

Quality is more than a word

ESPEC

Electrochemical Migration Evaluation System

Insulation Resistance/Leakage Current Measuring System

AMI-U

NEW

Made minor changes
in April 2021



Analysis and evaluation of electrochemical migration and evaluation of insulation resistance made more accurate, efficient, and easier

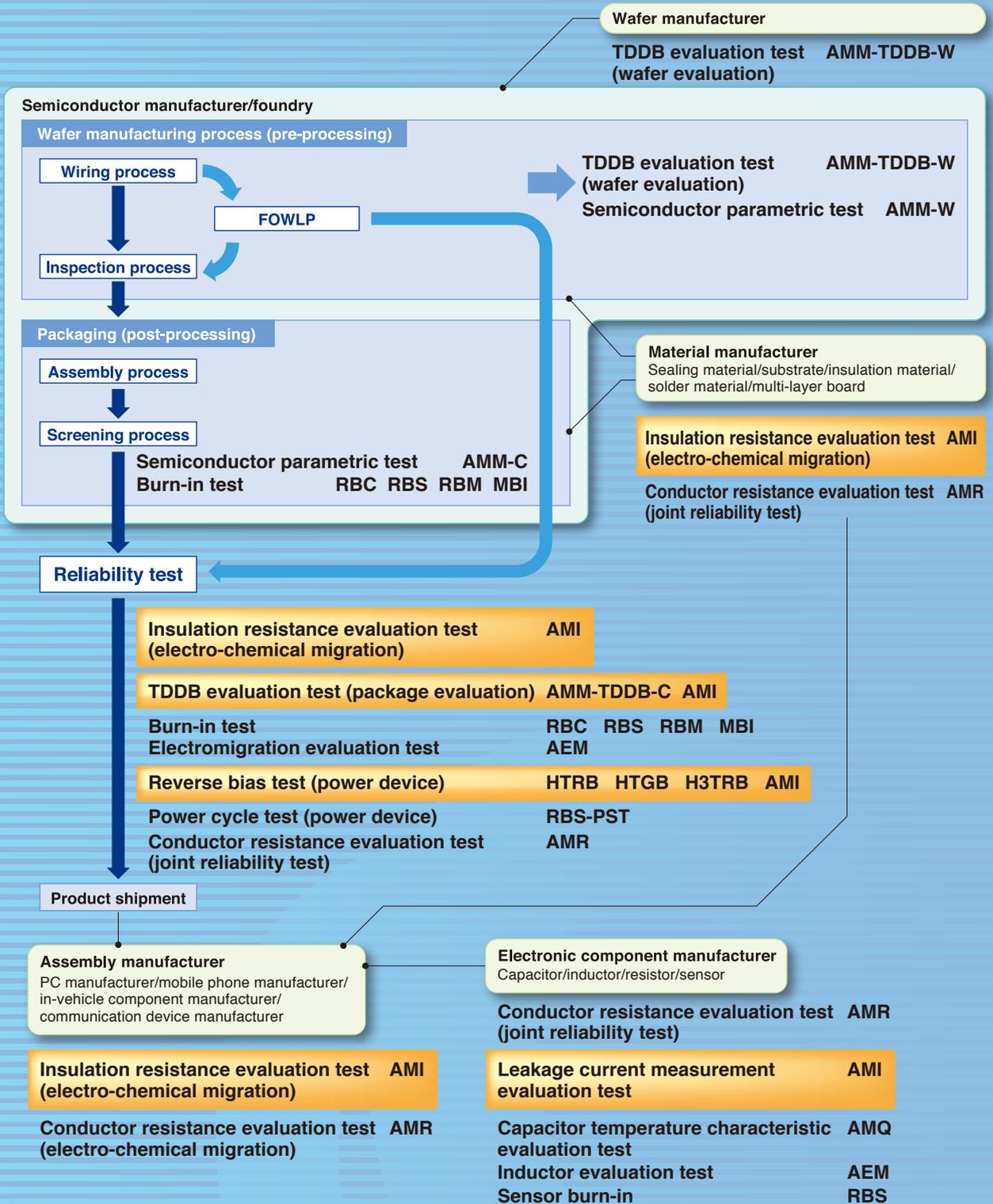
Electrochemical migration and insulation evaluation are becoming more and more important as electronic circuit design become finer, denser, and use of higher voltages in their circuits to save power.

The “Electrochemical Migration Evaluation System” allows these evaluations to be performed continuously with a high degree of accuracy and efficiency.

ESPEC fused environmental testing and measurements and evaluations successfully.



