

# Testing Battery Insulation

## How ripple can affect your test results.

The demand for Li-ion batteries (LIB) is surging owing to the escalating requirements of smart devices, laptop PCs, tablets, and other IoT devices, alongside the expanding markets for electric vehicles and energy storage. The market size of LIB was approximately USD 45 billion in 2022 and is projected to exceed USD 150 billion by 2032. Many countries are moving towards prohibiting the sale of gas-powered cars as part of a global initiative to address environmental issues, further driving the anticipated need for a larger LIB market.



**Key features!**

1

### Clean, Low Ripple Waveform

The TOS9300 series is equipped with specialized drive circuits designed for individual test modes (AC and DC withstanding, insulation resistance, earth connectivity/ground bond, leakage current test). This tailored design ensures a clean and high-quality output waveform with minimal ripple. The presence of excessive ripple can lead to the flow of a charging current, potentially causing incorrect test judgments. Our solution ensures reliability by providing accurate test results that you can depend on.

**Key features!**

2

### High Accuracy and Resolution

The TOS9300 series offers more than just a dependable output waveform. It features precision and high-resolution voltmeters and ammeters equipped with a True RMS measuring circuit. This configuration ensures accurate measurements. Additionally, with a minimum test time of just 0.1 seconds, you can efficiently conduct thorough safety tests for your Li-ion batteries, ensuring precision without compromising speed.

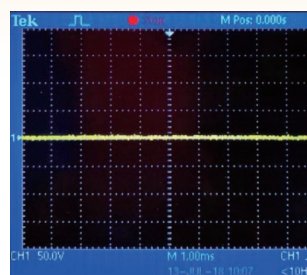
As the LIB market continues to expand, safety standards for batteries are progressively becoming more stringent. Inadequate isolation in batteries can lead to diminished battery life or pose a fire risk. When assessing the insulation between the electrode and battery casing or examining separator characteristics, testing equipment generating significant ripple current can yield misleading results. Accurate characterization during development or the accurate detection of defective products on the production line necessitates the ability to capture extremely small currents.

### Example of how ripple can affect the measurement.

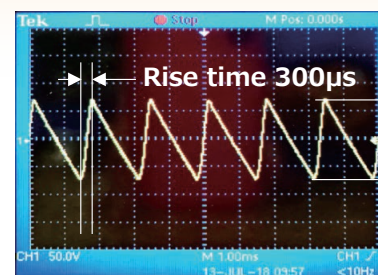
Insulation consists of electrical resistance and capacitance. Capacitor current ( $i$ ) is calculated as follows.

$$i = C \times \Delta V / \Delta t$$

If the EUT capacitance is 0.01  $\mu\text{F}$ , 5 mA may flow induced by the ripple voltage of the tester. ( $0.01 \mu\text{F} \times 150 \text{ V} / 300 \mu\text{s} = 5 \text{ mA}$ )



TOS9300 series, DC 2kV



Another brand's tester, DC 2kV

Ripple voltage  
150Vp-p

Kikusui Electronics provides withstanding voltage testers and insulation resistance testers tailored for battery module and pack testing. The TOS9300 series offers an accurate and reliable testing environment, featuring clean and high-performance output waveforms, along with precise measurement capabilities that meet the specific requirements for LIB testing.

- AC 5 kV/100 mA (500 VA), DC 7.2 kV/100 W hipot test
- 0.001 MΩ to 100.0 GΩ (DC -25 V to -1000 V/DC +50 V to +7200 V) insulation resistance test
- Electric discharge function after test
- Rise time/fall time control
- Interlock function
- High programmability through LAN/USB/RS232C and external I/O
- I/V analog monitor (BNC)
- Offset cancel function

## Electrical Safety Analyzer | TOS9300 series



### TOS9300

AC Hipot Tester with Insulation Resistance Test

ACW	5 kV/100 mA(500 VA)
IR	0.001 MΩ to 100.0 GΩ (DC-25 V to -1000 V)



D	430(16.93") (440(17.32"))W×132(5.2") (155(6.10"))H ×370(14.57") (410(16.14"))Dmm
W	17 kg(37.5 lbs)

### TOS9301

AC/DC Hipot Tester with Insulation Resistance Test

ACW	5 kV/100 mA(500 VA)
DCW	5 kV/20 mA, 7.2 kV/13.9 mA(100 W)
IR	0.001 MΩ to 100.0 GΩ (DC-25 V to -1000 V/ DC+50 V to +7200 V)



D	430(16.93") (440(17.32"))W×132(5.2") (155(6.10"))H ×370(14.57") (410(16.14"))Dmm
W	18 kg(39.7 lbs)

### TOS9301PD

AC/DC Hipot Tester with Insulation Resistance and Partial Discharge Test

ACW	5 kV/100 mA(500 VA)
DCW	5 kV/20 mA, 7.2 kV/13.9 mA(100 W)
IR	0.001 MΩ to 100.0 GΩ (DC-25 V to -1000 V/ DC+50 V to +7200 V)
PD	5 kV/50 mA(250 VA)



D	430(16.93") (440(17.32"))W×132(5.2") (150(5.9"))H ×525(20.67") (565(22.24"))Dmm
W	22 kg(48.5 lbs)

### TOS9302

AC Hipot Tester with Ground Bond Test

ACW	5 kV/100 mA(500 VA)
EC	0.001 Ω to 0.600 Ω (3.0 A to 42.0 A)

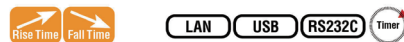


D	430(16.93") (440(17.32"))W×132(5.2") (155(6.10"))H ×500(19.69") (540(21.26"))Dmm
W	20 kg(44.1 lbs)

### TOS9303

AC/DC Hipot Tester with Insulation Resistance and Ground Bond Test

ACW	5 kV/100 mA(500 VA)
DCW	5 kV/20 mA, 7.2 kV/13.9 mA(100 W)
IR	0.001 MΩ to 100.0 GΩ (DC-25 V to -1000 V/DC+50 V to +7200 V)
EC	0.001 Ω to 0.600 Ω (3.0 A to 42.0 A)



D	430(16.93") (440(17.32"))W×132(5.2") (155(6.10"))H ×500(19.69") (540(21.26"))Dmm
W	21 kg(46.3 lbs)

### TOS9303LC

AC/DC Hipot Tester with Insulation Resistance, Ground Bond, and Leakage Current Test

ACW	5 kV/100 mA(500 VA)
DCW	5 kV/20 mA, 7.2 kV/13.9 mA(100 W)
IR	0.001 MΩ to 100.0 GΩ (DC-25 V to -1000 V/DC+50 V to +7200 V)
EC	0.001 Ω to 0.600 Ω (3.0 A to 42.0 A)
LC	1 μA to 100 mA(rms)



D	430(16.93") (440(17.32"))W×132(5.2") (155(6.10"))H ×500(19.69") (550(21.65"))Dmm
W	22 kg(48.5 lbs)

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