

DONUT LAB DEVELOPMENT UK LTD.

**Sankey Street, Floor 2
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TEST REPORT

SCOPE OF WORKS

Nail Penetration Test based on SAE J2464:2021 – Run #2 / Donut Lab Solid-State Pouch Cell

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CONCLUSION

The Nail penetration test (Run #2) based on SAE J2464:2021 was applied.

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SECTION 1 MEASUREMENTS AND TEST SPECIFICATIONS

SECTION 1.1 USED STANDARDS

Lithium-ion battery requirements according to the following standards:

STANDARD	DESCRIPTION OF STANDARD
SAE J2464:2021	Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing

Table 1 Used standards

SECTION 1.2 TEST SEQUENCE

Not applicable – only one test performed.

SECTION 2 DESCRIPTION OF DUT

SECTION 2.1 SIZE AND TYPE OF THE DUT

Definition of a cell according to UN 38.3 Rev. 8:

Cell means a single encased electrochemical unit (one positive and negative electrode) which exhibits a voltage differential across its two terminals, and may contain protective devices.

SECTION 2.1.1 SIZE



Small cell

(Small cell means a cell with a gross mass of not more than 500 g.)



Large cell

(Large cell means a cell with a gross mass of more than 500 g.)

SECTION 2.1.2 TYPE / CHEMISTRY

- ☐ Lithium polymer cell
- ☐ Lithium cobalt dioxide cell (LiCoO₂)
- ☐ Lithium titanate cell
- ☐ Lithium air cell
- ☐ Lithium manganese cell
- ☐ Lithium iron phosphate cell (LiFePO₄)
- ☐ other type
- ☒ not given by the manufacturer

SECTION 2.2 TECHNICAL DATA OF THE CELL



Weight of the product in g	< 50
Dimensions of the product in mm (l × w × h)	not specified
BMS	not available
Communication to BMS	not possible
Communication commands	not available
Cooling	not necessary
Electrical data:	
Capacity in Ah	not specified
Charge current threshold in Ampere	not specified
Charge current nominal in Ampere	not specified
End-of-charge voltage in Volt	not specified
Discharge current threshold in Ampere	not specified
Discharge current nominal in Ampere	not specified
End-of-discharge voltage in Volt	not specified
Cut-off current (constant-voltage procedure) in Ampere	not specified

Table 2 Technical data of the cell

SECTION 2.3 OPERATING CONDITIONS

No electrical operation of the cell.

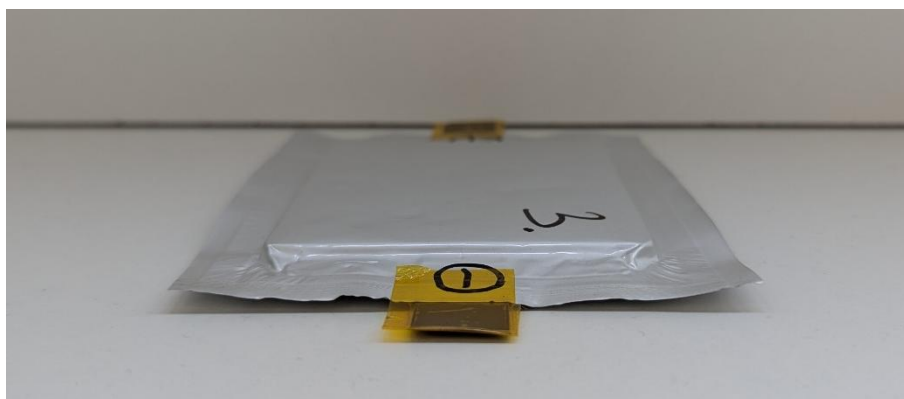
SECTION 2.4 GENERAL PICTURES



Picture 1 General picture of the DUT, top view



Picture 2 General picture of the DUT, side view I



Picture 3 General picture of the DUT, side view II



Picture 4 General picture of the DUT, side view III



Picture 5 General picture of the DUT, side view IV



Picture 6 General picture of the DUT, bottom view

SECTION 2.5 SERIAL NUMBERS

CLIENT SERIAL NUMBER	INTERTEK - ID	DATE OF DELIVERY	COMMENT
3.	KAU2608100838-001	2026-08-10	

Table 3 Serial numbers of DUTs

SECTION 3 TEST RESULT OVERVIEW

Results apply exclusively to DUT(s) tested and as received from client.