Espec's measuring products in the reliability evaluation of the electronic equipment market

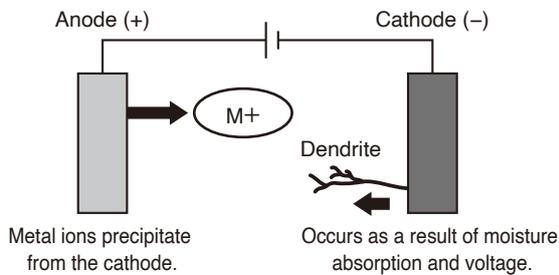
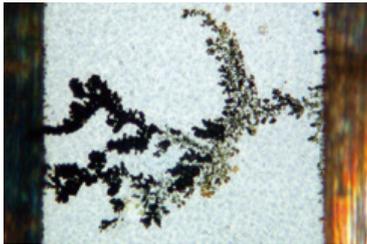


Electrochemical Migration Evaluation

Mechanism of electrochemical migration

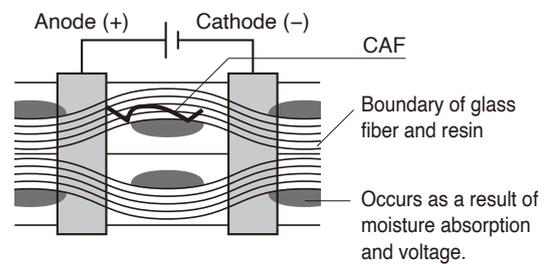
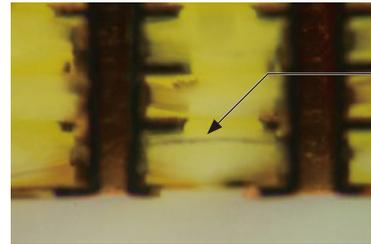
Electrochemical migration (ECM) can result in the growth of a metal deposit from cathode to anode. It could happen on both the surface and inside of PWB. In electronics, such growth can lead to a short-circuit by bridging the electrodes, potentially leading to intermittent or complete failure of electronic devices.

< Board surface >



Dendrite is a dendritic or branched growth of conductive metal filament on the surface of PCB under the influence of a DC voltage bias and ambient humidity.

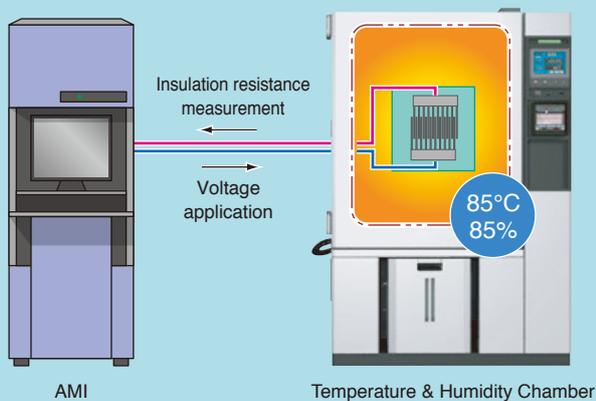
< Between board layers >



CAF or Conductive Anodic Filament is a metallic filament that grows from the anode toward the cathode sub-surface along the epoxy/glass interface. It can also grow from the anode on one layer to a cathode on another.

Test setup with an environmental test chamber

(Example)



- Electrochemical migration occurs when voltage is applied to a sample in a temperature and humidity environment.
- Sample lifetime evaluations are possible under a wide range of environmental conditions.

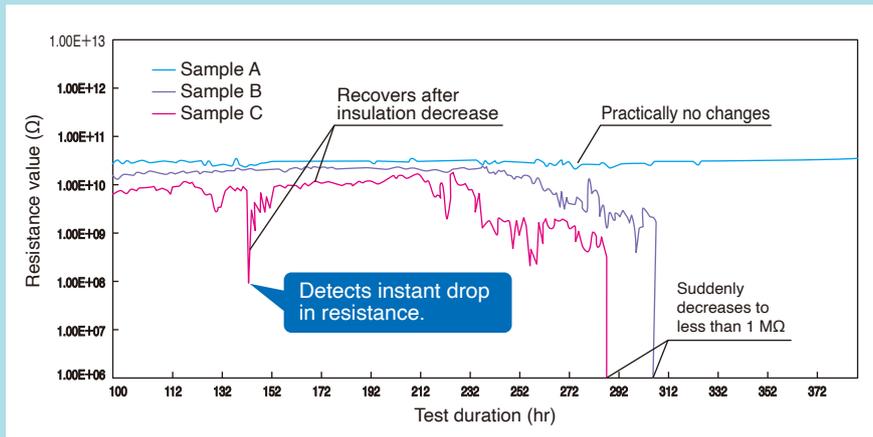
Linkable Models

Temperature & Humidity Chamber	Platinous J Series
	Bench-top Type Temperature (& Humidity) Chamber
Highly Accelerated Stress Test System	HAST Chamber

Electrochemical Migration Evaluation

Measurement results using AMI

- Deterioration of insulation resistance under high temperature and high humidity conditions (Circuit board surface)



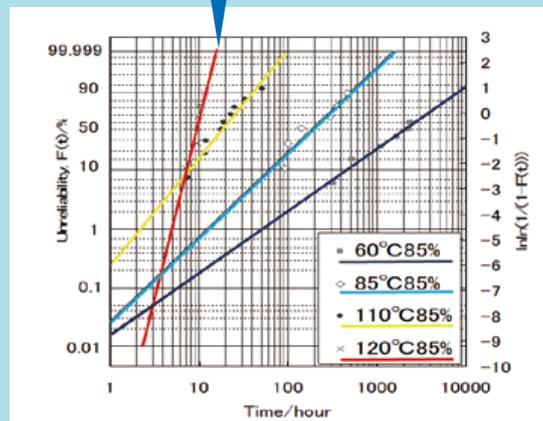
Test conditions
Temperature and humidity condition : 40°C, 90%rh
Stress voltage : 50 V DC
Measurement voltage : 50 V DC
Measurement intervals : 0.5h

* Data processed with Excel (spreadsheet software).

