

ENGINEERING PRACTICE STUDY

PROJECT NUMBER: 5961-2021-111

TITLE:

MIL-STD-750-1, TEST METHOD 1001:
"BAROMETRIC PRESSURE (REDUCED)"

SURVEY TO GATHER DATA CONCERNING
ELECTRICAL BIAS PROCEDURES USED DURING
REDUCED BAROMETRIC PRESSURE TESTING

21 JULY 2022

FINAL REPORT

STUDY CONDUCTED BY

DLA LAND AND MARITIME
Document Standardization Division (VA)
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Attachments: 2

I. OBJECTIVES: The objective of this Engineering Practices Study (EPS) was to survey the user community (military services, OEMs, and test laboratories) regarding the interpretation and usage of test method 1001 of MIL-STD-750-1.

II. BACKGROUND: At the September 2021 JEDEC MIL-STD-750 Test Methods Task Group meeting, a QML-19500 qualified manufacturer provided a briefing to the attendees regarding a requirements conflict with respect to electrical biasing of the device under test in method 1001. The conflict of requirements is in regards how the device terminals are to be biased during test. The briefing has been included as attachment 1.

III. RESULTS: A survey letter was sent to the FSC 5961 user community (military services, OEMs, and test laboratories). The responses to the survey were low with only 1 government and 3 military activity submitting comments. No industry entities responded. The questions with summarized responses have been included as attachment 2.

IV. CONCLUSIONS: DLA has concluded that the following actions should be pursued:

- a. Review and revise methods 1001, 1016 and 1081 to clarify the intent of the testing and possibly removing the reference to dielectric withstanding voltage from method 1001.
- b. Establish within method 1001 a default lead bias condition as "case-to-biased terminals" (operating) style since the "case-to-shorter terminals" (DWV) style is the default bias condition of method 1081.
- c. Update the MIL-PRF-19500 specification sheet boiler plate to include the parameters that must be required for group E inspection for method 1001 during future standardization actions.

V. RECOMMENDATIONS: Prepare a draft revision of method 1001 incorporating the conclusions of this study for review and comment. Also, since the MIL-PRF-19500 specification sheet should specify the electrical test configuration to be used, identify all specifications sheets that specify the use of method 1001 and initiate projects to align their requirements to the conclusions of this study.

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Attachment 1

Discussion of Barometric Pressure Test Bias Conditions

IR Hi Rel
1/24/2022

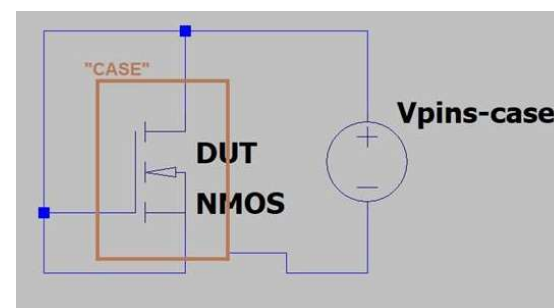
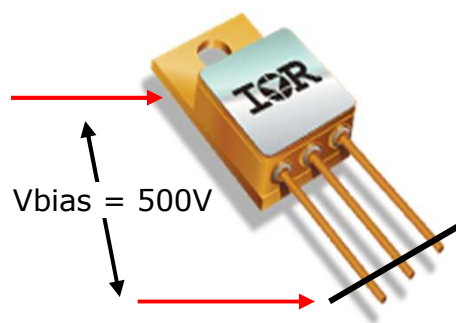
IOR HiRel
An Infineon Technologies Company

Introduction

- › A team at IR HiRel in Leominster, MA has been evaluating the interpretation of the bias condition requirements of MIL-STD-750 method 1001.4 for Barometric Pressure (Reduced)
- › Current IR HI Rel procedure defines bias application in the manner of a package isolation test – i.e. bias applied between the package metal case as one node, and all leads connected together as the other node.
- › Observation of some recent test results in T0-254 package led to investigation and consideration of the optimal means of applying bias to devices under test to meet intent of Method 1001, and provide most benefit to the user.

