



**19th Asian Battery
Conference &
Exhibition**

Virtual Conference · 3–5 November 2021

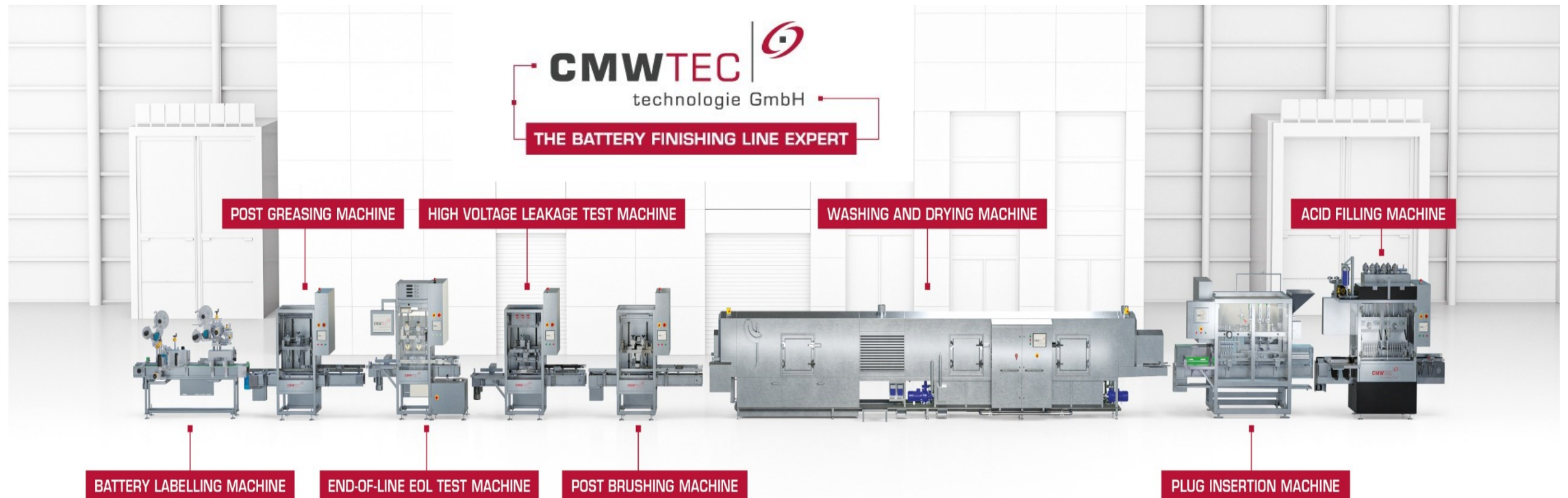
Improved High-Rate Discharge Process and Machine Design

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Tony Schröer, Business Development - Dr. Ing. Walter Wipperfürth, Senior Consultant**

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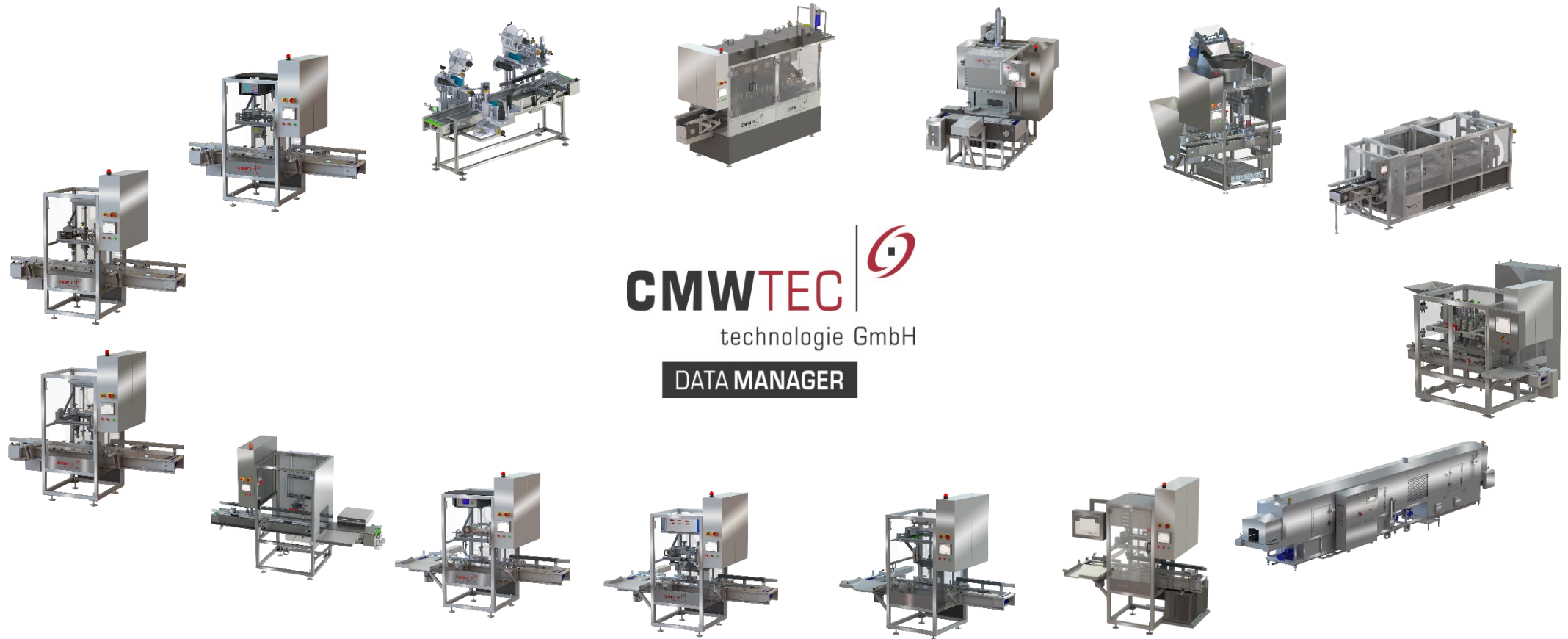
Premium Line at a Glance

