engineering Departments and other departments to maintain and improve quality levels and increased yields.
If a failure occurs during the production process or in the product itself, a failure information sheet is issued. Then relevant departments investigate the cause of failure and take corrective actions. Figure II-4 is a flowchart of a corrective action.
When the design, materials and parts, production methods, equipment, and such can be changed, prototype is made to check for quality levels and evaluate the reliability. If no problem is detected, the change is implemented after the customer has given an approval.
Quality control audits are performed by key members of all departments such as Design and Engineering, Manufacturing, Sales, Administration, Supplies regularly. They enable problems to be identified and corrected. They also increase awareness of quality control at the departmental level. The result is a more comprehensive quality control system.

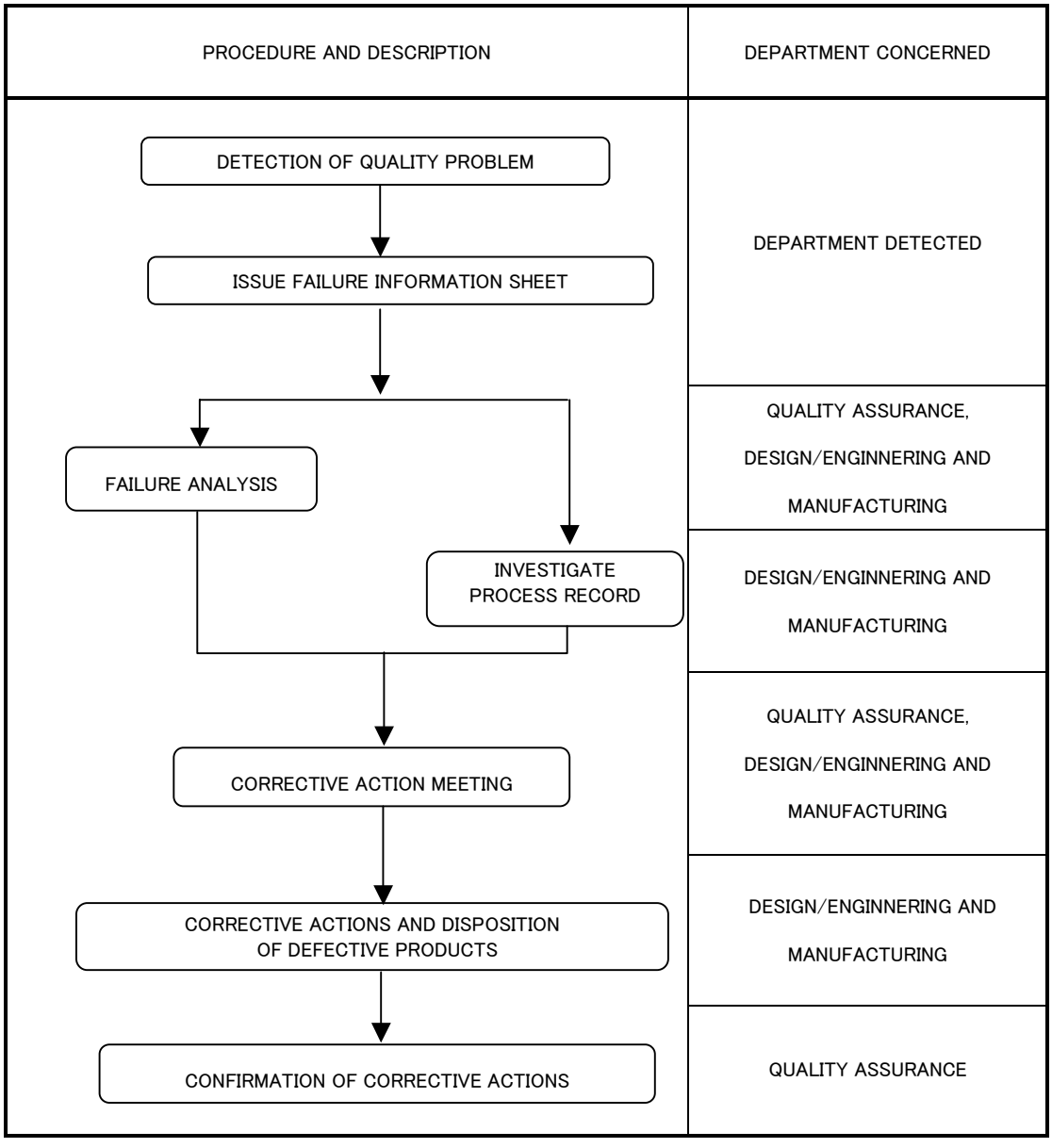


**Figure Ⅱ-4 Flowchart of a Corrective Action**

## 4. FAILURE AFTER SHIPPING AND CORRECTIVE ACTIONS

When a failure is found at the acceptance inspection, assembly, or field use by the customer, the Quality Assurance Department plays the major role in identifying the cause of failure and implementing corrective actions. Based on the analysis request issued by the Sales Department, the Quality Assurance Department investigates the failure and analyzes it using various testing equipment.

Based on the analysis result, Design and Engineering, Manufacturing, and other related departments hold a meeting. Then corrective action is taken as required, and a report is issued to the customer. Figure Ⅱ-5 shows the flowchart of returned product control.

