

Technical Note

RELIABILITY QUALITY CONTROL OF CATV MODULE

NEC Compound Semiconductor Devices, Ltd.

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1. CONCEPT OF RELIABILITY QUALITY CONTROL

NEC Compound Semiconductor Devices, Ltd. has been certified for ISO 9001 and ISO 14001. The company is intent on continually improving its quality system to provide high-quality/environment-friendly products that will satisfy the customer.

The reliability quality control of our microwave semiconductor devices is based on improving the reliability in individual processes, from development design to mass production design, by reflecting customers' needs identified through market research and customer feedback. We also aim to achieve production that maintains a balance between reliability quality and price by adopting effective management methods suitable for the application of individual products, and will devote our full efforts to manufacturing products that will meet our customers' expectations. Toward this realization, shipment and after-sales service are controlled under a coherent system in each process from material procurement to product delivery as follows:

- (1) Selection and procurement of environment-friendly material as well as components/parts
- (2) Quality control and inspection of the product in individual processes up to mass-production
- (3) Confirmation of the quality of the product by reliability testing

In addition, with the expansion and development of the application fields of microwave semiconductor devices such as mobile phones, the number of applications is drastically increasing and the quality expected of our products is steadily growing. In response to these expectations, NEC Compound Semiconductor Devices, Ltd. considers the following items key points:

- (a) improvement of design quality,
- (b) improvement and maintenance of the quality in the production phase, and
- (c) removal of potential defects by setting quality gates in each process.

