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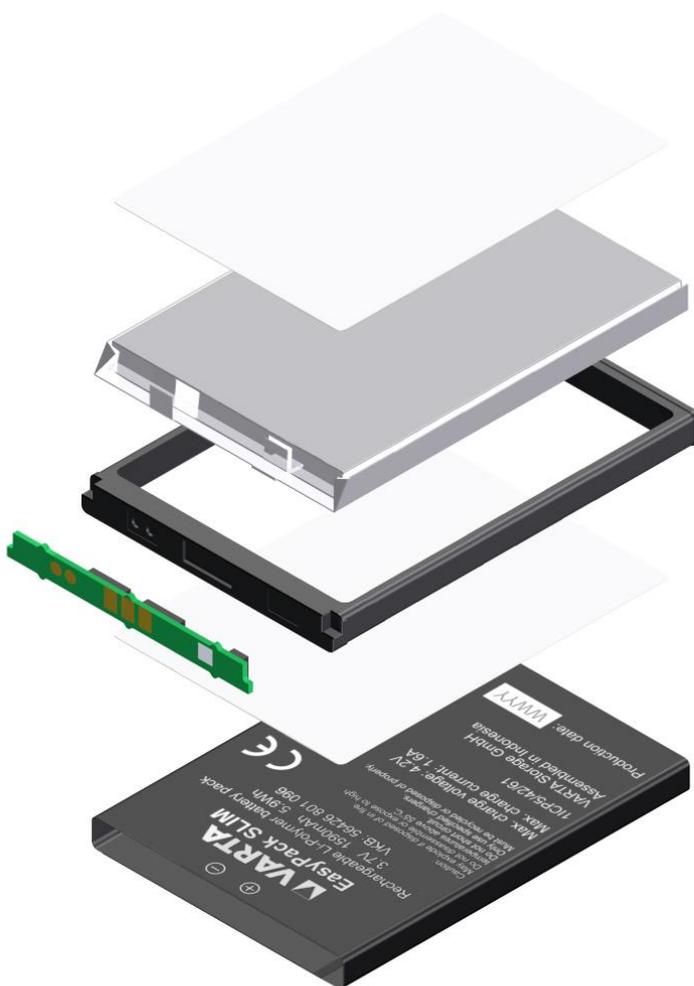


www.texim-europe.com



CELL PAC LITE

Technical Handbook



Overview



CellPac LITE - Our Range of Standard Lithium-Ion Packs

We offer a range of pre-configured battery packs that are immediately available for standard applications: CellPac LITE. They are made exclusively of cylindrical or prismatic lithium batteries. CellPac LITE power packs are fitted with an electronic protective switch and additional overcurrent protection. They comply with the requirements of safety standard UL 1642.



CellPac BLOX – Semi-Custom Battery Design

CellPac BLOX suits those customers in need of semi-customization and where design-cycles, engineering costs and time to market must be minimized for success. Battery designs are limited in their complexity, but available for nearly no NRE cost and development effort.



CellPac PLUS – Custom Lithium Rechargeable Design Service

VARTA Storage's CellPac PLUS service focuses on designing and manufacturing customer-specific battery packs for mobile equipment. VARTA Storage combines its expert knowledge in cell chemistry and electronics with extensive market experience – for example in the fields of communications, medical technology, robotics and special-industrial. Because they are designed for specific applications, CellPac PLUS power packs offer maximum safety, reliability and efficiency.

Find more information on the website: www.varta-storage.com

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For latest technical data please refer to our data sheets which you will find here on our website:

www.varta-storage.com/produkte/power/downloads/

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1. Introduction of CellPac LITE

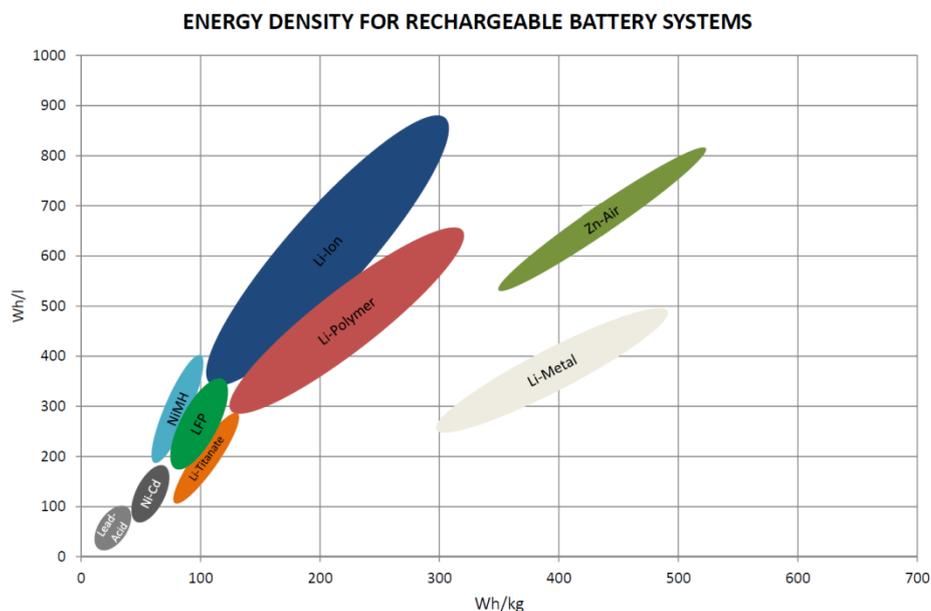
CellPac LITE is the standard range of lithium-rechargeable battery products from VARTA Storage GmbH.

