Improved High-Rate Discharge Process and Machine Design

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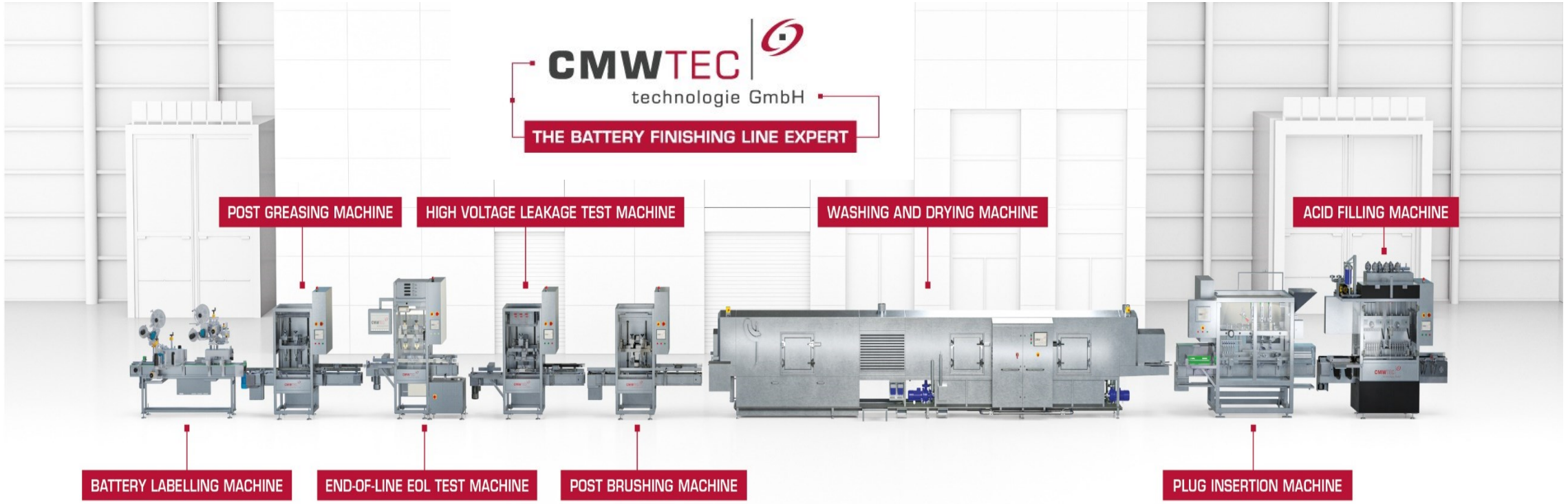
Premium Line at a Glance

A leading manufacturer of battery finishing line equipment for OE battery producers

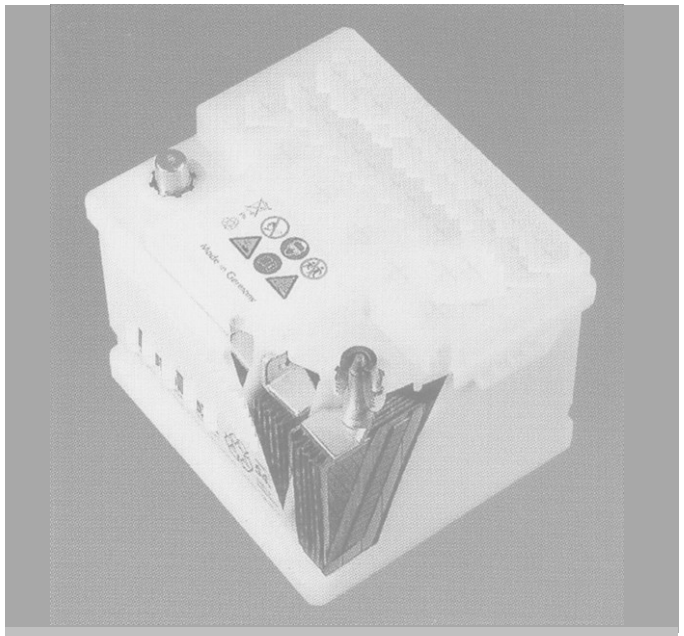


Premium Line at a Glance

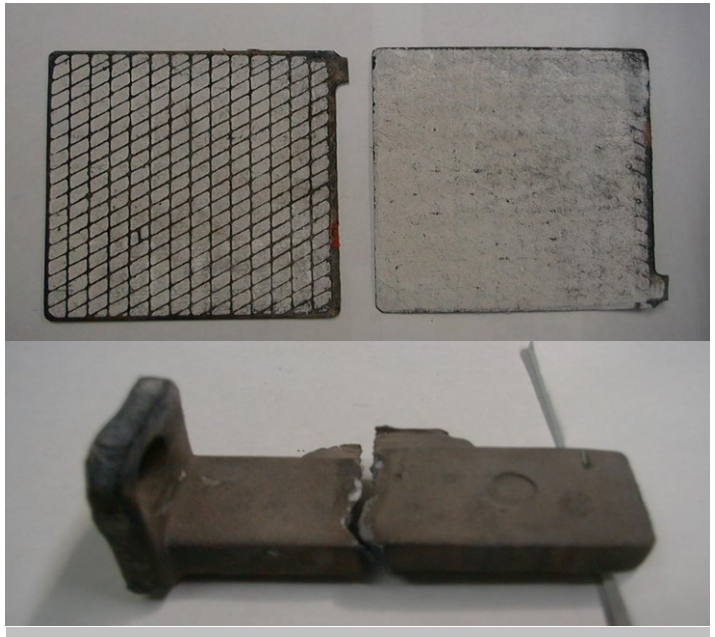
A leading manufacturer of battery finishing line equipment for OE battery producers

High-Rate Discharge Testing Today

100% quality test applying a high rate discharge for a few seconds after formation