Per ISO 17025 7.6.3, NOTE 1, a well-recognized test method was used that specifies the limits on major sources of uncertainty and controls the presentation and calculation of results.

Unless otherwise specified, the "Simple Acceptance" rule, also known as "Shared Risk approach" of ILAC-G8:09/2019 guide, is applied. Conformity statements are reported as follows:

Pass – when the measured values are within the specified limits.

Fail – when one or more measured values are outside the specified limits.

TEST	START OF TEST	END OF TEST	PASS	FAIL	APPLIED
Nail Penetration Test (Run #2)	2026-08-10	2026-08-10	☐	☐	☒

Table 4 Test overview

SECTION 4 TEST OVERVIEW

SECTION 4.1 NAIL PENETRATION TEST (RUN #2)

SECTION 4.1.1 NORMATIVE REFERENCES

TEST APPLIED ACCORDING TO THE FOLLOWING SPECIFICATIONS / STANDARDS WITH DEVIANCE	Based on SAE J2464:2021
--	-------------------------

SAMPLES RECEIVED	1
	KAU2608100838-001
DATE OF TEST	2026-08-10
PLACE OF TEST	Kaufbeuren

DESCRIPTION OF TEST SAMPLES

ONE (1) Donut Lab Solid-State Pouch Cell

PURPOSE OF TEST

This test serves to evaluate the DUT's response to penetration.

TEST PROCEDURE

Penetrate the DUT with a mild steel (conductive) rod.

- Diameter of rod: 3 mm
- Rod end type: tapered to a sharp point.
- Rate of penetration: 8 cm/s or greater
- Minimum depth of penetration: through cell.

The orientation of the penetration shall be perpendicular to the cell electrodes.

The DUT should be observed for a minimum of 1 h after the test with the rod remaining in place. If parallel cells are used in the Module, the cell level test should be configured with the same number of cells in parallel to the cell that is to be penetrated. When determining the Hazard Severity Level, a spark source should be present to ignite any potentially flammable vent gases or vapors from DUT.

ACCEPTANCE CRITERIA

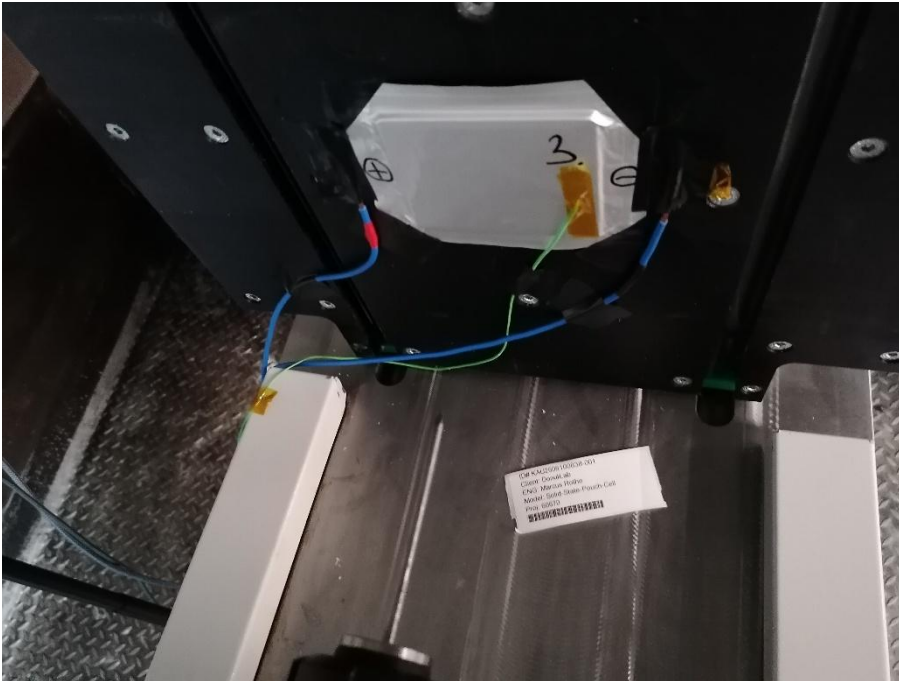
Hazard Severity Level (HSL) will be reported for the test.

