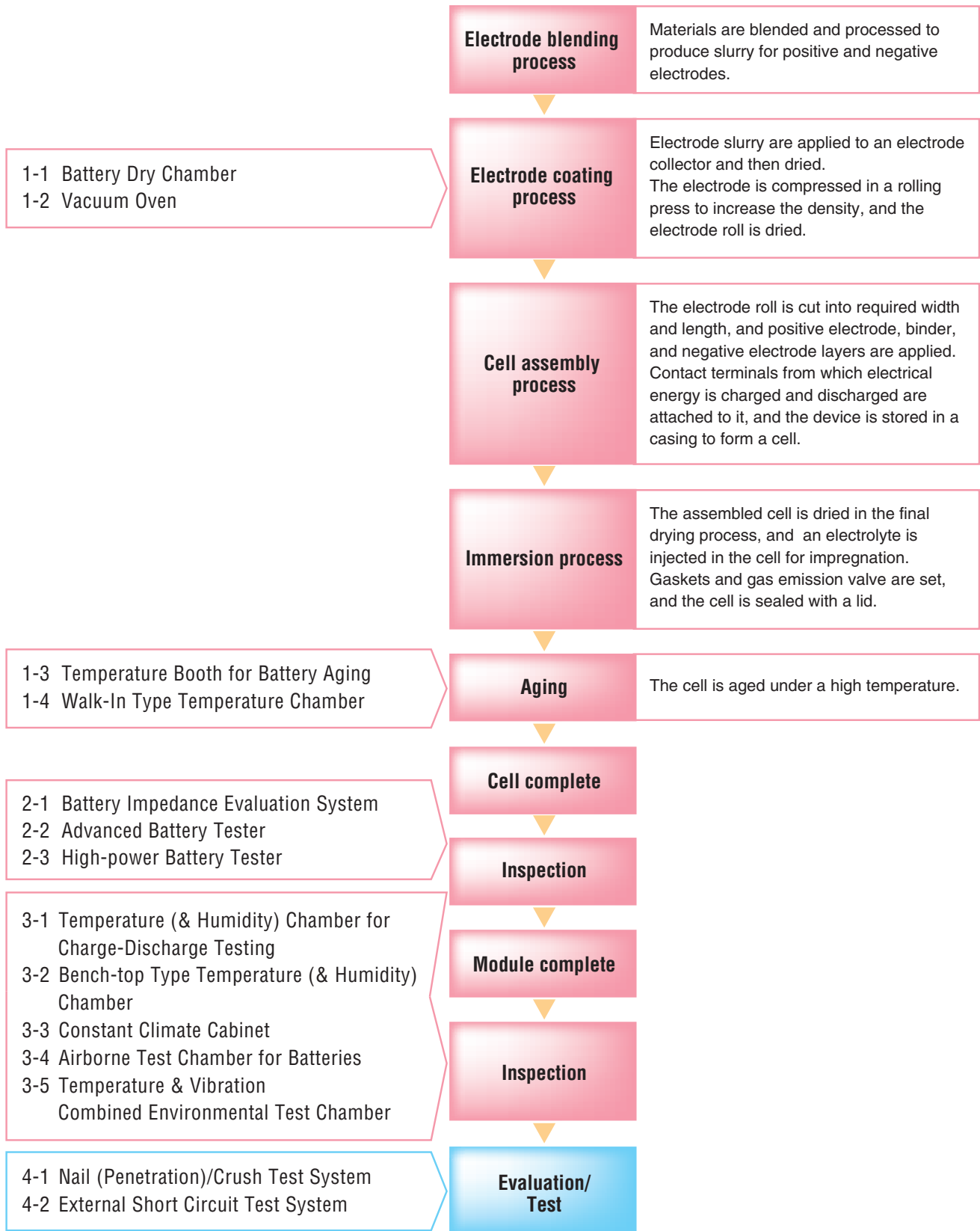


Quality is more than a word

ESPEC

# Products for Secondary Battery Production and Testing

# Lithium-ion batteries



# Test method for Secondary Battery

Test method	Standard	Conditions	Compliant product
Altitude (low-pressure) test	JIS8712 UN3480 UN3481 PSE	Pressure: 11.6 kPa or less Temperature: 20°C (±5°C) Duration: 6 hours	Vacuum Oven Airborne Test Chamber for Batteries
	UL1642	Pressure: 11.6 kPa or less Temperature: 20°C (±3°C) Duration: 6 hours	
Temperature test	UN3480 UN3481	Temperature: 6 hours at 75°C (±2°C), then temperature pull down to -40°C (±2°C) within 30 minutes. Hold the specimen for 6 hours. Repeat the cycle 10 times, then let the specimen hold for 24 hours at 20°C (±5°C).	Faster Temperature Chamber Rapid-Rate Thermal Cycle Chamber Thermal Shock Chamber
	UL1642	Increase the temperature from 20°C (±5°C) to 130°C (±2°C) at 5°C/min. (±2°C) and hold for 10 minutes.	Temperature Chamber Environmental Stress Chamber Faster Temperature Chamber Rapid-Rate Thermal Cycle Chamber
		Cycle: To 70°C (±3°C) within 30 minutes. Hold for 4 hours. Pull the temperature down to 20°C (±3°C) within 30 minutes, hold for 2 hours. Pull the temperature down to -40°C (±3°C) within 30 minutes, hold for 4 hours. Heat the temperature up to 20°C (±3°C) within 30 minutes hold for 4 hours. Repeat the above cycle 10 times, and then let the specimen hold for 24 hours.	Environmental Stress Chamber Faster Temperature Chamber Rapid-Rate Thermal Cycle Chamber Thermal Shock Chamber
	JIS8712 PSE	Keep the product for 7 hours at 70°C (±2°C). Remove from the chamber, and leave in an environment of 20°C (±5°C).	Temperature Chamber Large Volume Temperature Chamber Constant Climate Cabinet
Cycle: Hold for 4 hours at 75°C (±2°C). Pull the temperature down to 20°C (±5°C) within 30 minutes, hold for 2 hours. Pull the temperature down to -20°C (±2°C) within 30 minutes, hold for 4 hours. Heat the temperature up to 20°C (±5°C) within 30 minutes, hold for 2 hours. Repeat the above cycle 5 times, then let the specimen hold for 7 days.		Platinous Series Temperature Chamber Environmental Stress Chamber Faster Temperature Chamber Bench-Top Type Temperature Chamber Rapid-Rate Thermal Cycle Chamber Thermal Shock Chamber	
JIS8712 JIS8714	Increase the temperature to 130°C (±2°C) at 5°C/min. (±2°C) and hold for 10 minutes.	Temperature Chamber Environmental Stress Chamber Faster Temperature Chamber Rapid-Rate Thermal Cycle Chamber	
Vibration test	UN3480 UN3481	Make the specimen vibrate within the frequency range from 7 to 200 Hz, 12 times in 3 hours. Vibration shall occur in 3 directions perpendicular to each other.	Temperature & Vibration Combined Environmental Test Chamber
	UL1642 UL2054 PSE	Vary the frequency within 10 to 55 Hz range, at a rate of 1 Hz/min. Vibration shall occur in 3 directions perpendicular to each other.	