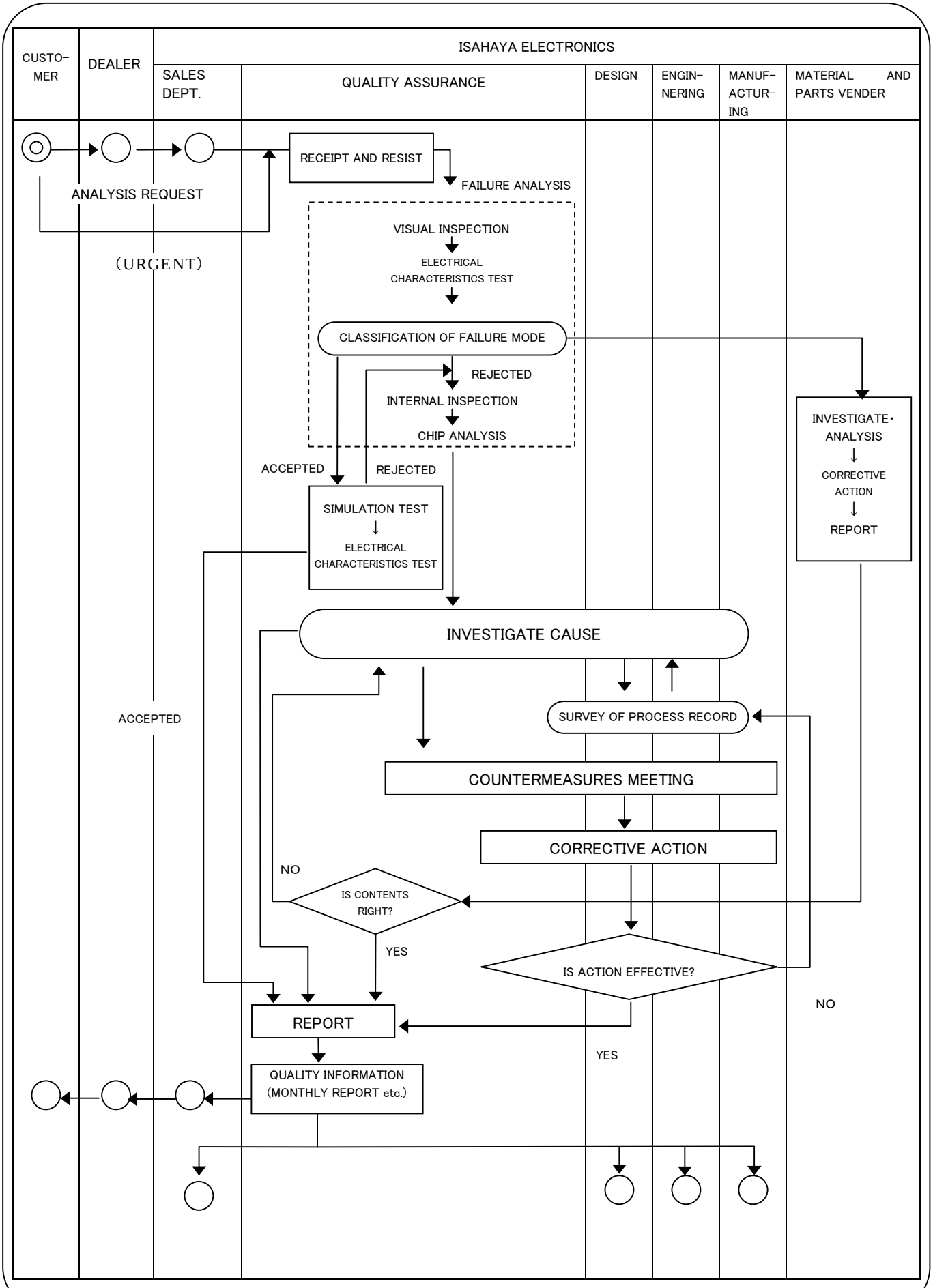


**Figure Ⅱ-5 Quality Assurance Program Flowchart**

## 5. QUALILTY ASSURANCE FOR MATERIALS AND PARTS

As the levels of performance, integrity, and mounting density of semiconductor devices increase, the requirements for the purity of materials and precision of parts have been becoming severer. Semiconductors are manufactured from assembly/packaging materials and parts (e.g. lead frames, metal paths, die bonding materials, packages, and resins). Each material or part requires highest levels of specifications and quality. When developing a new semiconductor device, Mitsubishi Electric compiles purchase specifications and diagrams for each material and part, then purchase them from specialty suppliers. We are carrying out the following quality assurance activities to maintain and improve the quality of materials and parts.

- Careful selection of materials and parts, and joint development with specialty suppliers to meet purchase specifications
- Quality control audit of suppliers' factories, and approval of suppliers and factories
- Qualification test and evaluation of each material or part type
- Acceptance inspection of materials and parts, or conclusion of a non-defective materials/parts delivery assurance agreement with suppliers
- Prevention of degradation causing by storage and handling of materials and parts
- Collection of quality data for materials and parts, and control of abnormalities
- Change control for materials and parts
- Regular quality assurance surveys on materials and parts suppliers, and quality meetings with them

Figure II-6 shows the relationship between these activities.

