



Failure Analysis of IC (Econo) Modules in Dynamic, Static, and ISO Process

Final Project

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STATEMENT OF AUTHENTICITY OF FINAL PROJECT

I, the undersigned, certify that the contents were in part or whole of my Final Project entitled: "Failure Analysis of IC (econo) Modules in Dynamic, Static, and ISO Process" is my work, completed without the use of materials that are not permitted, and is not the work of another party which I acknowledge as my work. All references cited or referred to have been written in full in the bibliography. If it turns out that my statement is not true, I am willing to accept sanctions following applicable regulations.

Cepléd, 25 February 2024



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APPROVAL

The Final Project was prepared to fulfill one of the requirements to obtain the degree of Associate Expert in Engineering (AMd.T.)

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Failure Analysis of IC (Econo) Modules in Dynamic, Static, and ISO Process

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Abstract— Dynamic, Static, and ISO are adapters that are useful for testing modules on the machine. In this system, Dynamic, Static, and ISO have their respective roles in the testing machine with the process of using a KWK 4-type machine. This research aims to analyze the frequent module rejects that occur in dynamic, static, and ISO. The analysis method used in this research is qualitative analysis. This type of research uses a qualitative descriptive approach, which describes and analyzes the problems found.

Keyword: Adapter, ISO, Dynamic, Static

I. INTRODUCTION

INFINEON Technologies AG Cegléd Kft. is an electronics company that produces semiconductor modules. The production process at Infineon Technologies AG Cegléd Kft uses very complex tools and is integrated with the IOT process, this making production at this company very good. There are several process stations to make a module, the tool or module produced by Infineon Technologies AG Cegléd Kft is commonly used to drive electric cars or giant windmills, and electric helicopters[1]

there are several processes, one of which is in the testing machine section, the process is a test that is used whether a module is functioning properly and whether ICs function perfectly and follow ISO standards that are in the module by predetermined process sequence. [1]

Before starting the production process (first run) IPQC (in-process quality control) must check whether the goods being run are by the document. [2]. In the testing process, it is very important to check the goods by the documents, besides that, it must pay attention to whether the adapter is by the material to be run.[3] In the project that the author made the final project entitled "Failure Analysis of IC Modules (Econo) in Dynamic, Static, and ISO Processes" to analyze or examine the causes of failure in the IC Module (econo) when dynamic testing, static testing, and ISO Test. and based on the author's observations during the internship from July 24, 2023, the author observed many rejected modules as many as 10 modules burned during the dynamic testing process, and 20 modules that failed during the static process and 3 modules that failed during the ISO process so the author will analyze what are the causes of failure.

Based on the background description above, the authors formulate and examine the problems that occur:

1. How to reduce process failure during testing?
2. How to find out the cause of the failure of a module?
3. How can a machine work perfectly to make the modules produced better by customer demand?

The purpose of this project is for the author to make efforts to minimize rejects that occur on the testing machine, to provide the best results for the company and customers.

The system that the author will create has several benefits, here the author describes the benefits of the project to be created:

1. To minimize the occurrence of damage and loss.
2. To complete production faster and according to standards
3. To reduce the time needed if the tested module must be retested due to inaccurate checking of the module on the adapter.

II. METHOD

A. Design of the Research

The test method in designing this system is as follows: the test method in designing this system is as follows:

1. Literacy studies.
2. Formulation of the problem.
3. Data collection.
4. Actions taken.
5. Implementation and results.
6. Conclusion comparison before and after improvement

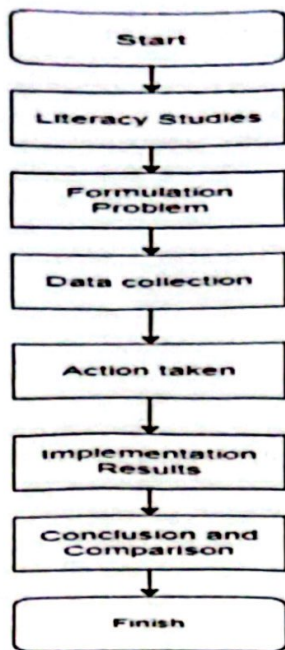


Fig. 1. Flowchart of test design

B. Data Collection Techniques

the main data sources in qualitative research are words and actions, the rest is additional data such as documents and others. additional data such as documents and others. What is meant by words and actions words and actions here are the words and actions of the people observed or interviewed. are the main (primary) data sources. While other data sources can be written sources (secondary), and documentation such as photographs.[4]

a) Primary data

Primary data is data obtained directly through observations and interviews with informants or respondents. Researchers will interview informants to dig up information about the problems that occur in the machine and the causes of product failure. This research is the main source of data is technologists who are experts in this field.