# Test method for Secondary Battery

Test method	Standard	Conditions	Compliant product
Impact test	UN3480 UN3481	Drop a rod (diameter of 15.8 mm and weight of 9.1kg) to the center of a cell from a height of 61cm ( $\pm 2.5$ cm), and hold the specimen for 6 hours.	Advanced Safety Tester Temperature Chamber Large Volume Temperature Chamber
	UL1642 UL2054	Drop a rod (diameter of 15.8 mm and weight of 9.1kg) to the center of a cell from a height of 61 cm ( $\pm 2.5$ cm).	
External short circuit	UN3480 UN3481	Connect the specimen at 55°C ( $\pm 2^\circ\text{C}$ ) with a resistance of 0.1 $\Omega$ to make a short circuit.	Advanced Safety Tester External Short Circuit Test System
	JIS8712 UL1642 UL2054	Connect the specimen at 20°C ( $\pm 5^\circ\text{C}$ ) and 55°C ( $\pm 5^\circ\text{C}$ ) with a resistance of 80 m $\Omega$ ( $\pm 20$ m $\Omega$ ) to make a short circuit.	
	JIS8714 PSE	Electrical cell: Connect the specimen at 55°C ( $\pm 5^\circ\text{C}$ ) with a resistance of 80 m $\Omega$ ( $\pm 20$ m $\Omega$ ) to make a short circuit.	
		Battery pack: Connect the specimen at 20°C ( $\pm 5^\circ\text{C}$ ) with a resistance of 80 m $\Omega$ ( $\pm 20$ m $\Omega$ ) to make a short circuit.	
Crush test	UL1642 UL2054 JIS8712 JIS8714 PSE	Between 2 flat plates, apply pressure at 13kN ( $\pm 1$ KN).	Advanced Safety Tester Crush Test System
	UN3480 UN3481	Between 2 flat plates, apply pressure at 13kN ( $\pm 0.78$ KN) .	
Forced internal short circuit test	JIS8714 PSE	Implant a nickel platelet into a battery. Apply pressure to the embedded area at 10°C and 45°C ( $\pm 2^\circ\text{C}$ ). (Upper limit value: 800 N or 400 N).	
Overcharge test	UL1642 UL2054	At 20°C ( $\pm 5^\circ\text{C}$ ), charge (3C) the specimen with three-times the rated current and power for a minimum of seven hours.	Advanced Safety Tester
	JIS8712 PSE	At 20°C ( $\pm 5^\circ\text{C}$ ), power the specimen until it reaches 250% of the rated capacity or the test voltage.	
Over discharge test	UL1642 UL2054	Connect a cell after being discharged and a cell after being charged in a series and short circuit by connecting 80 m $\Omega$ ( $\pm 20$ m $\Omega$ ) of resistance	Advanced Safety Tester
	JIS8712 PSE	At 20°C ( $\pm 5^\circ\text{C}$ ), reverse charge the specimen for 90 minutes.	
High-rate charge test	JIS8712 PSE	Temperature: at 20°C ( $\pm 5^\circ\text{C}$ ). Charge the product with a current 3 times higher than the maximum charging current.	

Test method	Standard	Conditions	Compliant product
Continuous and stable voltage charge test	JIS8712 PSE	Charge the product at 20°C (±5°C) for 28 days under designed constant-voltage charge condition.	Advanced Safety Tester
Overcharge protection function test	JIS8712 PSE	Perform the test at 20°C (±5°C) according to stipulated method.	
Drop test	JIS8712 PSE	Drop the specimen from a height of 1 m at 20°C (±5°C).	Advanced Safety Tester
Device drop test	JIS8714 PSE	Drop the product from a prescribed height at 20°C (±5°C).	Walk-In Type Temperature Chamber

According to in-house research as of December 2014.

# Test method for Vehicle Secondary Battery

Test method	Standard	Conditions	Compliant product
High temperature test	IEC62660-2	130°C, 30 minutes (heat-up 5°C/min)	Temperature Chamber Environmental Stress Chamber Faster Temperature Chamber Rapid-Rate Thermal Cycle Chamber
Thermal cycle	ISO12405-1,-2 IEC62660-2 UN ECE R100.02 Part II	-40°C/85°C (temperature change within 30 min), 5 cycles -40°C/85°C, 30 cycles -40°C/60°C (temperature change within 30 min), 5 cycles	Environmental Stress Chamber Thermal Shock Chamber
Storage test	ISO12405-1,-2 IEC62660-1	45°C, 28 or 42 days	Platinous Series Temperature Chamber Bench-Top Type Temperature Chamber Compact Ultra Low Temperature Chamber
Dew condensation test	ISO12405-1,-2	Run the temperature and humidity test pattern that conforms to IEC 60068-2-30 for 5 cycles	Platinous Series Temperature Chamber Environmental Stress Chamber Faster Temperature Chamber
Cycle life test	IEC62660-1 ISO12405-1 ISO12405-2	45°C charge/discharge cycle Room temperature charge/discharge cycle -10°C charge/discharge cycle	Advanced Battery Tester High-power Battery Tester Advanced Safety Tester
Performance test	ISO12405-1,-2	Run the charging/discharging test by various methods between -18°C to 45°C. Measure the power at high and low temperatures and calculate the internal resistance and energy efficiency. Also includes cycle life tests.	
Output test	IEC62660-1	-20°C, 0°C, 25°C, 40°C Voltage measurements after specified charge/discharge	
Overcharge test	UL2580 ISO12405-1 ISO12405-2 IEC62660-2 UN ECE R100.02 Part II	25°C, Maximum charging current 25°C, 5C 25°C, 2C 25°C, 1C(BEV), 5C(HEV) 20°C, 1/3 C or greater, standard charging current or less	Advanced Safety Tester External Short Circuit Test System
Forced discharge test	UL2580 ISO12405-1 ISO12405-2 IEC62660-2 UN ECE R100.02 Part II	95% of the current value that will cause the protection function to activate After full charge, 1 C, maximum 90 minutes After full charge, 1/3 C, maximum 90 minutes After full discharge, 1 C, 90 minutes 20°C, 1/3 C or greater, standard discharging current or less	
External short circuit test	UL2580 ISO12405-1 ISO12405-2 IEC62660-2 UN ECE R100.02 Part II	25°C, 20 mΩ or less Room temperature, 60 to 100 mΩ Room temperature, 10 to 20 mΩ Room temperature, 5 mΩ or less 20°C, 5 mΩ or less	Temperature & Vibration Combined Environmental Test Chamber
Vibration test	UL2580 ISO12405-1,-2 IEC62660-2 UN ECE R100.02 Part II	Conforms to SAE J2380 Maximum 200 Hz, 12 to 21 h, -40°C, 25°C, 75°C Maximum 2 kHz, 27.8 m/s <sup>2</sup> , 8 h, 25°C 7 to 50 Hz, 20°C	
Impact test	UL2580 ISO12405-1,-2 IEC62660-2	25 G, 18 times, conforms to SAE J2464 50 G, 10 times/direction, 25°C	Advanced Safety Tester Nail (Penetration) Test System
Nail penetration test	SAND2005-3123 SAE J2464	Nail diameter ø3 mm (cell), ø20 mm (pack), 80 mm/s	
Crush test	UL2580 UN ECE R100.02 Part II IEC62660-2 SAND2005-3123	Corrugated plate jig, maximum 100±6kN Corrugated plate jig, 100 to 105kN (to 100kN within 3 minutes) ø150 mm circular (semicircular) jig, pressure 1000-times the cell weight	Advanced Safety Tester Crush Test System

According to in-house research as of December 2014.