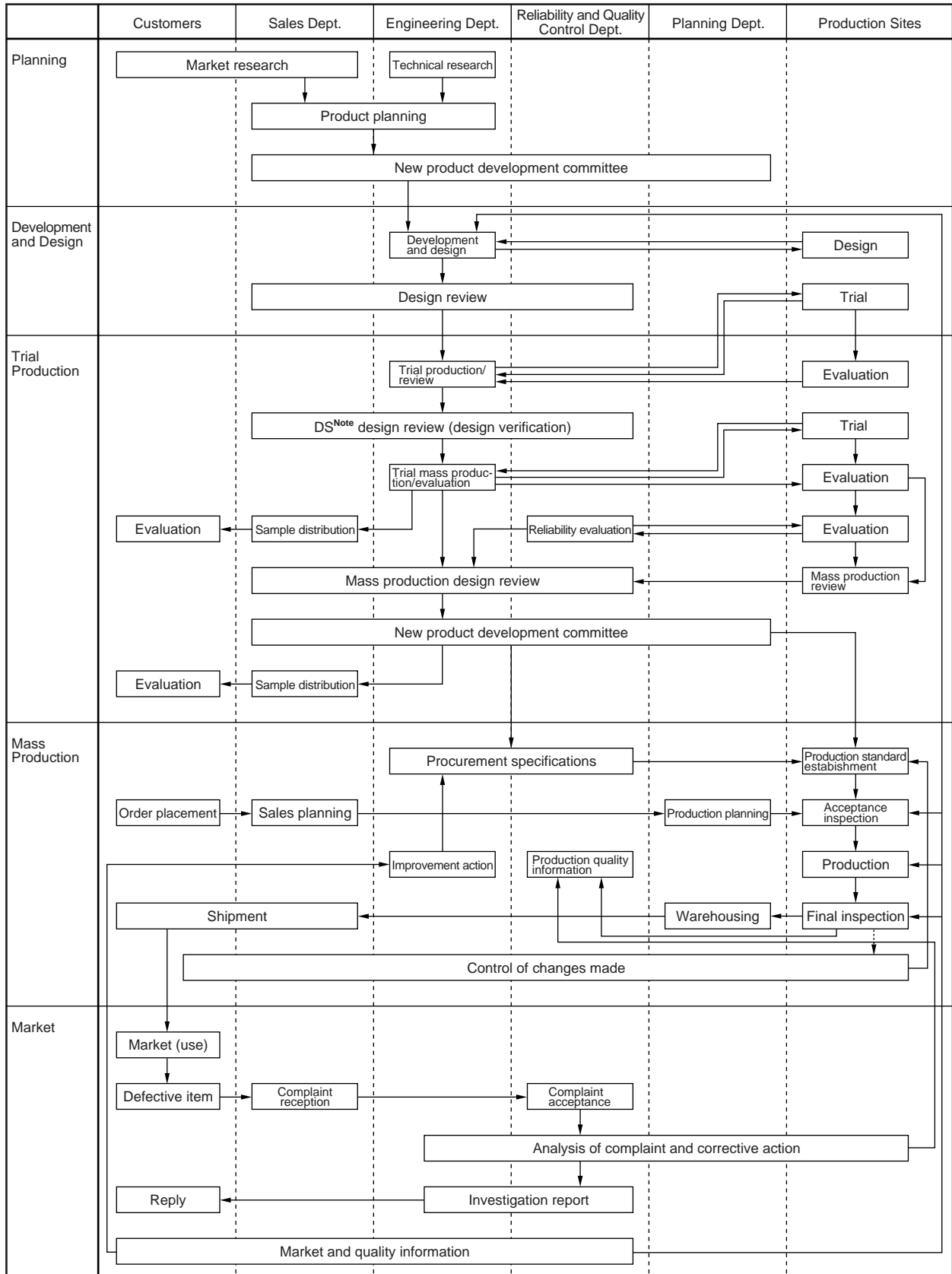
Aspects to be emphasized include

- (i) establishment of reliability by standardization of design rules,
- (ii) identification of non-reliability causes by design review,
- (iii) thorough evaluation of characteristics and reliability testing in development/trial production phase,
- (iv) automation of production facilities and product variation control by facility maintenance,
- (v) enhancement of staff awareness of the quality by small group activities such as QC circle,
- (vi) analysis, feedback and feedforward of quality information including field data, and
- (vii) prevention of defective products by PC (Process Check) in each process and feedback of results to the corresponding process.

By implementing these actions, we commit ourselves to providing semiconductor devices that satisfy the high quality/low price needs of the customer. Moreover, we also pledge to continue our efforts to improve product quality.

The flowchart of the quality (Q) and reliability (R) system is shown in Figure 1-1.

Figure 1-1 The flowchart of the quality (Q) and reliability (R) system



Note DS : Design Sample

2. QUALITY CONTROL OF PRODUCTION PROCESS

NEC Compound Semiconductor Devices, Ltd. manufactures and releases microwave semiconductor devices focusing on further improvement of the required product reliability by assessing customer requirements as well as the application environment of the product, and incorporating the results into the original design. To realize the reliability quality intended in the design, a production control system is required to obviate any defective elements caused by variations in individual production processes.

Therefore, emphasis is placed on the quality control of parts, components or secondary materials that will determine the reliability quality upon production and on related aspects such as the production environment. Further, by incorporating checking functions in the production processes, half-finished products in each process are checked with optimum frequency against the key control items.

A flowchart example of production process control is shown in Figure 2-1. Components, materials or secondary materials are controlled as described below.

Components, materials and secondary materials such as chemicals or high-purity gas are procured through the specified vendors. Acceptance testing is performed largely by sampling based on JIS Z 9015 or other procurement standards used by NEC Compound Semiconductor Devices, Ltd. The result of the acceptance test is monitored, and if necessary, corrective action is taken or factory inspections are conducted at the specified vendors to stabilize the quality of the purchased products.