Final evaluation will be performed by the client.

Hazard Severity Level	Description	Classification Criteria and Effect
0	No effect	No effect. No loss of functionality.
1	Passive protection activated	No damage or hazard; reversible loss of function. Replacement or re-setting of protection device is sufficient to restore normal functionality.
2	Defect/damage	No hazard but damage to DUT; irreversible loss of function. Replacement or repair needed.
3	Minor leakage/venting	Evidence of cell leakage or venting with DUT with loss < 50 % of electrolyte weight.
4	Major leakage/venting	Evidence of cell leakage or venting with DUT with loss > 50 % of electrolyte weight.
5	Rupture	Loss of mechanical integrity of the DUT container, resulting in release of contents. The kinetic energy of released material is not sufficient to cause physical damage external to the DUT.
6	Fire or flame	Ignition and sustained combustion of flammable gas or liquid (approximately more than one second). Sparks are not flames.
7	Explosion	Very fast release of energy sufficient to cause pressure waves and/or projectiles that may cause considerable structural and/or bodily damage, depending on the size of the DUT. The kinetic energy of flying debris from the DUT may be sufficient to cause damage as well.

Table 5 Hazard Severity Levels

SECTION 4.1.2 TEST SETUP



Picture 7 Test setup – nail penetration test

SECTION 4.1.3 TEST RESULTS

TEST REQUIREMENTS

☐ pass

☐ fail

☒ applied

COMMENT

All tests were performed as described in Section 4.1.1 and 4.1.2, with the following deviations:
No full charge was performed before the test and no spark source was used during the test.
In agreement with the client, the internal resistance was not measured.

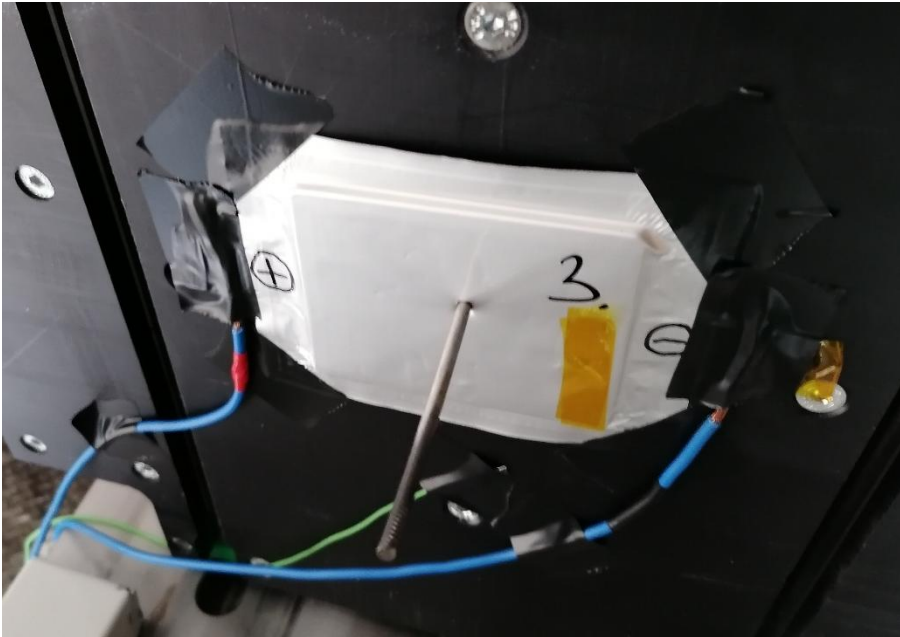
The rod remained in place overnight, since it was not possible to remove it after one hour (it appeared to be mechanically stuck within the cell). On the following day, the rod was successfully removed.