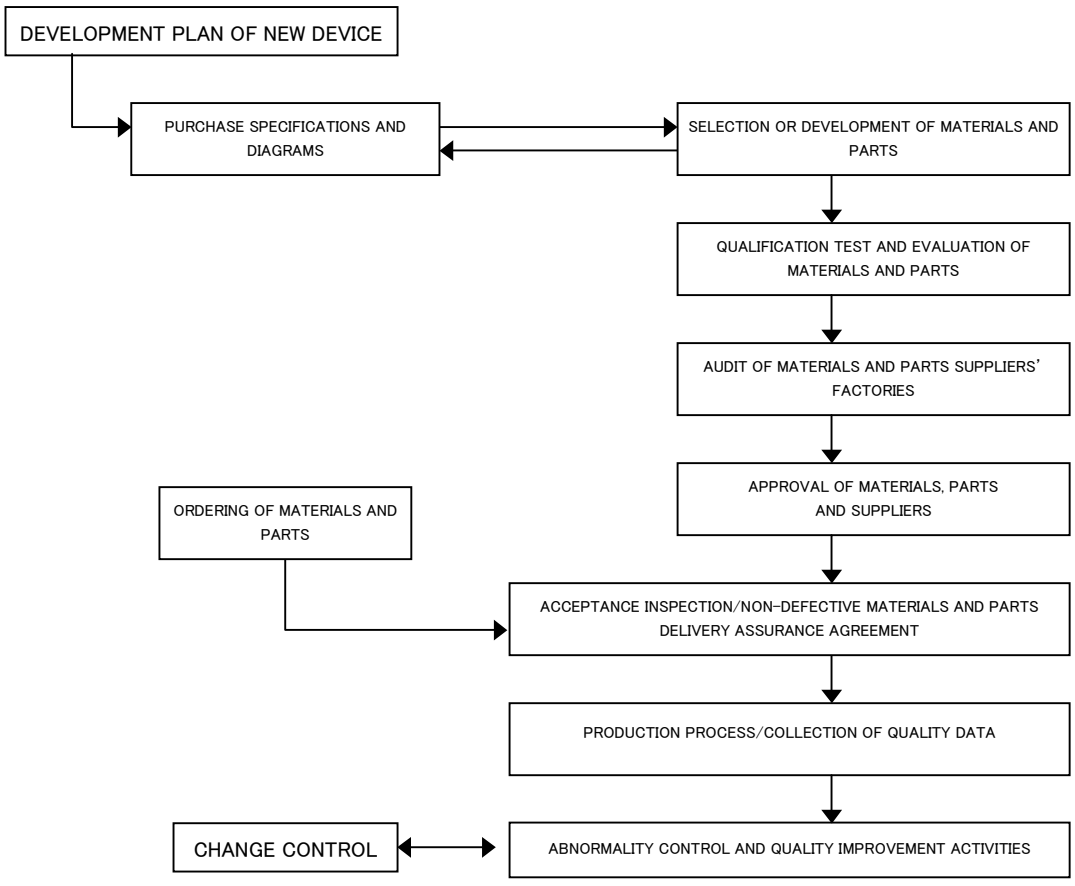


**Figure Ⅱ-6 Quality Assurance Activities for Materials and Parts**

## 6. EQUIPMENT, CALIBRATION, AND ENVIRONMENT CONTROL

The semiconductor industry is a production equipment intensive industry. That is equipment, measuring instruments, and other machinery must operate properly and accurately to maintain and improve the performance and quality of semiconductor devices.

For each piece of equipment, maintenance standard is established according to the effects on performance and quality. Then contents and frequencies of daily and routine inspections are defined based on the types of equipment and control standards. These inspections detect malfunction, abnormalities, and change in precision and provide the basis for a preventive maintenance system. Inspections and checks are carried out in-house, by suppliers, or by inspection laboratories.

The calibration control involves acceptance inspections and regular inspections to check and correct precision, and prevent failure and degradation in precision. These inspections also establish a preventive maintenance system.
Figure Ⅱ-7 shows the calibration control flowchart.

The production environment has greats on the quality and reliability of semiconductor devices. We select appropriate control items, methods, and criteria for factors such as temperature, humidity, and dust according to the fabrication process. The D.I. water, gases, and chemicals used on the production line are constantly monitored to maintain purity, resistance and other quality levels.

