2 List of Abbreviations

BOL	Begin Of Life
BOT	Begin Of Test
C_{act}	Actual Capacity
C_{nom}	Nominal Capacity (rated Capacity)
CC	Constant Current
CF	Constant Force
CH	Charge
CS	Constant Stiffness
CV	Constant Voltage
CYC	Cycle
DCH	Discharge
DOD	Depth of Discharge
DUT	Device Under Test
EOL	End Of Life
EOT	End Of Test
MOL	Mid Of Life
MOT	Mid Of Test
OCV	Open Circuit Voltage
RPT	Reference Parameter Test
RT	Room Temperature (25 ±2)°C, unless otherwise stated
SOC	State Of Charge
$U_{dyn,min}$	Minimum allowed dynamic voltage ###ording to operating window
$U_{dyn,max}$	Maximum allowed dynamic voltage ###ording to operating window
$U_{OC,min}$	Minimum allowed open circuit voltage ###ording to operating window
$U_{OC,max}$	Maximum allowed open circuit voltage ###ording to operating window

3 General Test Conditions

All parameters shall be ###ording to the operational window of the cell – provided by supplier. In case of system limitations (Current, Voltage as function of temperature/time) defined in the specification those shall be considered in addition.

3.1 General Cell Specifications

Manufacturer:	###
Format:	###
Rated Capacity (Cnom):	141,5 Ah
Cell Name:	###

3.2 General Testing Specifications

Testing position:	Vertical
Setup:	###
Ambient Temperature:	25°C – 35°C
Imax:	400 A

3.3 ### uracy/Tolerances and Resolution of Test Equipment

3.3.1 Current and voltage measurement:

- Minimum current ###uracy requirement: ≤ 0,2 % of measured value
- Minimum voltage ###uracy requirement: +/- 1 mV

Measuring Range Switchover (Messbereichsumschaltung) is necessary for smaller currents, e.g. C/3 and C/10 capacity determination.

Exapmples for ###epltable current deviation for 143 Ah Cell:

≥ 1C → +/- 286 mA → ≤ 0,2 % of measured value

= C/3 → +/- 95 mA → ≤ 0,2 % of measured value

≤ C/10 → +/- 28 mA → ≤ 0,2 % of measured value

3.3.2 Temperature measurement:

- Minimum ### uracy requirement: ± 0,25K (applies for sensor)
- For example PT100 Type A or AA is suitable
- Temperature ###uracy of PT100 Type A: ± 0,15K **(will be provided by ###)**
- Direct contact to measuring point shall be realized with Heat-conducting paste/tape or glue.

4 Test equipment and setup

- Climate chamber (25 °C – 35 °C)

The test is conducted via a specially designed constant stiffness (CS) setup for cell swelling. The constant force (CF) set up ist identical only with the addition of spring on the threaded rods. The specifications and a scheme of the cell swelling setup are listed below:

- Pipelines for tempering are not necessary, if the ambient temperatue is the test temperature
- At least **3**x Dial gauge / laser triangular sensors or similar shall measure the cell thickness with a resolution of 1 µm
- Load cell up to 100kN measuring range

Figure 1: Cell swelling test setup.

###

4.1 Positioning of Temperature Sensors

The following figure shows the positioning of the temperature sensors. Sensors 1-4 are mandatory. In the table, the description and the signal ###eptance is determined ###ording to the ###

Figure 2- Positioning temperature sensors

No.	Description	Signale name (conform to ###)	Tmax allowed
TEMP 01	Temperature sensor on negative pole	mess_temperatur_01	60°C
TEMP 02	Temperature sensor on cell Top	mess_temperatur_02	60°C
TEMP 03	Temperature sensor on positive pole	mess_temperatur_03	60°C
TEMP 04	Temperature sensor on cell bottom	mess_temperatur_04	60°C
~~TEMP 05~~	~~Temperature sensor on cell right side~~	~~EBT_Temp_Cell_05 (optional)~~	~~60°C~~
~~TEMP 06~~	~~Temperature sensor on cell left side~~	~~EBT_Temp_Cell_06 (optional)~~	~~60°C~~
Tamb	Ambient Temperature (pressure plate or air next to Cell)	ECS_Temp_Act	60

Cell temperature reference point:

Figure 3: Sensor Position on Cell Top

###

4.2 Current adjustment depending on cell Temperature

I_therm_cont: Maximum continuous currents need to be respected depending on temperature at **Cell temperature reference point** (Section 4.1).