Weibull analysis (option)

- Lifetime evaluation (same sample, same voltage)

In the graph below, the angle of the red line is very different from the rest, showing that its conditions (120°C and 85%rh) are a severe environment.



This is a Weibull plot that is used in lifetime reliability analysis.

AMI is equipped with a support tool for creating Weibull plots that are helpful for lifetime analysis.

Features

AMI captures not only gradual change in resistance but also an unexpected instantaneous rapid drop.



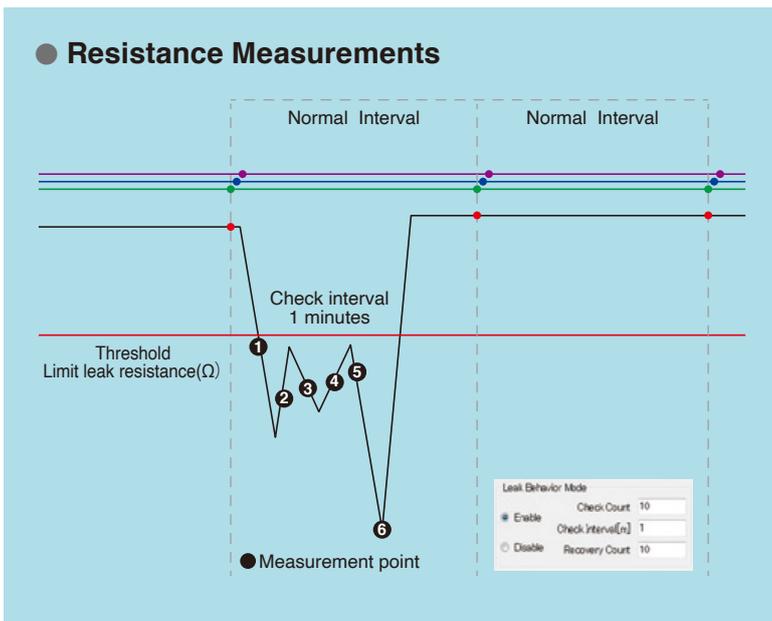
System rack

Tests from low-voltage to high-voltage ranges can be conducted

For evaluations ranging from mobile devices and other low-voltage applications to high-voltage on-board devices, ESPEC offers a lineup of specifications to meet each application and purpose including 100 V constant stress voltage, and optional 300 V and 500 V voltage specifications. Custom products can also be provided with 1000 V and 2500 V specifications.

- 100 V specification
(No voltage application, 1 to 100 VDC)
- 300 V specification
(No voltage application, 1 to 300 VDC)
- 500 V specification
(No voltage application, 1 to 500 VDC)
- Custom specifications**
- 1000 V specification
(No voltage application, 50 to 1000 VDC)
- 2500 V specification
(No voltage application, 50 to 2500 VDC)

Resistance Measurements



Control up to 300 ch \NEW/

Tests of up to 300 ch can be performed. Independent control of each module is possible, and the control ch can be selected from 5 or 25 ch.

Uniquely designed event detectors

Espec original event detectors are used to monitor each and every channel. Once the resistance drop below the predefined threshold, it will direct the measuring equipment to begin recording at a set interval.

Features

Improved operability and safety when linked with ESPEC environmental test chambers

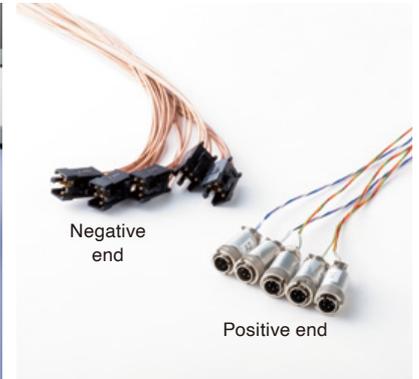
Improved workability and higher efficiency at regular part replacements

Installing a connection unit allows the measurement cables to be easily installed and removed.

The connection unit can be installed on the rack front or on the left or right side, for use according to the installation environment.



Connection unit



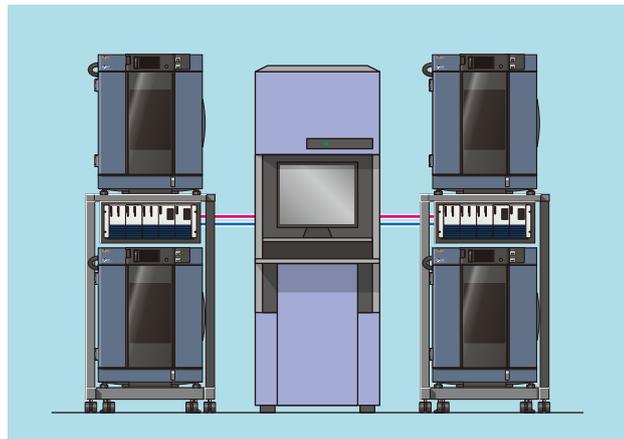
Measurement cable **\NEW/**
Used for each 5 ch connectors.

Achieving high-accuracy measurement

A coaxial cable is used on the negative end, reducing the effects of fine noise and achieving higher-accuracy measurement. The material is coated with Teflon, for superior heat resistance, humidity resistance, and voltage resistance, allowing use in higher-load environments.

