



# VI Chip Environmental Qualification Testing Standards



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## 1. Purpose

This report outlines environmental testing which were performed to qualify the Vicor VI Chip platform.

## 2. Executive Summary

VI Chip products are considered qualified to the following product environmental testing standards. Representative samples from each product family are tested to the standards referenced below. As part of Vicor's Ongoing Reliability Monitoring (ORM) program representative samples of Products are tested to verify continued compliance to the standards referenced below.

**TABLE 1**

Testing Activity	Reference Standard	Applicable Grade (C,T and M)
High Temperature Operating Bias/Life (HTOB/HTOL)	JESD22-A108D	All Grades
Temperature Cycling Test (TCT)	JESD22-A104D	All Grades
Temperature Humidity Bias(THB)	JESD22-A101C	All Grades
High Temperature Storage (HTS)	JESD22-A103D	All Grades
Low Temperature Storage (LTS)	JESD22-A119	All Grades
Random Vibration	MIL-STD-810G	Military Grade
Mechanical Shock	MIL-STD-810G	Military Grade
Highly Accelerated Life Test (HALT)	Internal Vicor Procedure DP-0265	All Grades
Salt Fog	MIL-STD-810G	Military Grade
Fungus	MIL-STD-810G	Military Grade
Res. Solvents	MIL-STD-202G	All Grades
Terminal Strength	MIL-STD-202G	All Grades
Solderability	IPC/ECA J-STD-002	All Grades
ESD Human Body Model	JEDEC JS-001-2012	All Grades
ESD Charged Device Model	JESD22-C101E	All Grades
Acceleration	MIL-STD-810G	Military Grade
Altitude	MIL-STD-810G	Military Grade
Explosive Atmosphere	MIL-STD-810G	Military Grade

### 3. Environmental Test Conditions.

#### 3.1. High Temperature Operating Bias Test (HTOB)

##### 3.1.1. HTOB Test Criteria

<b>Input Voltage:</b>	Nominal Line.
<b>Operating Temperature:</b>	Maximum Operating temperature
<b>Test Duration:</b>	1000 hours
<b>Test monitoring:</b>	Product temperature, output voltage and current monitored throughout the test.
<b>Output Conditions:</b>	Full Load
<b>Functional Verification:</b>	Pre and post functional testing performed. Interim testing is performed every 250hrs.
<b>Applicable standard:</b>	JESD22-A108D.
<b>Qty Tested:</b>	Minimum 15.

## 3.2. Temperature Cycling (TC) Test

### 3.2.1. Temperature Cycling (TC) Test Criteria

<b>Temperature extremes:</b>	125°C to –55°C (Military Grade) 125°C to –40°C (All other grades)
<b>Dwell:</b>	5 minute dwell at each temperature extreme.
<b>Temp Transition rate:</b>	8°C per minute.
<b>Test Duration:</b>	1000 cycles
<b>Sample Size:</b>	Minimum 15 units
<b>Functional Verification:</b>	Pre and post ATE testing as well as ATE testing at the 250 cycles.
<b>Applicable standard:</b>	JESD22-A104D

### 3.3. Temperature Humidity Bias (THB)

#### 3.3.1. THB Conditions

**Input Voltage:** Nominal Input Voltage.

**Output Conditions:** Minimum load

**Temperature:** 85°C, 85%RH

**Test Duration:** 1000 hrs.

**Test Monitoring:** Continuous Monitoring. Full functional ATE testing every 250 hrs

**Quantity Tested:** Minimum quantity of 15.

**Applicable standard:** JESD22-A101C

### 3.4. Low Temperature Storage Test ( LTS)

<b>Test Condition:</b>	-65°C, Non Biased.
<b>Test Duration:</b>	1000 Hours
<b>Sample Size:</b>	3 units
<b>Functional Verification:</b>	Pre and post ATE testing as well as ATE testing at the 250 hour test points.
<b>Applicable standard:</b>	JESD22–A119

### 3.5. High Temperature Storage Test ( HTS)

<b>Test Condition:</b>	125°C, Non Biased.
<b>Test Duration:</b>	1000 Hours
<b>Sample Size:</b>	13 units
<b>Functional Verification:</b>	Pre and post ATE testing as well as ATE testing at the 250 hour test points.
<b>Applicable standard:</b>	JESD22-A103-D

### 3.6. Highly Accelerated Life Test (HALT)

#### 3.6.1. HALT Test Detail

**Test Standard:** Internal Vicor specification DP-0265

**HALT test equipment:**

Model: QualMark Typhoon 2.0 calibration.