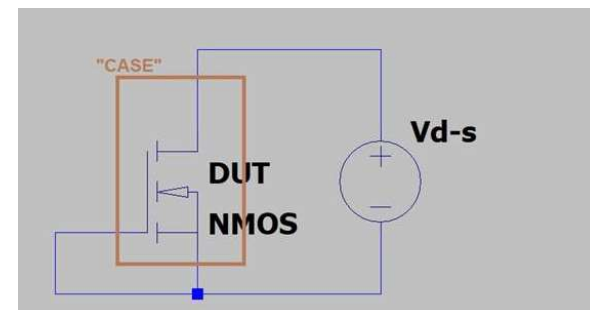
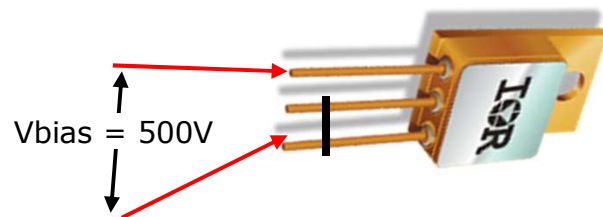
Example of recent test performed on T0-254 package

- › A set of test samples was subjected to a Barometric Pressure test at 500V.
- › For the initial run of the test, Bias was applied between case and leads.
- › Failures were identified at Vacuum levels >30 Torr (~1.2 Inches Hg); expectation is that devices will not show electrical leakage at vacuum levels well below 30 Torr.



Example of recent test performed on T0-254 package

- › Test was re-run with bias applied between the Drain and Source of the device (Gate shorted to Source)
 - › All samples passed at levels below 10 Torr.



Example of test performed on T0-254 package

- › The results of the testing on the T0-254 test were consistent with other earlier results, in which T0-254 samples were unable to meet barometric test conditions when bias was applied between case and “all leads connected together”
 - › These results generated discussion about what the proper method was for applying bias, since device in use will see max bias condition when applied between Drain and Source.
- › When the test was performed with bias between Drain and Source, the devices were easily able to meet leakage current expectations at vacuum representing 70,000 feet (condition C of method 1001.4)

Other package configurations

- › For non-isolated metal packages, like TO-3 or TO-39, where the case comprises the drain connection, the VD-S bias must be the applied condition.



- › For ceramic-lidded SMD packages, such as SMD 0.2C, 0.5C, the bias can only be applied between VD-S as there is no case connection.



Review of test conditions identified on existing 19500 slash sheets

- › For all devices with a $BV_{dss} \geq 250 \text{ V}$, 19500 slash sheets were reviewed, to determine what Barometric Pressure requirements were identified.
- › In all cases where the QCI tables identified conditions for Barometric pressure bias, the condition stated that V_{DS} was the applicable condition.

Interpretation of the intent of MIL-STD-750

- › With respect to the application of electrical bias to the test samples, there are several statements included in MIL-STD-750 method 1001.4:
- › In section 1:
...This test is intended primarily to determine the ability of component parts and materials to avoid **dielectric-withstanding-voltage failures** due to the lowered insulating strength of air and other insulating materials at reduced pressures. Even when low pressures do not produce complete electrical breakdown, corona and its undesirable effects, including losses and ionization, are intensified.
- › In section 3:
If not specified in the applicable performance specification sheet or acquisition sheet, the device shall be subjected to the **maximum voltage under rated conditions**.
- › Thus it can be seen there are, in the same method, a purpose to assess dielectric withstanding voltage failures, and a desire to subject the device to maximum rated voltage under rated conditions – which we interpret to relate to the actual max device application bias- for example BVdss for a MOSFET.
- › In actual testing, a device which passes the VDS bias test at atmospheric pressure and then fails this test at low pressure is failing due to dielectric withstanding failures.

Input from industry

- › As part of our investigation, we engaged in discussion with several customer and user representatives.
 - › The result of these discussions:
 - › In general, the user community acknowledged the reference to the dielectric withstanding voltage performance in the methods' purpose statement.
 - › The user community also recognized the benefit of applying a D-S bias during the barometric pressure test, because this was a better approximation or the worst case bias when the component was installed in next level assembly.

Other standards:

- › MIL-STD-883 method 1001:

With respect to the application of electrical bias to the test samples, there are several statements included in MIL-STD-883 method 1001:

- › In section 1:

- ...This test is intended primarily to determine the ability of component parts and materials to avoid **voltage breakdown failures** due to the reduced dielectric strength of air and other insulating materials at reduced pressures. Even when low pressures do not produce complete electrical breakdown, corona and its undesirable effects, including losses and ionization are intensified...

- › In section 3:

- ...The device shall have the specified voltage applied....

- › MIL-STD-202 method 105:

- › In section 1.1:

- ...This test is intended primarily to determine the ability of component parts and materials to avoid **dielectric-withstanding-voltage failures** due to the lowered insulating strength of air and other insulating materials at reduced pressures.