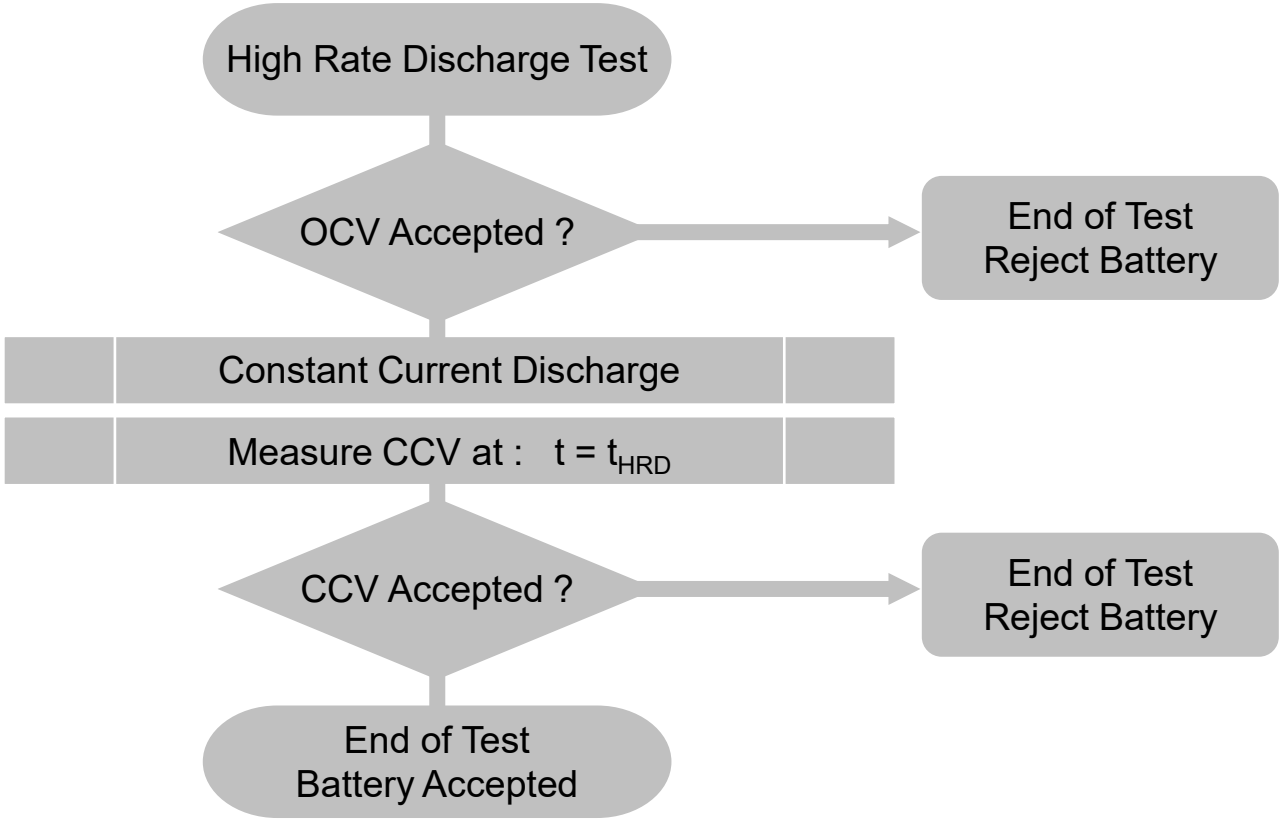
Compares OCV and CCV to nominal values to sort out defective batteries before shipment to customers

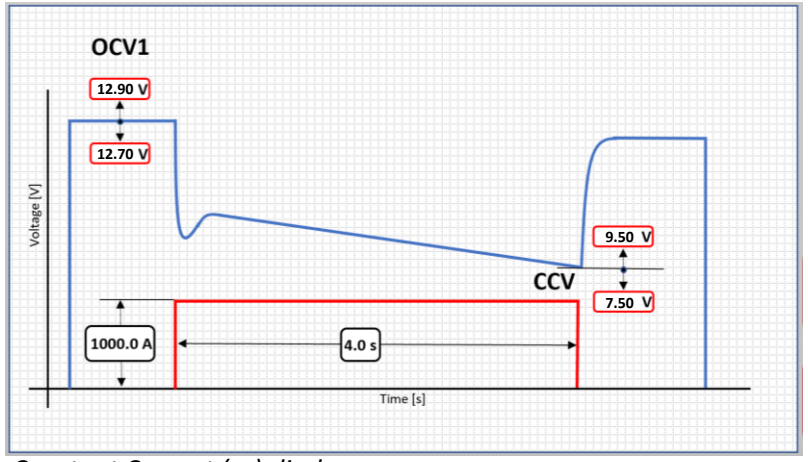


Evaluates gradient delta_V of the discharge curve and yields a more reliable and accurate test result

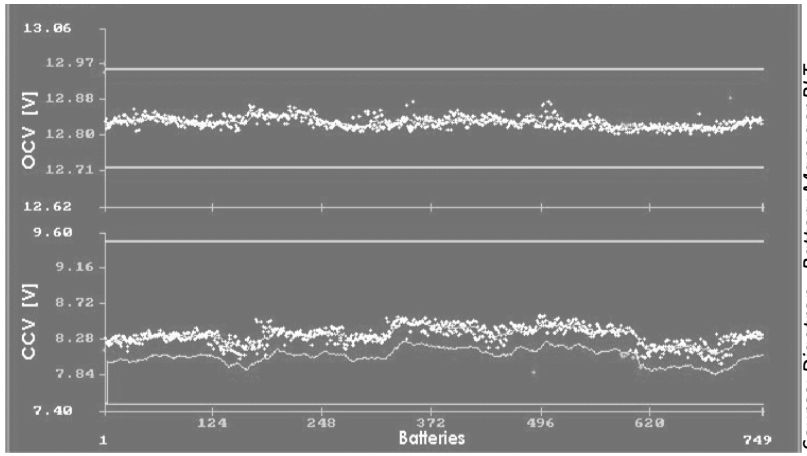
High-Rate Discharge Testing Today

The traditional process





Constant Current (cc) discharge



Source: Digatron, Battery Manager PLT

OCV's and CCV's of a typical production batch

High-Rate Discharge Testing New Requirements

New requirements to be realized

- **More flexibility** to create customized profiles
- Option **to create customer-specific characteristics** and signal shapes
- Evaluation of the measured data **with regard to internal resistance, impedance and relaxation voltage**
- Ability to run **multiple profiles in a sequence**
- dV/dt **detection of the load jump** as well as of the **discharge gradient**
- **Provision of all recorded data at PLC level** for pick-up by higher-level SCADA systems