We offer a range of pre-configured battery packs that are immediately available for standard applications. They are made exclusively from cylindrical or prismatic form-factor cells.

CellPac LITE power packs are fitted with an electronic protective circuit module (PCM) with additional overcurrent protection. All cells used comply with the requirements of the safety standard UL1642 and many packs are certified to additional safety standards UL2054 or IEC62133. These are a complete battery solution, complete with the necessary cables and connectors that are ready for use.

SYSTEM HIGHLIGHTS OF VARTA Storage CellPac LITE BATTERIES:

▶ Excellent energy density	▶ Good cycle-life (500 full cycles typically)
▶ Variety of form-factors	▶ Low self-discharge
▶ High cell voltage (~3.7 V nom.)	▶ IEC62133 ed. 2 certification for some packs
▶ UL2054 listing for EasyPack batteries	▶ Wide temperature range
▶ Charging technique compatible with Li-Ion (const. I / const. V)	▶ ISO9001 certified for design and manufacture
▶ Good high-rate discharge capability up to 2.5A continuous (see specifications)	▶ Good recovery of capacity after storage, even at elevated temperature



Comparison of different rechargeable battery systems regarding their energy densities

1.1 Definitions and Standards

BASICS

Unless otherwise stated the technical values and definitions are based on room temperature conditions (RT = 22°C ± 3°C).

SYSTEM – SPECIFIC DATA

The gravimetric energy density depends on battery size and ranges from approx. 170-200 Wh/kg and the volumetric energy density ranges from approx. 350-450 Wh/l incl. PCM.

VOLTAGE DEFINITIONS

Open Circuit Voltage (OCV): Equilibrium potential 3.0 V to 4.2 V on average, dependent on temperature, storage duration and state of charge.
Nominal Voltage is typically 3.7 V, see specifications for individual batteries.

End of Discharge Voltage (VE):
The voltage at the end of discharging is 2.75 V to 3.2 V per cell, depending on discharge rate and temperature.
End of Charge Voltage: Terminal voltage after charge is 4.2 V.

CAPACITY DEFINITIONS

The capacity C of a cell is defined by the discharge current I and the discharge time t : $C = I * t$
 I = constant discharge current
 t = duration from the beginning of discharge until the end of discharge voltage is reached

Rated Capacity: The rated capacity C denotes the energy amount in mAh (milli-Ampère hours) that the cell can deliver at the 5h discharge rate (0.2 CA). The reference temperature is +22°C ± 3°C, and the final discharge voltage 3.0 V.

Available Capacity:
Factors which affect the available capacity are:

- ▶ Rate of discharge
- ▶ End of discharge voltage
- ▶ Ambient temperature
- ▶ State of charge
- ▶ Age
- ▶ Cycle history

At higher than nominal discharge rates the available capacity is accordingly reduced.

CURRENT DEFINITIONS

Charge and discharge rates may be given as multiples of the Rated Capacity (C) in Ampères (A) with the term CA.
Example:
Rated Capacity $C = 1000$ mAh
0.1 CA = 100 mA, 1 CA = 1000 mA

Nominal Discharge Current:
The nominal discharge current of a CellPac LITE battery is the 5 hour discharge current (0.2 CA). It is the current at which the nominal capacity of a cell is discharged in 5 hours.
 $I = C/t = C/5 = 0.2$ CA when $t = 5$ h

1.2 General Design and Application Criteria

Choose the best suitable battery from our wide range of CellPac LITE batteries according to your needs relating to the specific application and its corresponding planned operation conditions:

The most important criteria for the type-selection are these:

- ▶ Required minimum operating time
- ▶ Max. and average current drain
- ▶ Min. and max. voltage of operation
- ▶ Operating temperature range
- ▶ Mechanical properties
- ▶ Available space
- ▶ Environmental conditions

All CellPac LITE batteries are equipped with our specially selected and carefully designed safety electronic modules which prevent the risks of hazards due to any foreseeable abuse / misuse.

1.3 Features

VARTA Storage CellPac LITE batteries are first choice for a number of modern high-tech products in the portable electronics field. They provide long lasting, reliable main power, occupying a minimum of space and weight in the corresponding devices.