Results:

- Set rate of penetration: 80 mm/s
- The nail penetrated the cell completely.
- HSL assessment: 2

Voltage [V]		Weight [g]		Height [mm]	
Pre test	Post test	Pre test	Post test	Pre test	Post test
12.263	4.144	48.108	48.045	5.19	5.09

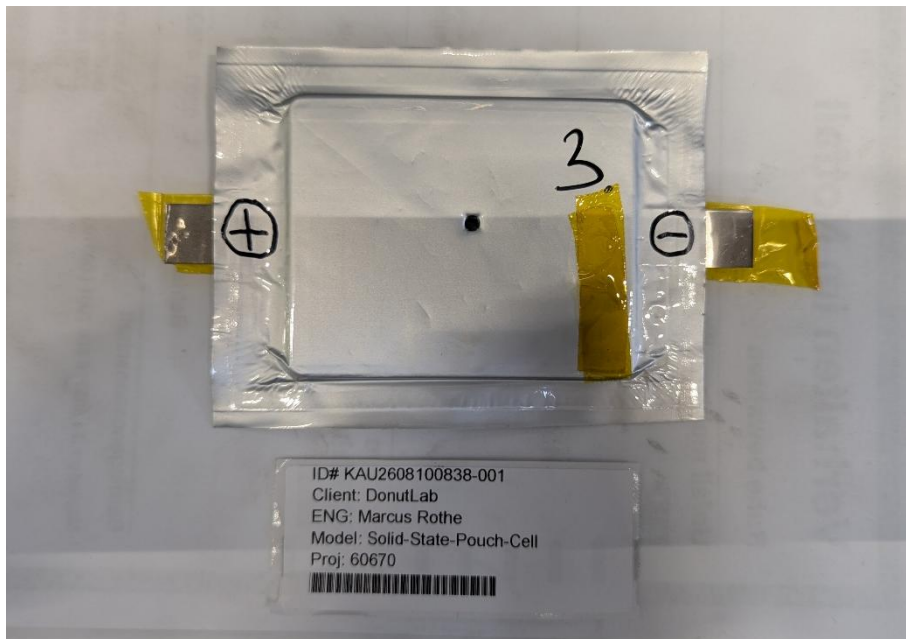
Table 6 Pre- and post-test measurements



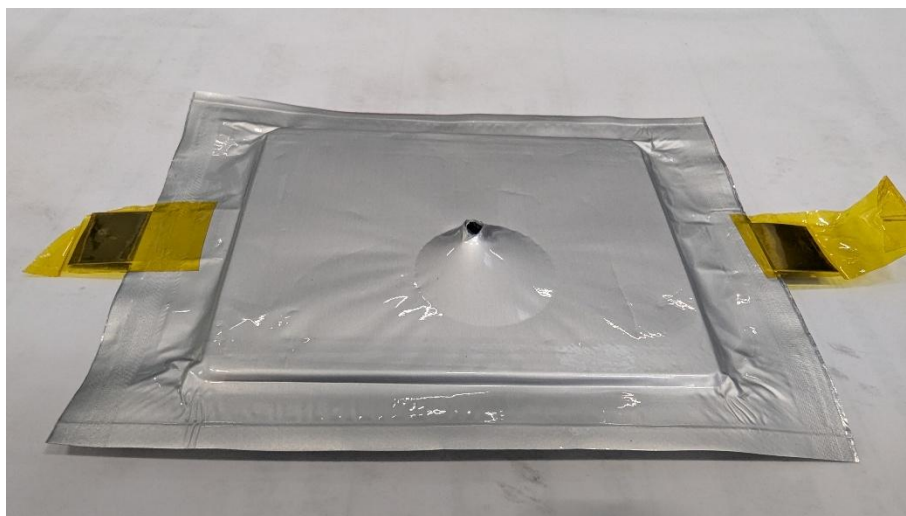
Picture 8 DUT after nail penetration test