# 1-1 Battery Dry Chamber

Rechargeable Li-ion batteries are classified as non-aqueous electrolyte batteries.

During the production process, a solvent of active material is applied to the collector and then dried. However, moisture in the anode and cathode of the rechargeable battery affects its quality.

The Battery Dry Chamber makes it possible to shorten the time required for solution drying and moisture removal.

High-temperature treatment performed under vacuum or inert gas conditions avoids workpiece oxidation while achieving superior drying performance. Processing is performed at a temperature that is suitable for drying of cathode roll, anode roll, and separator workpieces.

Special specifications can be provided to suit workpiece size and processing volume requirements, and jigs are available for workpiece support, etc.



Battery Dry Chamber

## Features

### ● Shorter drying time

Equipment performance has been improved to shorten the time required for workpiece heat-up and cool-down.

For example a cooling function is equipped to lower the workpiece to normal temperature so it can be removed.

### ● Improved temperature control

More uniform workpiece heat distribution improves heat distribution performance during temperature exposure even in a vacuum, which further improves workpiece drying quality.

### ● Workpiece oxidation prevention

To prevent workpiece oxidation during high-temperature treatment, inert gas is introduced into a vacuum to prevent oxidation of the collector.



Test area

## Specifications

Performance	Temp. range	+30°C to +250°C
	Pressure range	933×10 <sup>2</sup> to 1×10 <sup>2</sup> Pa
Inside capacity		500 to 2000 L
Operating mode	Program	20 patterns 99-steps
	Constant	

# 1-2 Vacuum Oven

Under low pressure environment, specimens dry at lower temperature and boiling point is also lower, which reduces stress on specimens.

Furthermore, the vacuum and N<sub>2</sub> gas exchange modes enable drying of oxidation-averse specimens, as well as drying and heat treatment within a clean environment by eliminating impurities in the chamber through repeated heat treatments or gas exchanges.



Vacuum Oven

## Features

- The vacuum chamber features doublelayered construction. A heater on the exterior of the test area minimizes heat loss and improves temperature uniformity.
- There are five operation ion modes available to select the pressure control. A wide variety of programs can be designed by combining constant-temperature operation and programmed operations.
- Oxygen inside the chamber can be eliminated by replacing it with N<sub>2</sub> gas, preventing oxidation

during the drying operation. In addition, a high-precision environment can be created by repeatedly performing the exchanges.

This mode also removes organic substances in addition to preventing oxidation, reducing the impact on specimens.

- Air-tightness and insulation capacity have a significant impact not only on temperature control but also on pressure control. Through improvement of these properties, the VAC-101 achieves up to 40% energy savings.

## Specifications

Model		VAC-101P	VAC-201P	VAC-301P
performance	Temperature range	+40 to +200°C		
	Pressure range	933×10 <sup>2</sup> to 1×10 <sup>2</sup> Pa		
	Ambient pressure *1	Less than 133 Pa		
	Pull-down time *1	From atmospheric pressure to 133 Pa		
	Atmospheric pressure recovery time *2	Within 7 min.	Within 15 min.	Within 30 min.
Effective internal volume	91L	216L	512L	
Effective internal dimensions	W450×H450×D450 mm	W600×H600×D600 mm	W800×H800×D800 mm	
Outside dimensions *3	W902×H1392×D780 mm	W1052×H1532×D930 mm	W1252×H1772×D1130 mm	
Pressure operation modes	Automated, Continuous, Open to atmosphere, Gas exchange, Ventilation			

\*1 Fixed temperature inside the chamber, vacuum pump connected with exhaust speed of more than 200L/min. and ultimate pressure of 13×10<sup>-2</sup> Pa or less, no gases emitted from specimen.

\*2 Recovery time to atmospheric pressure (10<sup>13</sup>×10<sup>2</sup> Pa) to 10<sup>10</sup>×10<sup>2</sup> Pa, recovery time may fluctuate depending on atmospheric pressure.

\*3 Excluding protrusions.



# 1-3 Temperature Booth for Battery Aging

Air circulation within the booth is available in vertical (ceiling installation) or horizontal (side installation) orientation. It can be chosen according to the size or setting method of the cell, in order to optimize the temperature uniformity in high temperature aging of various types of Li-ion batteries. The air conditioning unit is installed in a polycarbonate booth, accommodating expansion, automation and various other needs. The booth can be used in flexible production lines.



Temperature Booth for Battery Aging

## Features

- Air conditioning unit available in two configurations: ceiling-mounted and side-mounted type.
- Forced cross-circulation method achieves excellent temperature uniformity.
- Flexible modularity. Easy set up and connection. This chamber also fits for large volume specimens or automation.
- Space-saving folding door is available, requiring no space for closing/opening (option).

## Example of customized specifications

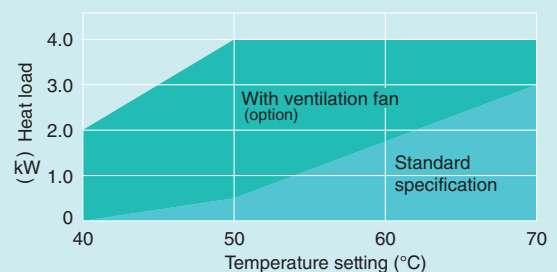
Model		PKB-1	PKB-2
System		Forced cross-circulation method	
Performance	Temp. range	+40 to +70°C	
	Temp. fluctuation	Within $\pm 0.5^\circ\text{C}$	
	Temp. heat up	Ambient temp. to +70°C within 40 min.	Ambient temp. to +70°C within 70 min.
Allowable heat load		Please refer to the range of allowable heat load below.	
Construction	Frame	T-slotted aluminium	
	Side walls / door	Hollow polycarbonate panel 4mm	
	Rear side / Ceiling	Aluminium composite panel 3mm	
Door (Booth front)		Single door	Double-door
Inside dimensions *	Side-mounted unit	W1100×H1990×D1910mm	W2300×H1990×D1910mm
	Ceiling-mounted unit	W1070×H1940×D1840mm	W2270×H1940×D1840mm

\* Excluding protrusions

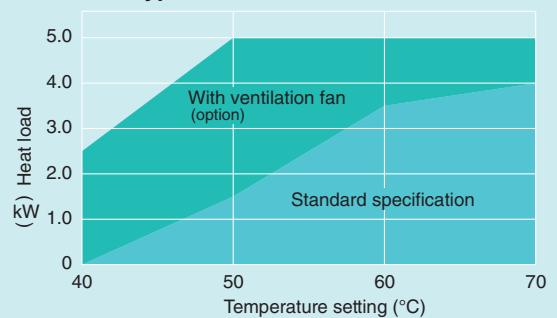
\* This chamber can be customized to meet customers' testing requirements.