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



Premium Line at a Glance

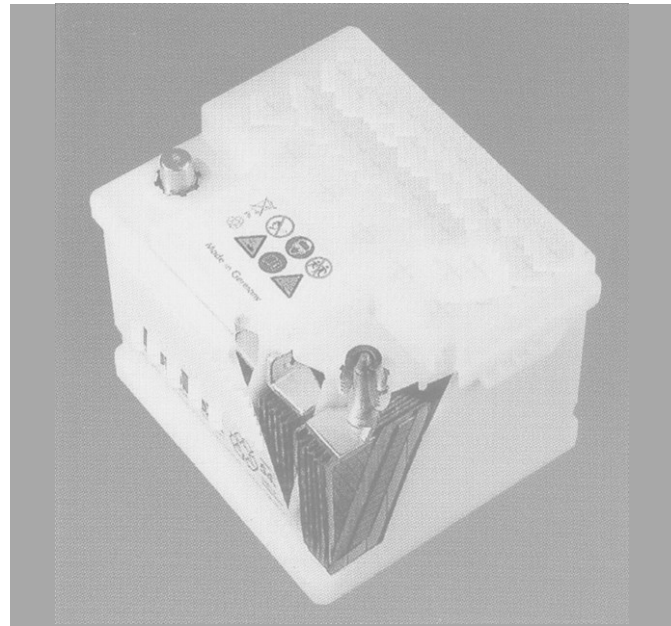
A leading manufacturer of battery finishing line equipment for OE battery producers



