

# Cyclic Damp-Heat Testing

## Preface

MAXMAC checks ion-module function through repeated temperature and humidity changes. The program combines six damp-heat cycles, functional checks at the high-temperature condition, natural recovery and a comparison of post-test current with the original baseline.

Samples 25#-30# passed the recorded checks before, during and after testing. Every cycle includes working-current, standby-current and LIN results. Post-test current remained within  $\pm 5\%$  of each sample's baseline, and all samples retained the required ion output.

## Exposure and Check Conditions

| Parameter         | Recorded setting                            |
|-------------------|---------------------------------------------|
| Upper temperature | 55 °C                                       |
| Lower temperature | 23 $\pm$ 5 °C; controller setpoint 25 °C    |
| Cycle count       | 6                                           |
| Functional check  | Mode 3.2 at the cycle's highest temperature |
| Sample group      | 6 modules; 25#-30#                          |

## Repeated Controller Program

| Target °C / %RH | Segment duration |
|-----------------|------------------|
| 55 / 97         | 3 h              |
| 55 / 93         | 15 min           |
| 55 / 93         | 8 h 30 min       |
| 55 / 97         | 15 min           |
| 25 / 97         | 3 h              |
| 25 / 97         | 9 h              |

Table 1 Repeated controller segments 5-10, source p. 92.

**Calculated cycle duration:** 24 h.

**Repeated-cycle total:** 6  $\times$  24 h = **144 h**.

## Original Chamber Arrangement



Figure 1 Original arrangement with connected modules on the chamber shelves.

## Test and Recovery Sequence

1. Record the baseline current, LIN, ion-output and appearance checks.
2. Maintain  $\geq 100$  mm between modules and from chamber walls.
3. Run the six-cycle chamber program. At the highest cycle temperature, use mode 3.2 and check function.
4. Allow natural recovery to room temperature and complete the final functional checks.
5. Compare current with the pre-test baseline at the same temperature without humidity load.

**After cold-chamber removal:** stand for more than 2 hours and allow condensation to evaporate before ion-output measurement.

**Test basis:** Q/MAT 5502-2023, 9.10.2; IEC 60068-2-30, method Db.

**Test dates:** 24 July-1 August 2025.

**Testing:** MAXMAC laboratory.

## Cycle-by-Cycle Electrical Checks and Current Retention

All six cycles recorded **LIN OK** for all six samples. Each standby-current reading was **0.03 mA**, meeting **<0.1 mA**. All recorded working-current values met the **≤100 mA** requirement.

| Sample | Cycle 1 | Cycle 2 | Cycle 3 | Cycle 4 | Cycle 5 | Cycle 6 |
|--------|---------|---------|---------|---------|---------|---------|
| 25#    | 11.5    | 11.7    | 11.6    | 11.8    | 11.5    | 11.4    |
| 26#    | 11.8    | 11.2    | 11.4    | 11.4    | 11.3    | 11.4    |
| 27#    | 12.3    | 11.9    | 11.7    | 11.7    | 12.1    | 11.8    |
| 28#    | 12.9    | 12.7    | 12.4    | 12.4    | 12.1    | 12.0    |
| 29#    | 12.6    | 12.3    | 11.9    | 12.2    | 12.1    | 12.4    |
| 30#    | 12.2    | 12.3    | 12.1    | 11.9    | 11.9    | 11.8    |

Table 2 Working current in mA. The six-cycle source tables also record 0.03 mA standby current and LIN OK at every entry. Source pp. 88-89.

## Post-Test Current Compared with Baseline

| Sample | Before (mA) | Reported ±5% range (mA) | After (mA) | Calculated change | Result |
|--------|-------------|-------------------------|------------|-------------------|--------|
| 25#    | 12.1977     | 11.59-12.81             | 12.6896    | +4.03%            | Pass   |
| 26#    | 13.3018     | 12.64-13.97             | 13.0151    | -2.16%            | Pass   |
| 27#    | 13.7173     | 13.03-14.40             | 13.9311    | +1.56%            | Pass   |
| 28#    | 13.6380     | 12.96-14.32             | 13.2619    | -2.76%            | Pass   |
| 29#    | 13.8318     | 13.14-14.52             | 14.3177    | +3.51%            | Pass   |
| 30#    | 13.0383     | 12.39-13.69             | 13.0637    | +0.19%            | Pass   |

Table 3 Original readings and acceptance ranges from source pp. 89-90. Percentage changes are calculated from the recorded readings.