## Allowable heat load range

### Standard type 1



### Standard type 2



# 1-4 Walk-In Type Temperature Chamber with Safety Devices

The need for large-volume production of rechargeable batteries has grown along with the increase in the use of hybrid automobiles. This makes it necessary to find ways to perform time-consuming processes in a way that treats a large number of units with a single operation.

The Walk-in Type Temperature Chamber with Safety Devices enables one-step large-volume processing of even large rechargeable EV batteries. This chamber really shines when it comes to charge-discharge testing and aging processing.

In addition, a number of safety mechanisms are built in for safe charge-discharge evaluation and other testing that presents the risk of fire due to gas leaking from a rechargeable battery.



Walk-In Type Temperature Chamber with Safety Devices

## Features

- A walk-in configuration makes it possible to wheel specimens directly into and out of the chamber without removing them from the cart. This capability is especially useful when testing large, heavy rechargeable EV batteries.
- Gas leaking from a rechargeable battery is detected by a gas detector. When gas is detected, outside air is introduced through a ventilation damper to reduce gas concentration. This device consists of a two-step detection and alarm system. Stage 1 is triggered whenever gas density reaches a preset alert point, and Stage 2 is triggered whenever gas density exceeds that point.
- Whenever flame is emitted from a rechargeable battery (due to abnormal overheating), a CO<sub>2</sub> fire extinguisher can be activated to automatically extinguish it. Operation is also shut down at the same time.
- Whenever pressure rises above explosion level, the ceiling comes off to release pressure. A punching metal frame prevents thermal insulation from scattering in the case of explosion.

## Safety devices

- Pressure relief vent
- H<sub>2</sub> & CO<sub>2</sub> gas detection alarm circuit
- Air intake/exhaust damper
- Reinforced door
- CO<sub>2</sub> fire extinguisher
- External alarm input/output terminal

## Example of customized specifications

System		Balanced Temp. Control System (BTC System)
Performance	Temp. range	-40 to +80°C
	Temp. fluctuation	± 0.3°C
	Temp. heat up time	-40°C to +80°C within 60 min. (with no load, no specimen)
	Temp. pull down time	+20°C to -40°C within 180 min. +20°C to -30°C within 120 min. (with no load, no specimen)
Inside dimensions		W2500 × H2100 × D1970 mm
Outside dimensions		W4095 × H2675 × D2783 mm (excluding protrusions)

\* Contact ESPEC concerning test space, specifications, etc.

\* This chamber can be customized to meet customers' testing requirements.

## 2-1 Battery Impedance Evaluation System

For secondary batteries, measuring their impedance and analyzing that change in the actual temperature environment they will be exposed to is considered effective for battery deterioration and safety evaluations.

The Battery Impedance Evaluation System automatically performs temperature control and impedance measurements and saves that data. This system can check the change in those characteristics in real-time.

In order to accurately measure minute changes in impedance, this system has been designed with wiring of a minimal length and it is equipped with functions to support secondary battery impedance characteristic analysis such as automatically charging batteries and batch measurements on multiple batteries.



System with Bench-Top Type Temperature Chamber

### Features

- Capable of performing impedance evaluations in temperature environments.  
Battery deterioration characteristics and temperature characteristics can be evaluated from low temperatures of  $-40^{\circ}\text{C}$  to high temperatures of  $+100^{\circ}\text{C}$ .
- Capable of automatically running battery charging, impedance measurements, and test area temperature control.
- Batteries can be easily added to and removed from the power supply section with the dedicated battery holder.
- Capable of evaluating multiple batteries at one time. The impedance of multiple batteries can be measured by combining the dedicated scanner, measuring instrument, and battery holder.
- The system can perform stable impedance measurements. Stable measurements in a temperature environment have been achieved with a structure for connecting the battery and measuring instrument at a minimal length and by utilizing a dedicated scanner.

### Example of customized specifications

Temperature control range		$-40^{\circ}\text{C}$ to $+100^{\circ}\text{C}$ * Can be connected to various chambers
Charge/discharge function		5V10A CC, CV charging/CC, CV discharging
OCV measurement function		0V to 10V
Impedance measurement function (Configuration case with measurement example)	Measured frequency	0.1Hz to 1kHz
	Frequency characteristics	50 steps
Test configuration selection function	Deterioration characteristics mode	After charging/ discharging, OCV at a constant period at the set temperature, impedance measurement
	Frequency characteristics mode	After charging/ discharging, OCV at each frequency at the set temperature, impedance measurement

## 2-2 Advanced Battery Tester

Combining charge-discharge power supplies and a test area within a single structure, the Advanced Battery Tester marks a new style in charge-discharge testing.

Select an optimal system based on battery capacity, shape, number, and other requirements.

### Features

#### ● Card edge connectors

Power supply to battery connection is completed simply by setting batteries in a battery holder equipped with a card edge connector, and inserting the connector into the slot at the back of the inner chamber.

#### ● Even temperature distribution with batteries in position

Taking into consideration factors like battery holder position and battery arrangement, the test area is designed to create an even temperature environment with air circulating horizontally - air blows in from the side in stacked-chamber models and from the back in single-chamber models.

#### ● Battery holders match battery shapes for easy setup

Battery holders are available for coin, cylindrical, rectangular, and laminated cells, as well as to suit charge-discharge conditions.

#### ● Parallel control supports high-rate testing

By increasing current using the power supply's parallel control function, high-rate tests can be performed with a single piece of equipment. Using dedicated battery holders for parallel control, the tester can be expanded to support parallel connections of up to 8 units.

#### ● Impedance measurement (option)

When the tester is in a standby state during the charge-discharge cycle, it is possible to perform impedance measurement (sweep measurement/ fixed point measurement).

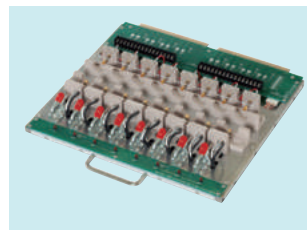
As it is possible to make continuous measurements without moving batteries, highly reliable data can be obtained.



