

EIA/JEDEC PUBLICATION

Guidelines for Preparing Customer-Supplied Background Information Relating to a Semiconductor-Device Failure Analysis

EIA/JEP134

SEPTEMBER 1998

ELECTRONIC INDUSTRIES ALLIANCE

JEDEC Solid State Technology Division



NOTICE

EIA/JEDEC standards and publications contain material that has been prepared, reviewed, and approved through the JEDEC Council level and subsequently reviewed and approved by the EIA General Counsel.

EIA/JEDEC standards and publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for use by those other than JEDEC members, whether the standard is to be used either domestically or internationally.

EIA/JEDEC standards and publications are adopted without regard to whether or not their adoption may involve patents or articles, materials, or processes. By such action JEDEC does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the EIA/JEDEC standards or publications.

The information included in EIA/JEDEC standards and publications represents a sound approach to product specification and application, principally from the solid state device manufacturer viewpoint. Within the JEDEC organization there are procedures whereby a EIA/JEDEC standard or publication may be further processed and ultimately become an ANSI/EIA standard.

No claims to be in conformance with this standard may be made unless all requirements stated in the standard are met.

Inquiries, comments, and suggestions relative to the content of this EIA/JEDEC standard or publication should be addressed to JEDEC Solid State Technology Division, 2500 Wilson Boulevard, Arlington, VA 22201-3834, (703)907-7560/7559 or www.jedec.org.

Published by
©ELECTRONIC INDUSTRIES ALLIANCE 1998
Engineering Department
2500 Wilson Boulevard
Arlington, VA 22201-3834

"Copyright" does not apply to JEDEC member companies as they are free to duplicate this document in accordance with the latest revision of JEDEC Publication 21 "Manual of Organization and Procedure".

**PRICE: Please refer to the current
Catalog of JEDEC Engineering Standards and Publications or call Global Engineering
Documents, USA and Canada (1-800-854-7179), International (303-397-7956)**

Printed in the U.S.A.
All rights reserved

PLEASE!

DON'T VIOLATE
THE
LAW!

This document is copyrighted by the EIA and may not be reproduced without permission.

Organizations may obtain permission to reproduce a limited number of copies through entering into a license agreement. For information, contact:

Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5704 or call
U.S.A. and Canada 1-800-854-7179, International (303) 397-7956

**GUIDELINES FOR PREPARING CUSTOMER-SUPPLIED
BACKGROUND INFORMATION RELATING TO A
SEMICONDUCTOR-DEVICE FAILURE ANALYSIS**

CONTENTS

	Page
1 Introduction	1
2 Rationale	1
3 Purpose	1
4 Scope	2
5 Responsibilities	2
6 Terms and definitions	2
7 Description of Failure Analysis Request Form	3
8 Explanation of Failure Analysis Request Form	4
8.1 Requester's tracking number	4
8.2 Requester	4
8.3 Technical contact	4
8.4 Failed device description	4
8.5 Failed-device history	5
8.6 Failure-mode description	6
8.7 Additional information and comments	8
9 Applicable Documents	8
 ANNEX A - Sample Failure-Analysis Request Form	 9

GUIDELINES FOR PREPARING CUSTOMER-SUPPLIED BACKGROUND INFORMATION RELATING TO A SEMICONDUCTOR-DEVICE FAILURE ANALYSIS

(From JEDEC Council Ballot JCB-98-14, formulated under the cognizance of the JC-14.6 Subcommittee on Failure Analysis.)

1 Introduction

This Guideline addresses acquiring and transmitting pertinent background information that a failure analyst should have to complete an accurate and timely failure analysis of a semiconductor device. To this end, a suggested background-data form and explanations of its data items are included.

2 Rationale

The electronic-equipment manufacturing industry is demanding ever shorter failure-analysis laboratory turnaround times. To meet this demand, failure analysts are trying to expedite the analysis process; however, to make correct decisions, the failure analyst should understand the requester's manufacturing processes, should know about deviations from normal operating conditions, and should be aware of problems observed near the time of failure. Lack of this key background information frequently forces the failure analyst to contact the requester's technical person, and this additional research effort delays initiation of the failure analysis, resulting in longer-than-necessary laboratory turnaround time.