I_therm_cont is not dependend on SOH, limits will therefore stay constant over lifetime.

➔ Especially relevant for high charging currents

v4:

Cont. charging currents are limited because of thermal limits to max. 500A (@25°C)

###

5 Basic conditions / Overview

Testing conditions to be performed.

Table 5.1: Test plan

No	Stiff-ness	Init. Force	SOCmax [SOC]	SOCmin [SOC]	Fast Charging proportion	T cyc in °C	Dch Profile	chilling Time after ch r	chilling Time after dch t	DUTs	Setup	Stempel	Plausi - Check	Imax [A]
1.1	K_2	F_1	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CS	nein	PC_1	400
1.2	K_2	F_1	$SOC_{max,2}$	$SOC_{min,2}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CS	nein	PC_1	400
1.3	K_2	F_1	$SOC_{max,3}$	$SOC_{min,0}$	IA_5	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CS	nein	PC_1	400
1.4	K_2	F_1	$SOC_{max,3}$	$SOC_{min,0}$	$I_{CH\_\#\#\#}$	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	$I_{DCH\_\#\#\#}$	r_1	t_1	1	CS	nein	PC_1	400
2.1	-	F_1	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	nein	PC_1	400
~~2.2~~	-	~~F_2~~	~~$SOC_{max,3}$~~	~~$SOC_{min,0}$~~	~~IA_2~~	~~$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$~~	~~I_{DCH_normal}~~	~~r_1~~	~~t_1~~	~~0~~	~~CF~~	nein	~~PC_1~~	~~400~~
2.3	-	F_2	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	nein	PC_1	400
2.4	-	F_3	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	nein	PC_1	400
~~2.5~~	-	~~F_4~~	~~$SOC_{max,3}$~~	~~$SOC_{min,0}$~~	~~IA_2~~	~~$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$~~	~~I_{DCH_normal}~~	~~r_1~~	~~t_1~~	~~0~~	~~CF~~	nein	~~PC_1~~	~~400~~
~~2.6~~	-	~~F_4~~	~~$SOC_{max,3}$~~	~~$SOC_{min,0}$~~	~~IA_2~~	~~$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$~~	~~I_{DCH_normal}~~	~~r_1~~	~~t_1~~	~~0~~	~~CF~~	nein	~~PC_1~~	~~400~~
2.7	-	F_4	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	nein	PC_1	400
2.8	-	F_5	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	nein	PC_2	400
~~2.9~~	-	~~F_6~~	~~$SOC_{max,3}$~~	~~$SOC_{min,0}$~~	~~IA_2~~	~~$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$~~	~~I_{DCH_normal}~~	~~r_1~~	~~t_1~~	~~0~~	~~CF~~	ja	~~PC_2~~	~~400~~
2.10	-	F_6	$SOC_{max,3}$	$SOC_{min,0}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	ja	PC_2	400
2.11	-	F_4	$SOC_{max,2}$	$SOC_{min,2}$	IA_2	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	nein	PC_1	400
~~2.12~~	-	~~F_2~~	~~$SOC_{max,3}$~~	~~$SOC_{min,0}$~~	~~IA_5~~	~~$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$~~	~~I_{DCH_normal}~~	~~r_1~~	~~t_1~~	~~0~~	~~CF~~	nein	~~PC_1~~	~~400~~
~~2.13~~	-	~~F_4~~	~~$SOC_{max,3}$~~	~~$SOC_{min,0}$~~	~~IA_5~~	~~$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$~~	~~I_{DCH_normal}~~	~~r_1~~	~~t_1~~	~~0~~	~~CF~~	nein	~~PC_1~~	~~400~~
2.14	-	F_6	$SOC_{max,3}$	$SOC_{min,0}$	IA_5	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	I_{DCH_normal}	r_1	t_1	1	CF	Ja	PC_2	400
2.15	-	F_4	$SOC_{max,3}$	$SOC_{min,0}$	$I_{CH\_\#\#\#}$	$T_{2,cyc}$ / $T_{2,\text{CH-RT}}$	$I_{DCH\_\#\#\#}$	r_1	t_1	1	CF	nein	PC_1	400
										13				