Equipment Limitations:

Maximum air temperature of 200°C

Minimum air temperature of – 100°C

Maximum vibration level of 75 Grms

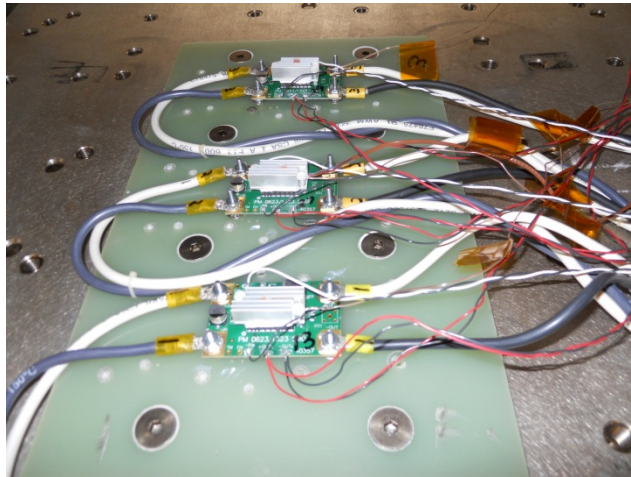
Vibration type: Omni-axis vibration system.





### Typical setup sample.

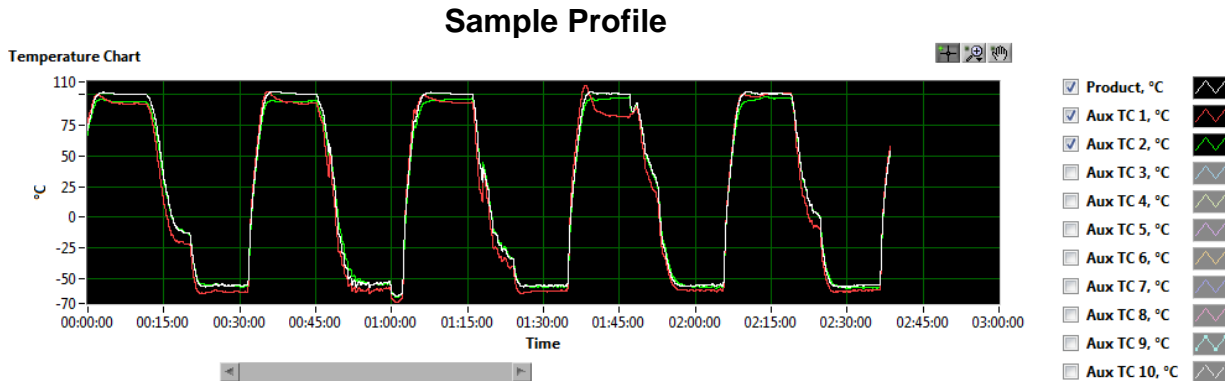
Product is mounted in a manner which mimics a customer application.



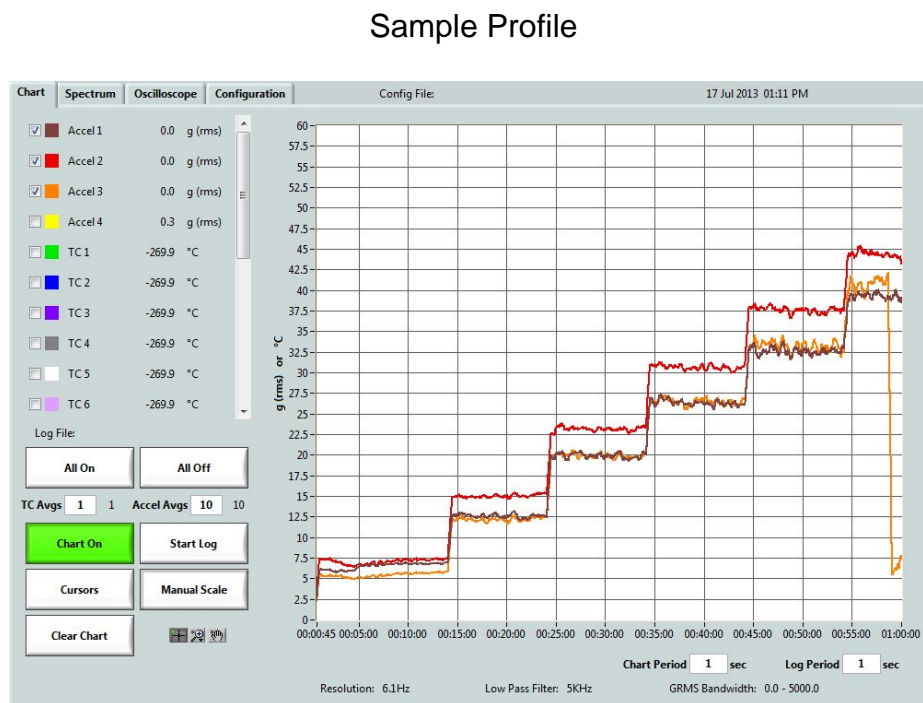
#### Test Conditions:

- a. **Low Temp** – Product low temperature operation specification verified, followed by reducing temperature to minimum operating temperature of chamber to induce failure.
- b. **High Temp** - Product maximum operating temperature specification verified, followed by increasing temperature to product shutdown or product failure.