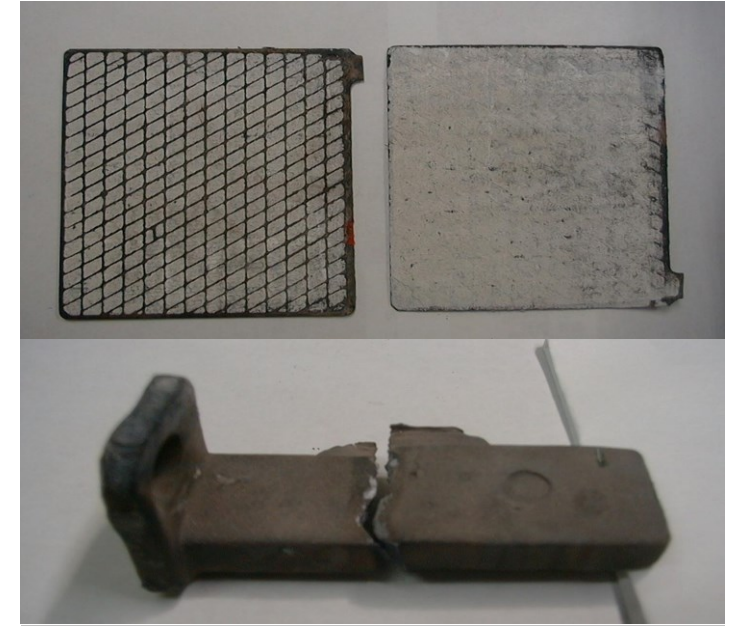
High-Rate Discharge Testing Today



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



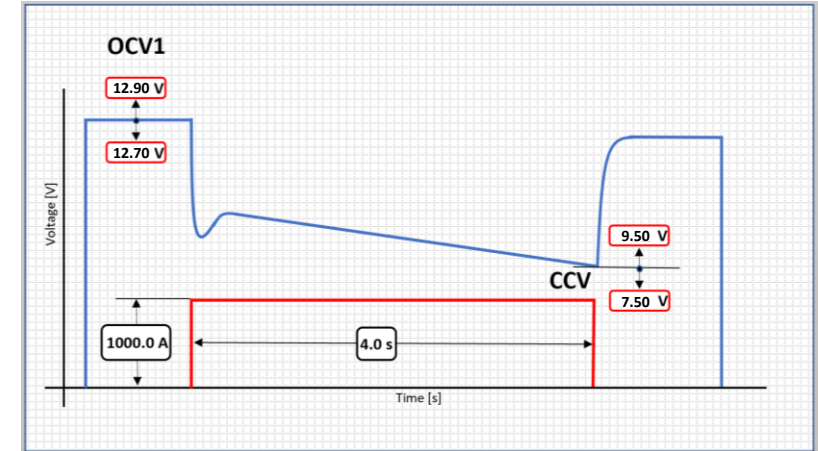
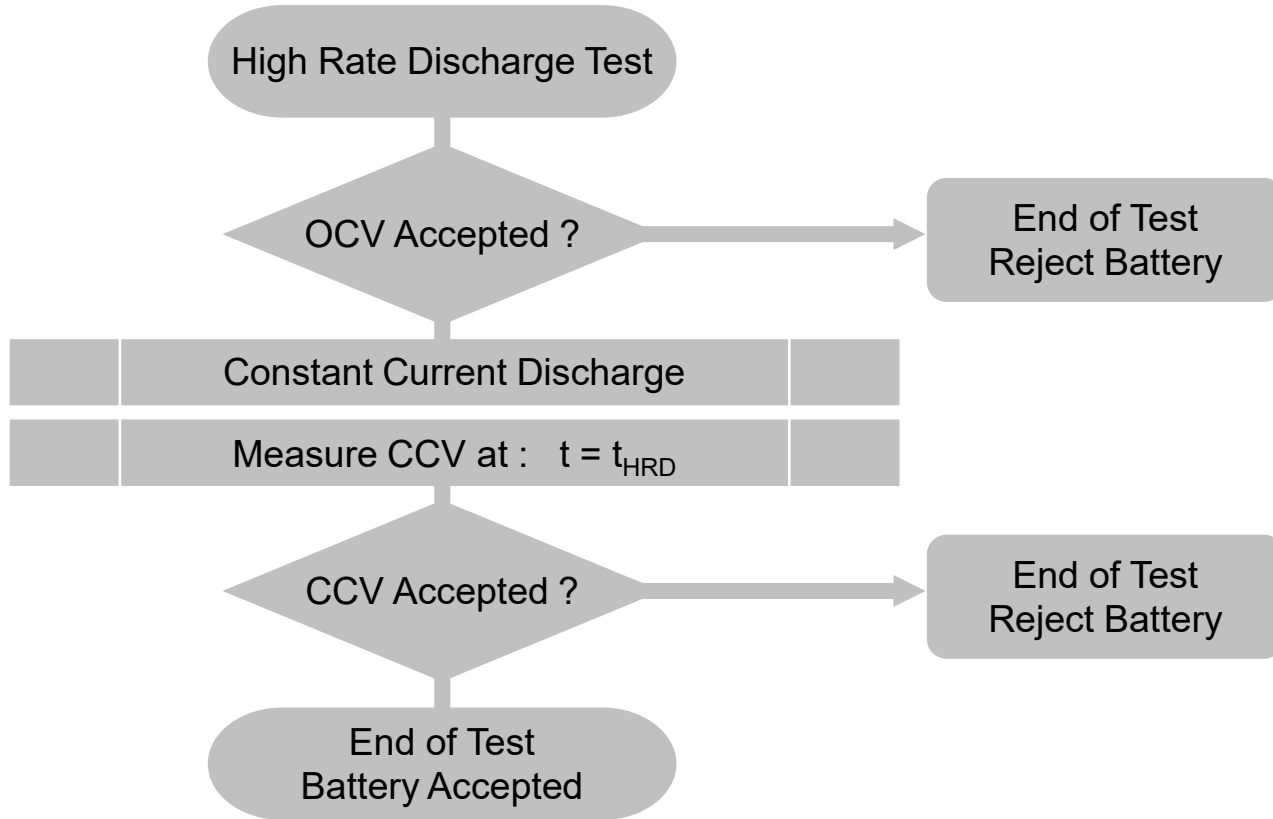
Compares OCV and CCV to nominal values to sort out defective batteries before shipment to customers



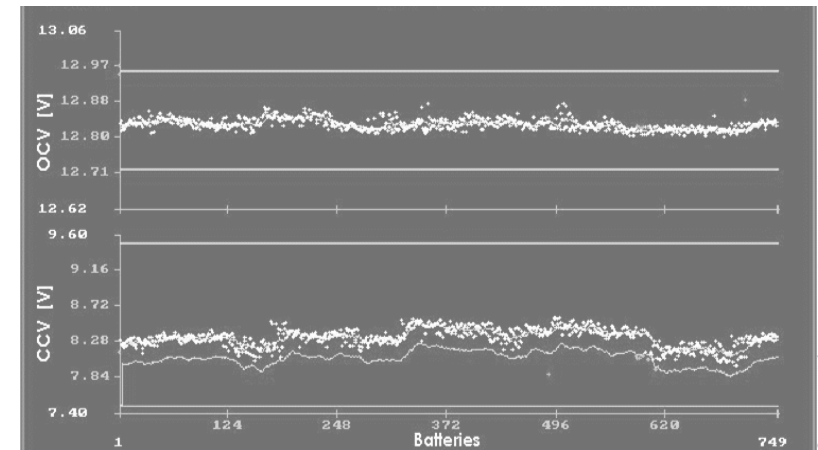
Evaluates gradient ΔV of the discharge curve and yields a more reliable and accurate test result

High-Rate Discharge Testing Today

The traditional process



Constant Current (cc) discharge



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

Source: Digatron, Battery Manager PLT

End-Of-Line HRD Testing



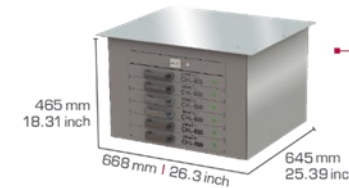
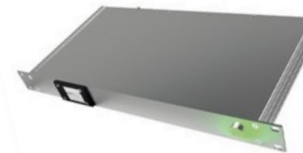
Click here to watch the full video
<https://youtu.be/CehHLBnIXCA>

End-Of-Line HRD Testing

New Electronic Load and Machine Design

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 Test Machine (EOL)