b) Secondary data

Secondary data is additional data in the form of information that will complement primary data. Additional data in question includes documents or archives obtained from various sources, existing supporting photos, as well as self-generated photos, and data related to this research. photos produced by themselves, as well as data related to this research. Additional data in this study are failure catalog and machine work instructions.

There are three kinds of interviews, namely structured interviews, semi-structured interviews, and unstructured interviews. In this study, the authors used a semi-structured interview method, which is an interview that is conducted more freely when compared to structured interviews. The purpose of this type of interview is to find more open problems where the interviewees are asked for their opinions and ideas. Interviews are conducted openly where the subjects know that they are being interviewed and know what the purpose of the interview is. Interviews were conducted until the researcher found no more new information (saturation).

In the process of data collection, the author initially interviewed interviewers from Econo Infineon Technology, for the next interviewers will be determined later after there is a recommendation from the first resource person or the researcher has another initiative after obtaining data from the first resource person. The researcher has other initiatives after obtaining data from the first resource person.[4]

C. Data validity

To avoid errors in the data to be analyzed, the validity of the data needs to be tested in several ways as follows:

1. Continuous data collection on the same research subject.
2. Triangulation on other sources that can be accounted for, and if necessary
3. Checking by the research subject.

III. RESULT AND DISCUSSION

In these results, the author has analyzed various problems that occur on testing machines (KWK), from problems that are caused by the machine, and material, to module handling, and to detect these failures the machine already has a system called (Orbit) this system detects This module is included in the defect category, and there are several weaknesses in this system, namely that the system cannot visually detect defects such as scratches on the module or burned pins. The system cannot read these [2]

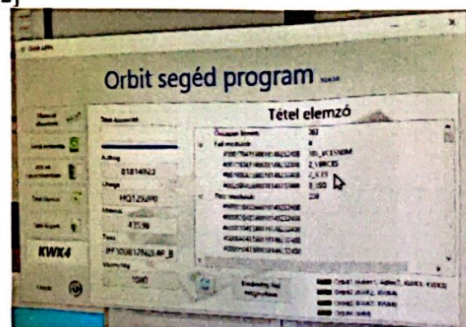


Fig. 2. Orbit System[1]

In the orbit system there is an abbreviation to detect what type of damage the module has. And this will make it very easy for

technicians and quality to take action on modules or machines what should be done first.[1]

causes of failure and handling as well as some improvements to the machine that have been made by the author and respondents. and several topics will be discussed regarding the causes of failure, among others:

1. Double bonding
2. Burn module
3. Wrong bond position.
4. Burn pin
5. Asymmetrical bonding

Double bonding

double bonding is caused by the previous process, namely framebonding, this is caused by program or operator error, if it is caused by the framebonding machine program where the machine re-bonds the module, and if the operator error is caused by the operator not knowing that the module has been bonded so that the module is put back into the machine and the machine re-bonds. For handling it must be confirmed whether the machine is running the appropriate program, but unfortunately, if we find this defect we cannot rework the module so that the item is declared defective.

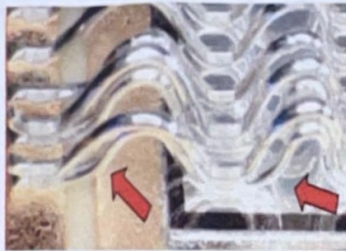


Fig 3. Double Bonding[1]

the author examined that since November 22, 2023, 35 modules had double bonding, but after researching and improving the program and material handling, the double bonding failure gradually decreased.

Double bonding also causes the module to explode when the module is tested in dynamic.