- Robust machine design, **suited to operate in heavy duty environment**
- **Space saving design** without bulky electronic load cabinets
- **Free access to relevant components** to adjust the machine and for maintenance purposes
- **Fail safe operation** to eliminate production downtime

End-Of-Line HRD Testing

Click here to watch the full video
https://youtu.be/CehHLBnIXCA

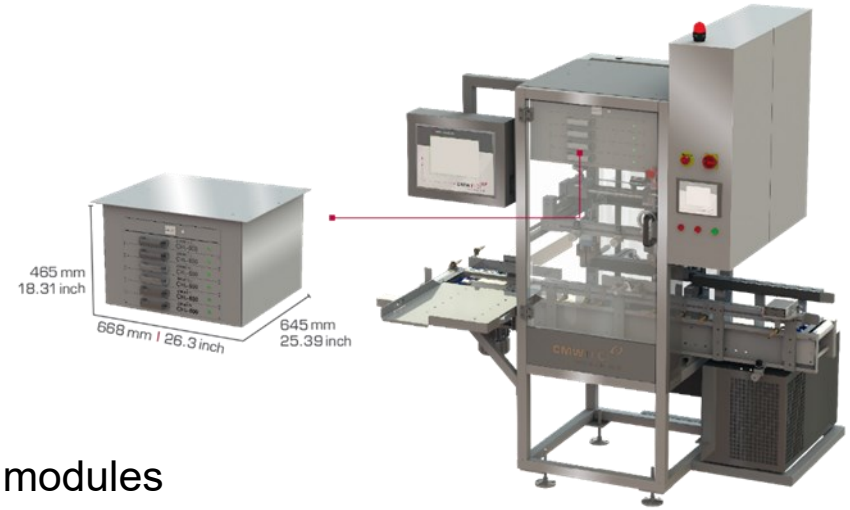
End-Of-Line HRD Testing

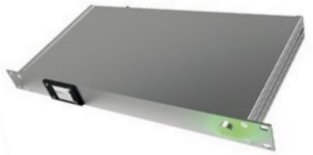
New Electronic Load and Machine Design

End-Of-Line Test Machine (EOL)

Water-cooled Electronic Load

- Small & large applications from 500A to 3000A
- Modular and scalable design by 500A plug-in modules
- High dynamic MOSFET technology
- Extremely small footprint due to new water-cooled heatsink design
- Fully enclosed and sealed. Suited for tough environmental conditions
- Integrated in the machine design. No extra space required
- Fail-Safe due to intelligent management of power strings inside 500A modules
- No noise