End-Of-Line HRD Testing

End-Of-Line Applications

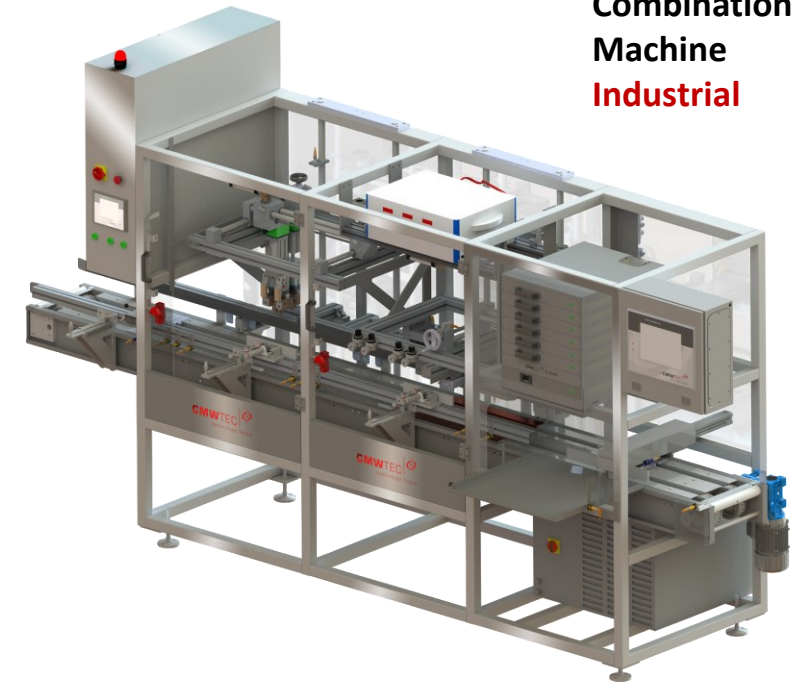
Single Machine
Car/Truck/MC



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

HRD BATTERY TEST SETUP

HRD MAIN MENU

Job Number: 20200714_143114_Line01 | Batt. Name/Test Sequence: seres | Profile 1: A-001 | Profile 2: | Profile 3: | Profile 4: | Profile 5: | Comment: | Time: 4:26:51 PM

Ready Active OCV1 CC CCV DV DCR OCV2 ACR

0.00 V 0.0 A

No.	Battery ID	Time	Result	Passed	Failed	OCV1	CC	CCV	DV	OCV2	DCR	ACR	Δ ACR
24	00052370112	3:18:59 PM	OK	24	0	0.00 V						12.129mΩ	
23	00052370096	3:18:43 PM	OK	23	0	0.00 V						12.345mΩ	
22	00052370111	3:18:26 PM	OK	22	0	0.00 V						12.509mΩ	
21	00052370109	3:12:20 PM	OK	21	0	0.00 V						10.420mΩ	0.000 mΩ
20	00052370105	3:12:04 PM	OK	20	0	0.00 V						10.104mΩ	0.000 mΩ
19	00052370104	3:11:48 PM	OK	19	0	0.00 V						7.165mΩ	0.000 mΩ
18	00052370115	3:11:32 PM	OK	18	0	0.00 V						14.793mΩ	0.000 mΩ
17	00052370043	3:11:15 PM	OK	17	0	0.00 V						12.344mΩ	0.000 mΩ
16	00052370103	3:10:59 PM	OK	16	0	0.00 V						12.552mΩ	0.000 mΩ
15	00052370113	3:10:43 PM	OK	15	0	0.00 V						10.414mΩ	0.000 mΩ
14	00052370102	3:10:27 PM	OK	14	0	0.00 V						0.435mΩ	0.000 mΩ
13	00052370119	3:10:11 PM	OK	13	0	0.00 V						0.277mΩ	0.000 mΩ
12	00052366863	3:09:55 PM	OK	12	0	0.00 V						0.271mΩ	0.000 mΩ
11	00052370114	3:09:39 PM	OK	11	0	0.00 V						0.316mΩ	0.000 mΩ
10	00052370117	3:09:22 PM	OK	10	0	0.00 V						0.320mΩ	0.000 mΩ
9	00052366938	3:09:06 PM	OK	9	0	0.00 V						0.210mΩ	0.000 mΩ

ALM HISTORY GRAFIC V(t) TEST SETUP DATA USER START SCREEN

HRD PROFILES MENU

Profile Name: VW_CC_015 | No: 015 | Comment: New specification V4711 del. 13.04.2005 | Created by: User 1 | Date: 05.09.2018

OCV1: 14.5 V, 13.5 V, 9.0 V, 7.5 V

CC: 1000.0 A, 4.0 s

CCV: 7.5 V

DCR: 1000.0 A, 1000.0 s

ACR: 1000.0 A, 1000.0 s

Polarity: +

Average of: 25 Batteries

Statistics after: 50 Batteries

Tolerance k: 5%

EDIT SAVE SAVE AS NEW DELETE EXIT HOME

HRD PROFILES MENU

Profile Name: Ford_CP_1 | No: 037 | Comment: Konstante Leistung 10kW | Created by: User 1 | Date: 20.07.2018

OCV1: 14.5 V, 13.5 V, 9.0 V, 7.5 V

CC: 10.0 A, 4.0 s

CCV: 9.0 V

DCR: 10.0 A, 1000.0 s

ACR: 10.0 A, 1000.0 s

Polarity: +

Average of: 25 Batteries

Statistics after: 50 Batteries

Tolerance k: 5%

EDIT SAVE SAVE AS NEW DELETE EXIT HOME

HRD PROFILES MENU

Profile Name: VW_CC-CV | No: 115 | Comment: New specification V4711 del. 13.04.2005 | Created by: User 1 | Date: 05.09.2018

