

High-Temperature Endurance Testing

Preface

MAXMAC tests ion modules through an extended powered program at +85 °C. Working and standby modes alternate on a defined schedule. The record combines chamber exposure, functional checks and physical inspection.

Six modules completed a 1,200-hour program and received a Pass judgment: Class A function, no abnormal appearance and no abnormal internal sound during shaking. This note presents the operating procedure, before-and-after check photographs, and the subsequent X-ray and cross-section inspection records.

Endurance Program

Parameter	Program setting
Chamber temperature	+85 °C
Duration	1,200 hours
Working segment	47 h / mode 3.2
Standby segment	1 h / mode 3.1
Samples	6 modules; 7#-12#

Cycle and Exposure Calculation

$$t(\text{cycle}) = 47 \text{ h} + 1 \text{ h} = 48 \text{ h}$$

$$N = 1,200 \text{ h} / 48 \text{ h} = 25 \text{ cycles}$$

$$t(\text{working}) = 25 \times 47 \text{ h} = 1,175 \text{ h}$$

$$t(\text{standby}) = 25 \times 1 \text{ h} = 25 \text{ h}$$

These totals are calculated from the specified operating schedule. Mode 3.2 is the working condition; mode 3.1 is the standby condition.

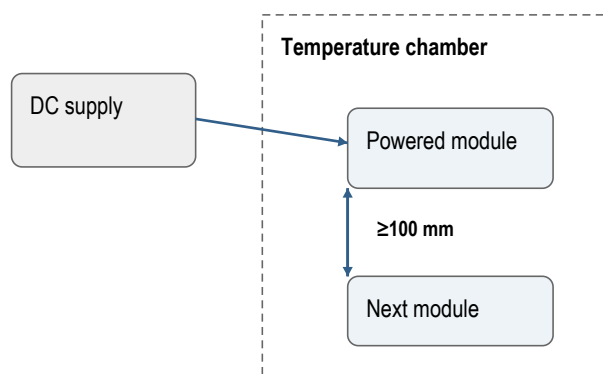
One Cycle within the Full Program



Figure 1 Repeat this 48-hour cycle 25 times to complete the 1,200-hour program.

Test Arrangement and Sequence

Place the modules in the chamber with $\geq 100 \text{ mm}$ between samples and $\geq 100 \text{ mm}$ from chamber walls.



Also $\geq 100 \text{ mm}$ from chamber walls

Figure 2 Powered arrangement and specified clearances.



Figure 3 Original chamber setup.

1. Initial function check and sample arrangement.
2. Stabilize the chamber at +85 °C.
3. Repeat the 47 h working / 1 h standby cycle for 1,200 h.
4. Recover naturally to room temperature, then check function, appearance and internal sound.

Temperature Record and Functional Verification

Original Chamber Temperature Record



Figure 4 Original temperature-versus-time record. The horizontal axis extends to 1,200 hours; the red trace records chamber temperature during the high-temperature program.

Sample 7#: Before Endurance



Figure 5 Original pre-test function checks.

Top left: air-speed measurement. Top right: ion counter. Bottom left: functional monitoring. Bottom right: supply and electrical measurement instruments.

Sample 7#: After Endurance



Figure 6 Original post-test function checks.

Top left: air-speed measurement. Top right: ion counter. Bottom left: functional monitoring. Bottom right: supply and electrical measurement instruments.

Recorded Results and Sample Evidence

Check	Recorded result	Original record
Functional status	Meets Class A	Function photographs, pp. 53-58
Appearance	No abnormality	Result statement, p. 53
Shake check	No abnormal internal sound	Result statement, p. 53
Overall judgment	Pass; six modules	Test conclusion, p. 59

Table 1 Sample photo index: 7# (before p. 53 / after p. 56); 8# (pp. 53-54 / p. 56); 9# (p. 54 / pp. 56-57); 10# (p. 54 / p. 57); 11# (p. 55 / pp. 57-58); 12# (p. 55 / p. 58).

