

# Laagohmige interne weerstanden Een must voor hoogwaardige batterijen

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Power Electronics & Energy Storage event  
14 juni 2022 | 1931 Congrescentrum 's-Hertogenbosch

ENERGY STORAGE  
EVENT 2022

A decorative graphic on the right side of the slide, consisting of a horizontal line that tapers into a fan shape of green and yellow lines, with small white plus signs scattered along the lines.



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de kracht van twee in één

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We are on our way to a brighter tomorrow



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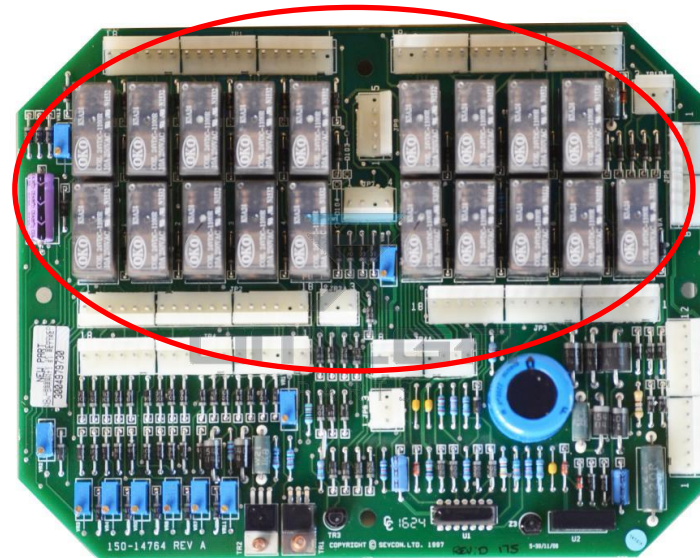
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# First AC resistance meter



3225 AC Resistance Meter



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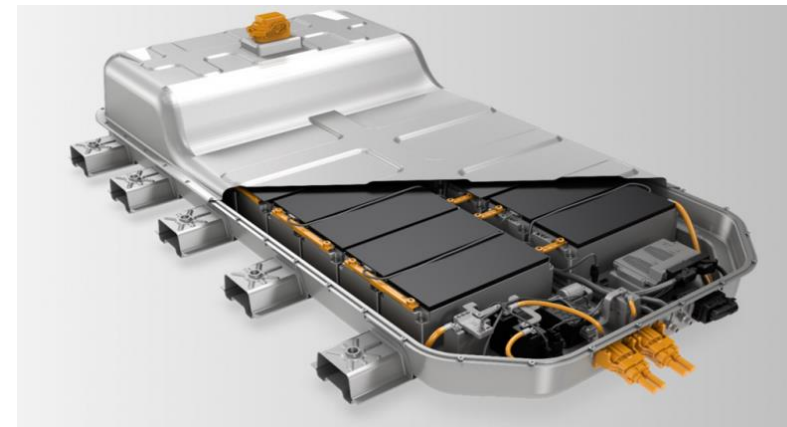
# First LiB



Akira Yoshino



3225 AC Resistance Meter



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# Battery production



Lithium-ion Battery Production Processes

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# AC or DC resistance measurement

	DC resistance measurement	AC resistance measurement
Measurement signal	DC	AC
Advantages	Highly precise measurement is possible High sensitivity	Not affected by electromotive force. Suitable for Reactance measurement
Disadvantages	Affected by electromotive force since not capable of performing DC superimposed measurement (Thermal EMFs can be corrected by OVC function)	Less sensitive and accurate
Applications	DC resistance of windings, contact resistance, insulation resistance, PCB wiring resistance	Battery impedance, inductors, capacitors, electrochemical measurement
Measurement range	$10^{-8}$ to $10^{16}$	$10^{-3}$ to $10^8$
Type of instrument	Resistance meter, DMMs, Insulation resistance meters	Battery testers LCR meters