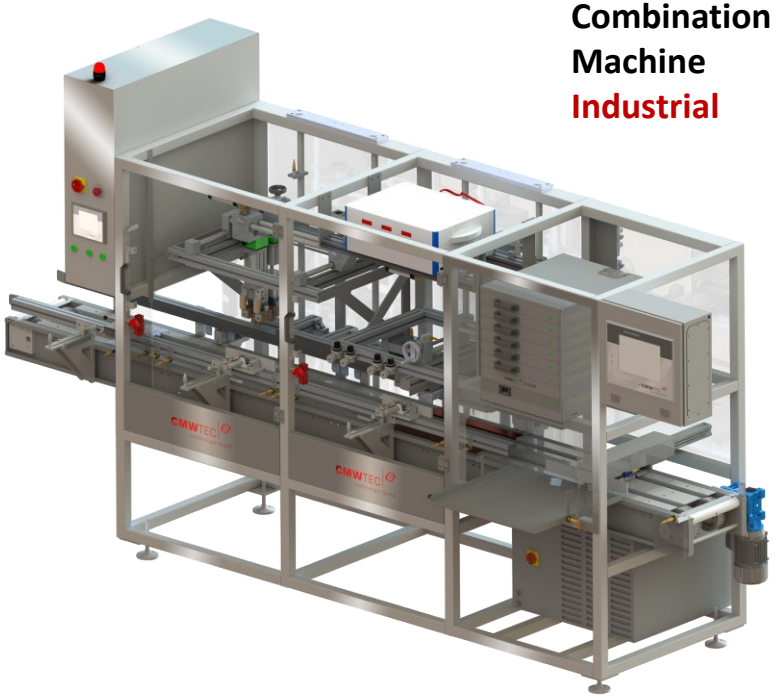


End-Of-Line HRD Testing

End-Of-Line Applications

Single Machine
Car/Truck/MC

Combination Machine
Car/Truck/MC



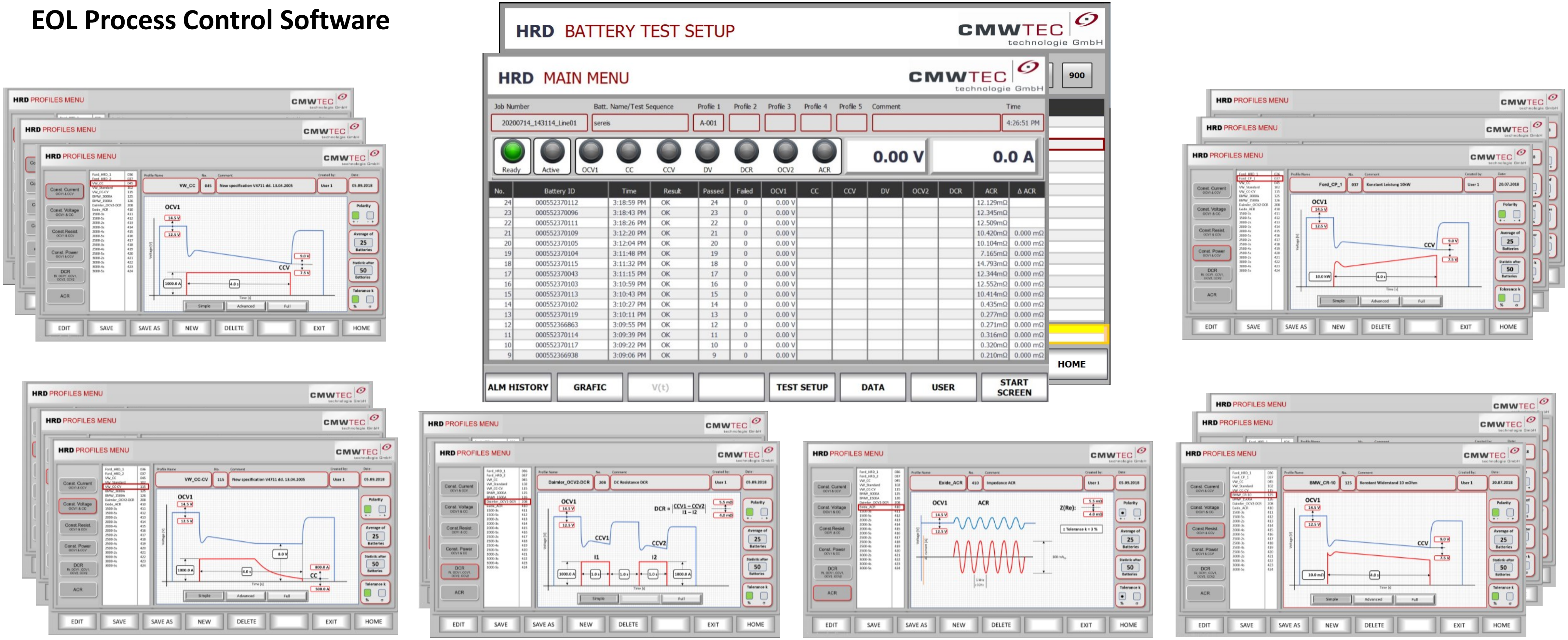
Combination Machine
Industrial

Stand-Alone Unit
Individual adding to Machines

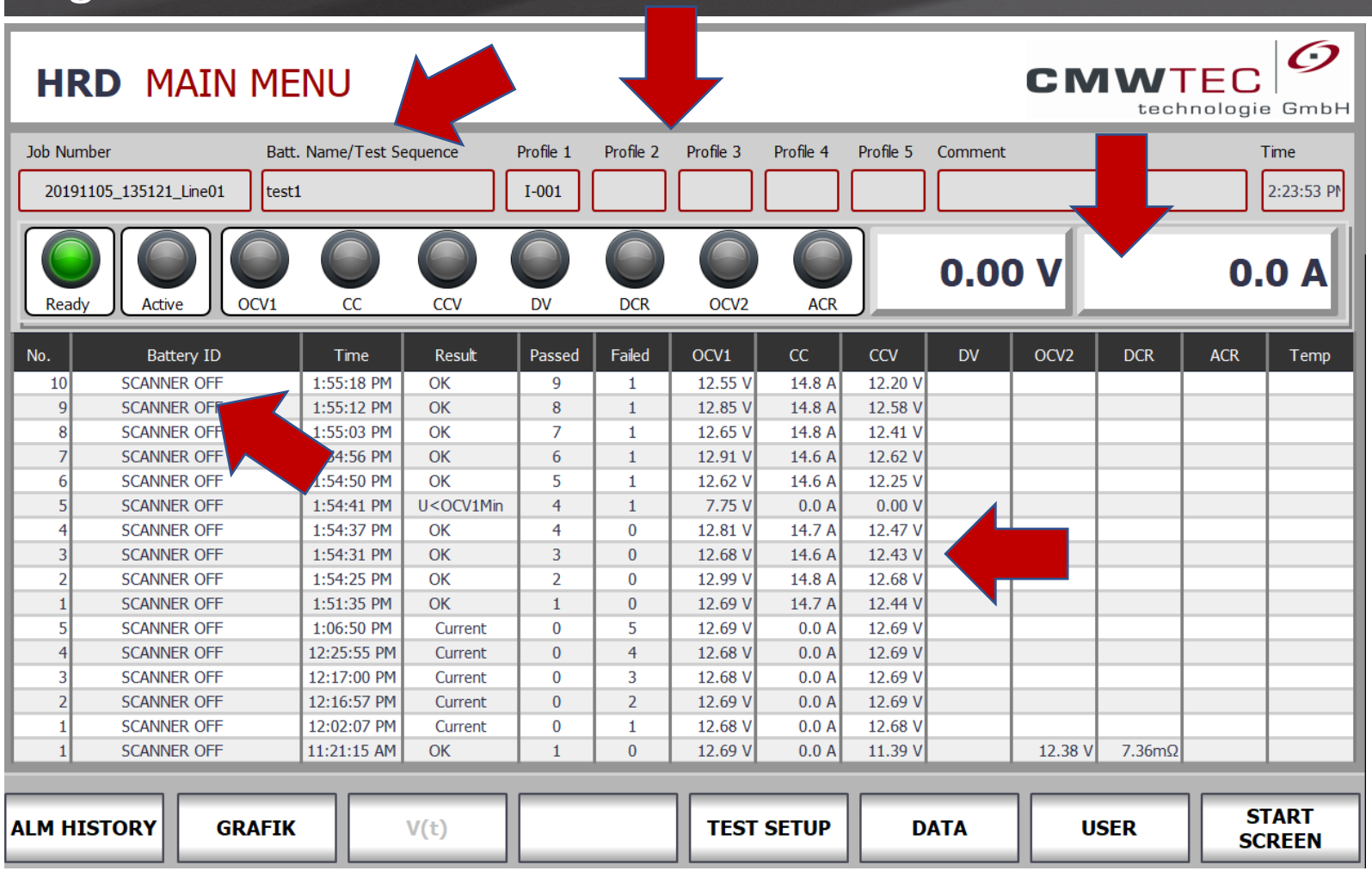
Racks for
3000A / 2000A /1500A / 1000A, others on request