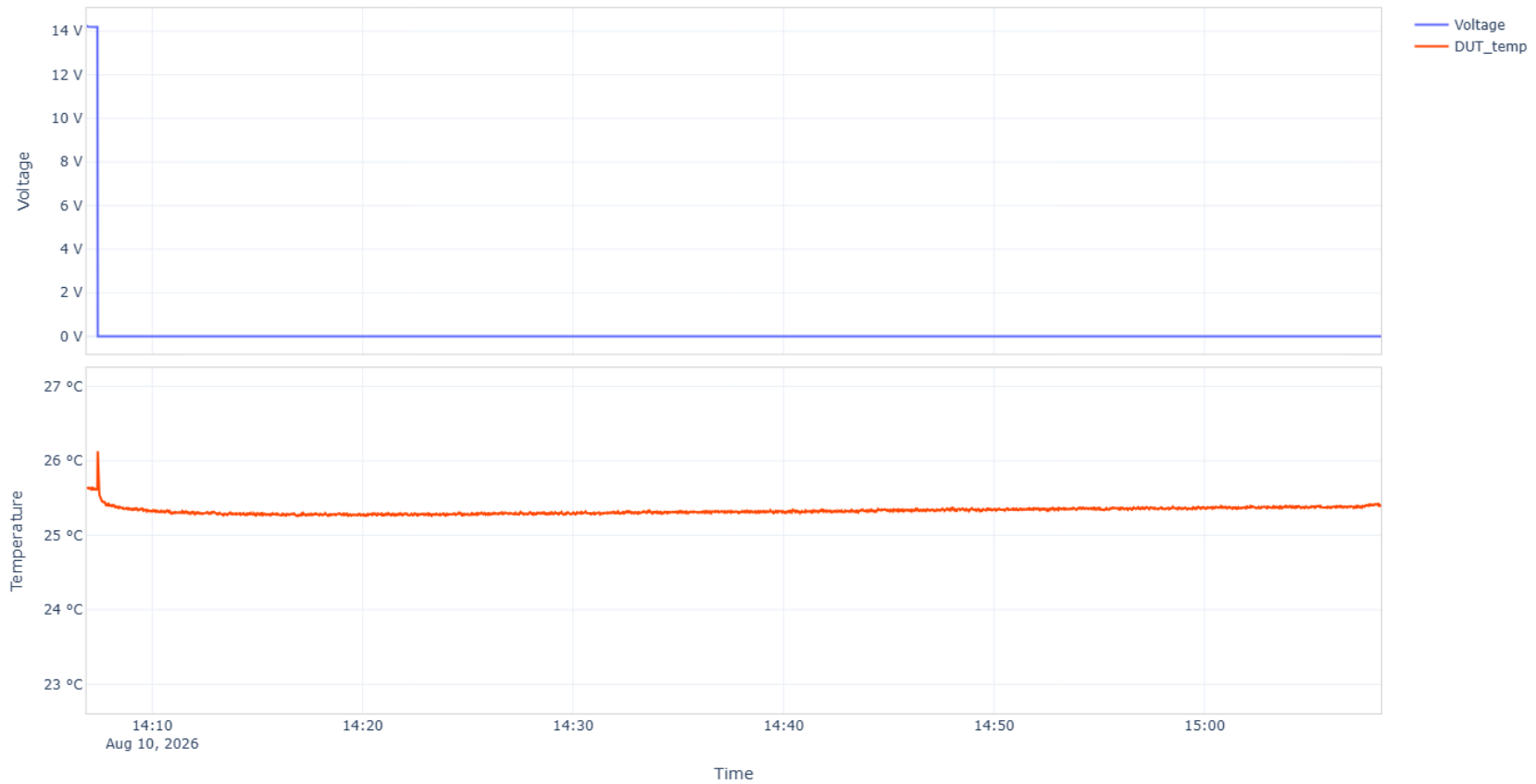
Picture 9 DUT after nail penetration test (after removal of nail)