OCV1: 14.5 V, 13.5 V, 9.0 V, 7.5 V

CC: 1000.0 A, 4.0 s

CCV: 7.5 V

DCR: 1000.0 A, 1000.0 s

ACR: 1000.0 A, 1000.0 s

Polarity: +

Average of: 25 Batteries

Statistics after: 50 Batteries

Tolerance k: 5%

EDIT SAVE SAVE AS NEW DELETE EXIT HOME

HRD PROFILES MENU

Profile Name: Daimler_OCV2-DCR | No: 008 | Comment: DC Resistance DCR | Created by: User 1 | Date: 05.09.2018

OCV1: 14.5 V, 13.5 V, 9.0 V, 7.5 V

CCV1: 7.5 V, 3.3 mΩ

CCV2: 4.0 mΩ

DCR: 1000.0 A, 1000.0 s

ACR: 1000.0 A, 1000.0 s

Polarity: +

Average of: 25 Batteries

Statistics after: 50 Batteries

Tolerance k: 5%

EDIT SAVE SAVE AS NEW DELETE EXIT HOME

HRD PROFILES MENU

Profile Name: Exide_ACR | No: 006 | Comment: Impedance ACR | Created by: User 1 | Date: 05.09.2018

OCV1: 14.5 V, 13.5 V, 9.0 V, 7.5 V

ACR: 1000.0 A, 1000.0 s

Z(Re): 5.3 mΩ, 4.0 mΩ

Polarity: +

Average of: 25 Batteries

Statistics after: 50 Batteries

Tolerance k: 5%

EDIT SAVE SAVE AS NEW DELETE EXIT HOME

HRD PROFILES MENU

Profile Name: BMW_CR-10 | No: 125 | Comment: Konstant Widerstand 10 mΩ | Created by: User 1 | Date: 20.07.2018

OCV1: 14.5 V, 13.5 V, 9.0 V, 7.5 V

CC: 10.0 A, 4.0 s

CCV: 9.0 V

DCR: 10.0 A, 1000.0 s

ACR: 10.0 A, 1000.0 s

Polarity: +

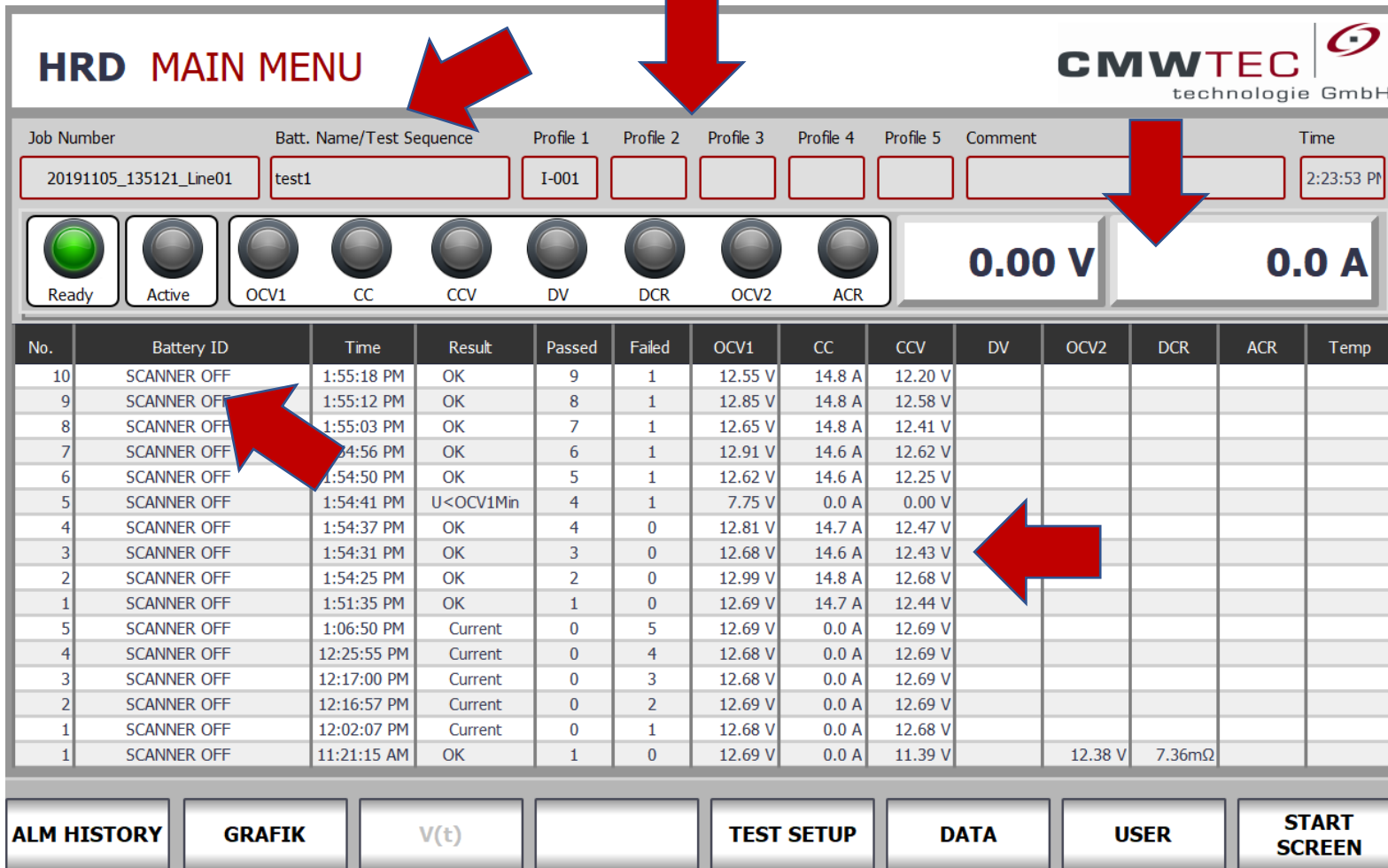
Average of: 25 Batteries


Statistics after: 50 Batteries

Tolerance k: 5%

EDIT SAVE SAVE AS NEW DELETE EXIT HOME

High-Rate Process Control Software



HRD MAIN MENU **CMWTEC** | 
technologie GmbH

Job Number: 20191105_135121_Line01 | Batt. Name/Test Sequence: test1 | Profile 1: I-001 | Profile 2: | Profile 3: | Profile 4: | Profile 5: | Comment: | Time: 2:23:53 PM