- c. **Rapid Thermal Cycling** – 5 rapid temperature cycles from maximum to minimum operating temperature under full load.



- d. **Random Vibration Test** – Sample product exposed to increasing levels of vibration to point of failure to establish destruct point, remaining samples exposed to a vibration level 25% less than destruct point.



- e. **Combined Stresses Test** - Product temperature cycled under load for 5 cycles with increasing vibration levels to test structural integrity of package.
- f. **Vibration Destruct limits.** Product samples vibrated to point of failure.

### 3.7. Random Vibration Testing (Operating)-

A total of 3 samples are exposed to the test environment noted below at an external test laboratory. All units are ATE tested pre and post exposure to vibration test. Units are also inspected for any signs of damage with no anomalies noted.

Test standard: MIL-STD-810G

Test Conditions: Method 514.6, Procedure I, Category 24, 20-2000 Hz, @7.7Grms, 1hour /axis for 3 axis. Product mounted on an evaluation board.

### 3.8. Mechanical Shock (Operating)-

A total of 3 samples are exposed to the test environment noted below. All units are tested pre and post exposure to shock testing. Units are also inspected for any signs of damage.

Test Standard: MIL-STD-810G

Test Conditions: MIL-STD-810G Method 516.5, Procedure I, Environment: Functional shock 40G, total of 18 shocks. Product mounted on an evaluation board.

### 3.9. Salt Fog

A total of 3 samples are exposed to the test environment noted below at an external test laboratory. Units are also inspected for any signs of damage.

Test Standard: MIL-STD-810G

Test Conditions: Method 509.5, 2 cyc. of: 24 hrs. exposure & 24 hrs. drying time @  $35\pm 2^{\circ}\text{C}$ .

### 3.10. Fungus Test

A total of 3 samples are exposed to the test environment noted below at an external test laboratory. Units are inspected for any signs of fungal growth.

Test Standard: MIL-STD-810G

Test Conditions: Method 508.6, 28 days exposure.

### 3.11. Resistance to Solvents

A total of 3 samples are exposed to the test environment noted below.

Test Standard: MIL-STD-202G.

Test Conditions: Method 215K, 3 minutes exposure.

### 3.12. Terminal Strength

Five devices are tested to failure to establish the terminal strength.

Test Standard: MIL-STD-202G.

Test Conditions: Method 211A Test Condition A.

### 3.13. Through-Hole Solderability

Three devices are tested in-house to the referenced standard.

Test standard: IPC/ECA J-STD-002 Test A (dip and look).

### 3.14. ESD Classification Testing.

Human Body Model (JEDEC JS-001-2012 Table 2B) Units meet class 1C– Qty 6

Charged Device Model (JESD22-C101E) Units meet Class II - Qty 6

### 3.15. Acceleration

Three devices are tested to the referenced standard at an external test laboratory.

Test standard: MIL-STD-810G

Test Method: Method 513, Procedure I, 3 g's, 6 directions, 1 minute.

### 3.16. Altitude

Three devices are tested to the referenced standard at an external test laboratory.

Test standard: MIL-STD-810G

Test Method: Method 500.5, Procedure 1, Conditions, 40k feet at 25°C for 1 hr. while operating.

### 3.17. Explosive Atmosphere

One device is tested to the referenced standard at an external test laboratory.

Test standard: MIL-STD-810G

Test Method: Method 511.5, Procedure I, Temperature 60°C, operational test performed at 40k feet and ground level.

#### 4. **Product Requirements**

All products which undergo testing are manufactured using the standard process.

#### 5. **Testing Requirements**

All products are tested at the scheduled intervals as outlined in the test datasheets or as dictated by the test standard specific to the individual test.

**Definition of Electrical Failure:** Components that are no longer generating valid output voltage are considered hard failures. These components must be evaluated to root cause. Changes in electrical performance (parameters outside acceptable tolerance limits of specification) or electrical failures caused by thermal transitions require that Vicor perform an evaluation.

**Corrective Action** – All product failures must be fully investigated, determining root cause and assigning corrective actions as deemed appropriate.