###

5.1 Definition of Testing conditions

C_{nom} Nominal capacity (141,5 Ah)
C_{act} Actual capacity: determined in RPT

Table 5-1 Parameter table.

Temperature $\mathbf{T_{1,cyc}}$ for cycling	$T_{0,cyc}$ =**25**°C ~~$T_{1,cyc}$ =30°C~~ $T_{2,cyc}$ =**35**°C ~~$T_{3,cyc}$ =40°C~~ $T_{4,cyc}$ =45°C
Temperature $\mathbf{T_{X,CH\text{-}RT}}$ for chilling time after Charging	$T_{0,CH\text{-}RT}$ =**25**°C ~~$T_{1,CH\text{-}RT}$ =30°C~~ $T_{2,CH\text{-}RT}$ =**35**°C ~~$T_{3,CH\text{-}RT}$ =40°C~~ $T_{4,CH\text{-}RT}$ =45°C
Ambient RPT Temperature	25°C
Vergleich Ladeprofile	Laderaten ###
Normal Charging: C-rate @ SOC (for charge) $\mathbf{I_{CH\_normal}}$	Continuous Charging Curve: **Example for 25°C** (can be used for all T variations) <table><tr><td>SOC [%] @ operating point</td><td>C-Rate (10% BF Puffer ab 90% SOC)</td></tr><tr><td>0 - 80</td><td>0,50 C_{act}</td></tr><tr><td>85</td><td>0,46 C_{act}</td></tr><tr><td>90</td><td>0,38 C_{act}</td></tr><tr><td>95</td><td>0,30 C_{act}</td></tr><tr><td>100</td><td>0,23 C_{act}</td></tr><tr><td></td><td>0,05 C_{act} CV-Phase (If a smooth transition between the last two steps cannot be implemented, insert a 5s pause before proceeding to CV Step)</td></tr></table>

###

<table>
<tr><td></td><td></td></tr>
<tr><td>Normal Discharging:
C-rate (CC mode, for discharge) $\mathbf{I_{DCH\_normal}}$</td><td>1 C_{nom} (CC-Discharging)
<table><tr><th>SOC in %</th><th>Current</th><th>comment</th></tr><tr><td>100-0</td><td>1 C_{nom}</td><td>No reduction over time</td></tr></table></td></tr>
<tr><td>### -Profile for Charging:
C-rate (CC mode, for Charge) $\mathbf{I_{CH\_CATL}}$</td><td>Stepcharging ###ording the table:
<table><tr><th>SOC in %</th><th>Current</th><th>comment</th></tr><tr><td>0-45</td><td>1,1 C_{nom}</td><td>No reduction over time</td></tr><tr><td>45-80</td><td>0,58 C_{nom}</td><td rowspan="2">Continue charging Step to aimed SOC with CV-Phase if U_{max} is reached early</td></tr><tr><td>80-100</td><td>0,27 C_{nom}</td></tr><tr><td>100</td><td>0,05 C_{nom}</td><td>CV to $U_{max,dyn}$</td></tr></table></td></tr>
<tr><td>### -Profile for Discharging:
C-rate (CC mode, for discharge) $\mathbf{I_{DCH\_\#\#\#}}$</td><td>### -Disharge-Profile: (CC-Discharging)
<table><tr><th>SOC in %</th><th>Current</th><th>comment</th></tr><tr><td>100-20</td><td>1 C_{nom}</td><td rowspan="2">No reduction over time</td></tr><tr><td>20-0</td><td>0,65 C_{nom}</td></tr></table></td></tr>
<tr><td>Fast Charging:
C-rate @ SOC (for charge) $\mathbf{I_{CH\_fast}}$</td><td>Adaption of currents over lifetime to Cact:
Interpolated charging curve shall be applied
See Operating Window