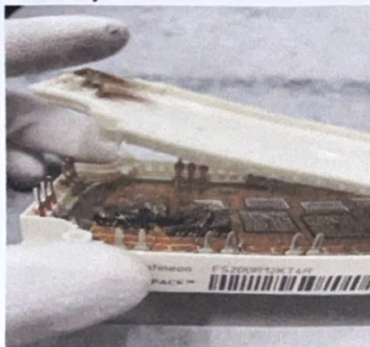


Fig. 4. Explode module[1]

Burnt Module

After the author analyzes the cause of the module burns caused by various things, first there is dirt on the module pins so that during the dynamic testing process the module is tested at high temperatures, the dirt sticks to the adapter and triggers a burn on the module, the second is caused by the previous process of binding the frame and filling silicone (potting) in the process of binding the cable frame is connected to other cables so that during the dynamic testing process the module is short-circuited and burns.



Fig. 5. Burnt Module[1]

in this case, we must make sure again before entering the module into testing whether the module is properly, if we find irregularities in the module we should immediately report to the shift leader so that it can be handled immediately, and if we find irregularities in the machine immediately report to the technician.

Wrong Bond Position

the author also analyzes the cause that occurs quite often, namely the wrong bonding position, this process is caused by the previous process, namely the framebonding process. In this process, the bonding position error occurs because the wrong reference is inserted so that the bonding machine does not fit on the pad. On December 28, 2023, 321 modules had wrong bonding, and almost every module was located at the same point, after investigating and improvising for 2 weeks 3 factors influenced the wrong bonding position, namely:

1. the size of the PCB was not suitable because it was wrong to solder the PCB according to the material being run.
2. the position of the module to the bonding machine is not according to the orientation.
3. incorrectly registering the material number into the machine which resulted in the module reading another material program.

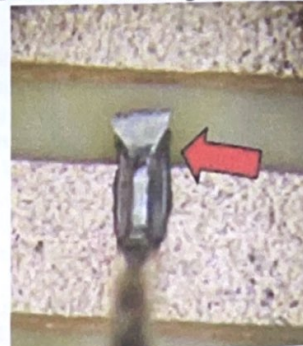


Fig. 6. Wrong bond position[1]

The result of the improvisation is to create information about the correct PCB installation so that the operator knows how to install the correct PCB and it is hoped that there will be no more errors.

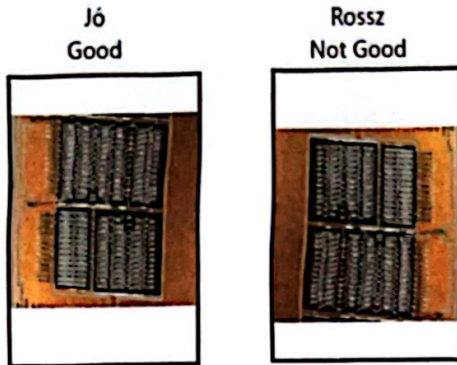


Fig. 7. Result of improvements[1]

Burnt Pin

the author analyzes that the next cause is burnt pins, burnt pins are caused by dirt on the pins, such as silicone attached to the pins so that the module burns during the testing process on the adapter.

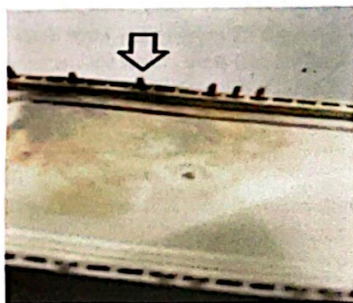


Fig. 8. Burnt pin[1]

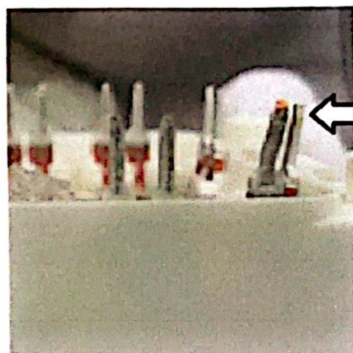


Fig. 9. Dirty on pin[1]

to overcome this, the module pin must be brushed first before being inserted into the machine using a wire brush, and only modules with hard pins can be brushed because this prevents the pin from bending.

Asymmetrical bonding

asymmetric bonding is caused by program errors during the bonding process. The position of the capillary that does not match the X and Y coordinates, and the placement of the module that does not match the coordinates also affect the bonding process, this asymmetrical bonding greatly affects the module, and this asymmetrical bonding is very difficult to detect on the testing adapter because the adapter cannot test the module, so it is important to check with a microscope and check thoroughly with X-ray to see if the bonding is symmetrical or asymmetrical.



