

Technical Note

RELIABILITY QUALITY CONTROL OF GaAs MMIC

NEC Compound Semiconductor Devices, Ltd.

Document No. PQ10355EJ01V0TN (1st edition)

Date Published June 2003 CP(K)

© NEC Compound Semiconductor Devices 2003

Printed in Japan

Caution	GaAs Products	<p>This product uses gallium arsenide (GaAs). GaAs vapor and powder are hazardous to human health if inhaled or ingested, so please observe the following points.</p> <ul style="list-style-type: none">• Follow related laws and ordinances when disposing of the product. If there are no applicable laws and/or ordinances, dispose of the product as recommended below.<ol style="list-style-type: none">1. Commission a disposal company able to (with a license to) collect, transport and dispose of materials that contain arsenic and other such industrial waste materials.2. Exclude the product from general industrial waste and household garbage, and ensure that the product is controlled (as industrial waste subject to special control) up until final disposal.• Do not burn, destroy, cut, crush, or chemically dissolve the product.• Do not lick the product or in any way allow it to enter the mouth.
----------------	---------------	--

• **The information in this document is current as of June, 2003. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC's data sheets or data books, etc., for the most up-to-date specifications of NEC semiconductor products. Not all products and/or types are available in every country. Please check with an NEC sales representative for availability and additional information.**

• No part of this document may be copied or reproduced in any form or by any means without prior written consent of NEC. NEC assumes no responsibility for any errors that may appear in this document.

• NEC does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC semiconductor products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC or others.

• Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of customer's equipment shall be done under the full responsibility of customer. NEC assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.

• While NEC endeavours to enhance the quality, reliability and safety of NEC semiconductor products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC semiconductor products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment, and anti-failure features.

• NEC semiconductor products are classified into the following three quality grades:
"Standard", "Special" and "Specific". The "Specific" quality grade applies only to semiconductor products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of a semiconductor product depend on its quality grade, as indicated below. Customers must check the quality grade of each semiconductor product before using it in a particular application.

"Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

"Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

"Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.

(Note)

(1) "NEC" as used in this statement means NEC Corporation, NEC Compound Semiconductor Devices, Ltd. and also includes its majority-owned subsidiaries.

(2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).

M8E 00.4-0110

CONTENTS

1. CONCEPT OF RELIABILITY QUALITY CONTROL	5
2. QUALITY CONTROL OF PRODUCTION PROCESS	7
3. PRODUCTION INSPECTION	9
4. RELIABILITY TEST	9
4. 1 Test Contents	9
4. 2 Failure Criteria	10

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.