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# Importance of low resistance

$$I = \frac{V}{R}$$

I = Current in Amperes (A)  
V = Voltage in Volts (V)  
R = Resistance in Ohms ( $\Omega$ )


$$P = VI = \frac{V^2}{R} = I^2 R$$

$$Q = i^2 \times R \times t$$

Joule's Law



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# Battery production



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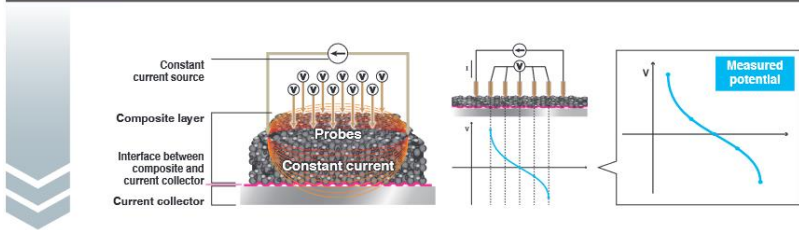
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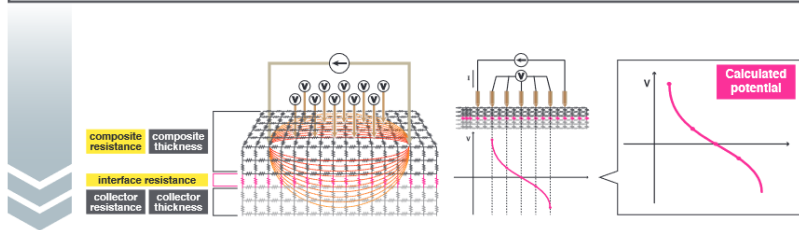


# Electrode resistance

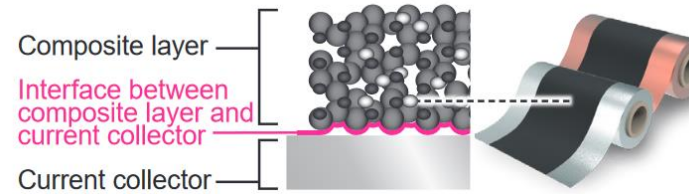
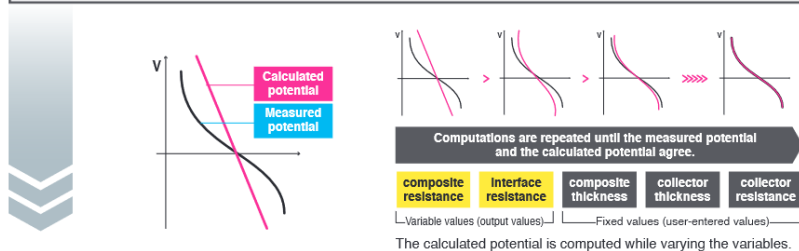
**STEP 1** **Acquire the observed potential**  
 The RM2610 applies a constant current to the electrode sheet and measures the potential distribution occurring on the surface at multiple points.



**STEP 2** **Perform modeling and obtain the calculated potential**  
 Next, the RM2610 models the electrode sheet and computes the potential occurring on its surface.



**STEP 3** **Repeatedly compute the calculated potential**  
 Using composite resistance and interface resistance as variables, the RM2610 repeatedly computes the calculated potential until it agrees with the observed potential. Once the observed potential and calculated potential agree, the resulting variables are output.



RM2610 Electrode Resistance Measurement System  
 measures Composite and Interface resistance