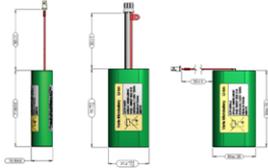
VARTA Storage CellPac LITE batteries fulfill the most important design-in requirements: Reliable high-power output, design flexibility with a minimum of space requirement and a slim form-factor.

Feature	Advantage	Customer Benefit
UN38.3 Certified	Approved for Transport	Declaration of Conformity Available
IEC62133 Certified ¹ UL Recognized/Listed ¹	Ready for design-in for certified applications	Reduced design-in cost
Multiple form-factors	Design flexibility	Product design convenience
Excellent overall performance	Supports many various applications	Highly satisfying product under extensive conditions of use
Complete pack solution	Supply of cells, electronics and assembly	Integrated performance and safety
Worldwide branch offices and distribution with technical support	Close customer relationship	Local contact, local knowledge - local language

2. Quick Reference Table CellPac LITE



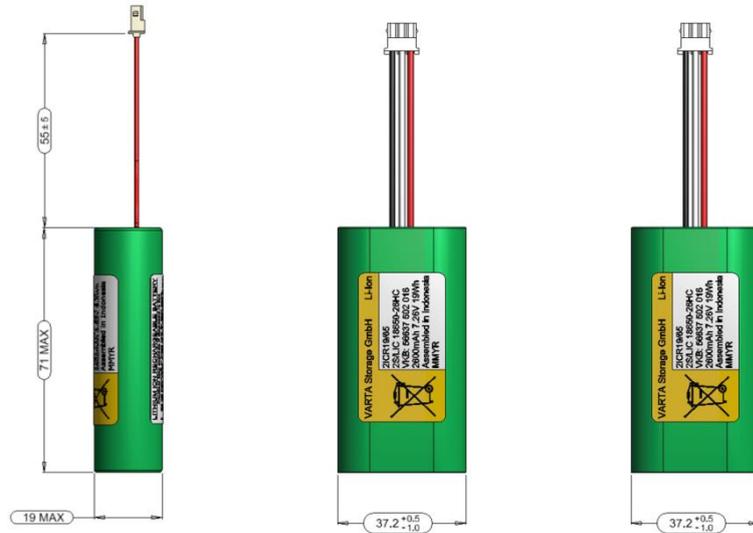
2.1 Reference Table: Li-Ion Cylindrical CellPac LITE



	1/LiIC 18650-26 HC PCM S WVC	2S/LiIC 18650-26 HC PCM S WVC	2P/LiIC 18650-26 HC PCM S WVC
Detailed information on:	Page 16	Page 16	Page 16
Order Number (UK)	55537 201 014	55537 502 013	55537 502 014
Rated Nominal Capacity (mAh)	2600	2600	5200
Nominal Voltage (V)	3.63	7.26	3.63
Operating Temperature Range			
Charging	-0°C to +45°C	-0°C to +45°C	-0°C to +45°C
Discharging	-20°C to +60°C	-20°C to +60°C	-20°C to +60°C
Storage	-20°C to +45°C	-20°C to +45°C	-20°C to +45°C
Life Expectance (typical)			
No. of cycles (>70% on Cmin)	300	300	300
Internal Impedance			
Approximate (mOhm)@1kHz	120	220	100
Miscellaneous			
NTC	Yes	Yes	Yes
Connector	Yes	Yes	Yes
Certification	UN38.3 IEC62133 Edition 2	UN38.3 IEC62133 Edition 2	UN38.3 IEC62133 Edition 2

Technical Handbook VARTA Energy GmbH
Waldstr. 28-34 20116
Borstel/Stein-Strasse 1
30775, Neustadt
Germany Page | 8