Real-time monitoring of 4 environmental test chambers **\NEW/** (via Ethernet connection)

Up to 4 environmental test chambers can be connected and tests performed. In addition to the resistance and voltage values, linking with an environmental test chamber allows the temperature and humidity in the test area to be monitored on the AMI side. The monitoring information is recorded in the measurement result file.



Example of connection to a Bench-top Type Temperature (& Humidity) Chamber

Temperature and humidity delay control by linking with the chamber

Setting a temperature and humidity stabilization time ensures that the sample fully absorbs moisture before starting the test.

	Status		TEMP [C]	HUMI [%]		TEMP [C]	HUMI [%]
c1		PV	23.1	60	SV	23.0	60
c2		PV	22.4	60	SV	23.0	60
c3		PV	104.2	95	SV	105.0	95
c4		PV	104.7	95	SV	105.0	95

METER 1	Status	Remote	Action	Waiting
METER 2	Status	Remote	Action	Waiting

Real-time monitoring (temperature, humidity)

Abnormality detection for safe design

In the event of an abnormality in the environmental test chamber during the test, AMI transitions to a test interruption process. The measurement data is saved up to the time when the abnormality was detected and the stress voltage to the sample was shut off. After the abnormality is resolved, the test can be resumed.

Measurement Info.											
Disp. Select											
<input type="radio"/> Measured Value(25P) <input checked="" type="radio"/> Detail(5P)											
A	B	C	D	E	F	G	H	I	J	K	L
A1	A2	A3	A4	A5							
	Absolute Value[ohm]	Changed Value[ohm]	Changed Ratio[%]	Check Count	Recovery Count	Supplied Voltage[V]	Leak Detect Time[s]	Status			
A1-1	1.051E+06	4.712E+04	4.7E+00			100.20		In Test			
A1-2	9.531E+05	-7.338E+03	-7.8E-01			100.01		In Test			
A1-3	9.957E+05	-1.174E+03	-1.2E-01			99.99		In Test			
A1-4	1.003E+06	5.043E+04	5.3E+00			104.93		In Test			
A1-5	1.046E+06	6.727E+04	6.9E+00			96.11		In Test			

Real-time monitoring (voltage, resistance)

Calibration service

ESPEC provides calibration of evaluation systems including the environmental test chambers.

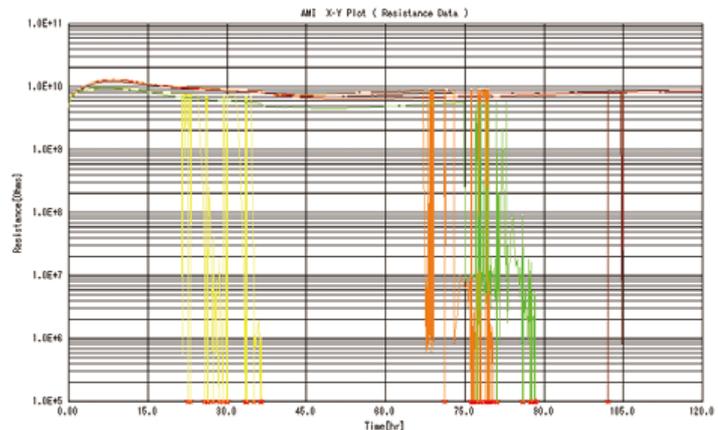
Hybrid measurement using scanner-type high-accuracy measurement and event detectors

What is scanner-type high-accuracy measurement?

- This is a measurement device (150 ch/device) that conforms to international standards measures all samples, reducing variation in measured values among different channels. It is equipped with an NPLC (Number of Power Line Cycle) function that reduces the effects of primary-side power noise and allows higher-accuracy measurement.

What is event detectors?

- A detection circuit is installed for each channel in order to detect momentary migration that cannot be captured by the measurement device. (The detection speed is less than 100 μ s.)



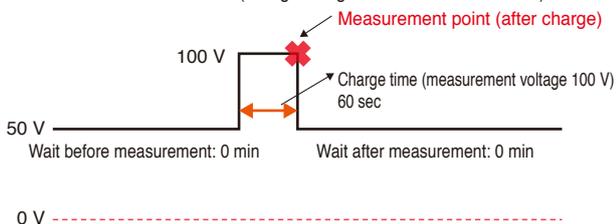
Initial migration is a short-circuit phenomenon in which the dendrite burns out and the original resistance value is restored. The ESPEC event detectors performs continuous monitoring in order to avoid overlooking this.