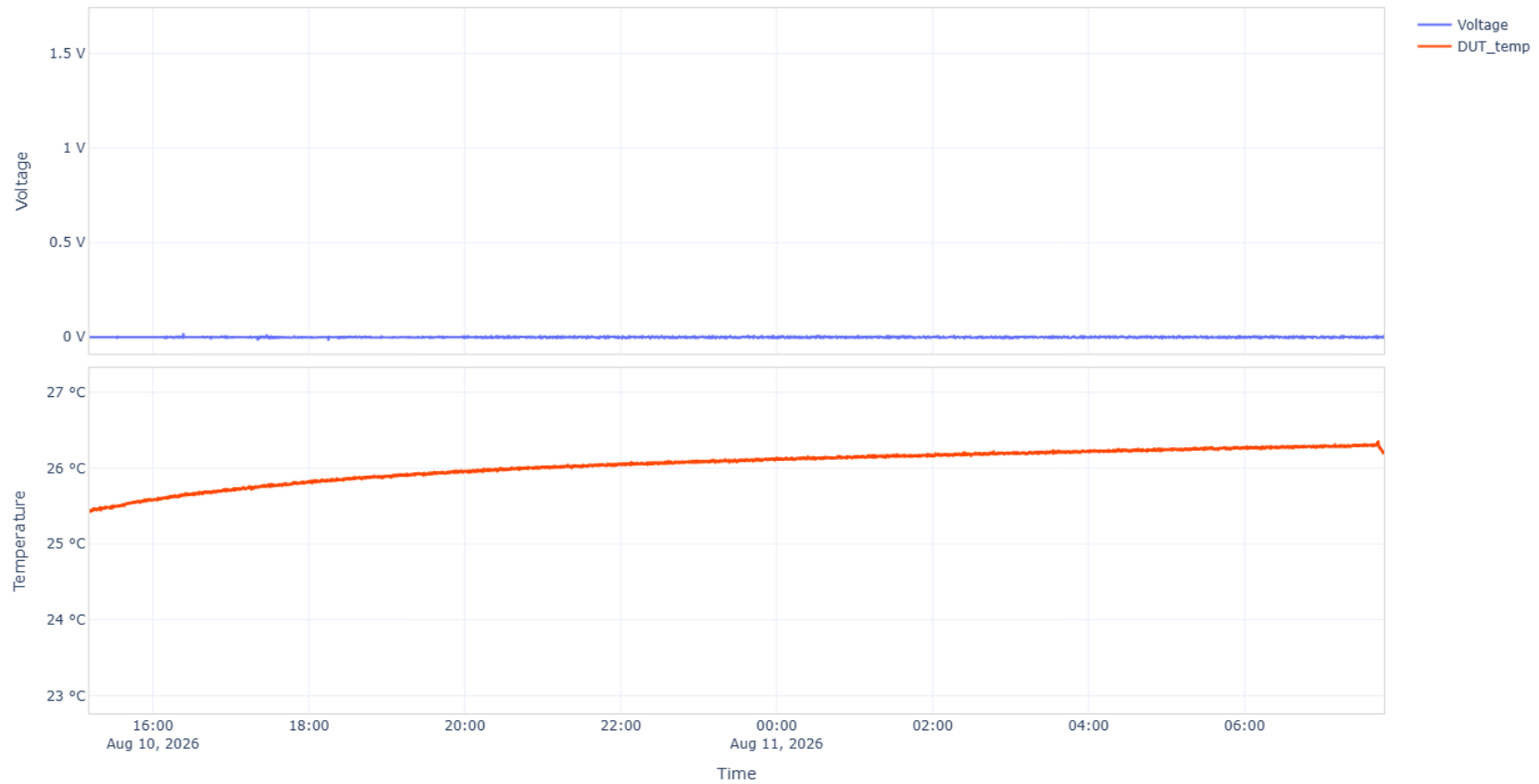
Picture 10 DUT after nail penetration test