2.1 Reference Table: Li-Ion Cylindrical CellPac LITE 1/1



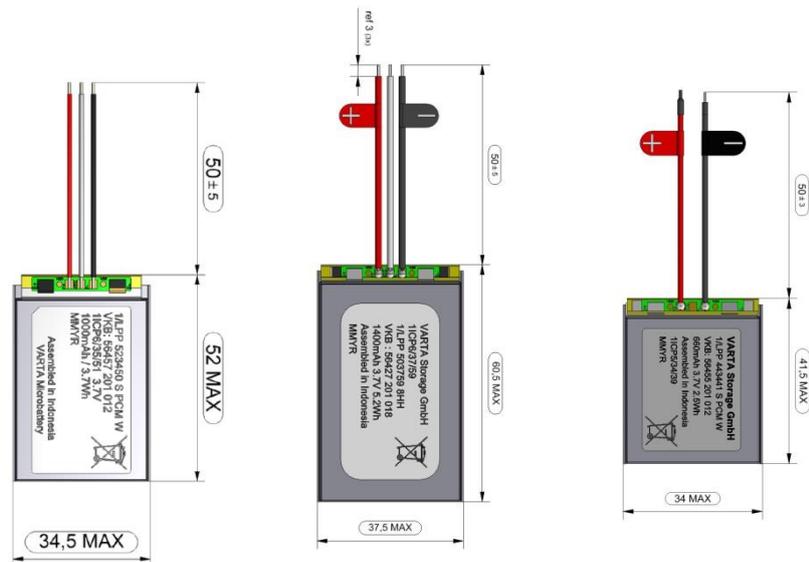
1/LIC 18650-26
SKE PCM S WC

2S/LIC 18650-26
SKE PCM S WC

2P/LIC 18650-26
SKE PCM S WC

Detailed Information on:	Page 18	Page 20	Page 22
Order Number (VKB)	56653 201 012	56653 502 012	56653 502 013
State of Charge	~ 25 %	~ 25 %	~ 25 %
Rated Nominal Capacity (mAh)	2600	2600	5200
Nominal Voltage (V)	3.7	7.3	3.7
Operating Temperature			
Charging	0°C to +45°C	0°C to +45°C	0°C to +45°C
Discharging	-20°C to +60°C	-20°C to +60°C	-20°C to +60°C
Storage	-20°C to +20°C	-20°C to +20°C	-20°C to +20°C
Life Expectance (typical)			
No. of cycles (on Cmin)	300 (80%)	300 (80%)	300 (70%)
Internal Impedance			
Approximate (mOhm)@1kHz	120	220	100
Miscellaneous			
NTC	None	Yes	Yes
Connector	None	None	None
Certification	UN38.3 IEC62133 Edition 2	UN38.3 IEC62133 Edition 2	UN38.3 IEC62133 Edition 2

2.2 Reference Table: Li-Ion Pouch CellPac LITE 1/2



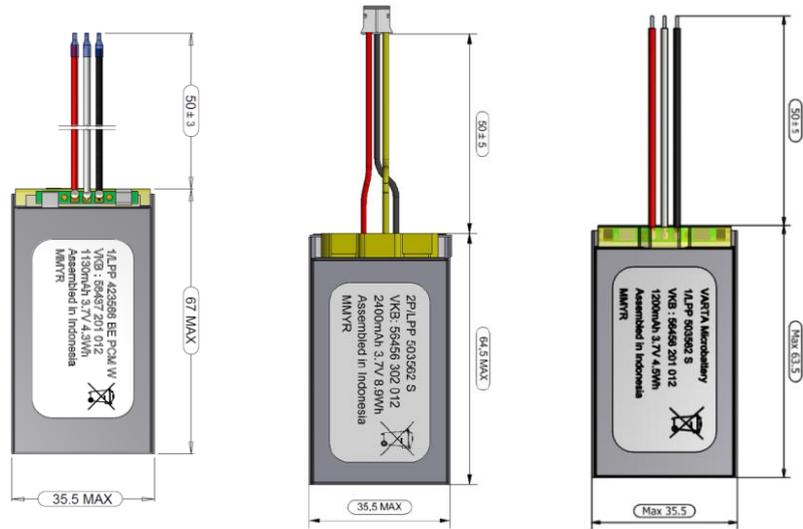
1/LPP 523450 S
PCM W

1/LPP 503759 8HH
PCM W

1/LPP 443441 S
PCM W

Detailed Information on:	Page 18	Page 20	Page 22
Order Number (VKB)	56457 201 012	56427 201 020	56455 201 012
State of Charge	~ 50 %	< 30 %	~ 50 %
Rated Nominal Capacity (mAh)	1000	1400	660
Nominal Voltage (V)	3.7	3.7	3.7
Operating Temperature			
Charging	0°C to +45°C	0°C to +45°C	0°C to +45°C
Discharging	-10°C to +60°C	-20°C to +60°C	-10°C to +60°C
Storage	-20°C to +45°C	at 23°C	-20°C to +45°C
Life Expectance (typical)			
No. of cycles (on Cmin)	500 (80%)	500 (80%)	500 (70%)
Internal Impedance			
Approximate (mOhm)@1kHz	100	100	120
Miscellaneous			
NTC	Yes	Yes	None
Connector	None	None	None
Certification	UN38.3 IEC62133 Edition 2	UN38.3 IEC62133 Edition 2	UN38.3 IEC62133 Edition 2