This Guideline offers a convenient Failure-Analysis Request form that provides a vehicle for acquiring and transmitting the desired information in a concise, organized, and consistent format. While all of the information requested in the aforementioned form may not be applicable or available, the form does facilitate transferring the maximum amount of background data to the failure analyst in a readily interpretable format, and immediate availability of this key information assists the analyst in completing a timely and accurate failure analysis.

3 Purpose

The purpose of this Guideline is to establish a uniform mechanism for transmitting background data on a suspected component failure to the failure analyst so that laboratory turnaround time can be reduced and probability for successful failure resolution can be improved.

4 Scope

This Guideline presents a suggested Failure-Analysis Request form for transmitting background information that is essential for accurate and timely completion of a failure analysis. Included also are explanations of terms used on the form. The sample Failure-Analysis Request form appended to this Guideline is quite general; that is, it applies to both semiconductor-device fabrication facilities as well as to manufacturers of printed-wiring boards and complete electronic systems.

5 Responsibilities

To facilitate transmission of the desired background information, the requester of a failure analysis should assume responsibility for initiating entry of the requested information on the Failure-Analysis Request form and transferring the completed form to the next person in the protocol chain. Each person who receives the completed form should assume responsibility for transmitting it to the next person in the chain until the form ultimately reaches the failure analyst. The failure analyst then should reciprocate by completing a timely and accurate failure analysis and starting a failure-analysis report through the reverse protocol chain.

6 Terms and definitions

failure analysis: A methodical process of testing, dissecting, and inspecting a semiconductor device that is suspected of malfunctioning with the goals of locating the failure site and determining the cause of failure.

failure analyst: A person, employed by either the manufacturer of the failed device or an independent laboratory, skilled in failure analysis of semiconductor devices.

failure-analysis laboratory turnaround time: The time period beginning with receipt in the failure-analysis laboratory of a failed device and associated background information and ending with submission of a failure-analysis report and closure with the customer.

requester: The person, employed by either the organization that uses the component in question (i.e., the customer) or the device manufacturer (e.g., in wafer fabrication), who initiates the request for a failure analysis.

catastrophic failure: A failure that has serious consequences for the failed device or other components associated with it in the circuit (e.g., input shorted to power supply or ground, power-supply-to-ground short circuit, destructive latchup, etc.)

6 Terms and definitions (cont'd)

functional failure: Failure of a device to deliver correct output data or signals during operation (e.g., stuck-high or -low output, open input or output, logic error, etc.).

parametric failure: Out-of-tolerance current or voltage level at an input, output, or power-supply terminal of a component; parametric failures are usually detected during input-leakage, output-voltage, and power-supply-current tests.

programming failure: Failure of a nonvolatile memory device, such as a programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), etc., to respond properly during a write and/or read test.

timing failure: Operational malfunction caused by propagation delays, read/write times, rise and fall times, setup times, etc. that do not meet device specifications.

7 Description of Failure Analysis Request Form

The sample Failure-Analysis Request form presented in the Annex A is intended to serve as a vehicle for organizing and transmitting background information that is essential to the failure analyst if an accurate and timely analysis is to be performed. This sample form is of a general nature, so it includes items that pertain specifically to the device-fabrication process and other items that relate to the device-user's processes for assembling printed-wiring boards and final products. Thus, the form includes items that may not be relevant to a particular device manufacturer's products, and some product-specific items that are important to a device manufacturer may have been omitted. Therefore, it is permissible for a device manufacturer to modify the form to eliminate irrelevant items and to add relevant items; however, it is strongly recommended that general structure, organization, and wording of the sample form be maintained in the modified version so that all personnel involved in component failure analyses can readily comprehend the needs for information and immediately understand the transmitted data.

The Failure-Analysis Request form, as embodied in the appended sample, is divided into sections. At the top of each page is a header in which the failure-analysis laboratory is identified; this header may be altered to accommodate company policy, but as a minimum it should include the name and location of the company that operates the failure-analysis laboratory. Logotypes, business addresses, telephone and fax numbers, e-mail addresses, etc. may be included optionally.