End-Of-Line HRD Testing

EOL Process Control Software



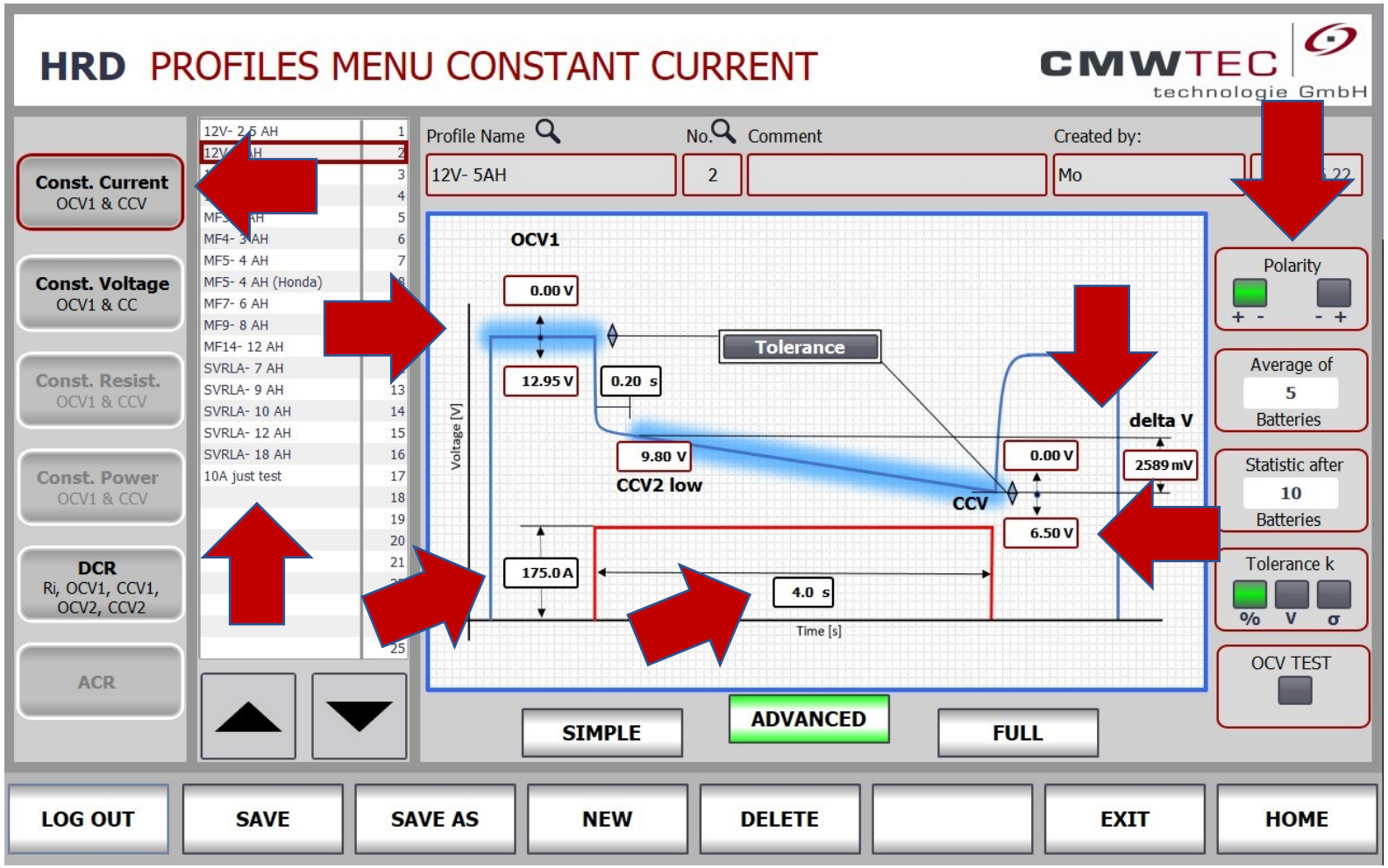
High-Rate Process Control Software



Main Screen Menu

- Last Test Results Overview
- Battery ID
- Job Number and Info
- Selected Profile(s)
- Live Test Values