**Current change (%) =  $(I(\text{after}) - I(\text{before})) / I(\text{before}) \times 100$**

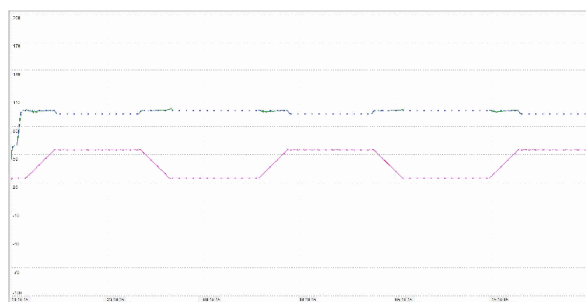
Acceptance: **-5% ≤ current change ≤ +5%**.

| Check                             | Recorded outcome                                                   |
|-----------------------------------|--------------------------------------------------------------------|
| Functional status                 | Class A before, during and after testing; all six samples passed.  |
| LIN communication                 | OK at all recorded stages.                                         |
| Ion concentration, before / after | Over-range above 20 million ions/cm <sup>3</sup> for every sample. |

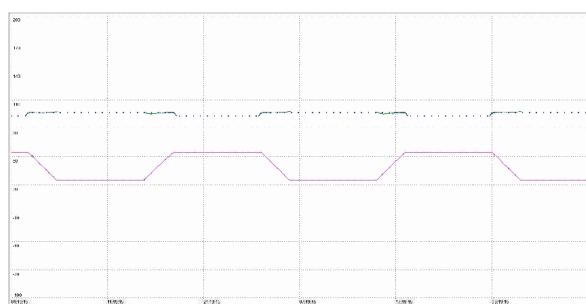
Table 4 Functional outcomes transcribed from the sample records, pp. 88-90.

# Original Process Evidence and Sample Verification

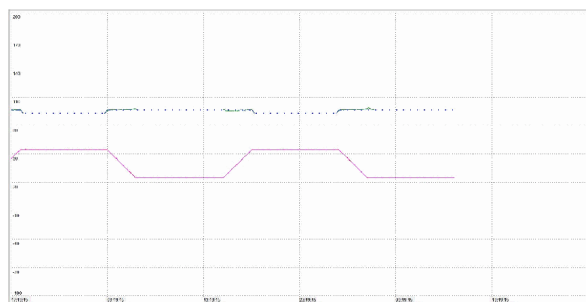
## Chamber Curves across the Program



Start of the recorded program.



During the recorded program.



End of the recorded program.

Figure 2 Original chamber history screenshots at the start, during and at completion, source pp. 92-93.

## Controller Settings

| NO. | 温度    | 湿度   | 时间   | T51 | T52 | T53 |
|-----|-------|------|------|-----|-----|-----|
| 001 | 25.00 | 60.0 | 0.10 | 关闭  | 关闭  | 关闭  |
| 002 | 25.00 | 60.0 | 0.20 | 关闭  | 关闭  | 关闭  |
| 003 | 25.00 | 97.0 | 0.25 | 关闭  | 关闭  | 关闭  |
| 004 | 25.00 | 97.0 | 0.20 | 关闭  | 关闭  | 关闭  |
| 005 | 55.00 | 97.0 | 3.00 | 关闭  | 关闭  | 关闭  |
| 006 | 55.00 | 93.0 | 0.15 | 关闭  | 关闭  | 关闭  |

Figure 3 Original controller pages for segments 1-6 and 7-10, source p. 92.

## Current Change against the $\pm 5\%$ Criterion

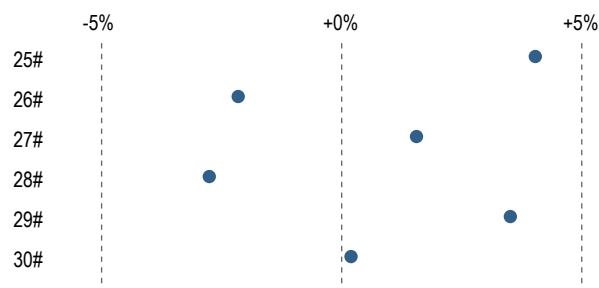


Figure 4 Calculated sample current change; all six points fall within the specified  $\pm 5\%$  range.

## Connected Monitoring Arrangement



Figure 5 Original supply/interface and monitoring connections, source p. 92.

## Sample 25#: Final Functional Check

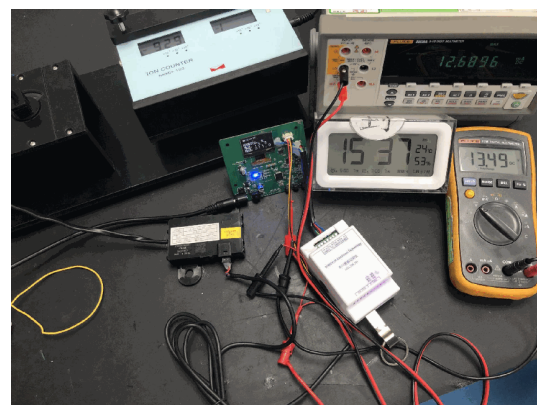


Figure 6 Original final functional photograph, source p. 94.

**Sequence-end inspection schedule:** the procedure calls for connector and internal visual inspection of the metal parts, PCB, connectors and plastics at completion of the full test sequence.

**Equipment:** KVTH-415T-4S chamber, NKMH-103 ion counter, PROVA AVM-07 anemometer.

**Source:** Leg3 pp. 87-95; measurements pp. 88-90. Version 1.0: 26 October 2026.