2.3 Reference Table: Li-Ion Pouch CellPac LITE 2/2



1/LPP 423566 BE
NTC W

2P/LPP 503562 S
PCM WC

1/LPP 503562 S
PCM W

Detailed Information on:	Page 24	Page 26	Page 26
Order Number (VKB)	56437 201 012	56456 302 012	56456 201 012
State of Charge	~ 50 %	~ 50 %	~ 50 %
Rated Nominal Capacity (mAh)	1160	2400	1200
Nominal Voltage (V)	3.7	3.7	3.7
Operating Temperature			
Charging	0°C to +45°C	0°C to +45°C	0°C to +45°C
Discharging	-20°C to +60°C	-10°C to +60°C	-10°C to +60°C
Storage	-20°C to +45°C	-20°C to +60°C	-20°C to +60°C
Life Expectance (typical)			
No. of cycles (on Cmin)	400 (75%)	500 (70%)	500 (70%)
Internal Impedance			
Approximate (mOhm)@1kHz	120	90	100
Miscellaneous			
NTC	Yes	Yes	Yes
Connector	None	Yes	None
Certification	UN38.3	UN38.3	UN38.3

2.4 Reference Table: EasyPack 1/2



EasyPack S

EasyPack L

EasyPack XL

Detailed Information on:	Page 22	Page 26	Page 26
Order Number (VKB)	56455 701 099	56456 701 099	56456 702 099
State of Charge	~ 50 %	~ 50 %	~ 50 %
Rated Nominal Capacity (mAh)	660	1200	2400
Nominal Voltage (V)	3.7	3.7	3.7
Dimensions			
Height (mm)	5.8	6.4	11.4
Width (mm)	35.4	36.6	36.6
Length (mm)	43.5	64.5	64.5
Weight, approx. (g)	14g	26g	48g
Operating Temperature			
Charging	0°C to +45°C	0°C to +45°C	0°C to +45°C
Discharging	-10°C to +60°C	-10°C to +60°C	-10°C to +60°C
Storage	-20°C to +45°C	-20°C to +45°C	-20°C to +45°C
Life Expectance (typical)			
No. of cycles (>70% on Cmin)	>500	>500	>500
Internal Impedance			
Approximate (mOhm)@1kHz	150	99	68
Miscellaneous			
NTC and ID Pin	Yes	Yes	Yes
Certification	UN38.3 UL Listing IEC62133 Edition 2	UN38.3 UL Listing IEC62133 Edition 2	UN38.3 UL Listing IEC62133 Edition 2

2.5 Reference Table: EasyPack 2/2



EasyPack PLUS

Detailed Information on:	Page 14
Order Number (VKB)	56637 702 099
State of Charge	~ 25 %
Rated Nominal Capacity (mAh)	5200
Nominal Voltage (V)	3.63
Dimensions	
Height (mm)	21.2
Width (mm)	40.6
Length (mm)	75.1
Weight, approx. (g)	105g
Operating Temperature	
Charging	-0°C to +45°C
Discharging	-20°C to +45°C
Storage	-20°C to +45°C
Life Expectance (typical)	
No. of cycles (>67% on Cmin)	>300
Internal Impedance	
Approximate (mOhm)@1kHz	80
Miscellaneous	
NTC and ID Pin	Yes
Certification	UN38.3 UL Listing IEC62133 Edition 2