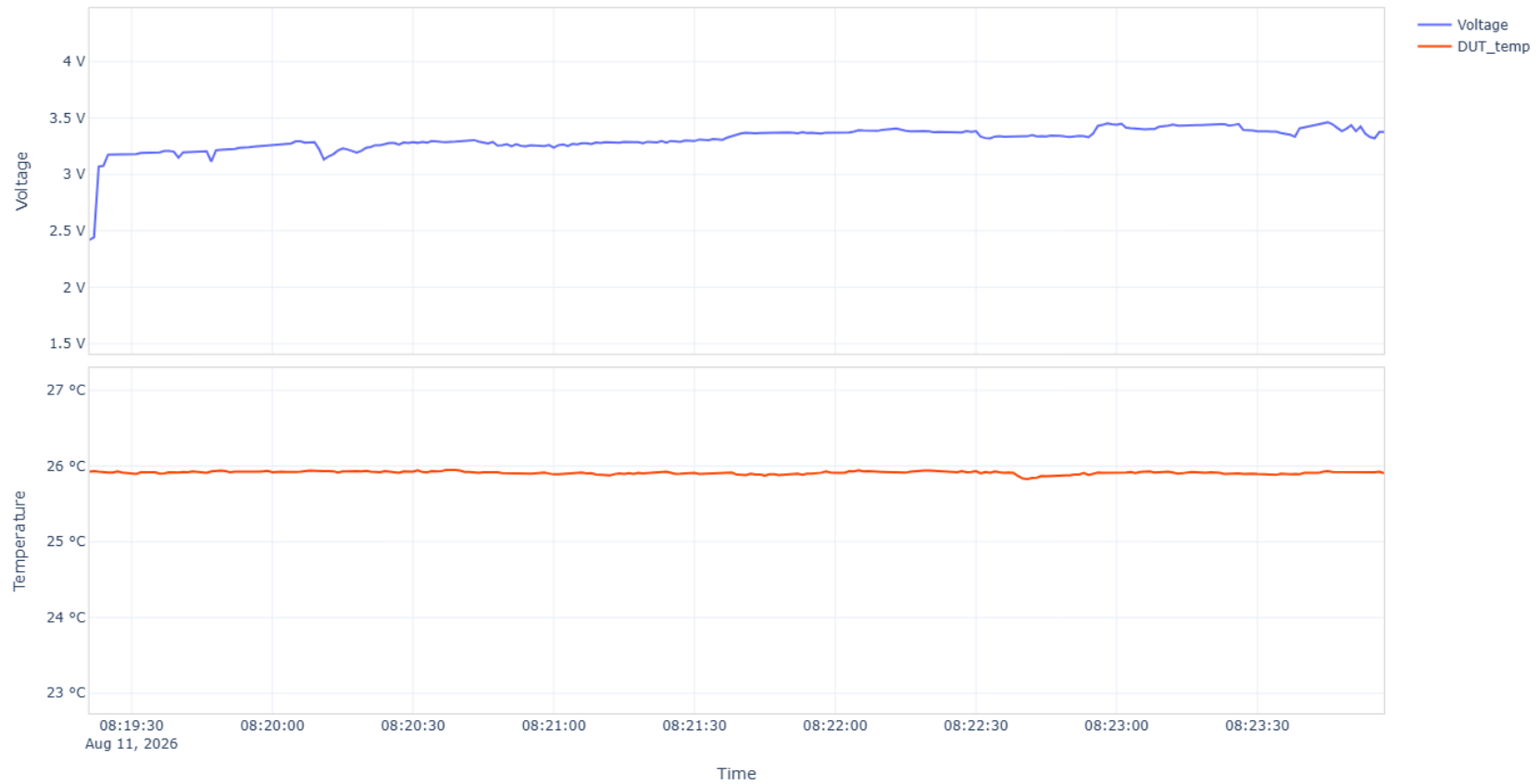
Picture 11 DUT after nail penetration test