Fig. 10. Asymmetrical bonding[1]

on January 3, 2024, 34 modules were found that had asymmetrical bonding on Type CW7698P0 type after further measurements were made with a comparison of the dummy module type CW7697P0 that the CW7698P0 module the results were unstable because the module did not touch the 2.56 v figure only up to the limit of 2.49-2.51v and for the normal of a module to function properly is at 2.56v-2.6v for the CW type

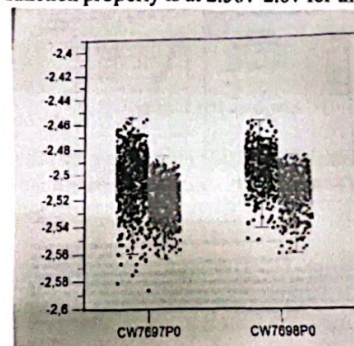


Fig. 11. Result of measurement type CW[1]

and the results of measurements that have been made in the dynamic, static, and iso machines the authors and respondents examined by testing 10 times, that the results of these measurements are that the measured VF (value field) value is close to the limit in both systems, and VCESat (Value Chip equipment static) is also close to the upper limit (Normal). and measured with 2 VF (value Field) testers and 1 VCE (Value chip equipment) tester.

tester 1 VF1 :2.593/2.772V
 tester 2 VF2 :2.542/2.576 V
 VCE tester: 1,866/1,86 V

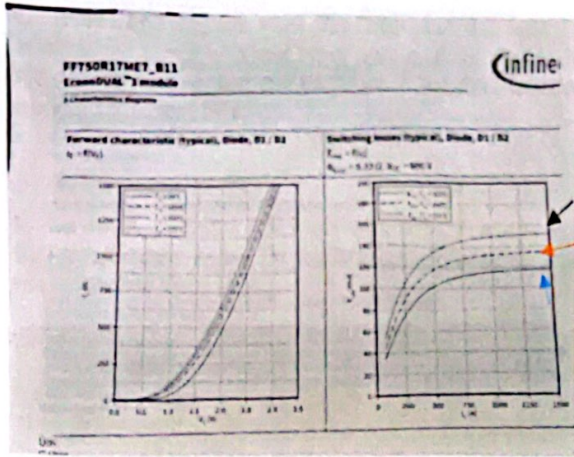


Fig. 12. Result of measurement on Dynamikus, Statikus, and ISO adapter[1]

the picture above on the right explains the measurements of dynamics, statistics, and ISO are classified into 3 lines and marked with an arrow symbol, the blue arrow shows the ISO measurement results, the orange arrow shows the statistics, and the black arrow shows the dynamics, on the blue arrow the measurement is carried out by giving a load on the module with temperature resistance gradually starting from the number 35 degrees Celsius to 125 Celsius, and the orange color arrow shows from 42 degrees Celsius to 150 degrees Celsius, and finally, the black arrow shows from 55 degrees Celsius to 175 degrees Celsius, and the results show that the module is in good condition after improvement.

A. Result Measuring Dynamikus

In this result, the author will explain the research results of the measurement of the dynamic before the improvement of the defect that the author has stated above.

This measurement was carried out with a sample of Econo 4 (HK type) modules. With the following module drawings.

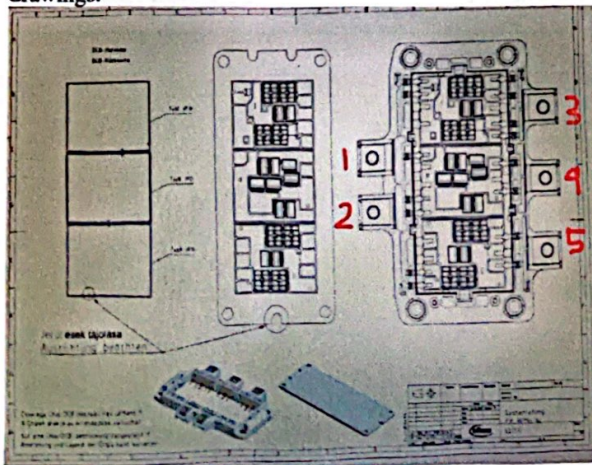


Fig. 13. Drawing module Econo 4 [1]

in the drawing there are 5 terminals contained in the module, the five terminals will be tested with a dynamic adapter.