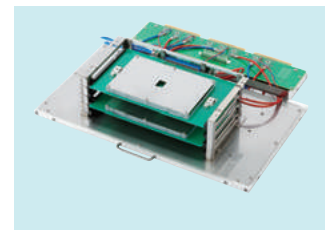
Single-chamber type

Three-chamber type

Advanced Battery Tester

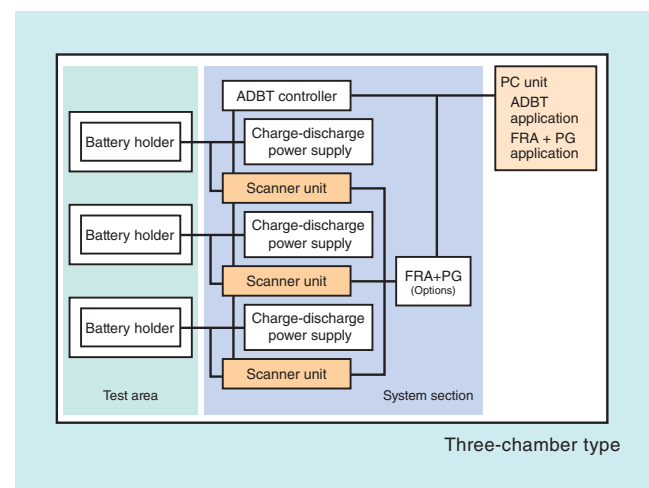


Battery holder for cylindrical cells



Battery holder for laminated cells

### System configuration



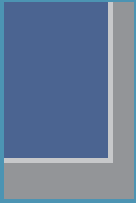
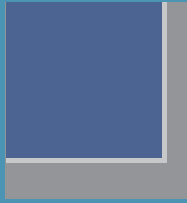


Three-chamber type

### Options

- Test area safety specifications
  - Heat detector
  - Smoke detector
  - Signal tower
  - CO<sub>2</sub> fire extinguisher
  - Pressure discharge vent, etc.
- Impedance measurement function
- Auto calibration board

## System types

Type		Three-chamber	Two-chamber	Single-chamber	Wide single-chamber
					
Interior dimensions (mm)		W 510 H 400 x3 chambers D 400	W 510 H 400 x2 chambers D 400	W 640 H 850 D 544	W 1110 H 850 D 544
Outside dimensions (mm)		W 950 H 2022 D 1300	W 950 H 1522 D 1300	W 1250 H 1875 D 1560	W 1720 H 1875 D 1560
ADBT-5-1	5V, 1A	72ch (24ch/chamber)	48ch (24ch/chamber)	72ch	144ch
ADBT-5-10	5V, 10A	72ch (24ch/chamber)	48ch (24ch/chamber)	72ch	144ch
	5V, 16A (2-unit parallel control)	36ch (12ch/chamber)	24ch (12ch/chamber)	36ch	72ch
	5V, 32A (4-unit parallel control)	18ch (6ch/chamber)	12ch (6ch/chamber)	18ch	36ch
ADBT-5-50	5V, 50A	24ch (8ch/chamber)	16ch (8ch/chamber)	24ch	48ch
	5V, 80A (2-unit parallel control)	12ch (4ch/chamber)	8ch (4ch/chamber)	12ch	24ch
	5V, 160A (4-unit parallel control)	6ch (2ch/chamber)	4ch (2ch/chamber)	6ch	12ch
	5V, 360A (8-unit parallel control)	3ch (1ch/chamber)	2ch (1ch/chamber)	3ch	6ch
ADBT-5-400	5V, 400A	3ch (1ch/chamber)	2ch (1ch/chamber)	3ch	6ch
ADBT-5-600	5V, 600A	3ch (1ch/chamber)	2ch (1ch/chamber)	3ch	6ch

## Example of customized specifications

Model		ADBT-5-1	ADBT-5-10	ADBT-5-50	ADBT-5-400
Test area	Control range	-40°C to +100°C			
	Temperature distribution	±1.5°C			
Output voltage	Setting range	0 to 5000mV			
	Output accuracy	±0.1% of F.S.			
Output current	Setting range	0 to 1mA 0 to 10mA 0 to 100mA 0 to 1000mA/1A	0 to 100mA 0 to 1000mA/1A 0 to 10000mA/10A	0 to 500mA 0 to 5000mA/5A 0 to 50000mA/50A	0 to 50A 0 to 200A 0 to 400A
	Output accuracy	±0.1% of F.S.			
Output power	Setting range	0 to 5W	0 to 50W	0 to 250W	0 to 2000W
	Output accuracy	±0.2% of F.S.			
Parallel connection function	2 units	—	16A	80A	—
	4 units	—	32A	160A	—
	8 units	—	—	360A	—
Measurement points	Current/Voltage	Current: 1 point per channel / Voltage (specimen edge): 1 point per channel			
	Temperature	1 point per channel		2 points per channel	2 points per channel

\* Requires separate battery holder for use with parallel connection.

\* Dedicated for 8-unit parallel connection. Cannot be used with non-parallel, 2-unit parallel, or 4-unit parallel connections.

## 2-3 High-power Battery Tester

In recent years, the variety of lithium-ion battery applications has expanded to include the automotive and electric power fields. In conjunction with this expansion, lithium-ion battery modules are being manufactured with larger capacities and higher voltages through the use of combinations of electrical cells. ESPEC provides charge-discharge evaluation systems for these kinds of large battery modules.

Up to three channels can be assigned per control rack allowing parallel control of up to four control racks (maximum of 12 channels).

The flexible system allows the number of parallel controls to be changed to match battery capacity and test items.

Moreover, synchronized operation with the test area makes it possible to implement standards tests with ease.

### Features

- High power delivered through parallel operation of up to 12 channels
  - 1 channel: 120V/200A
    - When charging: 8kW/
    - When discharging: 12kW
  - 12 channels: 120V/2400A
    - When charging: 96kW/
    - When discharging: 144kW
- As an evaluation system, synchronized operation of the test area and charge-discharge power supplies is possible. This makes it easy to implement standards tests combining temperature and charge-discharge conditions.
- Power regeneration function reduces heat generated during discharge, which in turn reduces the load on the installation environment.
- Operations programmed using a touch-panel controller.  
A LAN port and a function that enables the creation of programs of up to 1,000 steps allow the tester to be connected to an external host computer.
- All-in-one system provides everything from power supply systems to test areas and jigs.



