



ChiP Environmental Qualification Testing Standards



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1. Purpose

This report outlines environmental testing which were performed to qualify Vicor ChiP platform.

2. Executive Summary

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)	IPC-9592B	T Grade
	JESD22-A104D	All other 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

Applicable standard:	JESD22-A108D
Input voltage:	Nominal Line.
Output conditions:	Full Load
Operating temperature:	Maximum Operating temperature
Test duration:	1000 hours
Test monitoring:	Product temperature, output voltage and current monitored throughout the test
Functional verification:	Pre and post functional testing performed. Interim testing is performed every 250hrs
Sample size:	Minimum 15

3.2. Temperature Cycling (TC) Test

3.2.1. Temperature Cycling Test Criteria (T Grade)

Applicable standard:	IPC-9592B
Temperature extremes:	125°C to –40°C
Dwell:	30 minute dwell at each temperature extreme
Temp transition rate:	8°C per minute
Test duration:	700 cycles
Functional verification:	Pre and post ATE testing as well as ATE testing at the 250 cycles
Sample size:	Minimum 30 units

3.2.2. Temperature Cycling Test Criteria (M Grade)

Applicable standard:	JESD22-A104D
Temperature extremes:	125°C to –55°C (Military Grade) 125°C to –40°C (All other grades)
Dwell:	5 minute dwell at each temperature extreme
Temp transition rate:	8°C per minute
Test duration:	1000 cycles
Functional verification:	Pre and post ATE testing as well as ATE testing at the 250 cycles
Sample size:	Minimum 15 units

3.3. Temperature Humidity Bias (THB)

3.3.1. THB Test Criteria

Applicable standard:	JESD22-A101C
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
Sample size:	Minimum quantity of 15.

3.4. Low Temperature Storage Test (LTS)

3.4.1. LTS Test Criteria

Applicable standard:	JESD22-A119
Test condition:	-65°C, Non Biased.
Test duration:	1000 Hours
Functional verification:	Pre and post ATE testing as well as ATE testing at the 250 hour test points
Sample size:	3 units

3.5. High Temperature Storage Test (HTS)

3.5.1. HTS Test Criteria

Applicable standard:	JESD 22-A103-D
Test condition:	125°C, Non Biased.
Test duration:	1000 Hours
Functional verification:	Pre and post ATE testing as well as ATE testing at the 250 hour test points
Sample size:	3 units

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 Capabilities:

Maximum air temperature of 200°C

Minimum air temperature of – 100°C

Maximum vibration level of 75 Grms

Vibration type: Omni-axis vibration system.

Sample Size: 6



Typical setup sample.

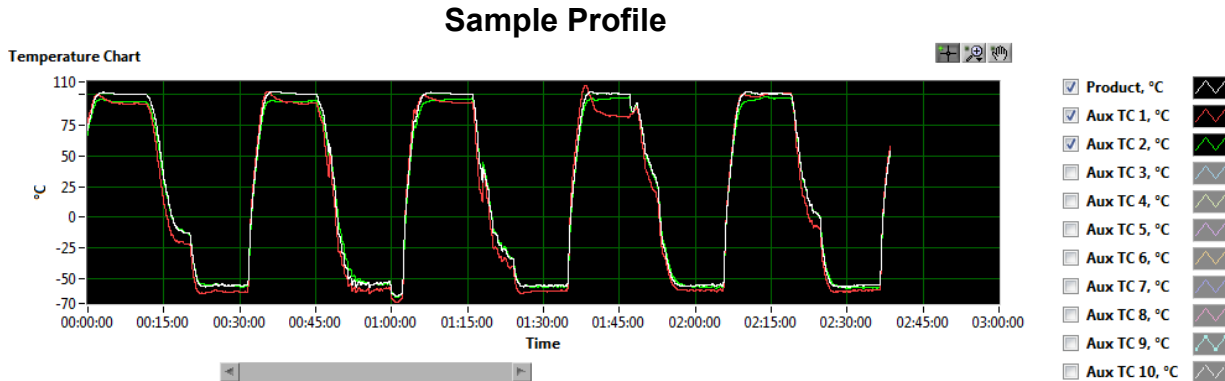
Product is mounted in a manner which mimics a customer application.