High-Rate Process Control Software

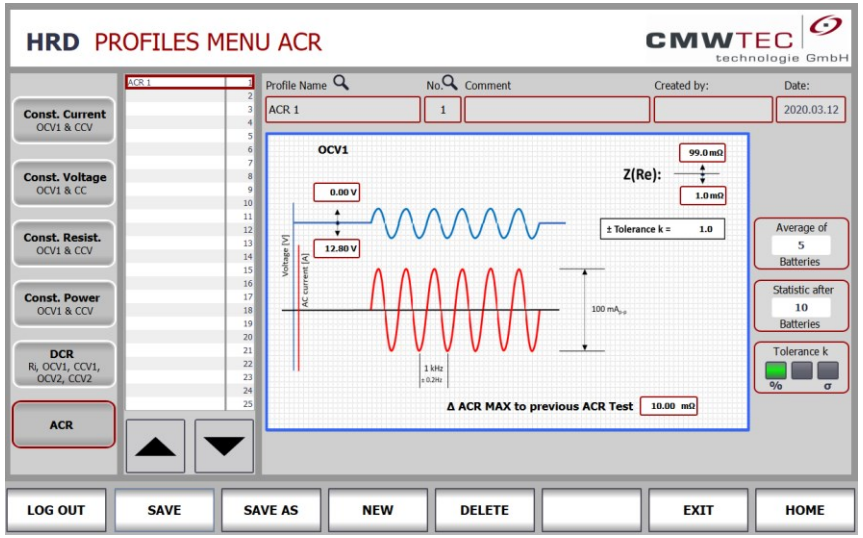


Example:
Constant Current Profile

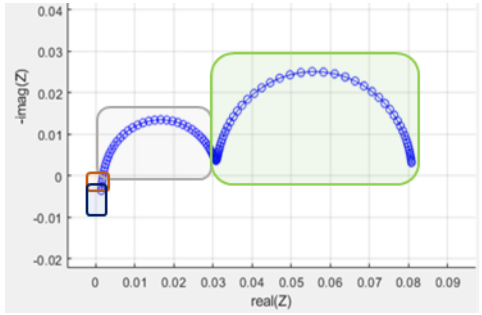
- Setting of test values
- Setting of test time
- Setting of min/max limits
- and much more like Polarity, Statistic, etc.
- Individually for each battery model

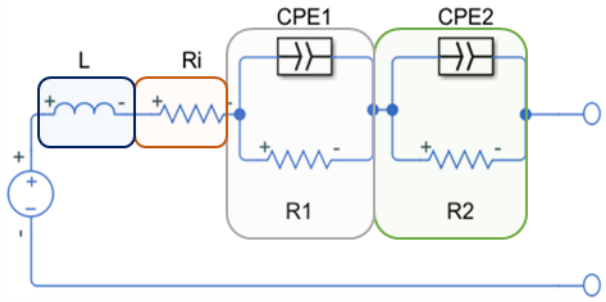
High-Rate Discharge Testing with SerEIS Impedance Testing

HRD with AC Impedance: We have the solution. Documented by the CMWTEC R&D Laboratory!



- Evaluations of the **impedance spectroscopy during and after formation** allow a **reliable statement** about the quality of the formation process
- Internal resistance values Re $\{Z_{1kHz}\}$ **indicate the possibility of measuring and documenting quality of electrolyte infiltration** and formation on the unopened battery
- With the new CMWTEC's HRD soft- and hardware concept it **is now possible to also perform impedance spectroscopy to detect production errors**



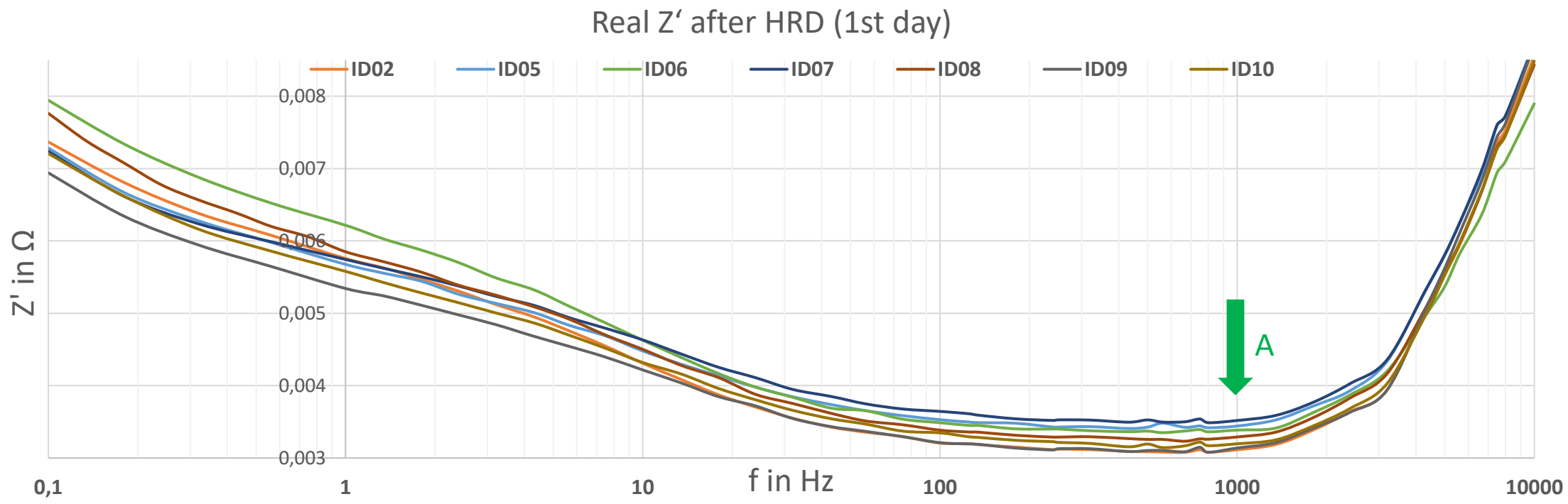


SerEIS Test device
Front side view

SerEIS Test device
Rear side view

Highlights of End-Of Line & SerEIS Impedance Testing

The diagram below shows the results of a frequency spectrum of SerEIS (0.1 Hz up to 10 kHz) in comparison with the frequency point of a common ACR-tester (with only 1 kHz) indicated with the green arrow A.