High-power Battery Tester J series (Example System)



Large Thermal Shock Chamber (Example System)



Walk-In Type Chamber (Example System)

## Example of customized specifications

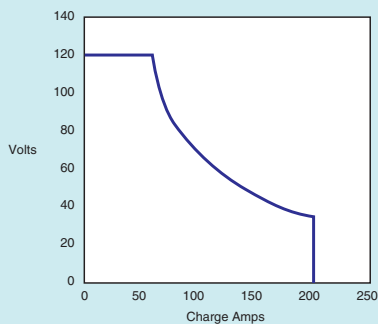
Model		HPBT-120-200	HPBT-600-40	HPBT-40-600	
Power supply unit	Operating environment	0 to 35°C			
	No. of power supplies	Max. 3 channels per control rack			
	Charging range	8kW(0 to 120V, 200A)	8kW(0 to 600V, 40A)	8kW(0 to 40V, 600A)	
	Discharging range	12kW(4 to 120V, 200A)	12kW(20 to 600V, 40A)	12kW(2 to 40V, 600A)	
	Output power	Setting range	0 to 12kW		
		Output accuracy	0.4-0.8% *1		
	Output voltage	Setting range	0 to 120V	0 to 600V	0 to 40V
		Output accuracy	0.05-0.1% *1		
		Noise	500mVrms		
	Output current	Setting range	0 to ±200A	0 to ±40A	0 to ±600A
		Output accuracy	0.1-0.2% *1		
		Noise	500mArms		
	Sampling rate	0.1sec			
	No. of parallel controls	Max. 12 channels *2			
	Safety functions	Overvoltage, overcurrent, overpower, overheat			
Other functions	Power regeneration function, battery emulation function				
Control rack dimensions	W711×H1830×D762mm				
Weight	Approximately 500kg (with 3 channels loaded)				
Test area	Control range	-40°C to +100°C			
	Temperature distribution	±1.5°C			
	Inside capacity	408L			
	Interior dimensions	W600×H850×D600mm			
	Exterior dimensions	W1010×H1690×D1273mm			

\*1 May differ according to set values.

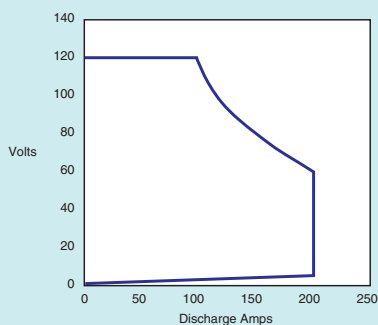
\*2 Consult ESPEC regarding applications involving parallel controls of 13 channels or more.

## Example configurable range Model: HPBT-120-200

### Configurable charge range (8kW)



### Configurable discharge range (12kW)



## Safety functions

- Power supply section has voltage-, current-, and power-limit alarms that can be set individually for each channel.
- Power supply section and test area both have interlock safety function for peace-of-mind.
- Test area options include pressure discharge vent, CO<sub>2</sub> fire extinguisher, H<sub>2</sub> gas meter, and CO gas meter.

## 3-1 Temperature (& Humidity) Chamber for Charge-Discharge Testing

The Temperature (& Humidity) Chamber for Charge-Discharge Testing provides easy access to specimens and features various safety functions.

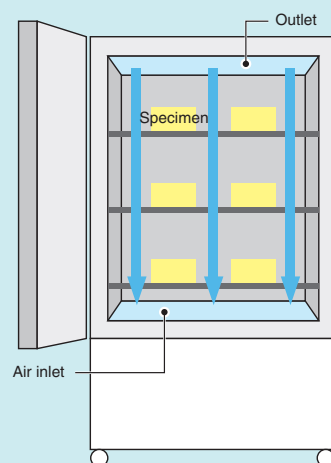
### Features

- Capacity of vertical airflow from the top is increased so that the air reaches every corner of the test area, realizing more uniform temperature distribution in the test area.
- Includes frost-free function to enable long-term continuous operation under a temperature setting of +15°C or higher, without the need to interrupt for defrosting.
- Two different supply circuits are provided. In case of failure, the temperature indicator-controller continuously monitors the temperature in the test area even if the machinery part stops operation.
- The chamber comes standard with safety features such as pressure relief vent, emergency stop button, and hand-tighten bolt door lock. In addition, you can select optional features like various detectors, fire extinguisher and cable ports to suit your application.
- The chamber will be shipped with three  $\phi 100\text{mm}$  cable ports on the right side (one for Type 2) as a standard. You can add or have them relocated as necessary.



Temperature Chamber for Charge-Discharge Testing

### ● Airflow in vertical direction





## Specifications

Model	BPU-2	BPU-3	BPU-4	BPL-2	BPL-3	BPL-4
Temperature range	-40 to +100°C					
Humidity range	—————			20 to 98%rh		
Temp. Heat up time	+20 to +100°C within 35min.					
Temp. Pull down time	+20 to +40°C within 60min.					
Capacity	225L	408L	800L	225L	408L	800L
Inside dimensions (W×H×Dmm)	500×750×600	600×850×800	1000×1000×800	500×750×600	600×850×800	1000×1000×800
Outside dimensions (W×H×Dmm)	700×1760×1343	800×1860×1543	1200×2010×1543	700×1760×1343	800×1860×1543	1200×2010×1543

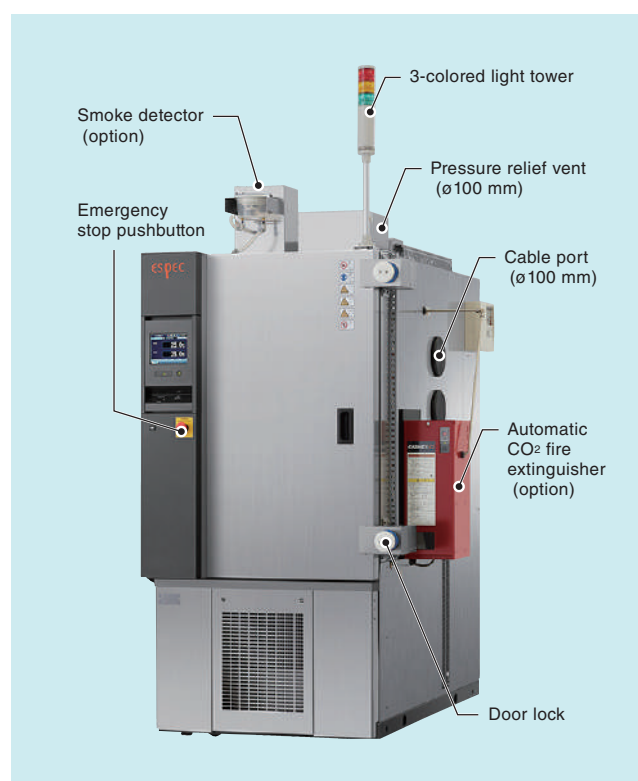
## Accessories

- Door lock (hand-tighten bolt)
- Pressure relief vent (ø100 mm)
- External input/output terminal
- Emergency stop pushbutton
- 3-colored light tower
- RS-485
- ø100 mm Cable port on the right side (with rubber plug)  
Type 2: x1, Type 3&4: x3
- Floor load capacity of 100 kg
- Shelf support (M5-tapped)
- Analysis certificate

## Options

- 300×300 mm-pressure relief vent (replaces the standard vent)
- Automatic CO<sub>2</sub> fire extinguisher (with cylinder)
- Automatic N<sub>2</sub> fire extinguisher (jet circuit, starting valve)
- Smoke detector (with suction circuit)
- Thermal detector (specifications of thermocouple, analog setter)
- H<sub>2</sub> detector (suction circuit, detector, indicator)
- CO detector (suction circuit, detector, indicator)
- Organic solvent detector (suction circuit, detector, indicator)
- Forced air supply/exhaust damper
- Cable port position alteration
- Additional cable port (ø50/ø100 mm)
- Heavy-duty shelf & shelf bracket

## Configuration



Model : BPU-3

## 3-2 Bench-top Type Temperature (& Humidity) Chamber

In charge-discharge tests, specimens are repeatedly charged and discharged while undergoing prolonged exposure to a uniform temperature environment.