Ready Active OCV1 CC CCV DV DCR OCV2 ACR

0.00 V **0.0 A**

No.	Battery ID	Time	Result	Passed	Failed	OCV1	CC	CCV	DV	OCV2	DCR	ACR	Temp
10	SCANNER OFF	1:55:18 PM	OK	9	1	12.55 V	14.8 A	12.20 V					
9	SCANNER OFF	1:55:12 PM	OK	8	1	12.85 V	14.8 A	12.58 V					
8	SCANNER OFF	1:55:03 PM	OK	7	1	12.65 V	14.8 A	12.41 V					
7	SCANNER OFF	1:54:56 PM	OK	6	1	12.91 V	14.6 A	12.62 V					
6	SCANNER OFF	1:54:50 PM	OK	5	1	12.62 V	14.6 A	12.25 V					
5	SCANNER OFF	1:54:41 PM	U<OCV1Min	4	1	7.75 V	0.0 A	0.00 V					
4	SCANNER OFF	1:54:37 PM	OK	4	0	12.81 V	14.7 A	12.47 V					
3	SCANNER OFF	1:54:31 PM	OK	3	0	12.68 V	14.6 A	12.43 V					
2	SCANNER OFF	1:54:25 PM	OK	2	0	12.99 V	14.8 A	12.68 V					
1	SCANNER OFF	1:51:35 PM	OK	1	0	12.69 V	14.7 A	12.44 V					
5	SCANNER OFF	1:06:50 PM	Current	0	5	12.69 V	0.0 A	12.69 V					
4	SCANNER OFF	12:25:55 PM	Current	0	4	12.68 V	0.0 A	12.69 V					
3	SCANNER OFF	12:17:00 PM	Current	0	3	12.68 V	0.0 A	12.69 V					
2	SCANNER OFF	12:16:57 PM	Current	0	2	12.69 V	0.0 A	12.69 V					
1	SCANNER OFF	12:02:07 PM	Current	0	1	12.68 V	0.0 A	12.68 V					
1	SCANNER OFF	11:21:15 AM	OK	1	0	12.69 V	0.0 A	11.39 V		12.38 V	7.36mΩ		

ALM HISTORY GRAFIK V(t) TEST SETUP DATA USER START SCREEN

Main Screen Menu

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

High-Rate Process Control Software

HRD PROFILES MENU CONSTANT CURRENT

CMWTEC technologie GmbH

Profile Name: 12V- 5AH No: 2 Comment: Created by: Mo

Const. Current OCV1 & CCV

Const. Voltage OCV1 & CC

Const. Resist. OCV1 & CCV

Const. Power OCV1 & CCV

DCR R_i , OCV1, CCV1, OCV2, CCV2

ACR

OCV1

0.00 V

12.95 V

0.20 s

Tolerance

9.80 V

CCV2 low

CCV

0.00 V

delta V

2589 mV

6.50 V

175.0A

4.0 s

Time [s]

Polarity

Average of 5 Batteries

Statistic after 10 Batteries

Tolerance k

OCV TEST

SIMPLE **ADVANCED** FULL

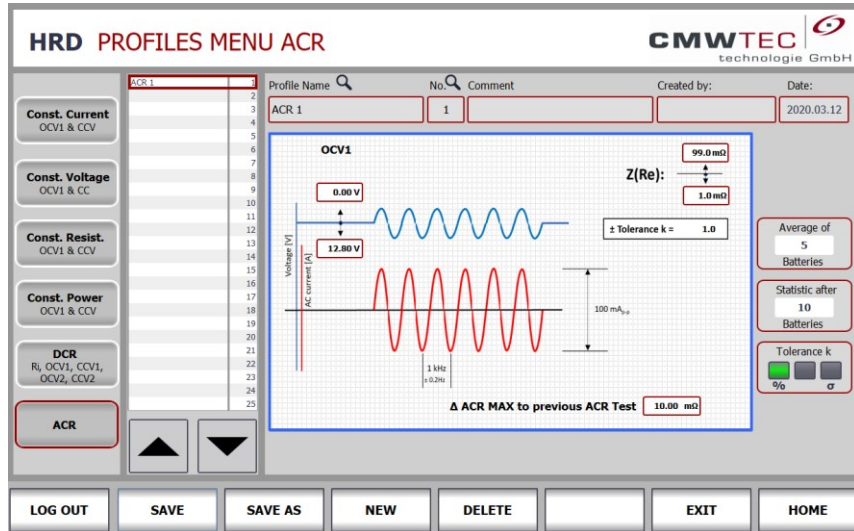
LOG OUT SAVE SAVE AS NEW DELETE EXIT HOME