IR Hi Rel proposal

- › After a review of the requirements of MIL-STD-750 method 1001.4 and discussion with the user community, IR proposal is to proceed with updates to our internal test procedure:
- › When applying bias to samples for the purpose of reduced barometric pressure testing, the bias shall be applied as follows:
 - › For MOSFET, apply the max rated BVDss between Drain and Source (gate shorted to Source)
 - › For diode, apply the max rated reverse bias between diode cathode and anode.
- › Justification:
 - › This method is consistent with section 3 of method 1001.4, in that it represents the worst case maximum voltage under dated conditions.
 - › In cases where existing IR HiRel product 19500 slash sheets define the bias conditions, the definition is for VDS bias.



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ATTACHMENT 2

QUESTIONS AND SUMMARIZED RESULTS TO THE SURVEY REGARDING METHOD 1001 OF MIL-STD-750-1

The 4 responses received have been summarized below the 7 questions that were in the survey.

Question 1. Does your activity/company perform testing in accordance with test method 1001 of MIL-STD-750-1? If so, please provide detailed information on how this test is performed, with emphasis on how the device terminals are wired (all shorted together or in a bias configuration).

Yes, we have performed 1001 testing using conditions A thru E and G. For conditions A thru E, testing was performed by monitoring case-to-terminal resistance using a Data Acquisition (DAQ) instrument. Terminals were not shorted together, but rather monitored on individual DAQ channels. For condition G, there is no electrical monitoring of devices under test.

Question 2. Does your activity/company use an outside laboratory to perform this test? If so, please identify the laboratory performing this test. If the information is available, please provide information that details how the outside laboratory performs this test with emphasis on how the device terminals are wired (all shorted together or in a bias configuration).

We have also used an outside laboratory to perform this test. The testing conditions used by the outside laboratory are unknown.

Question 3. Should clarification be added to the test method to specify whether the voltage should be applied in the same manner as a DWV test (method 1081 of MIL-STD-750-1) in a case-to-shorter terminals manner or should the voltage be applied in a case-to-biased terminals manner consistent with the device usage within a circuit/system (e.g. between Drain and Source for a MOSFET device)?

Yes, the test method needs clarification. The best way to clarify would be to specify device biasing (electrical test configuration) to be used in the group E qualification table of the MIL-PRF-19500 specification sheet that would address the device packaging.

This could be easily addressed in the MIL-PRF-19500 specification sheet and adjusted as needed for each package type. Recommend adding verbiage to TM 1001 as follows: "The specification sheet shall specify the electrical test configuration to be used. If the specification sheet does not specify an electrical test configuration, then the default electrical test configuration shall apply." That way there is a default electrical test configuration for devices when there is no direction in the specification sheet.

Additional commentary submitted regarding Question 3:

Test method as written is contradictory that in paragraph 1 (Scope) it mentions DWV testing and in paragraph 3 (Procedure) it requires that if not specified in the specification sheet or acquisition document, then devices are to be tested at the maximum voltage under rated conditions but there is no mention of electrical test configuration.

The statement about DWV in TM 1001 paragraph 1 was not in the original issue or revisions 1, 2 or 3 of the method. What was the reason for adding DWV to method 1001? There is a separate test method for DWV testing (method 1081). It is possible that there may be some overlap between methods 1016 (insulation resistance) and method 1081 (dielectric withstanding voltage) and/or conflict with method 1001.

ATTACHMENT 2

QUESTIONS AND SUMMARIZED RESULTS TO THE SURVEY REGARDING METHOD 1001 OF MIL-STD-750-1

Question 4. Should device bias testing at maximum voltage under rated conditions be performed as part of this test in order to comply with the procedure paragraph?

Yes, see answer to question 3.

Question 5. Should the test method specify additional information for different package types and for specific terminal/lead configurations using isolated and versus non-isolated packages as an example?

No, see answer to question 3.

Question 6. Should both DWV style and case-to-biased terminal style testing be performed as part of this method? Please provide rationale why one method is preferred over the other method or if only one method needs to be performed.

Both electrical test configurations can be included in the test method. However, the responsibility for selecting the correct electrical test configuration should fall on the package engineer, not the environmental tester. Therefore, the electrical test configuration required should be specified in the specification sheet, with a default electrical test configuration when one is not specified.

Question 7. Should the method distinguish separate bias conditions for isolated and non-isolated packages?

No, see answer to question 3.