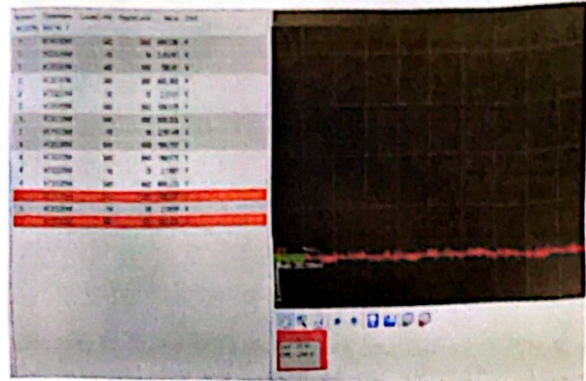


Fig. 14. Result of measurement on dynamics (before improvement)[1]

the results of the graph show that in the VCES1DM parameter, the value shown is 388,618 V. and the VCES3DM parameter shows a value of 394,258 V. This indicates that the measurement at terminal no. 5 has a problem with the module, namely the module cannot deliver current properly, the value is also not at the upper limit and lower limit, allowing the module to be damaged in the wire connection.

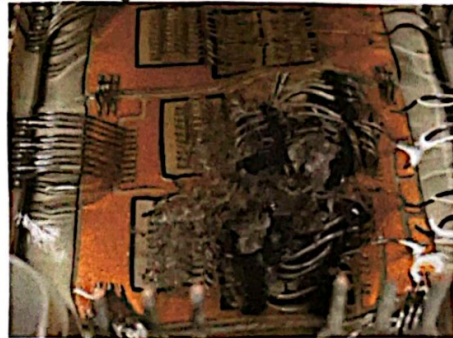


Fig. 15. Damaged wire connection[1]

In this result, the author will explain the research results from measuring the dynamics after the improvement of the defects that the author has mentioned above.

System	Parameter	LowerLimit	UpperLimit	Value	Unit
VCEON, Test No: 1					
1	VCE1DM	540	660	600,406	V
1	VCE3DM	-18	18	2,0659	V
1	VCE3DM	540	660	599,838	V
2	VCE1DM	540	660	599,61	V
2	VCE3DM	-18	18	1,9433	V
2	VCE3DM	540	660	599,408	V
3	VCE1DM	540	660	599,385	V
3	VCE3DM	-18	18	2,0059	V
3	VCE3DM	540	660	598,997	V
4	VCE1DM	540	660	599,61	V
4	VCE3DM	-18	18	2,80149	V
4	VCE3DM	540	660	600,101	V
5	VCE1DM	540	660	599,242	V
5	VCE3DM	-18	18	2,0659	V

Fig. 16. Result of measurement on dynamics (after improvement)[1]

the results of the graph show that the values that have been between the upper limit and lower limit so that the module is suitable for testing and can continue to the next test stage, namely Static, and ISO.

B. Result measuring ISO

In this result, the author will explain the research results of the ISO measurement before the improvement of the defect that the author has stated above.

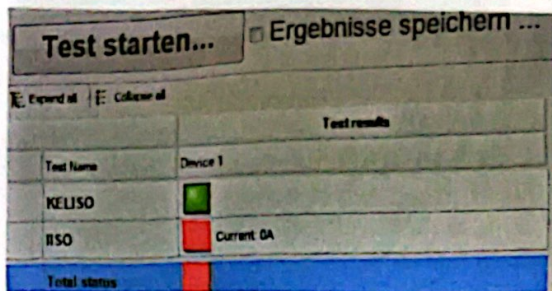


Fig. 17. Result of measurement on ISO (before improvement)[1]

the results above show that the module does not following ISO standards and after further inspection, there is double bonding contained in the module so that the module when checked shows a failed result.

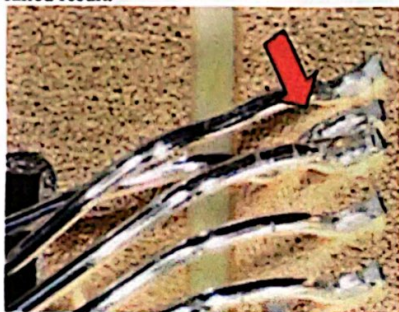


Fig. 18. Double bonding on a module[1]

In this result, the author will explain the research results from measuring the ISO after the improvement of the defects that the author has mentioned above.