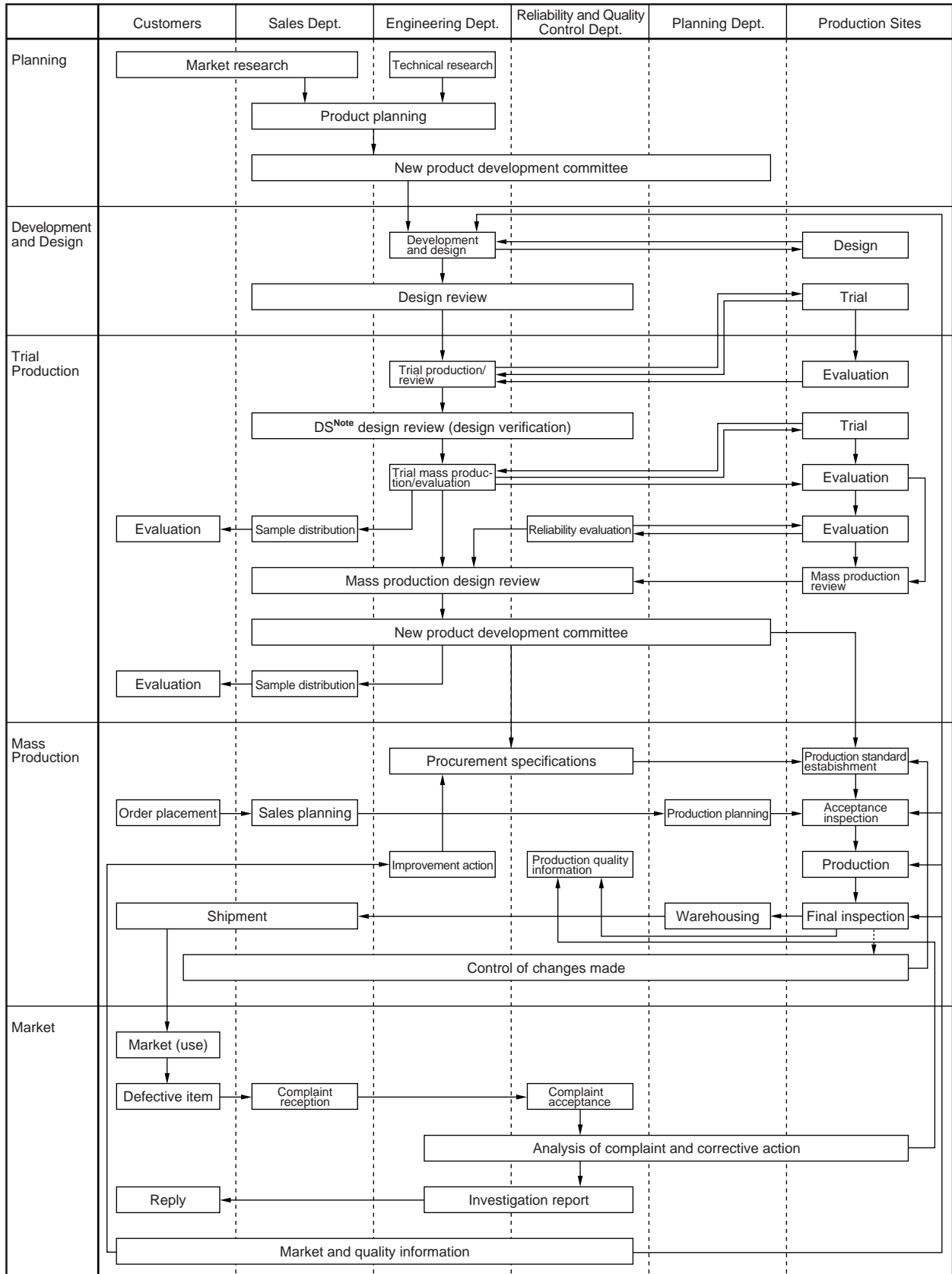
Aspects to be emphasized include

- (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

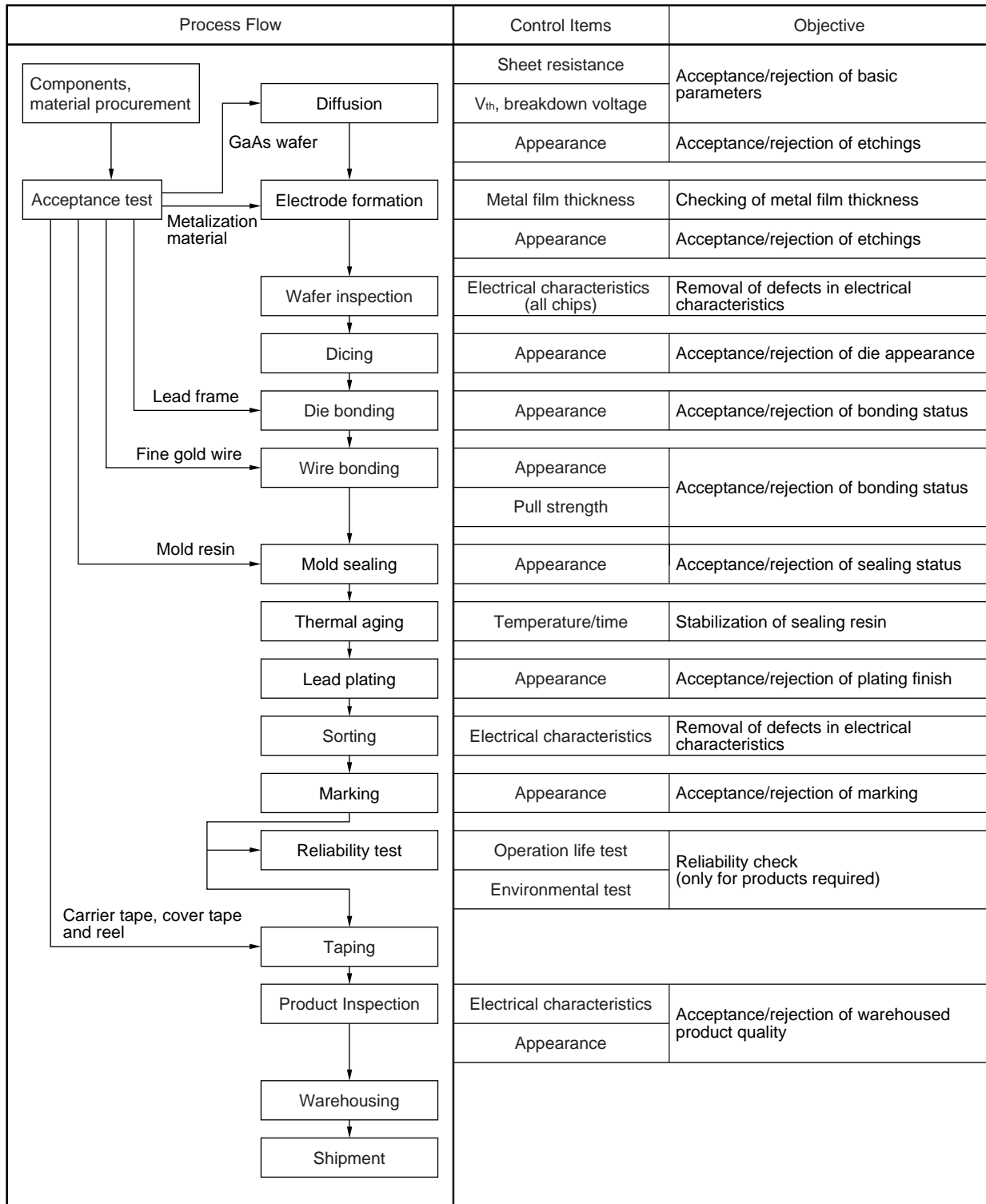
NEC Compound Semiconductor Devices, Ltd. manufactures and releases microwave semiconductor devices focusing on further improvement of the required product reliability by assessing customer requirements as well as the application environment of the product, and incorporating the results into the original 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 GaAs MMIC