SU/SH Series bench-top chambers are capable of maintaining a stable temperature environment for long periods of time.

These compact test chambers are available with an interior volume of either 22.5L or 60L. They also come in three types that can precisely control temperature range from  $-60^{\circ}\text{C}/-40^{\circ}\text{C}/-20^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ . This allows you to select the optimal test chamber based on the shape and number of batteries.



Bench-top Type Temperature (& Humidity) Chamber

### Features

- Special movable stand with vibration-damping brackets allows two bench-top chambers to be stacked one on top of the other for effective use of space.
- Heat distribution is  $\pm 0.5^{\circ}\text{C}$  up to  $100^{\circ}\text{C}$  and  $\pm 0.8^{\circ}\text{C}$  from  $100$  to  $150^{\circ}\text{C}$ .
- Capable of high temperature control to the upper limit  $+180^{\circ}\text{C}$ . (Option)

\* Temperature and humidity models also available.

### Specifications

Model		SU-222	SU-242	SU-262	SU-642	SU-662
System		Balanced Temperature Control system (BTC system)				
Temp. performance *1	Temp. range	$-20$ to $+150^{\circ}\text{C}$	$-40$ to $+150^{\circ}\text{C}$	$-60$ to $+150^{\circ}\text{C}$	$-40$ to $+150^{\circ}\text{C}$	$-60$ to $+150^{\circ}\text{C}$
	Temp. fluctuation	$\pm 0.3^{\circ}\text{C}$ ( $-20$ to $+100^{\circ}\text{C}$ ) $\pm 0.5^{\circ}\text{C}$ ( $+100.1$ to $+150^{\circ}\text{C}$ )	$\pm 0.3^{\circ}\text{C}$ ( $-40$ to $+100^{\circ}\text{C}$ ) $\pm 0.5^{\circ}\text{C}$ ( $+100.1$ to $+150^{\circ}\text{C}$ )	$\pm 0.3^{\circ}\text{C}$ ( $-60$ to $+100^{\circ}\text{C}$ ) $\pm 0.5^{\circ}\text{C}$ ( $+100.1$ to $+150^{\circ}\text{C}$ )	$\pm 0.3^{\circ}\text{C}$ ( $-40$ to $+100^{\circ}\text{C}$ ) $\pm 0.5^{\circ}\text{C}$ ( $+100.1$ to $+150^{\circ}\text{C}$ )	$\pm 0.3^{\circ}\text{C}$ ( $-60$ to $+100^{\circ}\text{C}$ ) $\pm 0.5^{\circ}\text{C}$ ( $+100.1$ to $+150^{\circ}\text{C}$ )
	Temp. rate of change	Heat up rate Pull down rate	3.2°C /min. 2.1°C /min.	3.2°C /min. 2.1°C /min.	3.2°C /min. 2.1°C /min.	2.9°C /min. 1.7°C /min.
Capacity		22.5L			64L	
Inside dimensions *2		W300×H300×D250mm			W400×H400×D400mm	

\*1 The performance values are based on IEC 60068-3-5:2001 for the temperature chamber. Performance figures are given for a  $+23^{\circ}\text{C}$  ambient temperature, 65%rh, rated power supply and no specimens inside the test area. However, the lowest attainable temperature is given for a max. ambient temperature of  $+30^{\circ}\text{C}$ .

Heat-up time is the achieved time from lowest temperature to highest temperature within temperature range.

\*2 Excluding protrusions.

## 3-3 Constant Climate Cabinet

In charge-discharge tests, specimens are repeatedly charged and discharged while undergoing prolonged exposure to a uniform temperature environment.

These constant climate cabinets are capable of maintaining a stable temperature environment for long periods of time.

They are available with an interior volume of either 105L or 206L and can create a stable temperature environment of between  $-20^{\circ}\text{C}$  and  $+85^{\circ}\text{C}$  with a temperature distribution of  $\pm 2.0^{\circ}\text{C}$ .



Constant Climate Cabinet

### Features

- Can be used with a 100 VAC 15 A power supply.
- Tests can be registered up to 12 steps in program operation and three patterns in constant operation.

\* Temperature and humidity models also available.

### Specifications

Model		LU-114	LU-124
System		Balanced Temperature Control system (BTC system)	
Performance *1	Temperature control range	$-20$ to $+85^{\circ}\text{C}$	
	Temperature fluctuation	$\pm 1.0^{\circ}\text{C}$	
	Temp. extreme achievement time (Pull down time)	$+20$ to $-20^{\circ}\text{C}$ Within 130min.	
Capacity		105L	206L
Inside dimensions *2		W500×H600×D390mm	W500×H750×D590mm

\*1 The temperature chamber conforms to IEC60068-3-5:2001 and the humidity chamber conforms to IEC60068-3-6:2001 under the conditions of an ambient temperature of  $+23^{\circ}\text{C}$ , rated voltage, and no specimen.

\*2 Excluding protrusions.

# 3-4 Airborne Test Chamber for Batteries (Low Pressure Low Temperature Chamber)

Airborne test recreates supposed conditions of low pressure during air transportation of devices. This equipment can perform tests according to below standards.

## Features

- Magnetic coupling airflow system.
- Thorough safety chamber thanks to various safety measures such as specimen temperature protection, refrigeration circuit protection, etc.

## Test standards

- **IEC 62133 (JIS C8712)**  
Safety requirements for portable sealed secondary cells
- **IEC 62281**  
Safety of primary and secondary lithium cells and batteries during transport
- **UL 1642 Lithium Batteries**

## Specifications

Model	VLC-300
System	Mechanical cascade refrigeration system (water-cooled condenser)
Temperature range	-20°C to +80°C
Temp. fluctuation	±0.5°C
Temp. heat up time	+20°C to +80°C within 60 min.
Temp. pull down time*	+20°C to -20V within 90 min.
Temp. uniformity	+5°C (at +20°C, 11.6kPa)
Pressure control range	93.3kPa to 10.1kPa
Attainment pressure	Below 10kPa
Inside dimensions	W800 × H800 × D700 mm
Capacity	448 L

\* With no load, no specimen, under atmospheric pressure conditions.

\* Please ask us for CE-marked product.



Airborne Test Chamber for Batteries

# 3-5 Temperature & Vibration Combined Environmental Test Chamber

This combined test chamber accurately recreates usage conditions of various industrial products such as mobile electronic devices, precision machinery, automotive components, or aircraft, to evaluate the product reliability.

The Temperature & Vibration Combined Environmental Test Chamber carries out tests complying with lithium batteries safety standards. The product lineup offers great variations to be selected according to the test purpose and installation environment.

