

Electrical Insulation Testing

Preface

MAXMAC evaluates ion-module insulation using DC insulation-resistance and AC voltage-withstand tests after damp-heat conditioning. Both methods measure three terminal-to-housing paths across six modules and include post-test functional verification.

The resistance readings were 856-3,340 MΩ at 500 V DC. Leakage-current readings were 0.007-0.019 mA at 500 V AC, 50 Hz. Both tests received a Pass judgment, with normal post-test current, LIN communication, ion generation and appearance recorded for all six samples.

Two Complementary Measurements

Parameter	Insulation resistance	Voltage withstand
Test voltage	500 V DC	500 V AC; 50 Hz
Duration	60 s	60 s
Test temperature	+23 °C	+23 °C
Acceptance	R >10 MΩ	Leakage <1 mA
Test basis	Q/MAT 5502-2023, 7.16	Q/MAT 5502-2023, 7.15

Table 1 Conditions and limits from the original method and parameter tables, pp. 96 and 104.

Three Recorded Measurement Paths

1. Positive terminal to nonmetallic housing.
2. Negative terminal to nonmetallic housing.
3. LIN terminal to nonmetallic housing.

The method specifies aluminum or copper foil over the nonmetallic housing for the terminal-to-housing measurement. The original bench photographs show the foil-wrapped arrangement.

Conditioning and Test Sequence

1. Complete **six damp-heat cycles** using IEC 60068-2-30, method Db.
2. Remove the modules and leave them in a standard atmospheric environment for **0.5 h (30 min)**. If conductive wrapping is required, begin wrapping at **25 min**.
3. Apply the specified DC or AC test voltage for **60 s** and record all three measurement paths.
4. Complete the post-test function, current, LIN, ion-output and appearance checks.

Sample Group and Laboratory

Samples: 25#-30#; six modules.

Dates: 31 July-1 August 2025.

Testing: MAXMAC laboratory.

Recorded ambient: start 25 °C / 53% RH; end 25 °C / 54% RH.

Original record: Leg3; insulation resistance pp. 96-103; voltage withstand pp. 104-111.

Insulation Resistance: 500 V DC for 60 Seconds

Six-Sample Resistance Results

Sample	Positive to housing (MΩ)	Negative to housing (MΩ)	LIN to housing (MΩ)	Result
25#	955	856	2,210	OK
26#	2,330	1,970	2,990	OK
27#	2,080	1,690	1,560	OK
28#	1,220	1,630	1,000	OK
29#	1,790	3,340	1,470	OK
30#	2,090	2,710	2,250	OK

Table 2 All 18 terminal-to-housing resistance readings from the original six-sample table, source p. 97.

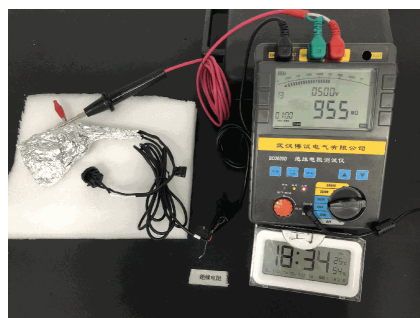
Acceptance: R >10 MΩ. Every reading met the requirement.

Observed minimum: **856 MΩ** (25#, negative to housing). Observed maximum: **3,340 MΩ** (29#, negative to housing).

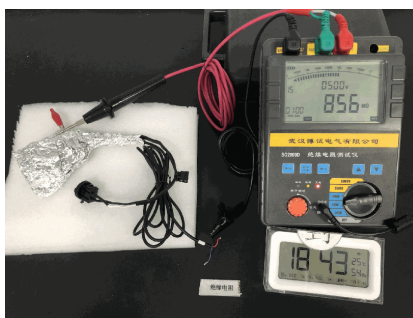
Minimum reading / criterion = 856 / 10 = 85.6.

The minimum measured resistance was 85.6 times the 10 MΩ criterion.

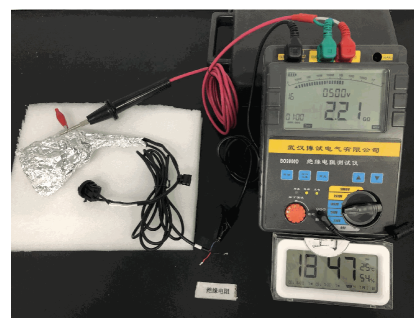
Sample 25#: Original Measurement Photographs



Positive to housing



Negative to housing



LIN to housing

Figure 1 Original 500 V DC measurement photographs for the three paths of sample 25#. The housing is covered with conductive foil. Source p. 99.

Method Parameters

The detailed parameter table specifies **mode 1.1, 500 V DC, 60 s**, one test cycle and six samples. The result table records positive, negative and LIN connections to the nonmetallic housing for every sample.

Recorded Judgment

All six samples were recorded as **OK**. Their resistance exceeded 10 MΩ, and the source records **Class A after the test**. The overall insulation-resistance judgment is **Pass**.

Sources: conditions p. 96; measurements and function p. 97; conclusion p. 98; measurement photographs pp. 99-101.

Voltage Withstand: 500 V AC, 50 Hz for 60 Seconds

Six-Sample Leakage-Current Results

Sample	Positive to housing (mA)	Negative to housing (mA)	LIN to housing (mA)	Result
25#	0.009	0.019	0.007	OK
26#	0.015	0.015	0.013	OK
27#	0.013	0.013	0.012	OK
28#	0.018	0.018	0.018	OK
29#	0.016	0.017	0.017	OK
30#	0.016	0.016	0.015	OK

Table 3 All 18 leakage-current readings from the original six-sample table, source p. 105.