7 Description of Failure Analysis Request Form (cont'd)

Remaining sections of the sample form provide spaces for entering detailed information about personnel requesting the failure analysis, description, history, and failure symptoms related to the failed device, and additional information and comments that may assist the failure analyst. In most of these sections, there are specific questions that should be answered as completely as possible if a satisfactory failure analysis and a short laboratory turnaround time are expected.

8 Explanation of items on Failure Analysis Request Form

Terminology used in each section of the sample Failure-Analysis Request form (Annex A) is explained in this section of this Guideline. Items are addressed in the order that they appear on the sample form.

8.1 Requester's tracking number

The **Requester's tracking number** is assigned by the requester for purposes of associating information entered in the Failure-Analysis Request form (Annex A) with related data and records held by the requester's organization.

8.2 Requester

The requester is the person, employed by either the organization that uses the component in question (i.e., the customer) or the device manufacturer (e.g., in wafer fabrication), who initiates the request for a failure analysis; this person should provide information needed to fill in the relevant lines in the **Requester** box on the form.

8.3 Technical contact

The technical contact is a person who has first-hand technical knowledge of the failure, including conditions existing just prior to failure and conditions under which the failure was detected. Because it may be necessary for the failure analyst to contact this person for additional information or clarification, this person should completely fill in the relevant lines in the **Technical Contact** box on the form.

8.4 Failed-device description

Markings on the failed-device package should be recorded in this section of the form. Additional items that may not be included in the device markings are also desired; these include the date code for the lot from which the failed device came, the device-manufacturer's part number, the device-manufacturer's lot number, the requester's part number, and the quantity of devices submitted for failure analysis.

8 Explanation of items on Failure Analysis Request Form (cont'd)

8.5 Failed-device history

Assessment of device history is a very important part of the failure-analysis process. Because information entered in this section is especially important, items are described on a line-by-line basis.

Where were devices purchased? When? On this line, the user's (i.e., requester's) source of the failed parts and the date of purchase are requested. Possible sources include, for example, the device manufacturer's sales organization or a local or national distributor.

Lot quantities: Information that should be entered on this line includes (1) the number of units in the originally purchased lot of devices, (2) the quantity from this lot that was tested or inspected, and (3) the quantity of tested or inspected devices in which the suspected failure mode was detected.

Were devices subjected to any value-added processing? ... For purposes of this question, value-added processing includes such operations as burn-in, screening (e.g., for specific ranges of electrical parameters), lead forming, environmental testing (i.e., environmental stress screening), incorporation of the parts in a subassembly, etc. A "yes or no" answer is desired. If value-added processing was performed, then names and addresses of providers of these services should be included, and the types of processing performed should be described fully. Specifications and drawings are useful supplements to the description placed on the form.

Where in the process was failure discovered? ... The appropriate box in this section should be checked, or if the listed items are not relevant, then the **Other** space should be used to describe the point in the process at which failure was detected. Note that the process points listed on the sample form cover semiconductor-device fabrication as well as user product-manufacturing process steps.

What was the last assembly step before failure was discovered? Within each of the major process steps associated with the previous question, there may be numerous substeps; it is the specific substep at which failure was detected that is requested in answer to this question. For example, in a semiconductor-device fabrication operation, a wafer-level failure might have been discovered after patterning of the first metal level; thus, in this example, the answer to this question would be "Patterning of metal 1." Similarly, in a printed-wiring-board assembly facility, a board-level failure may have been discovered after the pick-and-place operation, but before soldering; in this example, the answer to this question would be "Pick and place."

8 Explanation of items on Failure Analysis Request Form (cont'd)

8.5 Failed-device history (cont'd)

Describe deviations from normal manufacturing-process conditions that occurred at or near the time of failure: If shortly before or at the time that the failure was discovered there were any deviations from conditions that normally prevail on the production line, these should be reported and described fully; numerical data, if available, are important. For example, had a thunderstorm occurred shortly before (If so, how long before?) failures were discovered, or was one in progress at the time of failure? Was there a power outage, a power-line transient, or an air-conditioning failure? Were process conditions (e.g., temperatures, humidities, dwell times, mechanical forces, electrical forcing functions during test, etc.) outside of usual tolerance limits shortly before (If so, how long before?) or when the failure was discovered? If so, by how much were the conditions out of tolerance?