Adapt Currents to Cell Temperature EBT_Temp_Cell_02 considering I_therm_cont [A]

Fast charging currents @ 25°C
<table><tr><th>SOC in % @ working point</th><th>Current/C-Rate (0,90* Imax)</th></tr><tr><td>0</td><td>4,29 C_{act}</td></tr><tr><td>10</td><td>2,89 C_{act}</td></tr><tr><td>20</td><td>2,17 C_{act}</td></tr><tr><td>30</td><td>1,84 C_{act}</td></tr><tr><td>40</td><td>1,54 C_{act}</td></tr><tr><td>50</td><td>1,25 C_{act}</td></tr><tr><td>60</td><td>1,01 C_{act}</td></tr><tr><td>70</td><td>0,83 C_{act}</td></tr><tr><td>80</td><td>0,61 C_{act}</td></tr><tr><td>90</td><td>0,44 C_{act}</td></tr><tr><td>100</td><td>0,28 C_{act}</td></tr><tr><td>100</td><td>0,050 C_{act} CV</td></tr></table>
$U_{OCV\_SOCmax,x}$ CV to 0.05C until $U_{max,dyn}$ (###ording OW)

If temperature at measurement point exeeds 35°C currents must be reduced ###ording to Operating Window.
Cell temperature reference point (Section 4.1)</td></tr>
</table>

###

<table>
<tr>
<td>Fast Discharging:
C-rate (CC mode, for discharge) I_{DCH_fast}</td>
<td>0.95 Imax in OW under considering I_term_cont limits

<table>
<tr><th>SOC in %</th><th>Current</th><th>comment</th></tr>
<tr><td>100-0</td><td>0,95 Imax C_{nom}</td><td>No reduction over lifetime</td></tr>
</table>
</td>
</tr>
<tr>
<td>SOC_{max}/SOC_{min}/DOD</td>
<td>Values based on ###-XX1455-B1

<table>
<tr><th>SOCmax operating points</th><th>OCV-values</th></tr>
<tr><td>$SOCmax_1$ = 75%</td><td>Laderichtung: 4,011 V
Entladerichtung: 3,995 V</td></tr>
<tr><td>$SOCmax_2$ = 90%</td><td>Laderichtung: 4,090 V
Entladerichtung: 4,084 V</td></tr>
<tr><td>$SOCmax_3$=100%</td><td>-</td></tr>
</table>

<table>
<tr><th>SOCmin operating points</th><th>OCV-values</th></tr>
<tr><td>$SOCmin_0$ = 0%</td><td>-</td></tr>
<tr><td>$SOCmin_1$ = 10%</td><td></td></tr>
<tr><td>$SOCmin_2$ = 20%</td><td>Laderichtung: 3,492 V
Entladerichtung: 3,433 V</td></tr>
<tr><td>$SOCmin_3$ = 40%</td><td>Laderichtung: 3,679 V
Entladerichtung: 3,635 V</td></tr>
<tr><td>$SOCmin_4$ = 50%</td><td></td></tr>
</table>

For test conditions that do not regularly approach 0 or 100% SOC, a recalibration interval of the ah-counter based on the OCV-values given in the table above must be introduced after consultation with the client.

When the SOC is reached, the charging process is interrupted.
Definiton:
$SOC=C/C_{Act}$
Definiton of DOD
DOD= $SOCmax_i$ - $SOCmin_j$</td>
</tr>
<tr>
<td>Fast Charge Proportion</td>
<td>IA_0 = 0% Normal Charging I_{CH_normal} after every Cycle
IA_1 =16,66% Fast Charging I_{CH_fast} after every sixth Cycle
IA_2 = 33% Fast Charging I_{CH_fast} after every third Cycle
IA_3 = 50% Fast Charging I_{CH_fast} after every second Cycle
IA_4 = 66% Fast Charging I_{CH_normal} after every third Cycle
IA_5 = 100% Fast Charging I_{CH_fast} after every Cycle</td>
</tr>
<tr>
<td>chilling time $t_{1,2,3,...}$ after current discharge</td>
<td>t_1 =1h</td>
</tr>
<tr>
<td>chilling time after the current laod $r_{1,2}$</td>
<td>r_1 = 0.5h
r_2 = $t_{kal.100\%/100\%-ETP}$ =64,2h @T:35C°</td>
</tr>
<tr>
<td>Modul stiffness</td>
<td>K_1 =40kN/mm → with springs
K_2 =525kN/mm → M20x4
K_3 =700kN/mm → M20x8
K_4 =350kN/mm → M12*6</td>
</tr>
</table>