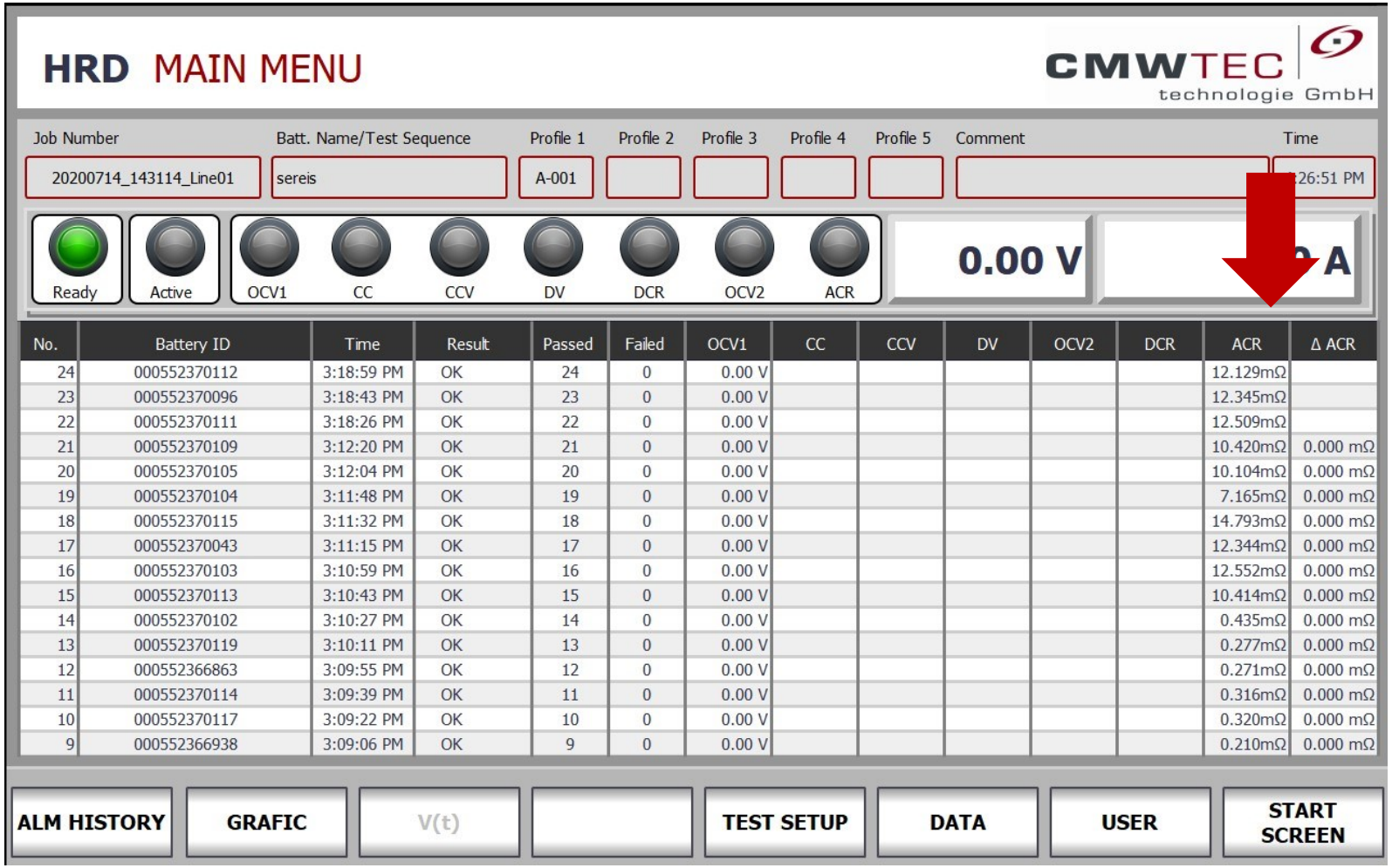


Highlights of End-Of Line & SerEIS Impedance Testing

The figure shows the main screen of the HMI with result fields.

On the right columns we see the values of impedance test ACR and Delta-ACR (will show in case there were second ACR-test.

An entire packet of results with test setting will be stored in the test report as CSV.