3. Charging / Discharging

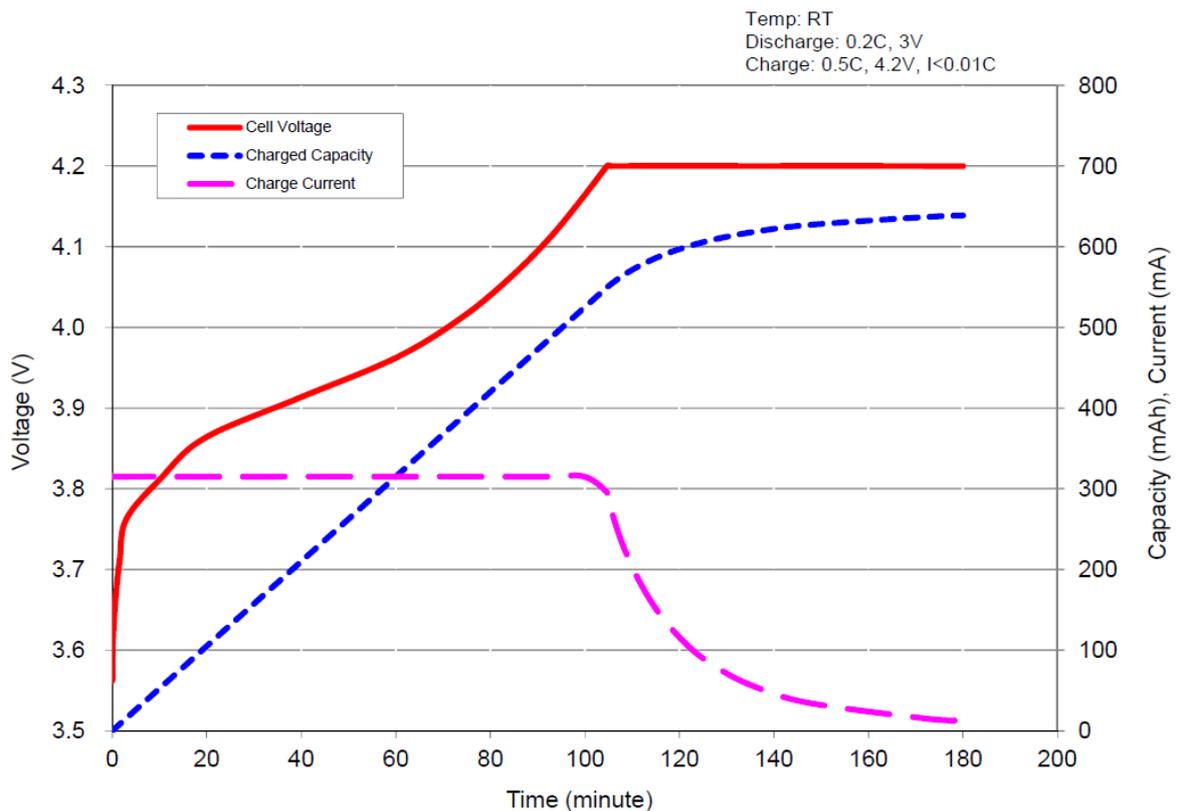
3.1 Charging

Fast charging can be achieved in a temperature range of 0 ... +45°C.

The current of charging needs to be limited to individual specification of the battery selected. Limiting factors may be the PCM, wire connector assembly or the cell itself.

In order to avoid overcharging along with damaging the battery or even hazardous situations, the charging voltage has to be limited strictly to 4.2 V per cell, see the individual specification for your battery choice for the most in detail information. It is recommended to terminate the charging either after 3hrs and/or after the charging current falls below 0.02 C.

The charging process is illustrated below showing current and voltage of a LPP 443441 S battery using 1 C charging.

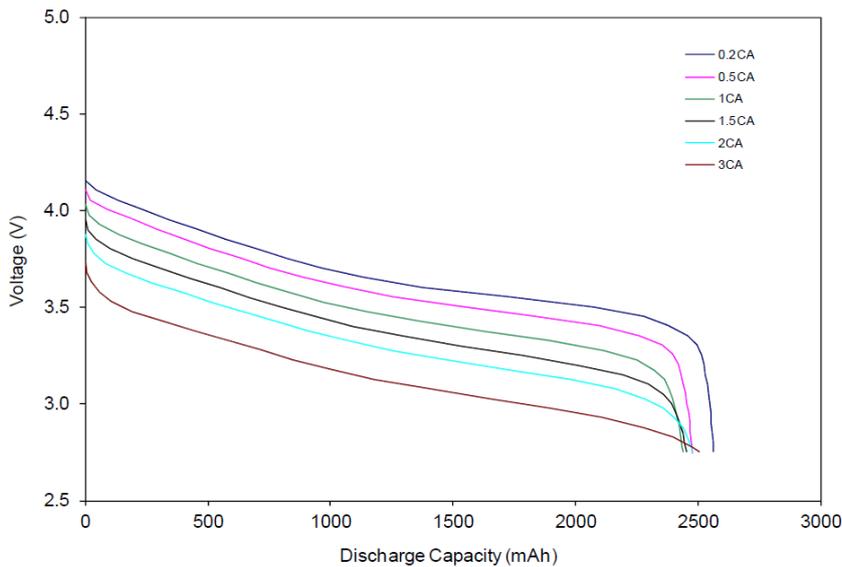


Example cell charging characteristics

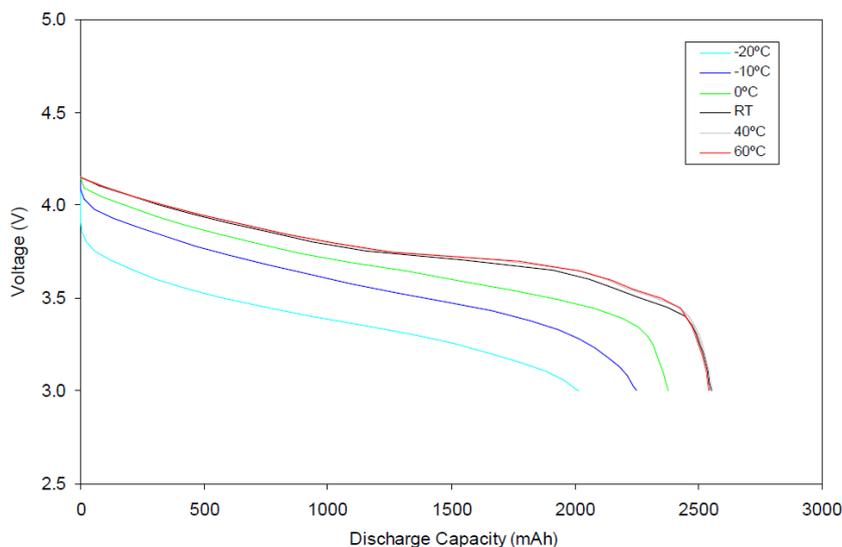
3.2 Discharging

Since all CellPac LITE batteries are delivered with a safety-circuit the maximum current rating established in the specification must be observed. There are two levels of overcurrent protection of which the first one will lead to a reversible interruption of current supply, while exceeding the second level will make the battery unusable permanently.