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# Connection resistance



Lithium-ion Battery Production Processes

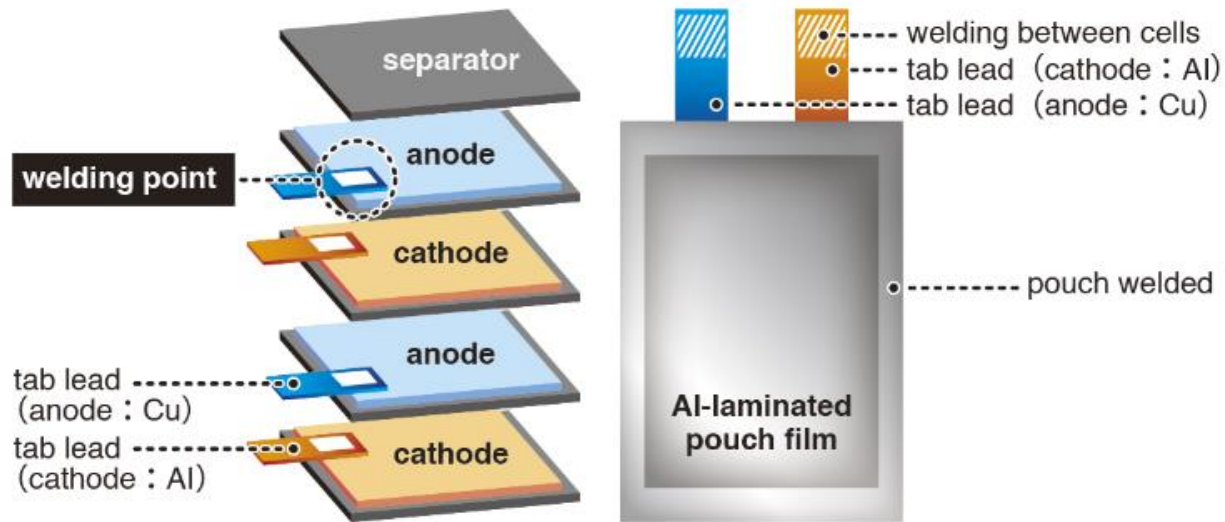
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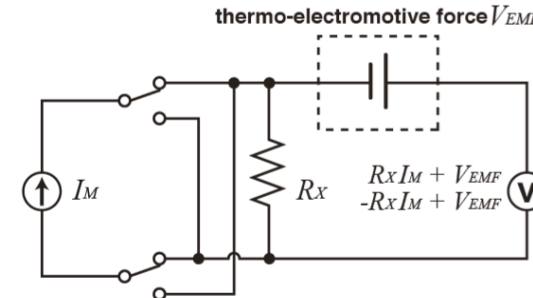
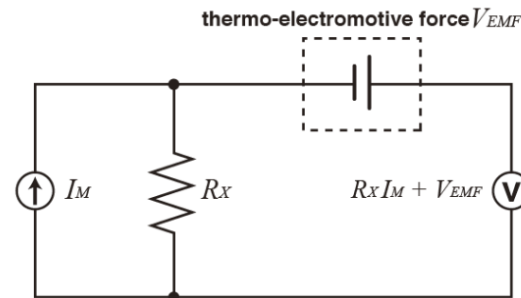
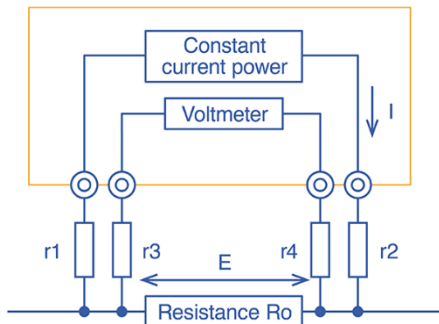