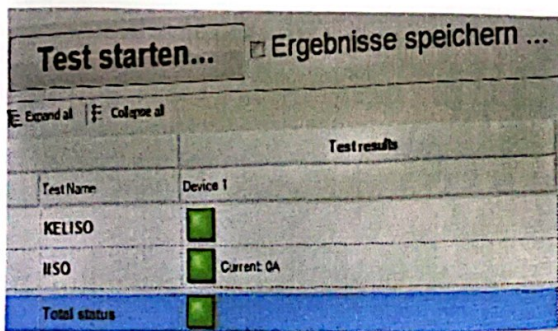


Fig. 19. Result of measurement ISO (after improvement)[1]

after making improvements to the module and also the engine the measurement results shown on the ISO adapter result in that the module passes and complies with ISO standards.

C. Result measuring Static

In this result, the author will explain the research results of the Static measurement before the improvement

System	Parameter	LowerLimit	UpperLimit	Value	Unit
VGES Test Nr: 1					
1	IGESDM	14,85	15,15	14,99	V
2	IGESDM	14,85	15,15	14,925	V
3	IGESDM	14,85	15,15	14,98	V
4	IGESDM	14,85	15,15	14,9875	V
5	IGESDM	14,85	15,15	14,983	V
6	IGESDM	14,85	15,15	14,9825	V

Fig. 20. Result of measurement on static (before the improvement)[1]

The results above show the data on terminal no. 5 PIN 8, a failure occurred when reading on the IGESDM parameter (Ignore Static Electrical Depend Module) shows a number - 2,585 V this number is very far from the upper limit and lower limit, and after checking the module there is an overflow solder that causes the module to have static electricity.

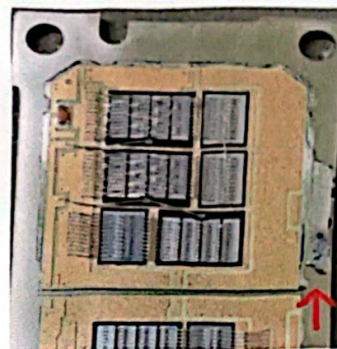


Fig. 21. Overflow solder[1]

In this result, the author will explain the research results of the Static measurement after the improvement

System	Parameter	LowerLimit	UpperLimit	Value	Unit
VGES Test Nr: 1					
1	IGESDM	14,85	15,15	14,9875	V
2	IGESDM	14,85	15,15	14,9825	V
3	IGESDM	14,85	15,15	14,98	V
4	IGESDM	14,85	15,15	14,9875	V
5	IGESDM	14,85	15,15	14,99	V

Fig. 22. Result of measurement static (after improvement)[1]

The results of the graph, show that the value is between the upper limit and the lower limit so that the module is eligible for use and can be continued to the next stage of packaging.

IV. CONCLUSION

The conclusion of this project is that the author makes efforts to minimize time and reduce rejects that occur in the process carried out on the testing machine, by ensuring that the module has no defects and the program is run in accordance with the material used, the test can produce good results. and

also must ensure that the machine has no critical and non-critical damage because engine damage can also affect module damage. a functioning module is a module that has passed 3 stages of testing, namely dynamics, statistics, and iso because these three stages are very important to ensure that the module can function and is safe for consumers.

ACKNOWLEDGMENT

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Attachment

PROCESS TESTING MACHINE

One of the processes at Infineon Technologies AG Cegléd Kft is the final testing process. The final testing process is the process of testing the module whether the module can function properly and if there are no defects based on the failure catalog. This testing process goes through 5 stages of checking. 1. checking the module in the dynamic process which this process serves the durability of the module at a certain temperature, 2. Checking the ISO process which this process serves to check whether this module is standard with ISO and safe from short circuits, 3. Checking the module in the static process which this process serves to determine whether the module can function statically and whether electricity can flow in the module, 4. Checking the pin on the module whether the pin on the module can function properly, 5. Visual checking this process serves whether the module has defects or not and according to standards based on the failure catalog.