Please see the individual Product Information sheets for details of the safety parameters built into our modules which are set differently depending on the type designation.



Example discharge curves with the C rates as parameter



Example discharge at 1C with the temperature as parameter

4. Individual Cell Specifications

4.1 Technical Cell Data: LIC 18650-26 SKE PCM S WC

Relevant for the following model:

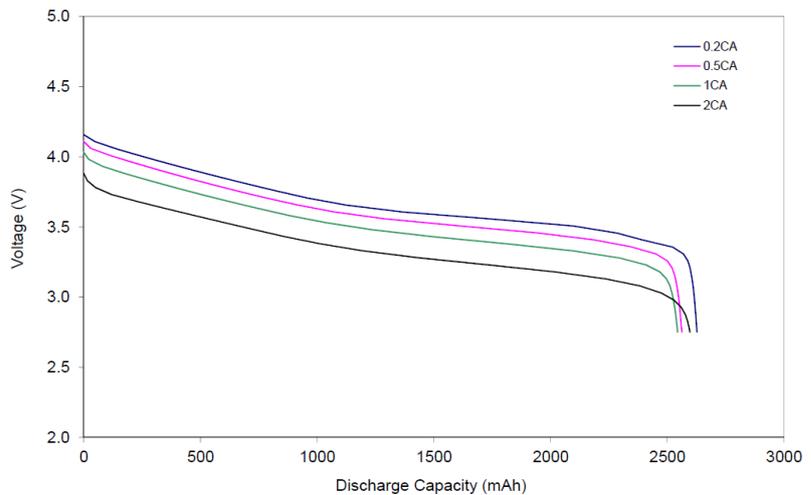
- ▶ 1/LIC 18650-26 SKE PCM S WC
P/N: 56653 201 012**
- ▶ 2S/LIC 18650-26 SKE PCM S WC
P/N: 56653 502 012**
- ▶ 2P/LIC 18650-26 SKE PCM S WC
P/N: 56653 502 013**

LIC 18650-26 SKE Discharge Profile

Test Conditions:

- 1 – 3 cycles Charge 0.5; tmax = 3h;
 Imin = 0.02C; 4.2V
 Discharge 1.0C
 UEOD = 3.0V
- 2 – 1 cycle Charge 1.0C; tmax = 3h;
 Imin = 0.02C; 4.2V
 Discharge 0.2C
 UEOD = 3.0V

Maximum Discharge Current taken from the product specification

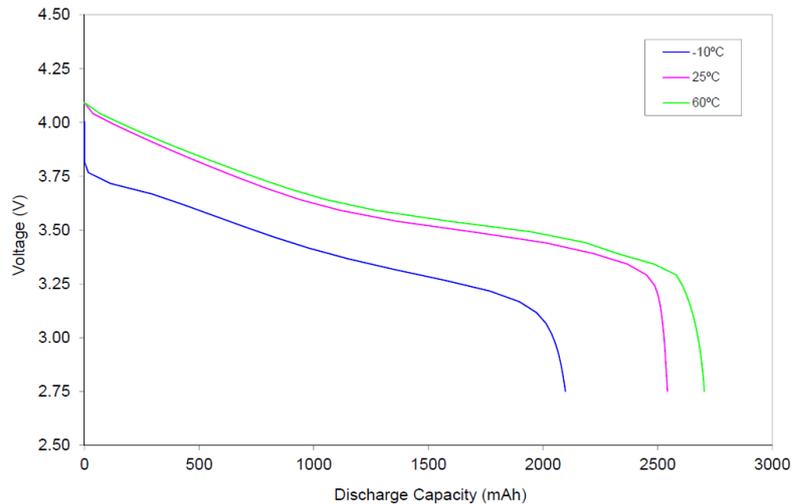


LIC 18650-26 SKE Temperature Profile @ 0.5C

Test Conditions:

Charge (0.5C; t = 3h; Imin 0.02C; Umax = 4.2V at room temperature)
4h rest at the below mentioned temperatures