* Migration occurs gradually over a period of several tens of hours. (IPC standard: Measurement interval 20 min or less)

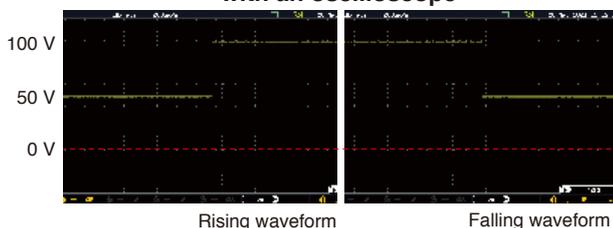
Test voltage to suit the individual sample

Board insulation evaluation (Test standard: IPC-TM-650 2.6.3.3)

Applied stress voltage: 50 VDC
Measurement voltage: 100 VDC
(voltage charge 60 sec → measurement)

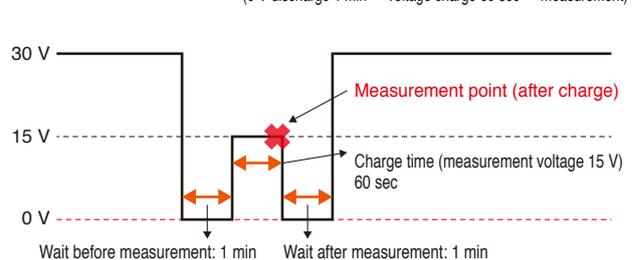


Actual output control waveform acquired with an oscilloscope

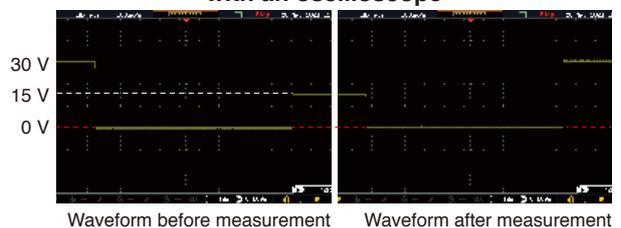


Capacitor insulation evaluation (Test standard: AEC-Q200)

Applied stress voltage: 30 VDC
Measurement voltage: 15 VDC
(0 V discharge 1 min → voltage charge 60 sec → measurement)



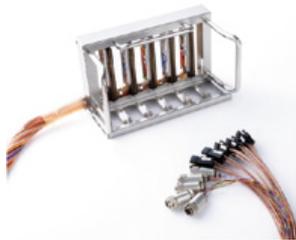
Actual output control waveform acquired with an oscilloscope



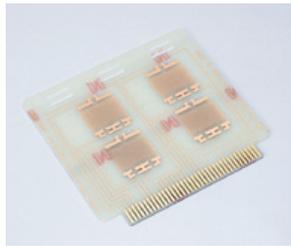
Reasons why ESPEC Electrochemical Migration Evaluation Systems are chosen worldwide

A manufacturer of environmental test chambers providing temperature chambers, jigs and tools, and test boards which conform to test standards

- Voltage application is interrupted when the temperature chamber door is not closed or when an abnormality occurs, preventing condensation on the sample and dielectric breakdown.
- Tests which conform to IPC-TM650 (Section 2.5) and other global standards are possible. IPC-B-24 board and special rack are available as options.



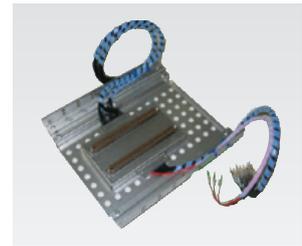
IPC test board rack



IPC-B-24 board



HAST slide-out jig



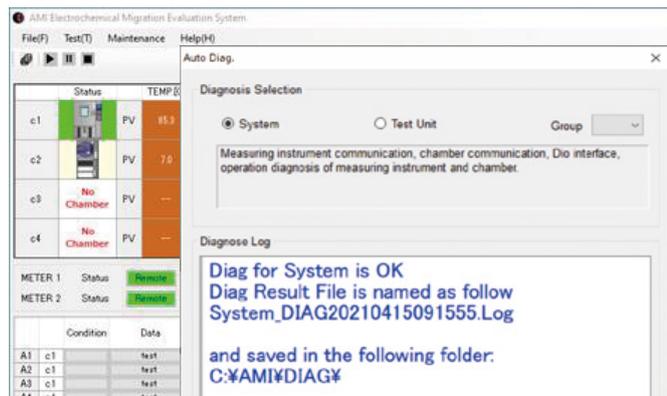
Card edge type

Simple self-diagnosis

Self-diagnosis tests can be conducted using the resistor that is provided for regular maintenance.

Diagnosis contents:

- Chamber communications
- Measurement instrument communications
- Interface
- Voltage output
- Leak detection circuit ...others



Extensive network of service facilities



Customer support is available in 50 countries and regions around the world.

TEST PREPARATION

Condition registration

Test time, measurement interval, measurement voltage, applied stress voltage, limit values, and other test conditions can be configured and saved in a file.

The 'Test Conditions Set-up' dialog box is divided into four tabs: Stress, Limit, Measurement, and Schedule.

- Stress Tab:** Shows 'Stress Mode' set to 'DC' and 'Voltage [V]' set to '1.0'.
- Limit Tab:** Shows various limit settings: 'Absolute Value[ohm]' (checked, 1.00E+06), 'Change Value[ohm]' (unchecked), 'Changed Ratio[%]' (unchecked), 'Leak Current[μA]' (unchecked), and 'Leak Resistance[ohm]'.
- Measurement Tab:** Shows 'Measuring Mode' set to 'Long', 'Voltage [V]' set to '1.0', 'Averaging [Count]' set to '4', and options for 'Lower Range Limit Select' and 'Shift Lower Range Limit When Retry' (2E-5A or 2E-9A).
- Schedule Tab:** Shows 'Test Duration[h]' set to '1', 'Measure Interval' with 'Fixed Interval[m]' selected (1) and 'Exp Interval' (0.1). It also includes 'Wait Before Measure[m]', 'Charge Time[s]' (60), and 'Wait After Measure[m]'. A 'Test period = 1 + 2 + 3 + 4' diagram shows a sequence of 'Charge', 'Measure', 'Wait', and 'Stress' phases.