Post-Endurance Internal Inspection: X-ray

The subsequent internal inspection documents two board locations using X-ray imaging and microscopic cross-sections. The original inspection images identify the boards as **67#** and **68#**; these identifiers are retained throughout the following pages.

Inspection Method

The sample is placed on the X-ray inspection stage. After closing the safety door, the X-ray source is activated and the image position is established. Voltage and current are adjusted to obtain clear images of the specified soldered locations, which are then photographed.

Equipment and Conditions

Item	Recorded detail
X-ray system	phoenix micromex neo 160
Ambient conditions	24.1 °C / 43% RH
Inspection samples	2508006682-1 and -2
Locations	Two specified positions per board

Board Inspection Locations

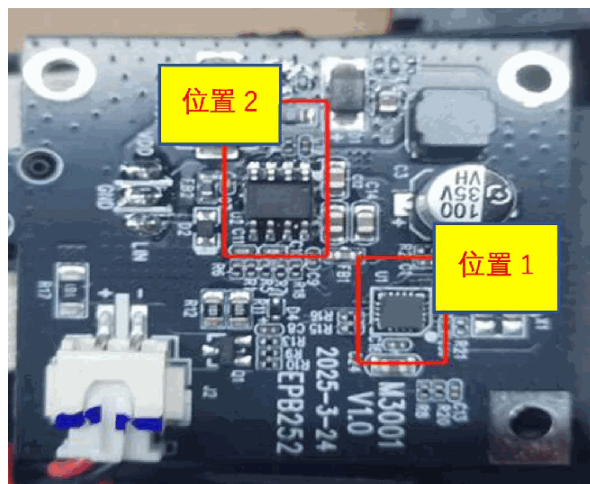
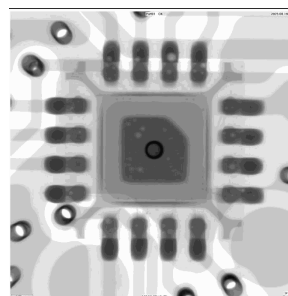


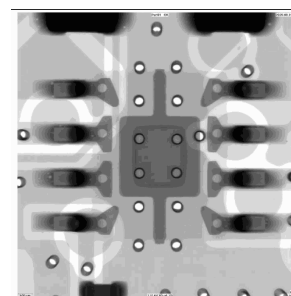
Figure 7 Original board photograph. The marked areas identify Position 1 and Position 2 used in the inspection.

Original X-ray Images

Inspection board 67#

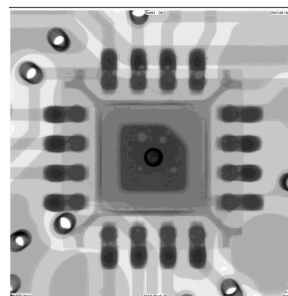


Position 1

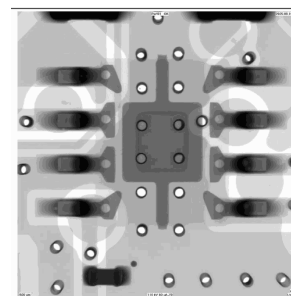


Position 2

Inspection board 68#



Position 1



Position 2

Figure 8 Four original X-ray views, covering both specified locations on each inspection board.

Inspection Sequence

Board location identification → X-ray imaging → mounting, grinding and polishing → microscopic cross-section examination and photography.

The report records the combined post-endurance X-ray and cross-section inspection as **Pass**. The measured cross-section results and original microscopic images are presented on the next page.

Inspection	Requirement recorded in the test outline
X-ray	Voids ≤25%.
Post-test cross-section	Crack length ≤50%.

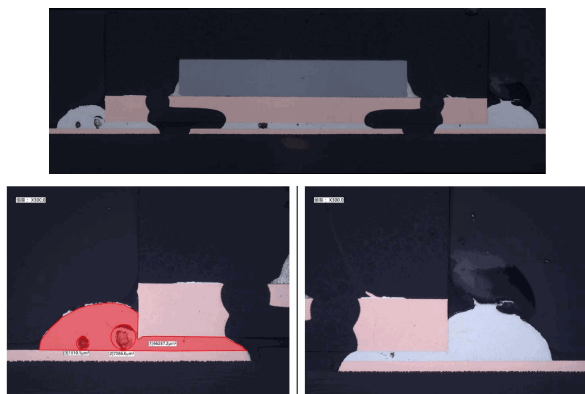
Table 2 Acceptance requirements from source p. 116.