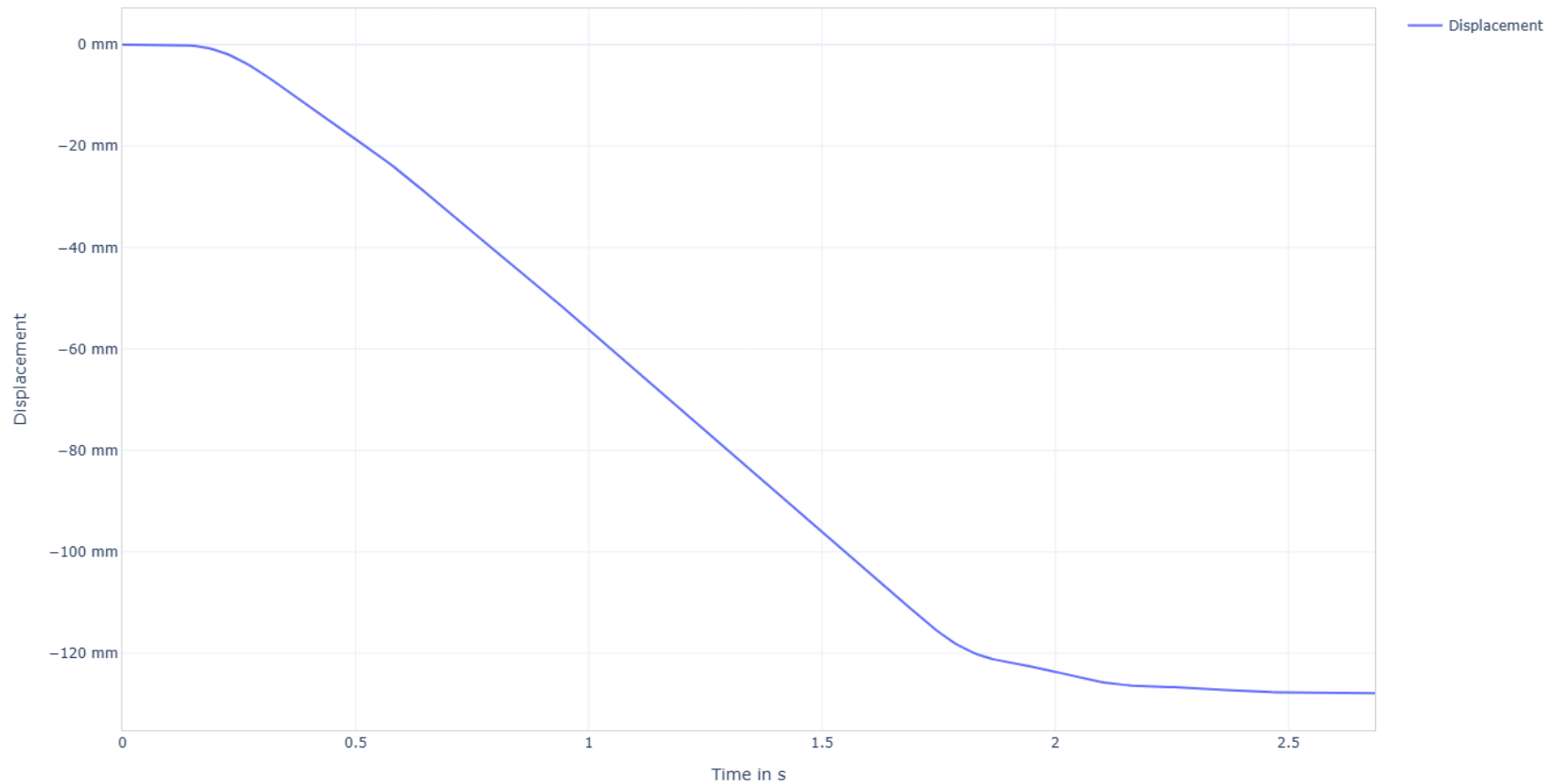
Graph 1 DUT voltage and temperature during nail penetration test



Graph 2 DUT voltage and temperature during observation overnight after nail penetration test



Graph 3 DUT voltage and temperature after removal of nail on the following day



Graph 4 Displacement during nail penetration test

SECTION 4.2 LABORATORY CONDITIONS

Unless stated otherwise, the samples were stored and tested under controlled ambient conditions within the environmental tolerances specified in IEC 60068-1:2013, Table 2.

After the completion of testing, all samples were stored until sent back to the customer or disposed of.

SECTION 5 ATTACHMENT

SECTION 5.1 USED TEST EQUIPMENT

Intertek is an ISO 17025 accredited testing laboratory and the test equipment is subject to regular calibration, where appropriate.

EQUIPMENT	TYPE	MANUFACTURER	INVENTORY-NO.
Data logger	DAQ970A	Keysight Technologies	PM KF 3775
Thermocouple	Type K	OMEGA Engineering	PM KF 3939
Control cabinet	-/-	Intertek	PM KF 3930
Control cabinet	-/-	Intertek	PM KF 3931
Nail penetration tester	-/-	CFM Schiller GmbH	PM KF 4275
Scale	PLS 1200-3A	Kern & Sohn GmbH	PM KF 2839
Multimeter	U1251B	Keysight Technologies	PM KF 3696
Slot card	DAQM900A-FG	Keysight Technologies	PM KF 3851
Data logger	2590-2A	AHLBORN	PM KF 4282
Temp/Humidity/Air pressure sensor	FHAD 46-C2L00	AHLBORN	PM KF 4283
Temp/Humidity sensor	FHAD46-2L00	AHLBORN	PM KF 2341