# Connection resistance



RM3545 Resistance Meter

Fast measurement, excellent repeatability



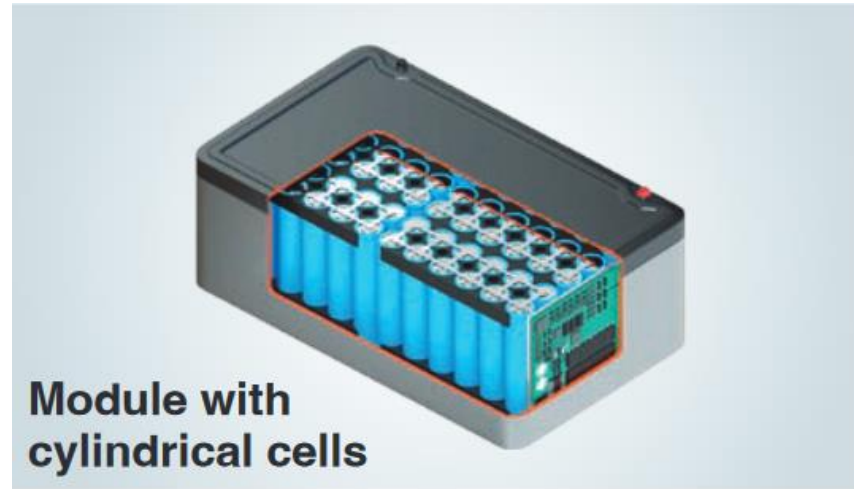
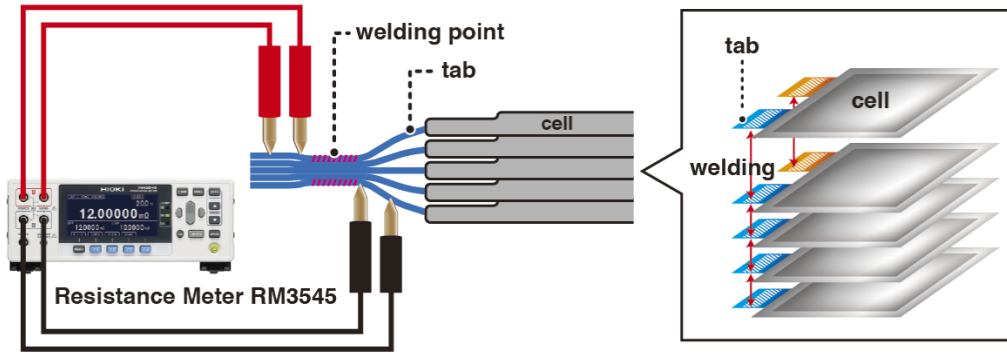
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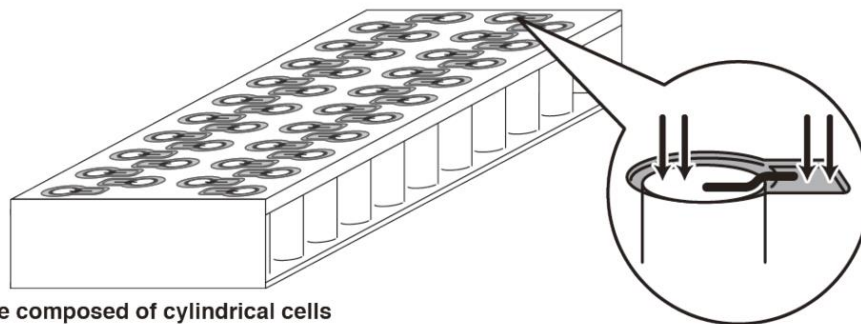
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# Connection resistance