<table>
<tr><td>Compression force $F_{1,2,3...}$</td><td>Initial Pressure settings

<table>
<tr><th>Pressure</th><th>Force</th><th>Springs</th></tr>
<tr><td>F_1= 212 kPa</td><td>3.6 kN @ 30% SOC</td><td>8 x violett | 4 x grün</td></tr>
<tr><td>F_2 = 425 kPa</td><td>7.2 kN @ 30% SOC</td><td>8 x grün</td></tr>
<tr><td>F_3 = 652 kPa</td><td>11,1 kN @ 30% SOC</td><td>8 x blau</td></tr>
<tr><td>F_4 = 1 MPa</td><td>17 kN @ 30% SOC</td><td>8 x blau | 8 x rot</td></tr>
<tr><td>F_5 = 1,53 MPa</td><td>26,1 kN @ 30% SOC</td><td>8 x rot</td></tr>
<tr><td>F_6 = 2,35 MPa</td><td>~~40 kN @ 30% SOC~~
30 kN @ 30% SOC</td><td>~~8 x gelb~~
8 x rot → Stempel</td></tr>
</table></td></tr>
<tr><td>Plausi-Check</td><td>PC_1: Im 1 RPT und EOT-RPT bitte bei SOCmin und SOCmax, die absoluten Plattenabstände an vier Seiten messen.
PC_2: Im 1 RPT bis 5 RPT und EOT-RPT bitte bei SOCmin und SOCmax, die absoluten Plattenabstände an vier Seiten messen.</td></tr>
<tr><td>Force Sequence f</td><td>f_1=[F_1–F_3–F_5]
f_2=[F_2–F_4–F_6]

The force shall be adjusted after every 13% loss of capacity in the SOHc (±1%) after each RPT. If the new force is set, the RPT is repeated. For an example compare to the Figure 3.</td></tr>
<tr><td>Constant Force (CF)</td><td>The cell is tensioned and aged under a constant force ###ording table 3. (without compression pad)

Compressing Procedure:

1. Presse aufrecht hinstellen und Pressen-Platten abnehmen
2. Kraftmessdose nullen
3. Zelle mit Positionierungshilfe auf untere Pressenplatte auflegen
4. Obere Platte auflegen

Schritte 6-8 innerhalb von 5 Minuten durchführen:

5. Vorsichtig Zielkraft über Kreuz einstellen
6. Presse drehen
7. Genaue Kraft final einstellen (+- 10% oder kleiner 500N bei hohen Kräften)

Relaxierte Kraft nach 12-24h dokumentieren und RPT starten.
Sollte die Kraft um 10% oder bei großen Kräften um mehr als 500N von der Zeilkraft abweichen, mit ### über weiteres Vorgehen abstimmen.</td></tr>
<tr><td>Constant Stiffness (CS)</td><td>The cell is tensioned and aged under a constant stiffness with compression pad provided by ### .