Explanation of how the Testing machine works or processes:

1. The process of inserting goods into the machine in the form of modules that are placed on the conveyor
2. The process of registering the module in the machine based on the module description paper.
3. the process of checking the adapters used are by the module to be used and checking the adapter pin
4. Running the machine
5. Then, when all the modules are ready, the next step is for the modules to

Then when all modules are ready, the next step is for the module to enter the inspection process, which is a process where it is visually checked whether the module has defects or not.[1]

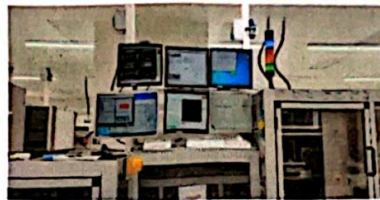


Figure 1. Machine testing

End Testing Process

In the End testing of Econo products, there are several stages of product quality checking and quality testing by machines, and I summarized the process with a flow chart.

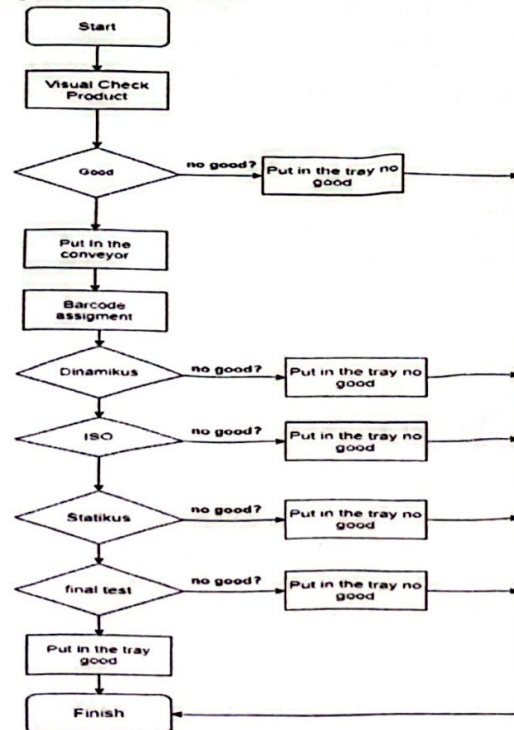


Figure 2. Flowchart End Test Process

1. **Start**, the machine is set up and the machine is ready for the testing process.
2. **Visual check product**, In this section, we look at the physical viability of the products visually, and if any products are not of good quality, place them in the tray where the no-good products are.
3. **Put in the conveyor**, for the Good and if the product is of good quality place it on the conveyor.
4. **Barcode assignment**, After the product is on the conveyor. then, the conveyor directs the product to the barcode assignment machine. the assignment of this barcode is important to sort the product number.
5. **Dinamikus**, barcode is available and the conveyor directs the product to test the heat resistance of the product by the machine. and if there is a product that is not heat resistant, then the quality of the product is less, and the machine will remove the product by itself, and place it in the not-good tray.
6. **ISO**, The product durability test is smooth, then the product will be directed by the conveyor to the quality checking machine, this quality check aims to find out whether the quality obtained by the product is up to standard or not. If not, the machine will automatically remove the product.
7. **Statikus**, products whose quality is appropriate will be directed by the conveyor to the machine testing the electricity in the product, and if the quality obtained is not appropriate, the machine will automatically remove the product.
8. **Final test**, After all product testing processes are completed, good quality products are visually checked again and a quick test is performed by the adapter, if the product quality is good, place the products on the array and arrange the good products onto one available pallet.
9. **Finish**, The good quality products will be delivered to the next section

Dynamic Testing

Dynamic testing is a test for a module whether the module can withstand high temperatures in this test a module will be inserted into the adapter where the adapter will measure and provide a voltage of 600 volts and given a temperature of 120 degrees Celsius and in the dynamic adapter there is a contactor designed to handle much higher currents involved in applications such as turning on and off a module[2], the test takes different times depending on the type of material or IC that is bonded to a certain type2, and this test usually takes 2-5 seconds per module after that proceed to the next stage.

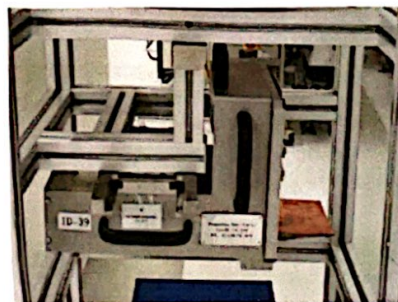


Figure 3. Adapter Dynamic

ISO Testing

ISO is short for The International Organization for Standardization. It is a non-governmental body made up of more than 160 countries. They are responsible for developing standards for various industries that promote quality, safety, and efficiency. While no company is forced to adhere to ISO standards, choosing an ISO-registered supplier ensures that your suppliers manage their business to a consistent standard that drives out waste and costs and encourages product and delivery quality.