Was the device being used in a new application or had application conditions changed? ... Assembly-line and operating conditions to which the failed device had been subjected are important factors in determining cause of failure, particularly if these conditions were new and unproven. If the application, including, for example, circuit design, assembly process or conditions, operating environment, etc., was new or changed so that device performance had not been proven and effects of stresses impressed on the device had not been established by experience and long-term testing, then facts related to the new or changed application should be reported in answer to this question. Numerical data are valuable to the failure analyst. If the space provided on the form is not sufficient for a complete answer to this question, then the answer may be continued in the **ADDITIONAL INFORMATION AND COMMENTS** section or on additional sheets attached to the form.

Impact on production line ... The degree to which a device failure impacts the requester's production line may affect urgency of the failure analysis. Accordingly, the answer to this question should be an accurate and honest assessment of production-line impact; for example, short answers to this question might range from "none" to "temporary diversion of product to storage" to "total shutdown of line"; however, the short answer is not adequate, so the requester should also elaborate on the impact. Note that abuse of this item (i.e., overstating the production-line impact to gain priority in the failure-analysis laboratory) will adversely affect future credibility of the requester.

8.6 Failure-mode description

Detailed description of the failure mode (i.e., symptoms of malfunction) is absolutely essential if a useful failure analysis is to be obtained. Such symptoms could be visual (e.g., illegible markings, etc.), mechanical (e.g., damaged or broken leads, cracks in the package, etc.), or electrical (e.g., catastrophic, functional, parametric, programming, timing, etc.). Not only the general category of the failure, but also details, including numerical data, should be provided to facilitate verification of the malfunction.

8 Explanation of items on Failure Analysis Request Form (cont'd)

8.6 Failure-mode description (cont'd)

Failure mode ... The appropriate general category of the failure should be indicated by circling one of the listed terms: **Visual**, **Mechanical**, or **Electrical**. In addition, a complete description of the failure or malfunction should be given; this description should include not only supporting test data or inspection reports, but also a full description of the observed symptoms that suggest that a failure or malfunction has occurred. If the desired description is too long for the space provided, then it may be continued in the **ADDITIONAL INFORMATION AND COMMENTS** section or on additional sheets attached to the form.

How was failure isolated to this device? In answering this question, the methods (e.g., visual inspection, automatic test system, bench testing, circuit-board probing, system diagnostics, etc.) that were used to isolate the failure to the specific device being submitted for failure analysis should be identified and described. In describing the isolation method, the degree to which the method is specific should be stated (i.e., does the test method clearly point to a specific component or does it indicate only an uncertainty group of components that could contribute to the observed board- or system-level malfunction?). If the isolation method identifies a specific component, does it indicate the failing pin and does it tell how that pin is failing?

Has the failure mode occurred previously? ... If the same failure mode in the same type of component has been previously observed in the same or a similar application, then the "Yes" answer to this question should be circled. In addition, if the answer is "Yes", then a detailed description should be provided. For example, relevant information includes approximate dates of the previous manifestations of the observed failure mode, date codes of parts that were involved in previous failures, how those failures were detected, how many devices were involved, whether the problems were resolved, who performed the previous failure analyses (if failure analyses were performed), etc. Also, any differences between conditions associated with the present failure and the previous ones should be stated in the elaboration.

Was the failure intermittent? ... Characteristics of a "hard failure" do not change after the failure occurs. On the other hand, an "intermittent failure", which is often caused by a loose electrical connection, for example, is elusive; that is, it is clearly detectable at a particular time, but is not detectable at another time.

In answer to this question, the requester should indicate whether the failure was intermittent by circling the appropriate response item. If "Yes" is circled, then a complete description of the failure, the conditions under which it was detected, how frequently the failure could be detected, the methods employed in detecting the failure, etc. should be included. If the requested description is too long for the space provided, then it may be continued in the **ADDITIONAL INFORMATION AND COMMENTS** section or on additional sheets attached to the form.