Test settings

Settings including test module selection, name of data file to save, linked chamber setting, whether or not to output text data, whether or not to use the Leak Touch behavior mode, and comment entry can be configured.

The 'Test Setting Contents [Chamber c1]' dialog box includes the following settings:

- Measurement File Name:** A text input field with an 'Interlock with Chamber' checkbox.
- Group Select:** A vertical list of test groups from A1 to J2.
- Comments:** Three text input fields for 'Comment 1', 'Comment 2', and 'Comment 3'.
- Alarm:** A checked checkbox for 'Alarm : invalid measured data' with an 'Exponent' dropdown set to '3'.
- Condition File:** A text input field with a 'Select...' button.
- Test Name:** A text input field with a 'Confirm...' button.
- Output Text File:** A checked checkbox with options for 'Test Unit' and 'Separator' (Comma or Tab).
- Leak Behavior Mode:** Radio buttons for 'Enable' or 'Disable', and input fields for 'Check Count', 'Check Interval[m]', and 'Recovery Count'.

TEST START AND ANALYSIS

Test start

During test

- The progress of the test is indicated in real time.
- The test can be stopped, paused, resumed, and extended.

Test end

The test results data can be saved as a CSV file or as a special file for the data processing software.

Weibull analysis

- Weibull analysis of test data can be performed by the statistical processing software.
- A normal probability plot and logarithmic probability plot can be displayed.

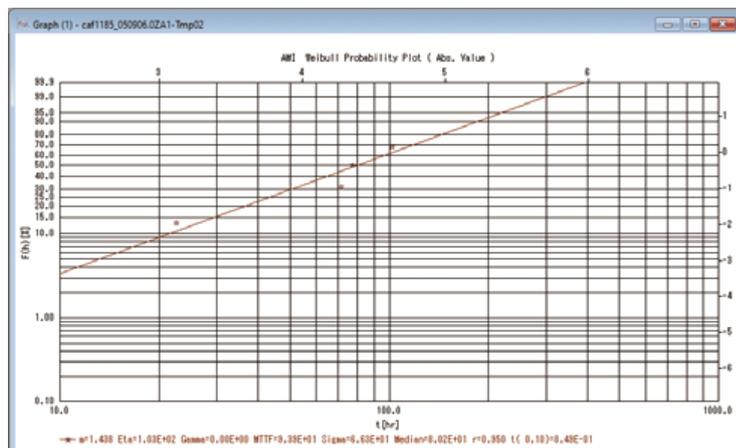
Click on a cell.

Click on a cell.

Graph display

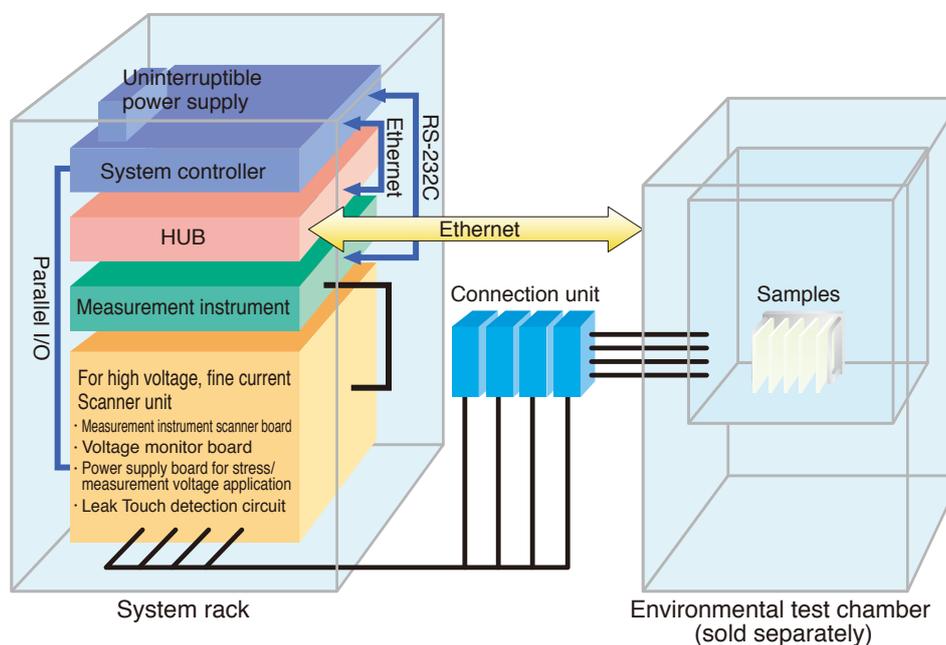
Data display

Test time extension **\NEW/**
The test time can be extended while the test is in progress.