Post-Endurance Internal Inspection: Cross-sections

Samples were mounted, ground and polished, then examined and photographed under a **VHX-7000 3D digital microscope**, following **IPC-TM-650-2.1.1F**. Recorded ambient conditions were 21.5 °C and 63% RH.

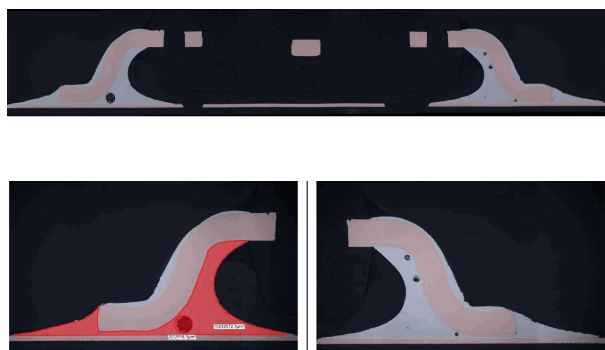
Inspection Board 67#

Position 1



Overview and detailed microscopic views.

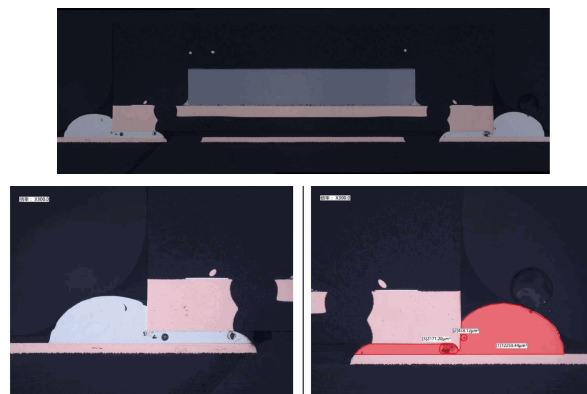
Position 2



Overview and detailed microscopic views.

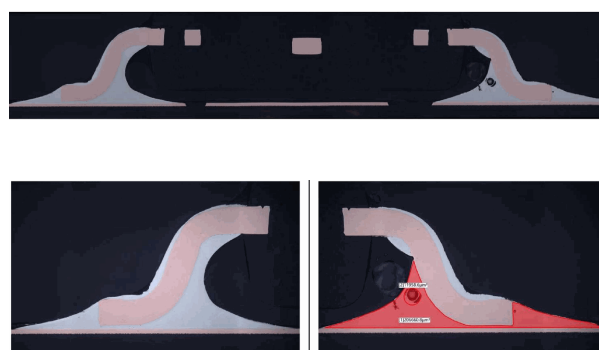
Inspection Board 68#

Position 1



Overview and detailed microscopic views.

Position 2



Overview and detailed microscopic views.

Figure 9 Original cross-section images. Colored overlays and measurement marks are retained from the inspection record.

Measured Results at the Inspected Positions

Inspection board / record ID	Position 1: void ratio	Position 2: void ratio	Recorded observation
67# / 2508006682-1	11.8%	5.3%	No solder-joint cracks or obvious abnormalities observed.
68# / 2508006682-2	3.5%	5.5%	No solder-joint cracks or obvious abnormalities observed.

Table 3 Values and observations transcribed from the cross-section result table on source p. 122.

Test basis and records. Endurance: Q/MAT 5502-2023, 12.1; DIN EN 60068-2-2; Leg2 pp. 34, 49-59. Internal inspection: Leg2 pp. 116-125; inspection report SZA03-25086300-QC-01F. Endurance dates: 20 June-10 August 2025. Internal inspection dates: 19-22 August 2025.