With this organization in place, ISO will provide specifications for world-class in a variety of ways. Companies that have been verified by ISO will have the opportunity to win the global market competition because it provides a guarantee of product quality so that consumers have more confidence in the product.

The ISO standard used in the module by Infineon is ISO 26262 which is a functional safety standard for the automotive industry. and highly integrated systems equipped with safe electronic semiconductors are essential for key application areas such as connectivity, electromobility, and higher levels of automated driving. The ISO 26262 series of standards specifies requirements and guidelines for products to be integrated in automotive safety applications. Testing is very crucial if the module is out of this ISO test then the module must be discarded and cannot be repaired anymore and it is also important to check the ISO adapters periodically so that the module being tested can meet the standards, this test takes 2-4 seconds depending on the type of material and module type.



Figure 4 . ISO 26262

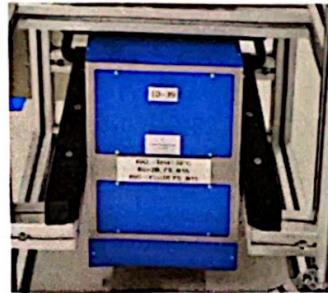


Figure 5. Adapter ISO

Static Testing

The last test of the testing machine is static testing, which tests the suitability of the module to function properly from the terminal pins and the module is safe from static electricity. This test also tests whether the module can withstand a temperature of 20 degrees Celsius and can function according to its circuit. This test takes about 1-2 seconds per module, but some modules can reach 0.9 ms per module depending on the type of material to be run. and each adapter has a different type to run a material so it is important to ensure the material number is registered and adjusted to the adapter used so that the test can run properly.



Figure 6. Static Adapter

Table 1. List of details Orbit system

Type	Code	Description
Dynamikus	101_VCES1DM	a module cannot warm up to 110 degrees Celsius
	1ESDM	one of the pins can't touch the adapter properly
	KELLESDM	the program does not detect module
	IGESDM	module burns, and explodes
Statikus	2_VBRCES	wrong chip attached to the module
	2_ICES	one of the pins can't touch the adapter properly
	KELLStat	the program does not detect module
ISO	0_IISO	defective modules not conforming to ISO standards
	1_KELLISO	the program does not detect module

How to Detect Failure Process

A method of detecting failures or identifying defects in a module is that the machine will provide notifications and alarms that a fault or defect has been detected in the previous process or the process being executed. For example, the display will look like this if there is an identification or detection of an existing process failure.

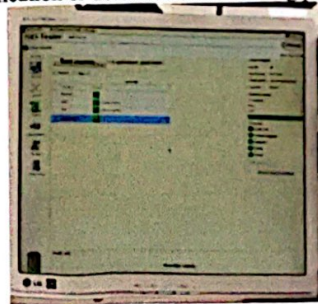


Figure 7. Display ISO testing

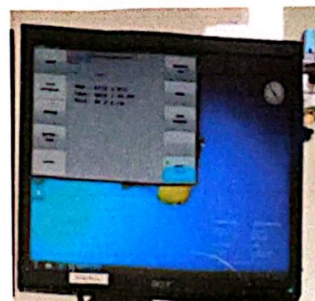


Figure 8. Display Static testing

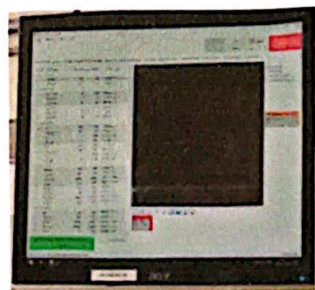


Figure 9 . Display Dynamic testing

This figure shows the notifications that will appear when an item is rejected from Dynamic, Statikus, and ISO. The following are some ways to detect module failures on the testing machine:

1. **Visual Inspection:** Visual inspection is the most common method of detecting faulty modules or faulty machines. Operators or technologists can perform this inspection by checking if the module has the wrong orientation, wrong lot of items, connected wires, bent pins, burnt pins, or broken testing adapter needles.
2. checking through the machine by looking at the machine notification and the machine settings.