Weibull analysis

SYSTEM CONFIGURATION DIAGRAM



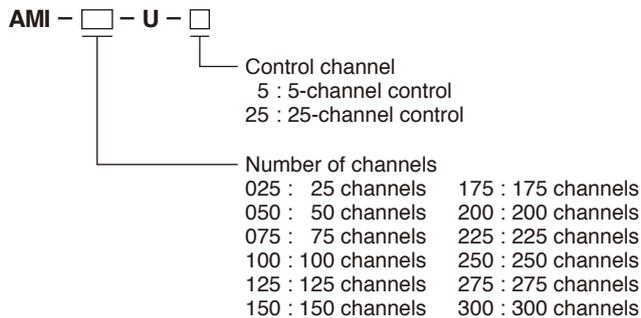
SPECIFICATIONS

Type	Stress constant voltage 100 V specification	Stress constant voltage 300 V specification (option)	Stress constant voltage 500 V specification (option)
Channel configuration	25 to 300 ch per rack		
Channel control	5 ch / 25 ch		
Software *1	Windows OS		
Stress power supply	Stress voltage	0 VDC, 1.0 to 100 VDC	0 VDC, 1.0 to 300 VDC
	Min. set voltage resolution	0.1 V (1.0 to 100 V. Can be set independent of the measurement voltage.)	0.1 V (when 1 to 200 V is set) 1.0 V (when 200 to 300 V is set)
	Applied voltage accuracy	±(0.7% of set voltage + 300 mV)	
Measurement functions	Resistance measurement range (Ω)	2.0 x 10 ⁵ to 1.0 x 10 ¹³ (when applying 100 V) 2.0 x 10 ³ to 1.0 x 10 ¹¹ (when applying 1 V)	6.0 x 10 ⁵ to 3.0 x 10 ¹³ (when applying 300 V) 2.0 x 10 ³ to 1.0 x 10 ¹¹ (when applying 1 V)
	Measurement accuracy	10 TΩ ±30% (when applying 100 V)	
	Measurement voltage	1.0 to 100 VDC (0.1 V increments)	1.0 to 300 VDC (1.0 to 200 V: 0.1 V increments) (200 to 300 V: 1.0 V increments)
Leak detection speed	Constantly detects with speed of less than 100 μs.		
Measurement cable	Type	Heat-resistant single cable	
	Coating material	Teflon (heat resistance +150°C)	
	Length	Between scanner unit and connection unit: 2.5 m Between connection unit and end: 1.5 m	
Connection unit	25 ch/unit + Positive: Metal connectors - Negative: Square coaxial connectors		
No. of measurement instrument	25 ch to 150 ch: 1 175 ch to 300 ch: 2		
Accessories	Communication cable (Ethernet), setup CD, user's manual (1 set), maintenance (10 MΩ) resistor box, warranty certificate		
Outside dimensions *2	W530 x H1750 x D1040 mm		
Power supply	100 VAC, 1 φ, 15 A		

*1 The (software) operating environment may change as a result of version changes in the Windows OS. Please ask for current supported operating system version.

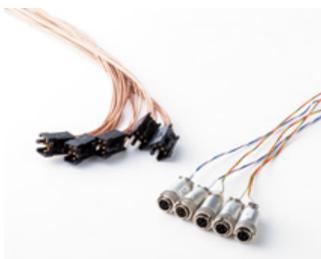
*2 Excludes protrusions.

MODEL



OPTION

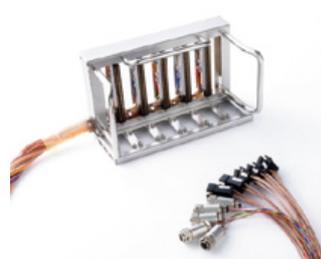
Option name	Details	Installation after chamber purchase
Applied stress constant voltage (high-voltage specification)	Changes the applied voltage to 300 V or 500 V.	×
Measurement cable for 25 channels	A separate measurement cable from the standard component, consisting of both the positive side and negative side, is available. 1.5 m / 3 m / 5 m	○
Extension measurement cable for 25 channels	The standard 1.5 m cable supplied with the product can be changed to a 3 m or 5 m cable.	×
Extension cable for connecting the scanner unit and connection unit	The standard 2.5 m cable supplied with the product can be changed to a 4 m (external) cable.	×
IPC-B-24 SIR test coupon	This board conforms to IPC-B-24 that is prescribed in TM-650. * 100 V resistance component	○
Test board rack type A	This is a special rack for IPC-B-24 SIR test coupon. * 100 V resistance component	○
Board folder jig	A wide range of jigs for fastening boards is available. (Screw-screw type, screw-solder type, solder-solder type)	○
Additional channel (25 channel basis)	Additional channels (25 channel basis, maximum 300 ch) can be installed.	○
Additional scanner box	This is required when the total number of installed channels is 175 or more.	○
Statistical processing software (Adds functions to the data processing software.)	Adds Weibull analysis functions to the standard statistical processing software.	×
Language support	Select from English, Chinese (simplified), and Chinese (traditional).	×
Current value display function	Displays the resistance value as an electrical current value.	×
RS-485 communication support	Communication can be changed from Ethernet to RS-485.	×
Emergency stop switch	This switch is used to stop equipment operation immediately in case of emergency.	×
Power supply voltage	<ul style="list-style-type: none"> • 120 VAC ±10%, single phase, 12.5 A • 220 VAC ±10%, single phase, 6.9 A • 230 VAC ±10%, single phase, 6.6 A • 240 VAC ±10%, single phase, 6.3 A * A step-down transformer (single phase, compound winding) is used.	×
CE support	Changes to a product that supports CE.	×
Export specifications	The product is protected by a desiccant (silica gel) and other means when it is exported.	×
Data (at time of shipping)	Measurement instrument calibration record, certificate, traceability system chart Chamber test and inspection report, test data, calibration record, traceability certificate, traceability system chart	×



Measurement cable



IPC-B-24 SIR test coupon



Test board rack type A



Board holder jig: Screw-screw type

Examples of Insulation Evaluations

* These include some custom specifications.