## Features

- Capable of performing vibration testing conform to IEC, UN, UL and Electrical Appliances and Material Safety Act standards relating to Li-ion batteries.
- ESPEC suggests system combination of temperature chamber and shaker according to the test purpose, installation environment, and mounting method of specimen.
- The system comes in two models with optimized test space, featuring a large viewing window and a programmed instrumentation with interactive input.

## Test standards

- **IEC 62133 (JIS C8712)**  
Safety requirements for portable sealed secondary cells
- **Table 9: Li-ion batteries, Technical Standards for Electrical Appliances and Material Safety Law**
- **UL 1642 Lithium Batteries**
- **UN Manual of Test and Criteria, Part III**
- **IEC 62281**  
Safety of primary and secondary lithium cells and batteries during transport



Temperature & Vibration Combined Environmental Test Chamber

## Specifications

### Chamber

Model	Temp. range	Inside dimensions (W×H×D mm)
PVU-3KP(H)	-40 to +100 (150)°C	600×850×600
PVU-5KP(H)		1000×1000×1000
PVG-3KP(H)	-70 to +100 (150)°C	600×850×600
PVG-5KP(H)		1000×1000×1000

### Shaker

Model	Force magnitude	Frequency	Max. load capacity*
V1	120kgf	5 to 4500Hz	66kg
V2	200kgf		
V3	300kgf	5 to 4000Hz	116kg
V4		2 to 2000Hz	122kg
V5S	600kgf	5 to 3000Hz	192kg
V6S	1000kgf		5 to 2000Hz
V7S		1500kgf	5 to 3000Hz
V8S	2000kgf		
V9S	3000kgf	5 to 2500Hz	492kg
V10S	100kgf		
S1S	200kgf	5 to 4000Hz	116kg
S2S	300kgf		
S3S	300kgf	2 to 2000Hz	292kg
S4S			
S5S	500kgf	5 to 4000Hz	196kg
S6S	1000kgf		
S7S		5 to 2000Hz	292kg
S8S	1500kgf	5 to 3000Hz	
S9S	2000kgf		
S10S	3000kgf	5 to 2500Hz	

\* For a shaft of ø125xH180mm

\* Please ask us for CE-marked product.

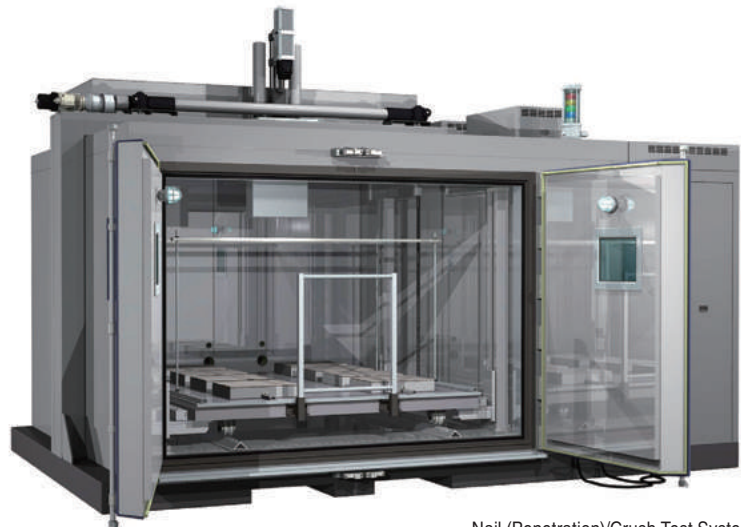
# 4-1 Nail (Penetration)/Crush Test System

This system evaluates the safety of batteries suffering internal short circuits caused by penetration by a foreign object or deformity caused by a heavy object.

It consists of a test area equipped with a safety function and a nail (penetration)/crush (mechanical section).

The structure features a design that allows for easy post-test cleaning and maintenance.

The system also supports tests on large battery packs for vehicles.



Nail (Penetration)/Crush Test System

## Features

- The integrated design allows for nail (penetration) and crush tests to be conducted in an accurate temperature environment.
- Supports tests for various standards for different-sized batteries, from (small size) batteries to large battery packs.
- Equipped with safety functions that protect against fire and bursting of the battery, including a door lock, pressure (relief) vent, forced exhaust, and fire extinguisher.
- The chamber structure is designed for easy maintenance and cleaning after testing.
- Viewing window and external camera allow for observation of test progress.
- Pressure and speed can be selected for the nail (penetration)/crush mechanical) section.
- Supports testing of various battery sizes with an automatic lift stage inside the chamber. (optional)
- Supports testing for UN ECE R100.02 Part II requirements.

## Example of customized specifications

Nail (penetration)/crush cylinder section	Lift system	Hydraulic cylinder
	Stroke	350mm Min. 1mm step
	Stop accuracy	Within $\pm 1$ mm
	Load range	1.0kN to 100kN (Consult us for details regarding load range and velocity)
	Velocity	1 to 100mm/s (Consult us for details regarding load range and velocity)
Measuring section	Temperature measurement	Supports various types of thermocouples
	Voltage measurement	-100V to +100V (Consult us for higher voltages)
	Nail (penetration) section	Analog measurement output
Test area section	Temperature range	-40 to 95°C
	Temperature fluctuation	$\pm 4.0^\circ\text{C}$
	Test chamber interior dimensions	W3000 × H2000 × D3000 mm
	Safety devices	Gas detector, pressure (relief) vent, forced exhaust system, fire extinguishers

## 4-2 External Short Circuit Test System

This test system evaluates the safety of batteries with short circuits between the positive and negative electrodes.

It consists of a test area equipped with a safety function and an external short circuit (mechanical) section.

The structure features a design that allows for easy post-test cleaning and maintenance.

The system also supports tests on large battery packs for vehicles.



External Short Circuit Test System

### Features

- The integrated design allows for external short circuit tests to be conducted in an accurate temperature environment.
- Supports tests for various standards for different-sized batteries, from (small size) batteries to large battery packs.
- Equipped with safety functions that protect against fire and bursting of the battery, including a door lock, pressure (relief) vent, forced exhaust, and fire extinguisher.
- The chamber structure is designed for easy maintenance and cleaning after testing.
- Viewing window and external camera allow for observation of test progress.
- Supports a wide range of tests that use variable resistance up to a maximum current of 24,000A.
- Measures the pre-test resistance using a circuit resistance checker.
- Supports testing for UN ECE R100.02 Part II requirements.

### Example of customized specifications

External short circuit test section	Short circuit resistance range	5 to 100 mΩ
	Maximum voltage	500V
	Allowable current	24,000A (0.1s) 12,500A (0.4s) 2,500A (10s)
Measuring section	CCD camera	270,000 pixels Max. recording time: 24 hours
	Data logger	200 Ch (voltage/temperature measurement) Min. measuring time: 10ms
Test area section	Temperature range	10 to 60°C
	Temperature fluctuation	±2.0°C
	Test chamber interior dimensions	W3000×H1800×D3000 mm
	Safety devices	Gas detector, pressure (relief) vent, forced exhaust system, fire extinguishers

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