Figure 2-1 An example of production process control flowchart of CATV module

Process Flow	Control Items	Objective
Components, material procurement	Sheet resistance	Acceptance/rejection of basic parameters
	V_{th} , breakdown voltage	
GaAs wafer	Appearance	Acceptance/rejection of etchings
Metalization material	Metal film thickness	Checking of metal film thickness
	Appearance	Acceptance/rejection of etchings
Wafer inspection	Electrical characteristics (all chips)	Removal of defects in electrical characteristics
Dicing	Appearance	Acceptance/rejection of die appearance
Lead frame	Appearance	Acceptance/rejection of bonding status
Fine gold wire	Appearance	Acceptance/rejection of bonding status
	Pull strength	
Mold resin	Appearance	Acceptance/rejection of sealing status
Sealing cure	Temperature/time	Stabilization of sealing resin
Sorting	Electrical characteristics	Removal of defects in electrical characteristics
Resin board	Appearance	Acceptance/rejection of parts mount status
Board division 1	Appearance	Acceptance/rejection of division status
Heatsink	Appearance	Acceptance/rejection of heatsink attachment
	Void confirmation	
	Pull strength	
Board division 2	Appearance	Acceptance/rejection of division status and mounted parts
Lead	Appearance/measurement	Acceptance/rejection of lead forming
Cover	Appearance	Acceptance/rejection of marking
Final sorting	Electrical characteristics	Removal of defects in electrical characteristics
Product Inspection	Electrical characteristics	Acceptance/rejection of warehoused product quality
	Package measurement/appearance	
Warehousing		
Shipment		

3. RELIABILITY TEST

Reliability tests are conducted regularly based upon JIS C, MIL-STD-750/883 and other standards. Examples of the tests and of the failure criteria are shown in 3. 1 and 3. 2 below.

3. 1 Test Contents

An example of CATV module is shown below.

Test Item	Test Conditions	Number of Samples	Related Standards
High-temperature Storage	T _{stg} max., 1 000 hours	18	MIL-STD-750 1031
Low-temperature Storage	T _{stg} min., 1 000 hours	18	JIS C 0020
High-temperature Steady State Operation Life	T _j = T _j max., 1 000 hours	18	MIL-STD-883 1005
High-temperature High-humidity Steady State Operation Life	T _{stg} max., V _{DD} = V _{DD} max., 1 000 hours	18	MIL-STD-883 1006
Temperature Cycle ^{Note}	T _{stg} min. to T _{stg} max. 30 minutes each, 100 cycles	18	MIL-STD-750 1051
Mechanical Shock	4 900 m/S ² , 1 msec, 5 times for 1 ms in each direction (X, Y, and Z)	18	JIS C 0041
Variable Frequency Vibration	20 to 2 000 Hz, 196 m/S ² , 4 times for 4 minutes in each direction (X, Y, and Z)	18	JIS C 0040
Soldering Heat	260±5°C, lead dip for 10 seconds	18	JIS C 0054
Solderability	245±5°C, 5±1 seconds, with flux	5	JIS C 0054
Terminal Strength (bending)	Apply the specified weight (2.2 N), 0° → 90° → 0°, 3 times	5	MIL-STD-750 2036
Terminal Strength (pulling)	Apply the specified weight (19.6 N), 10±1 seconds (choose randomly three terminals)	5	MIL-STD-750 2036
Electrostatic Discharge Sensitivity	C = 100 pF, R = 1.5 kΩ, n = 3 times, All pin combinations	5	MIL-STD-883 3015

Note Preconditioning: High-temperature storage (85°C, 24 hours) + High-temperature high-humidity storage (85°C, 85%, 24 hours) + Solder iron application (260°C, 10 seconds, once each to all pins)

Remark Acceptance/rejection is determined by (0, 1) regardless of the number of samples.

3. 2 Failure Criteria

Product	Parameter	Failure Criteria	
		Lower	Upper
CATV Module	ΔG _{L1}	-1 dB	+1 dB
	ΔG _{L2}	-1 dB	+1 dB
	ΔI _{DD}	-10%	+10%

Test Item	Inspection Item	Acceptance Criteria
Solderability	Lead appearance	Solder covers 95% or more of the surface
Terminal Strength (bending)		No evidence of breakage or loosening

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