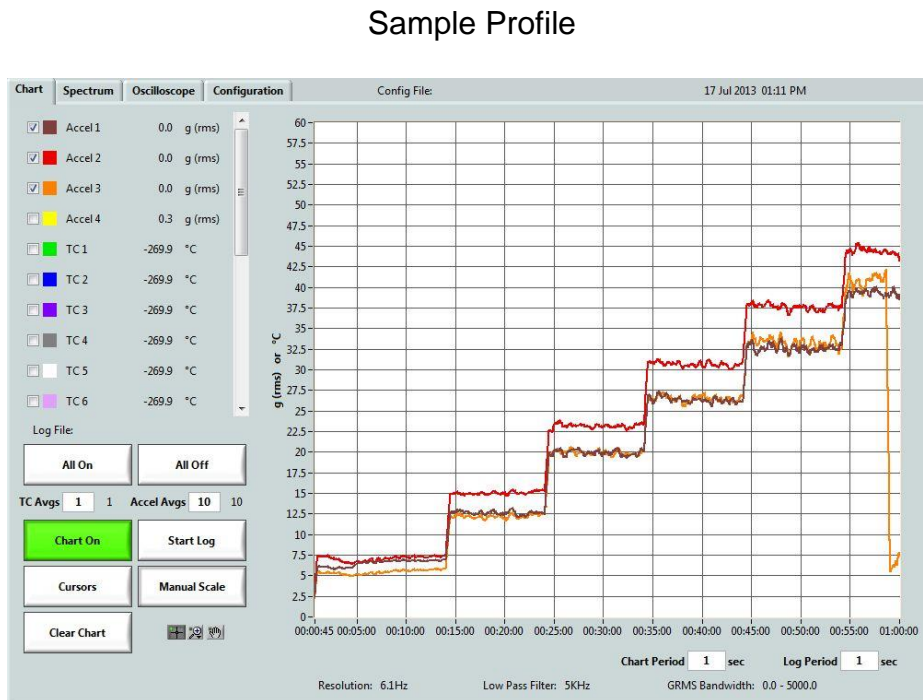
Test Conditions:

- 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)

3.7.1. Random Vibration Test Criteria

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
Input voltage:	Nominal Line
Output Load:	50% Load
Functional verification:	Pre and post ATE testing as well as ATE testing. Pre and post visual inspection
Sample size:	3

3.8. Mechanical Shock (Operating)

3.8.1. Random Vibration Test Criteria

Test standard:	MIL-STD-810G
Test conditions:	Method 516.5, Procedure I, Environment: Functional shock 40G, total of 18 shocks. Product mounted on an evaluation board
Input Voltage:	Nominal Line
Output Load:	50% Load
Functional verification:	Pre and post ATE testing as well as ATE testing. Pre and post visual inspection
Sample size:	3

3.9. Salt Fog

3.9.1. Salt Fog Test Criteria

Test standard: MIL-STD-810G

Test conditions: Method 509.5, 2 cyc. of: 24 hrs. exposure & 24 hrs. drying time @ 35±2°C

Functional verification: Pre and post ATE testing as well as ATE testing. Pre and post visual inspection looking for signs on corrosion on contact pins or surface finishes

Sample size: 3

3.10. Fungus Test

3.10.1. Fungus Test Criteria

Test standard: MIL-STD-810G

Test conditions: Method 508.6, 28 days exposure

Test verification: Post exposure visual verification to verify absence of fungus growth

Sample size: 3

3.11. Resistance to Solvents

3.11.1. Resistance to solvents test criteria

Test standard: MIL-STD-202G

Test conditions: Method 215K, 3 minutes exposure

Test verification: Post exposure verification of product condition/markings

Sample size: 3

3.12. Terminal Strength

3.12.1. Terminal strength test criteria

Test standard: MIL-STD-202G

Test conditions: Method 211A Test Condition A

Sample size: 5

3.13. Through-Hole Solderability

3.13.1. Through-hole solderability test criteria

Test standard: IPC/ECA J-STD-002

Test conditions: Test A (dip and look)

Test verification: Post exposure verification of soldered area per standard

Sample size: 3

3.14. ESD Classification Testing

3.14.2. ESD Classification test criteria

Test standard: JEDEC JS-001-2012 – Human Body Model (HBM)
JESD22-C101E – Charged Device Model (CDM)

Test conditions: Units meet class 1C (HBM)
Units meet Class II (CDM)

Functional verification: Pre and post functional verification

Sample size: 6 (HBM Qty 3, CDM Qty 3)

3.15. Acceleration

3.15.1. Acceleration test criteria

Test standard: MIL-STD-810G

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

Functional verification: Pre and post functional verification

Sample size: 1

3.16. Altitude

3.16.1. Altitude test criteria

Test standard: MIL-STD-810G

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

Input Voltage: Nominal

Output Load: 50%

Functional verification: Pre and post functional verification

Sample size: 1

3.17. Explosive Atmosphere

3.17.1. Explosive atmosphere test criteria

Test standard: MIL-STD-810G

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

Functional verification: Pre and post functional verification

Sample size: 1

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.