Example: Constant Current Profile

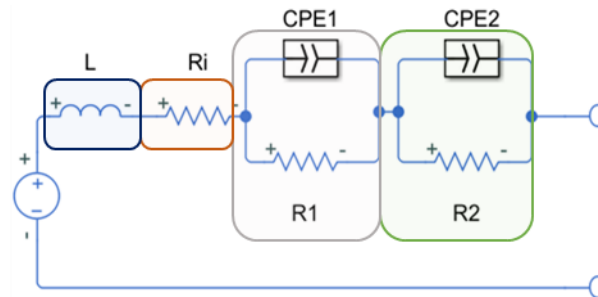
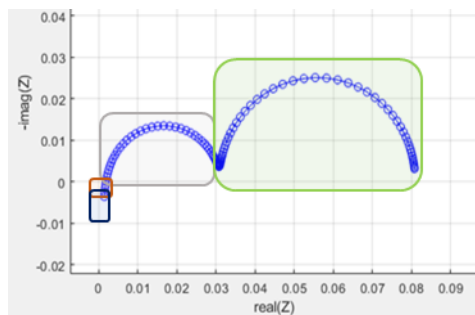
- Setting of test values
- Setting of test time
- Setting of min/max limits
- and much more like Polarity, Statistic, etc.
- Individually for each battery model

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**



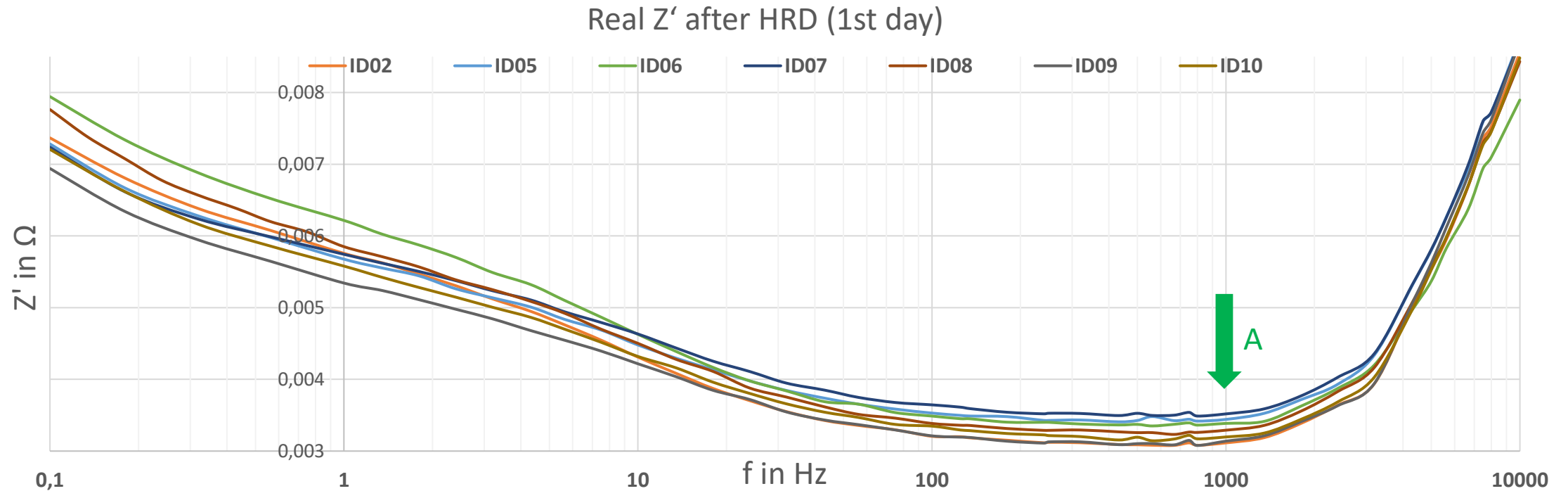
SerEIS Test device
Front side view



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**.