3. PRODUCTION INSPECTION

Product inspections are conducted by sampling to determine whether or not the package appearance and electrical characteristics of products that have already passed the sorting inspection meet the specified standard.

4. RELIABILITY TEST

Reliability tests are conducted regularly based upon EIAJ ED-4701, MIL-STD-750, MIL-STD-883 and other standards.

Examples of the tests and of the failure criteria are shown in 4. 1 and 4. 2 below.

4. 1 Test Contents

An example of GaAs MMIC (plastic package) is shown below.

Test Item	Test Conditions	Number of Samples	Related Standards
Soldering Heat	260±5°C, 10 seconds	22	MIL-STD-750 2031
High-temperature Bias	T _{op} max. ^{Note 1} , V = V _{DD} max., 1 000 hours	20	MIL-STD-883 1005
Temperature Cycle ^{Note 3}	T _{stg} min. ^{Note 1} to T _{stg} max. ^{Note 1} 30 minutes each, 100 cycles	22	MIL-STD-883 1010
High-temperature High-humidity Bias ^{Note 3}	T _A = 85°C, Rh = 85%, V = V _{DD} max. ^{Note 2} , 1 000 hours	20	MIL-STD-883 1005
Autoclave (Pressure Cooker) ^{Note 3}	T _A = 125°C, P = 223 kPa, 96 hours	22	–
Solderability	245±5°C or 215±5°C, 5 seconds	22	MIL-STD-883 2003
Terminal Strength (bending)	Apply the specified weight (0.5 N), 0° → 90° → 0°, Once	11	MIL-STD-883 2004
Electrostatic Discharge Sensitivity	C = 200 pF, R = 0 Ω, Once, Between the weakest terminals	10	EIAJ ED-4701 C-111A

Notes 1. Absolute maximum ratings

2. Recommended operating conditions

3. Preconditioning: High-temperature storage (125°C, 24 hours) + High-temperature high-humidity storage (85°C, 85%, 168 hours) + SH (260°C, 10 seconds, 3 times or IR reflow)

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

4.2 Failure Criteria

An example of SW IC is shown below.

Product	Parameter	Failure Criteria	
		Lower	Upper
GaAs SW IC	Insertion loss	-	U
	Isolation	-	U
	Control current	-	U

Remark U : Upper value of the product standard

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

► For further information, please contact

NEC Compound Semiconductor Devices, Ltd.

5th Sales Group, Sales Division TEL: +81-44-435-1588 FAX: +81-44-435-1579 E-mail: salesinfo@csd-nec.com

NEC Compound Semiconductor Devices Hong Kong Limited

Hong Kong Head Office TEL: +852-3107-7303 FAX: +852-3107-7309 E-mail: ncsd-hk@elhk.nec.com.hk

Taipei Branch Office TEL: +886-2-8712-0478 FAX: +886-2-2545-3859

Korea Branch Office TEL: +82-2-558-2120 FAX: +82-2-558-5209

NEC Electronics (Europe) GmbH <http://www.ee.nec.de/>

TEL: +49-211-6503-01 FAX: +49-211-6503-487

California Eastern Laboratories, Inc. <http://www.cel.com/>

TEL: +1-408-988-3500 FAX: +1-408-988-0279