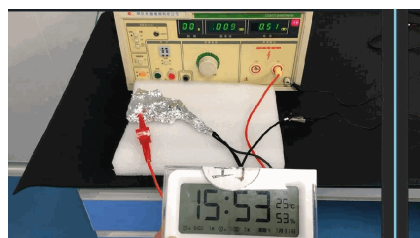
Acceptance: leakage current <1 mA. Every reading met the requirement.

Observed range: **0.007-0.019 mA**. The maximum was recorded for sample **25#**, negative to housing.

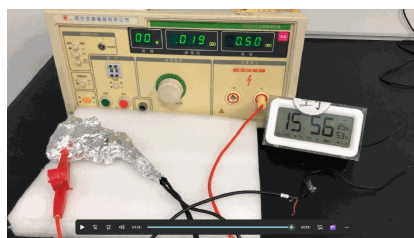
Maximum leakage / limit × 100 = 0.019 / 1 × 100 = 1.9%.

The highest recorded leakage was 1.9% of the 1 mA limit.

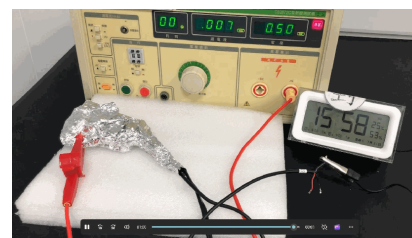
Sample 25#: Original Withstand-Test Photographs



Positive to housing



Negative to housing



LIN to housing

Figure 2 Original AC withstand-test photographs for sample 25#, showing the tester, foil-covered housing and measurement connections. Source p. 107.

Observed Physical Condition

For all six samples, the report records **no breakdown, fire, smoke or cracking**. Leakage current remained below 1 mA and the during-test requirement was recorded as **Class C**.

Recorded Method and Judgment

The detailed parameter table specifies **mode 1.2, 500 V AC at 50 Hz, 60 s**, one test cycle and six samples. All six samples were **OK**; the overall judgment was **Pass**.

Sources: detailed parameters p. 104; results pp. 105-106; measurement photographs pp. 107-109.

Post-Test Function and Sample-Level Traceability

Recorded Working Current after Each Test

Sample	After DC resistance (mA)	After AC withstand (mA)	LIN	Ion-output result	Appearance
25#	12.3509	12.3509	OK	>20 million ions/cm ³	Intact
26#	12.6411	12.6411	OK	>20 million ions/cm ³	Intact
27#	13.8102	13.8102	OK	>20 million ions/cm ³	Intact
28#	12.8242	12.8242	OK	>20 million ions/cm ³	Intact
29#	14.5273	14.5273	OK	>20 million ions/cm ³	Intact
30#	12.7064	12.7064	OK	>20 million ions/cm ³	Intact

Table 4 The two source result tables record the same post-test current values. The DC-stage values are from p. 97; the AC-stage values are from p. 105. Every sample was recorded as OK.

Working-current requirement: ≤100 mA. The recorded range was **12.3509-14.5273 mA**.

Ion-output indication: -1, identified in the source as over-range above **20 million ions/cm³**.

LIN: normal, with no message errors or faults recorded. **Appearance:** intact.

Sample 25#: After DC Resistance

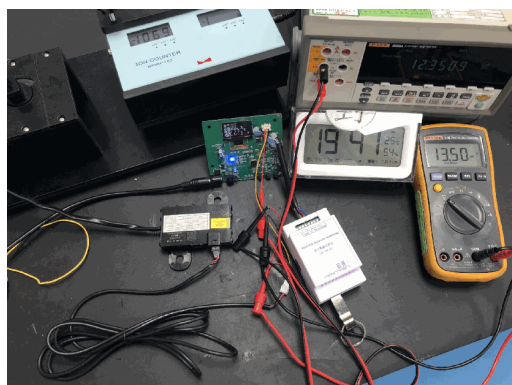


Figure 3 Original final functional check after the insulation-resistance test, source p. 103.

Sample 25#: After AC Withstand

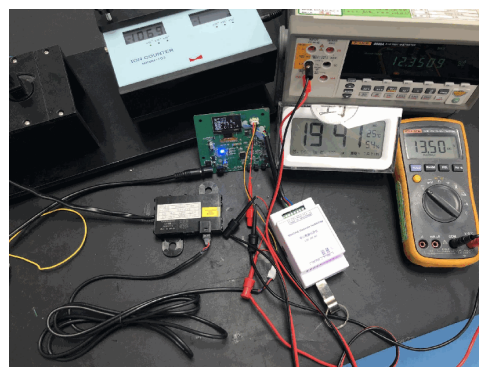


Figure 4 Original final functional check after the voltage-withstand test, source p. 110.

Functional Measurement Conditions

Supply 13.5 ± 0.5 V; airflow 120 kg/h / 5.5 m/s; distance 100 mm; ambient 23 ± 5 °C and 45-75% RH. The source records an 80 mm circular duct transitioning to a 75 × 75 mm rectangular fixture.

Equipment and Record Index

Resistance tester: BO2000D, E-029.

Withstand tester: CS2672C, E-024.

Ion counter: NKMH-103, E-143.

Anemometer: PROVA AVM-07.

Six-sample final photographs:

DC resistance: 25#-30#, p. 103.

AC withstand: 25#-28#, p. 110; 29#-30#, p. 111.

Original report: Kunlun-DVC_R-30.01-P000025455001-003-V1.0.
Version 1.0: 26 October 2026.