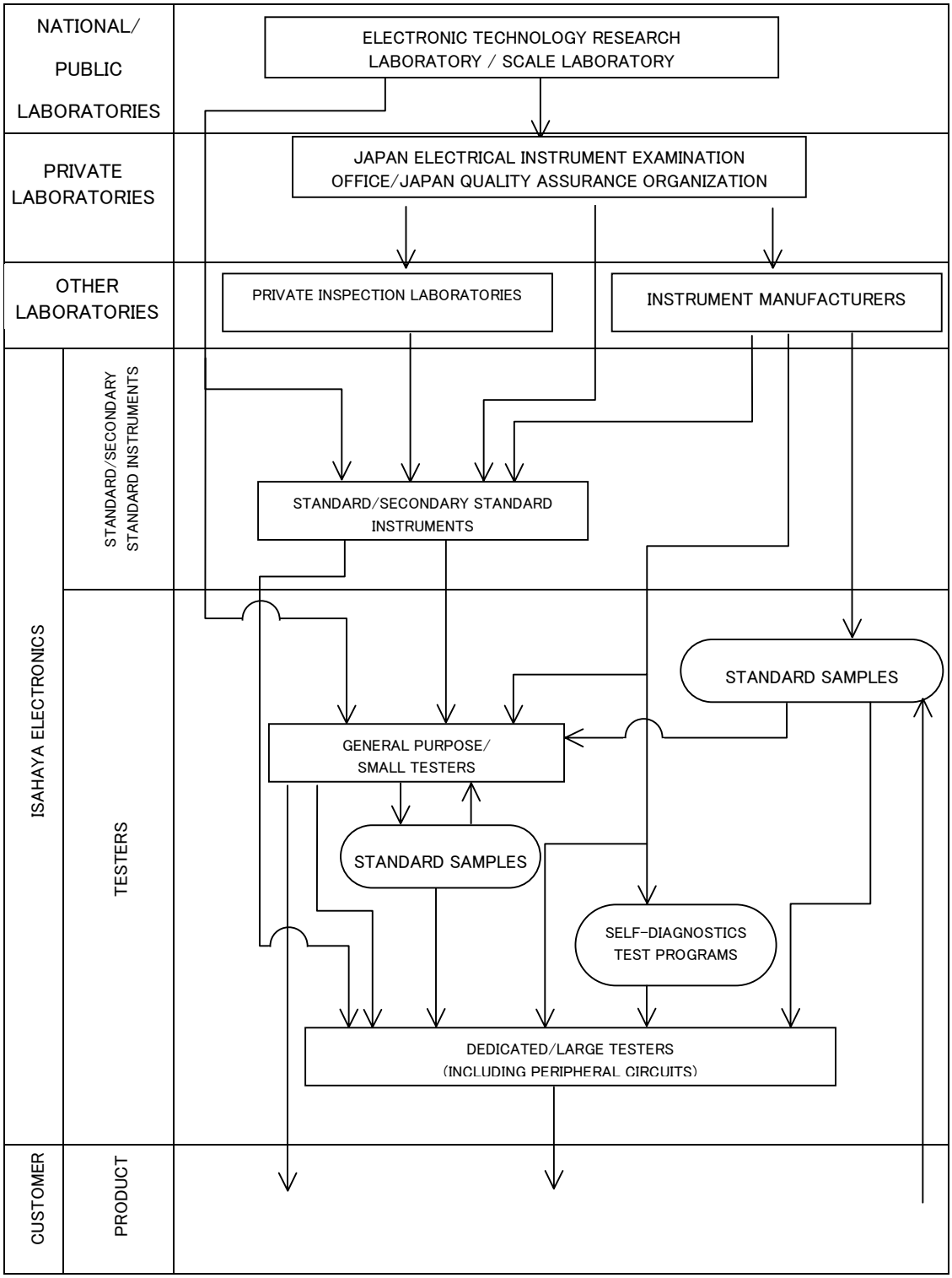


**Figure Ⅱ-7 Calibration Control Flowchart**

## 7. DOCUMENT CONTROL. SMALL GROUP ACTIVITIES, QUALITY CONTROL/RELIABILITY EDUCATION SYSTEM

### 7.1 Standardization and Document Control

The essence of quality control is standardization. We promote establishment of appropriate stdards based on our standard systems.

- Company/in-house rules and regulations
  Rules for organization, personnel, management, and business are defined and applied.
- In-house standards
  Standards and outlines for products, design, materials, packing, equipment maintenance, inspection, and tasks are defines. They are centrally controlled.
- In-house design handbooks/manuals
  Design standard and procedure manuals are published to promote incorporation of quality at the design stage. Standardization flowcharts are prepared to prevent errors resulting from carelessness.

### 7.2 Small Group Activities

As a part of total quality control, we have self-development programs to resolve problems, improve productivity and safety, and increase sales. People from the same or different workshops gather to form small groups to discuss quality control issues as a collective group. . These are voluntary and continuous activities that everyone in the workshop can participate in.

### 7.3 Quality Control/Reliability Education

The employee education system consists of basic, intermediate, and advanced courses. The basic courses are run on target all employees. They include quality control, reliability basics and general performance of the in-house work. The intermediate courses are run in-house. They consist of skill development. The advanced courses consist of seminars run outside the company. They also include quality control courses to promote organized education and in-house training. In addition, regular company events such as quality improvement month and daily small-group activities are carried out to promote awareness of quality.