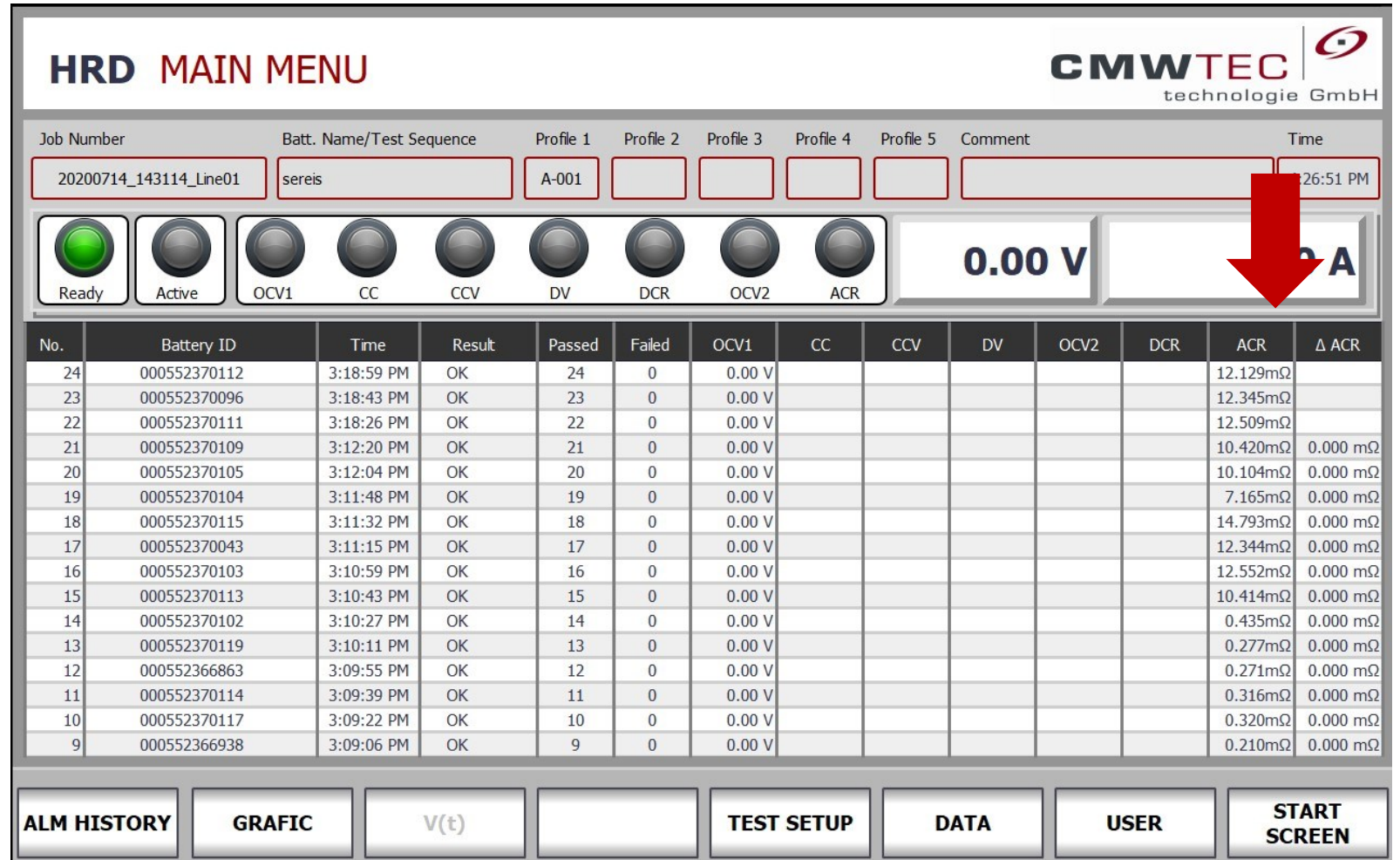



Highlights of End-Of Line & SerEIS Impedance Testing

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.



HRD MAIN MENU **CMWTEC** | 
technologie GmbH

Job Number: 20200714_143114_Line01 | Batt. Name/Test Sequence: sereis | Profile 1: A-001 | Profile 2: | Profile 3: | Profile 4: | Profile 5: | Comment: | Time: 26:51 PM

Ready (Green) | Active (Grey) | OCV1 (Grey) | CC (Grey) | CCV (Grey) | DV (Grey) | DCR (Grey) | OCV2 (Grey) | ACR (Grey) | **0.00 V** | **0.00 A**

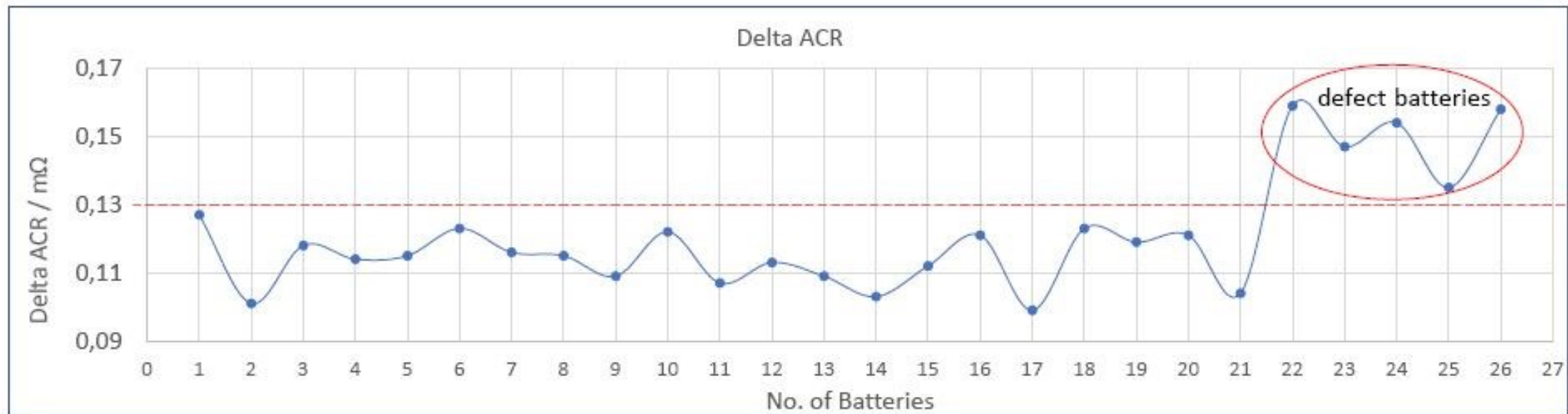
No.	Battery ID	Time	Result	Passed	Failed	OCV1	CC	CCV	DV	OCV2	DCR	ACR	Δ ACR
24	000552370112	3:18:59 PM	OK	24	0	0.00 V						12.129mΩ	
23	000552370096	3:18:43 PM	OK	23	0	0.00 V						12.345mΩ	
22	000552370111	3:18:26 PM	OK	22	0	0.00 V						12.509mΩ	
21	000552370109	3:12:20 PM	OK	21	0	0.00 V						10.420mΩ	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

Buttons: ALM HISTORY | GRAFIC | V(t) | TEST SETUP | DATA | USER | START SCREEN

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.

Visit our booth for more information's



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

**Stay interested what's coming up next.
visit our website www.cmwtec.de**