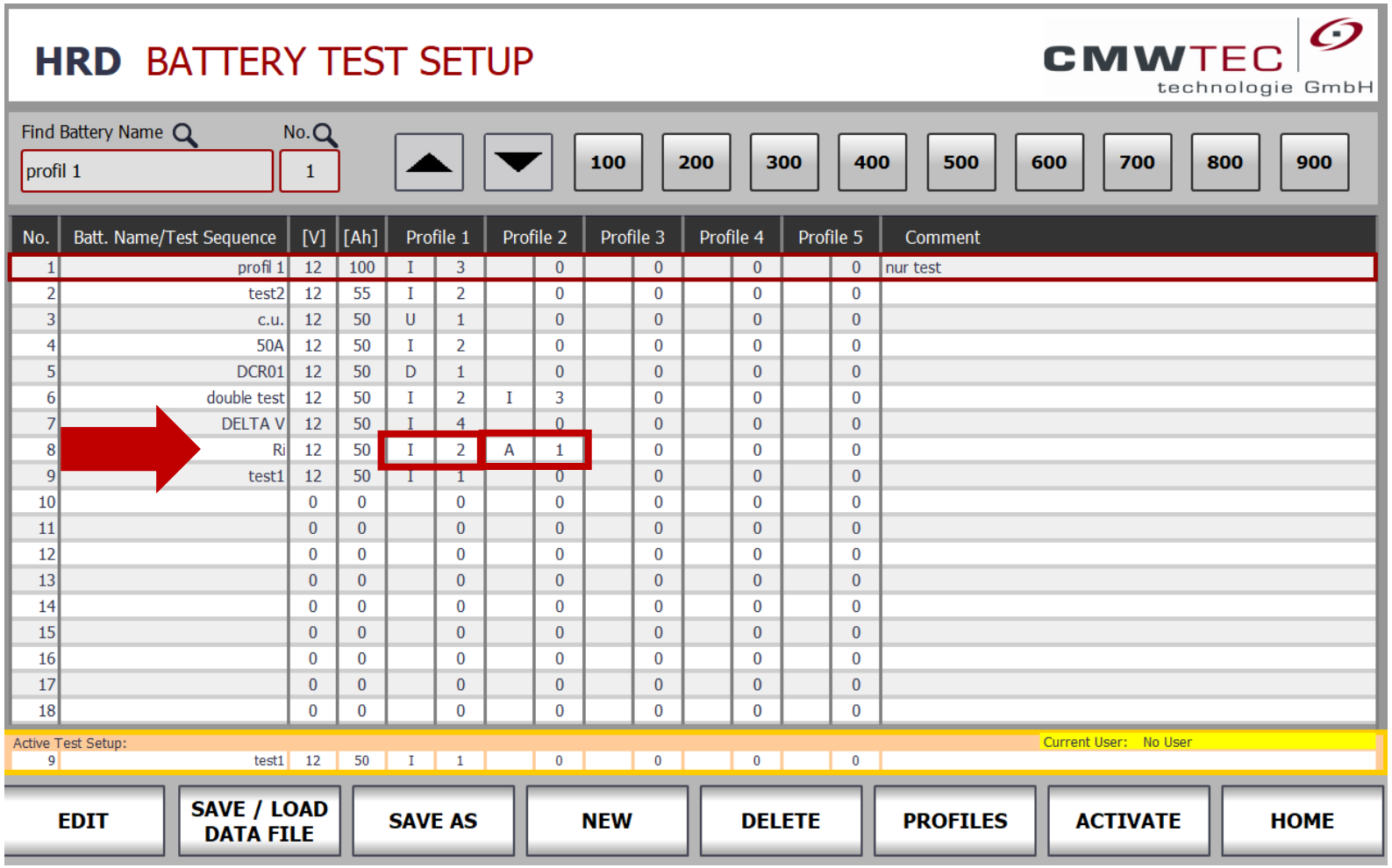
No.	Battery ID	Time	Result	Passed	Failed	OCV1	CC	CCV	DV	OCV2	DCR	ACR	Δ ACR
24	000552370112	3:18:59 PM	OK	24	0	0.00 V						12.129mΩ	
23	000552370096	3:18:43 PM	OK	23	0	0.00 V						12.345mΩ	
22	000552370111	3:18:26 PM	OK	22	0	0.00 V						12.509mΩ	
21	000552370109	3:12:20 PM	OK	21	0	0.00 V						10.420mΩ	0.000 mΩ
20	000552370105	3:12:04 PM	OK	20	0	0.00 V						10.104mΩ	0.000 mΩ
19	000552370104	3:11:48 PM	OK	19	0	0.00 V						7.165mΩ	0.000 mΩ
18	000552370115	3:11:32 PM	OK	18	0	0.00 V						14.793mΩ	0.000 mΩ
17	000552370043	3:11:15 PM	OK	17	0	0.00 V						12.344mΩ	0.000 mΩ
16	000552370103	3:10:59 PM	OK	16	0	0.00 V						12.552mΩ	0.000 mΩ
15	000552370113	3:10:43 PM	OK	15	0	0.00 V						10.414mΩ	0.000 mΩ
14	000552370102	3:10:27 PM	OK	14	0	0.00 V						0.435mΩ	0.000 mΩ
13	000552370119	3:10:11 PM	OK	13	0	0.00 V						0.277mΩ	0.000 mΩ
12	000552366863	3:09:55 PM	OK	12	0	0.00 V						0.271mΩ	0.000 mΩ
11	000552370114	3:09:39 PM	OK	11	0	0.00 V						0.316mΩ	0.000 mΩ
10	000552370117	3:09:22 PM	OK	10	0	0.00 V						0.320mΩ	0.000 mΩ
9	000552366938	3:09:06 PM	OK	9	0	0.00 V						0.210mΩ	0.000 mΩ

Highlights of End-Of Line & SerEIS Impedance Testing

In the Battery Test Setup, you can choose **up to 5 test profiles** to be run **on each battery**. The tests could be OCV, HRD with different modes CC and/or CV, DCR and ACR (SerEIS).

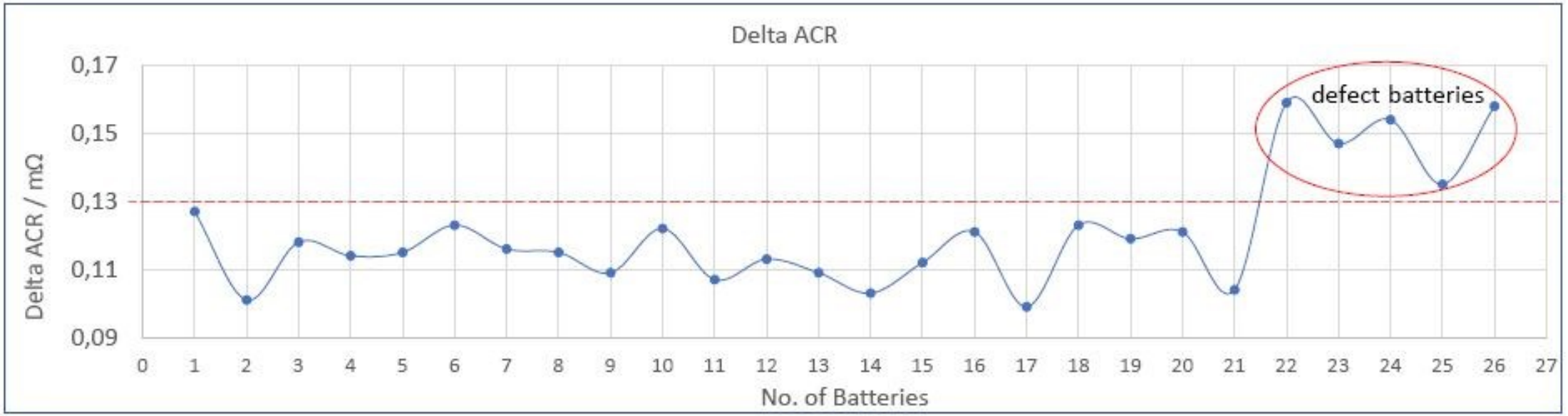
For Example, you can run for

1 battery type 2 test profiles



Highlights of End-Of Line & SerEIS Impedance Testing

Impedance analyses in combination with HRD (High rate discharge test) in early-stage detection
More than 25 FLA batteries from a production line with 5 common defects were prepared for this test. By using both impedance analysis and high rate discharge test we could detect all 5 defect batteries. The diagram below shows the differences between the impedance values before and after High rate discharge test.



(Delta ACR = ACR2-ACR1), were ACR1: impedance before HRD and ACR2: Impedance after HRD test.

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CMWTEC technologie GmbH

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of battery finishing line equipment
for OE battery producers

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