ESPEC provides not only evaluation equipment, but also a variety of compatible jigs.

【Evaluation application 1】 Capacitor insulation evaluation test

Evaluations can be performed of capacitor insulation deterioration characteristics, which are covered by the AEC-Q-200 standard for vehicle electronic devices.

Capacitor insulation evaluation

Environmental stress
(High temperature, high humidity / High temperature)

Capacitor MLCC

Printed board

HAST (Highly Accelerated Stress Test) System and special capacitor jig

【Evaluation application 2】 Common specification insulation evaluation test

Insulation evaluation is possible when a common connection is used on one side of the sample.

Common connection on one side

Sample

Scanner circuit
For each ch
• Protective resistance
• Leak detection

Common jig

【Evaluation application 3】 Reverse bias test (HTRB: High Temperature Reverse Bias Test)

Evaluations of high-voltage resistance can be conducted for power devices. For reasons of energy efficiency, power devices require reliability evaluations for high-voltage resistance and in a wide range of temperature environments.

Power device reverse bias test

Drain

Gate

Source

Vds

Jig for use of TO package (same for TO-220/247 (3P))

Custom Specification

1000 / 2500V stress voltage modifications

	High-voltage specification
Channel configuration	25 to 150 ch per rack
Channel control	5 ch / 25 ch
Measurement voltage	50 to 1000 VDC / 50 to 2500 VDC * For voltages higher than 2500 V, please consult with us. (50 to 200 V: 0.1 V increments, 200 to 2500 V: 1 V increments)
Resistance measurement range	1 x 10 ⁵ to 1 x 10 ¹³ Ω or higher (when applying 100 V) 1 x 10 ⁶ to 1 x 10 ¹⁴ Ω or higher (when applying 1000 V) 2.5 x 10 ⁶ to 2.5 x 10 ¹⁴ Ω or higher (when applying 2500 V)
Resistance measurement accuracy	Measured resistance accuracy when 1000 V is applied to a 10 TΩ resistor: ±4% *1 (Measurements from 96 to 104 pA are possible for a true current of 100 pA.) Measured resistance accuracy when 2500 V is applied to a 10 TΩ resistor: ±4% *1 (Measurements from 240 to 260 pA are possible for a true current of 250 pA.)
Stress voltage control function	Step rise with a one second wait every 100 V (See Fig. 1 below.)
No. of measurement instrument	1
External dimensions	Cabinet: W530 x H1750 x D1040 mm Connection unit: W500 x H1705 x D600 mm (50 ch/unit)

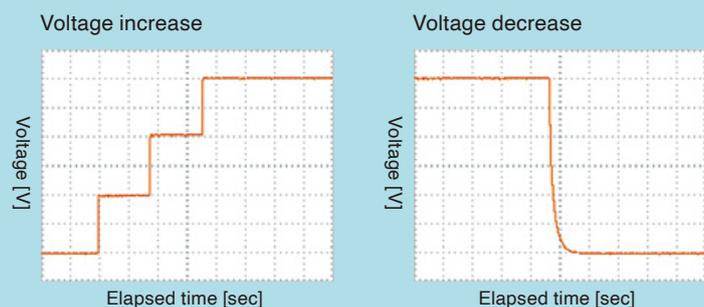
*1 This is the value from connection unit to measurement cable end (2 m). When the extension cable option was selected, the guaranteed values are different.

[Test conditions]	Ambient temperature	: Room temperature (23 ±5°C)
	Ambient humidity	: 60% rh or less
	Measurement mode	: Long
	Measurement range	: Auto
	Measurement voltage [V]	: 1000
	Averaging count	: 4
	Charge time [sec]	: 60

VARIOUS SAFETY FUNCTIONS

- Electric shock prevention indicator lamp (when high voltage is being applied)
- Overshoot prevention
When stress voltage is increasing, a one second wait is added every 100 V during rise control.
- The high-voltage connection unit contains a stress power-side relay and noise prevention circuit.
- Electric shock prevention
A relay is also added for each individual channel on the sample stress power supply side (positive voltage). Voltage is reliably shut off when a test is not in progress, or after testing of an individual channel ends.
- In order to prevent operator electric shock, the voltage drops immediately to a safe voltage when the test ends or when the chamber cover is removed or the chamber door is opened.

● Stress voltage (Fig. 1)



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ISO 9001 (JIS Q 9001)

Quality Management System Assessed and Registered

ESPEC CORP. has been assessed by and registered in the Quality Management System based on the International Standard ISO 9001:2015 (JIS Q 9001:2015) through the JSA Solutions Co.,Ltd.

* The organization of these certificates is
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QMS
JIS Q 9001
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MS
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ISO 27001 (JIS Q 27001)

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ISMS
JIS Q 27001
JSAI 165



ISMS-RC
ISMS ISR008

ISO 14001 (JIS Q 14001)

Environmental Management System Assessed and Registered

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