Compressing Procedure:

1. Presse aufrecht hinstellen und Pressen-Platten abnehmen
2. Kraftmessdose nullen
3. Spannmatten auf Zelle aufkleben
4. Zelle mit Positionierungshilfe auf untere Pressenplatte auflegen
5. Obere Platte auflegen

Schritte 6-8 innerhalb von 5 Minuten durchführen:</td></tr>
</table>

	6. *Vorsichtig Zielkraft über Kreuz einstellen* 7. *Presse drehen* 8. *Genaue Kraft final einstellen (+- 10% oder kleiner 500N bei hohen Kräften)* Relaxierte Kraft nach 12-24h dokumentieren und RPT starten. Die Kraft nicht noch einmal nachziehen.
RPT	RPT's shall be performed • BOT, • every 50 cycles • or every **25 cycles** for high pressure Settings (F4,F5) and Const. Stiffness Settings • EOT.
EOT	End of Measurement after • reaching 60% SOHc (Cact) • or after consultation with the commissioner, an earlier EOT can be agreed

Generic tempering time – if not otherwise specified: For each Kelvin difference use min 6 min tempering time Example: 25°C → T=-10°C use min. 3.5h for tempering (if test equipment is too weak to fulfill a thermal equilibration ΔT<0.5K/5min → extend tempering duration; the contractor shall ensure that the temperature requirement is fulfilled for the complete cell, ΔT<0.5K over complete cell)

Figure 3: Illustration of sequences

###

5.2 RPT procedure

Table 5: Test procedure for RPT (determination of actual capacity C_{act}, $C_{25°C,C/3}$, $E_{25°C,C/3}$ and $\eta_{25°C,C/3}$).

Step	Command	Parameter	Exit Condition	Comment	Bookmark_ Counter_1
1	CYCLESTART-01			Pre Cycle and determination of C_{act}	
2	TEMP SET	T = 25 °C			10000
3	CHILL		t-step = 30 min*	chilling time for tempering the cell. *CHILLthe cell for each Kelvin temperature difference 6 min, at least 30 min.	10000
4	CH	I = C/3 $U = U_{OC,max}$	I < 0.05 C	No derating required	10000
5	CHILL		t-step = 30 min*	chilling time for tempering the cell. *CHILLthe cell for each Kelvin temperature difference 6 min, at least 30 min.	10000
6	DCH	I = C/3 $U = U_{OC,min}$	I < 0.05 C	For comparability C/3 to $U_{OC,min}$ vs. C/3 to $U_{dyn,min}$	11003
7	CHILL		t-step = 30 min*	chilling time for tempering the cell. *CHILLthe cell for each Kelvin temperature difference 6 min, at least 30 min.	10000
8	CH	I = C/3 $U = U_{dyn,max}$	I < 0.05 C	No derating required	12003
9	SET	Ah-Set = 0		Set/reset Ah-Counter after full charge to reduce drift	10000
10	CHILL		t-step = 30 min	Time step in an open circuit, no current flux	10000
11	DCH	I = C/3	$U \leq U_{dyn,min}$	Determination of C_{act} based on C/3 C_{act} is the amount of charge, which can be charged and discharged within the OCV-Voltage limits. C_{act} is the basis for the definition of the limits of the “Ah-counter”	11001
12	CHILL		t-step = 30 min	Time step in an open circuit, no current flux	10000
13	CYCLEEND-01	COUNT = 1			
14	CYCLESTART-02			Determination of C/10 discharge capacity	
15	CH	I = C/3 $U = U_{dyn,max}$	I < 0.05 C	C/3 charge to calculate energy efficiency No derating required	12001
16	SET	Ah-Set = 0		Set/reset Ah-Counter after full charge to reduce drift	10000
17	CHILL		t-step = 30 min	CHILLfor electrical relaxation	10000
18	DCH	I = C/10	$U = U_{OC,min}$	Determination of C/10 discharge capacity CC	11004
19	CHILL		t-step = 30 min	CHILLfor electrical relaxation	10000
20	CH	I = C/3 $U = U_{dyn,max}$	I < 0.05 C	C/3 charge, No derating required Reset Ah-Counter after full charge.	10000
21	SET	Ah-Set = 0		Set/reset Ah-Counter after full charge to reduce drift	10000
22	CHILL		t-step = 10 min		10000
23	CYCLEEND-02	COUNT = 1			
24	CYCLESTART-03			Determination of interal resistance based on OAD529	
25	DCH / CH	I = C/3*	Ah-Counter < - xx C_{act} (DCH)	Set the SOC to xx % based on C_{act} and ###ording to the supporting points in **Table 6**	10000