8 Explanation of items on Failure Analysis Request Form (cont'd)

8.6 Failure-mode description (cont'd)

Did replacing the device fix the problem? ... If replacing the suspect component with a known good device fixed the problem, then it is likely that the suspect device was causing the observed board- or system-level malfunction. On the other hand, if replacing the suspect component did not completely fix the problem, then it is highly likely that the suspect device did not malfunction or that more than one component failed. After circling the appropriate "Yes" or "No" answer, the requester should provide a description of the effect of replacing the suspect device. If the answer was "No", then such points as the effects of replacing the suspect device on observed higher-level (i.e., board or system) failure symptoms and the effects of replacing other components should be addressed. Also, if the known good replacement device failed after being installed, then this fact and other related observations should be reported. If the requested description is too long for the space provided, then it may be continued in the **ADDITIONAL INFORMATION AND COMMENTS** section or on additional sheets attached to the form.

8.7 Additional information and comments

This space may be used to provide other relevant information about the failed device, its history, conditions of failure, etc. Circuit diagrams, sketches, test data or other numerical data, comments, continuations of long answers to previous questions on the form, and any other information that will assist the failure analyst in locating and diagnosing the device problem may be included in the space provided in this section.

Additional pages may be attached if necessary. If additional pages are attached, they should be identified as part of the information submission, sequentially numbered, and dated; additionally, the number of attached pages should be noted at the bottom of the **ADDITIONAL INFORMATION AND COMMENTS** section.

9 Applicable documents

- a. *Standard For Failure-Analysis Report Format*, Joint Electron Devices Engineering Council, EIA/JESD38, 1995.
- b. *Fault-Tree Analysis Application Guide*, Reliability Analysis Center, IIT Research Institute, 1990.

Annex A Sample Failure-Analysis Report Form

See the following pages for form.

OPTIONAL
LOGOTYPE

BIGCHIP SEMICONDUCTOR COMPANY
Silicon Gulch, ST

OPTIONAL
LOGOTYPE

FAILURE-ANALYSIS REQUEST

REQUESTER

Name: _____ Date: _____
Company: _____
Address: _____
City: _____ State: _____
Phone: _____
Fax: _____
E-Mail: _____

TECHNICAL CONTACT

Name: _____ Date: _____
Company: _____
Address: _____
City: _____ State: _____
Phone: _____
Fax: _____
E-Mail: _____

FAILED-DEVICE DESCRIPTION

Device manufacturer: _____ Date code: _____
Manufacturer's part number: _____ Requester's part number: _____
Manufacturer's lot number: _____ Quantity submitted for analysis: _____

COPY DEVICE MARKINGS IN BOXES BELOW

Markings on top of device package:

Markings on bottom of device package:

FAILED-DEVICE HISTORY

Where were devices purchased? _____ When? _____

Lot quantities:

Purchased: _____	Tested or inspected: _____	Failed: _____
------------------	----------------------------	---------------

Were devices subjected to any value-added processing? (Circle one) Yes No If "Yes", please state where processing was performed and describe type of processing: _____

Where in the process was failure discovered? (Check one) Wafer ☐ Packaging ☐ Electrical test ☐
Incoming inspection ☐ Reliability test ☐ Burn in ☐ Environmental stress screening ☐
Board level ☐ System level ☐ Programming ☐ Field ☐ Other: _____

What was the last assembly step before failure was discovered? _____

Describe deviations from normal manufacturing-process conditions that occurred at or near the time of failure: _____

Was device being used in a new application or had application conditions changed? (Circle one) Yes No
If "Yes", please describe: _____

Impact on production-line (Please describe): _____

OPTIONAL
LOGOTYPE

BIGCHIP SEMICONDUCTOR COMPANY
Silicon Gulch, ST

OPTIONAL
LOGOTYPE

FAILURE-ANALYSIS REQUEST

FAILURE-MODE DESCRIPTION

Failure mode (Circle one): Visual Mechanical Electrical (Note: Please provide detailed test data)

Describe failure symptoms: _____

How was failure isolated to this device? _____

Has the failure mode occurred previously? (Circle one) Yes No If "Yes", please elaborate: _____

Was the failure intermittent? (Circle one) Yes No If "Yes", please describe: _____

Did replacing the device fix the problem? (Circle one) Yes No Please elaborate: _____

ADDITIONAL INFORMATION AND COMMENTS

Please use this space for additional information, circuit diagrams, sketches, data, and comments that could help the failure analyst provide you with a timely and accurate determination of the cause of failure. Attach additional numbered and dated pages if necessary.

Quantity of attached pages: _____