FT1240 Flying probe tester



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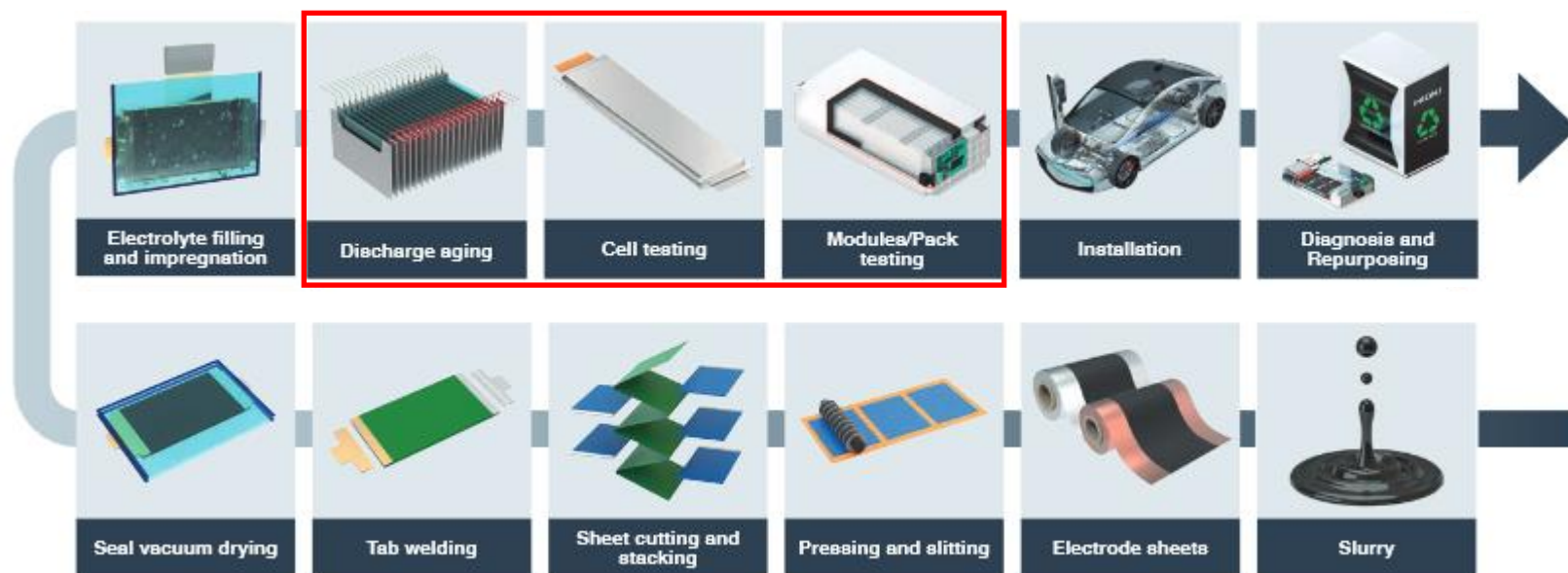


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<https://www.youtube.com/watch?v=1uZEVtx-sPI&t=7s>



# Cell and Pack resistance



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BT3560 series Battery Tester  
Measures OCV and resistance simultaneous

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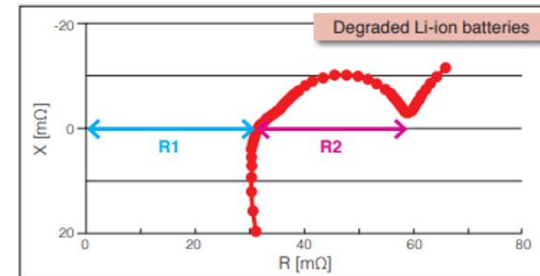
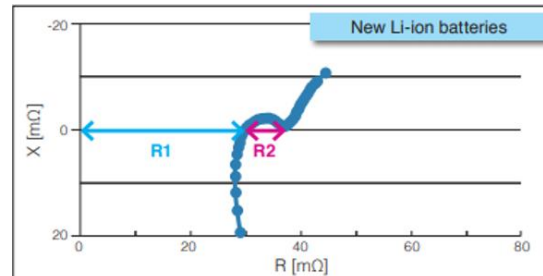
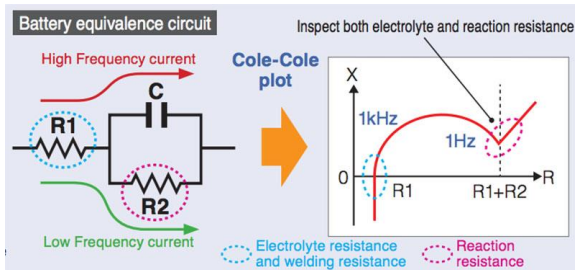
# Cell and Pack resistance



Lithium-ion Battery Production Processes



BT4560 Battery Impedance Meter  
AC-IR measurement for more detailed characterization



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