###

		U_{min} = $U_{OC,min}$ U_{max} = $U_{OC,max}$	or Ah-Counter > -xx C_{act} (CH)	*If necessary, derate the C-rate ###ording to operating window	
26	CHILL		t-step > 1 h	CHILLfor electrical relaxation	10000
27	DCH / CH	I = xx C*	t > t_{Pulse} U < $U_{dyn,min}$ U > $U_{dyn,max}$ Ah-Counter < -C_{act} Ah-Counter > 0	Pulse to evaluate Ri. Pulse shall be done in CC mode without derating. *The current of the Ri pulse shall not be derated over the pulse duration. If the pulse current violates the operating window, stop the pulse.	### ording to table 6
28	CHILL		t-step = 10min	CHILLfor Relaxation	10000
29	CYCLEEND-03	COUNT = XX		End of Cycle for Determination of interal resistance	

Table 6: Supporting points for Ri determination in case of performance tests. (based on OAD529)

Ri pulse	T / °C	SOC / %	t_{pulse} / s	CH or DCH	C-rate* or current I / A	Bookmark_Counter_1
#1	25	50	180	DCH	$1C_{Nom}$	31001
#2	25	50	180	CH	$1C_{Nom}$	32002

Bookmarks:

Bookmark Counter 1: Pulses and Capacities
Bookmark Counter 3: Distinction between CH and Dch (for cycling)
Bookmark Counter 4: Cycles 1-x

For more details see “Prozessanweisung Messdaten 8.0”

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5.3 Cyling procedure

Table 5-2: Test Procedure

Step	Command	Parameter	Exit Condition	Comment	Bookmark Counter 1	Bookmark Counter 3
1	CYCLESTART-01			Pre-Cycle for full residual capacity and charge capacity determination		
2	TEMP SET	T = 25°C			10000	0
3	CHILL		t-step = 30 min*	chilling time for tempering the cell. *CHILLthe cell for each Kelvin temperature difference 6 min, at least 30 min.	10000	0
4	CH	I = C/3 U = $U_{dyn,max}$	I < 0.05 C	No derating required	10000	0
5	SET	Set-Ah = 0		Set Ah-Counter after full charge	10000	0
6	CHILL		t-step = 30 min	Time step in an open circuit, no current flux	10000	0
7	CYCLEEND-01	COUNT = 1				
8	CYCLESTART-02			Determination of discharge capacity		
	DCH	I = C/3	U ≤ $U_{dyn,min}$	Determination of C_{act} (Optional) If C_{act} can be taken from previous RPT, steps 2 – 10 can be skipped	11001	0
10	CHILL		t-step = 1 min	CHILLfor electrical relaxation	10000	0
11	TEMP SET	T = $T_{X,cyc}$ °C		Temperature setting for the cycling	10000	0
12	CHILL		t-step = 30 min*	chilling time for tempering the cell. *CHILLthe cell for each Kelvin temperature difference 6 min, at least 30 min.	10000	0
13	CYCLEEND-02	COUNT = 1				
14	CYCLESTART-03			Cycling profile	**Bookmark Counter 4:** +1 for every Cycle	
15	CH	I = I_{CH}*		*Charge cell ###ording to charging profile definded in Chapter 5. **Reset Ah-Counter after every full charge.**	1-xx	1
16	CHILL		t-step = 20min	Time step in an open circuit, no current flux (see $t_{1,...}$ in table 4.2). For each chilling time you have to do one test.	1-xx	0
17	CH / DCH	I = C/3 U= OCV value of SOC_{max}	I < 0.05 C_{nom}	If SOC_{max} < 100% add recalibration step after 20min of CHILLtime (step 16)	1-xx	100
18	CHILL		t-step = $\mathbf{r_x}$ – 20min		1-xx	0
19	DCH	I = I_{DCH}*	U < U_{min_dyn}	*Discharge cell ###ording to charging profile definded in Chapter 5.	1-xx	2
20	CHILL		t-step = $\mathbf{t_x}$	Time step in an open circuit, no current flux.	1-xx	0
21	CYCLEEND-03	COUNT = x		EOT – see Table 5-1		

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