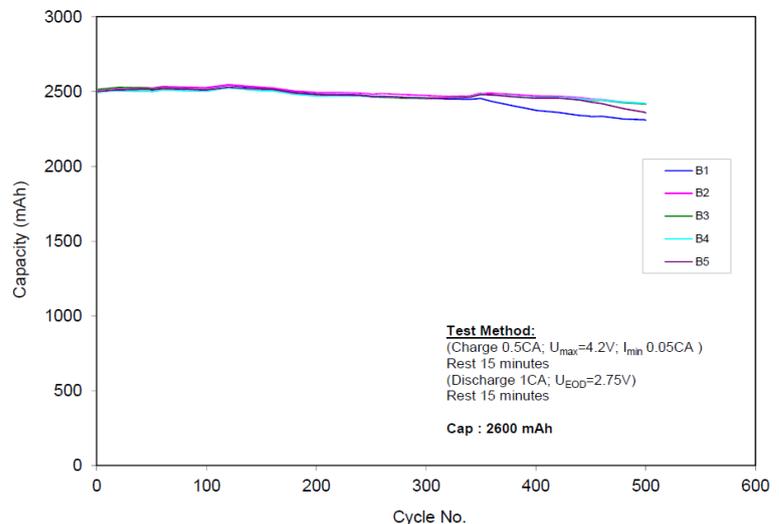
Discharge (0.2C; UEOD = 3.0V) at the following temperatures:
60°C, 25°C, -10°C
Starting with 0.2C at -20°C; always charging at RT after 4h rest time



LIC 18650-26 SKE Cycling at 20°C

Test Conditions:

- a) Capacity charge (0.5C; t = 3h; Imin 0.02C; Umax = 4.2V) discharge (1.0C; UEOD = 3.0V) Determination of the 0.2C capacity (discharge 0.2C; UEOD = 3.0V) after charging each 50 cycles
- b) Impedance measurements before and after cycling reference impedance according to specification of cell.
- c) Thickness measurement before and after cycling reference thickness according to specification of cell-



4.2 Technical Cell Data: LPP 523450 S

Relevant for the following model:

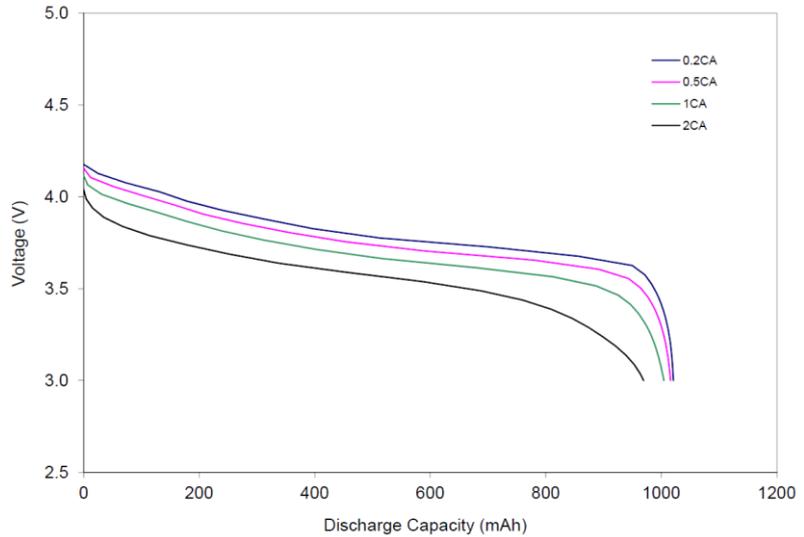
- ▶ 1/LPP 523450 S PCM W
P/N: 56457 201 012

LPP 523450 S Discharge Profile

Test Conditions:

- 1 – 3 cycles Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 1.0C
UEOD = 3.0V
- 2 – 1 cycle Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 0.2C
UEOD = 3.0V

Maximum Discharge Current taken from the product specification

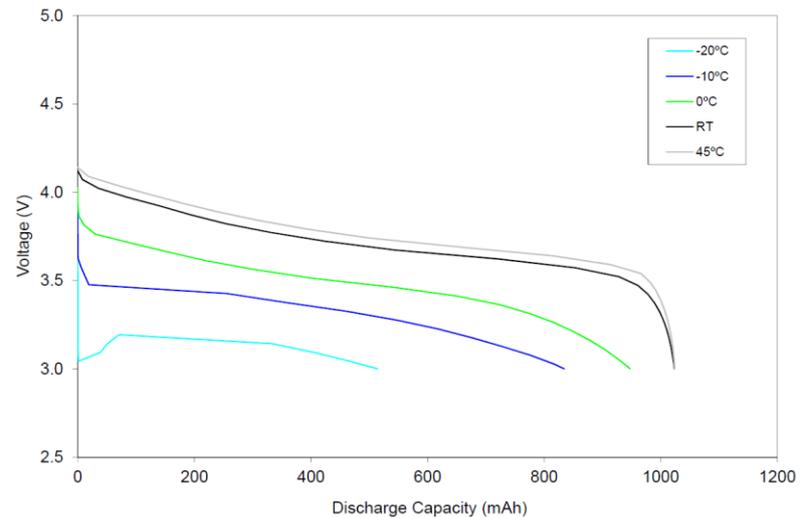


LPP 523450 S Temperature Profile @ 1C

Test Conditions:

Charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V at room temperature)
4h rest at the below mentioned temperatures

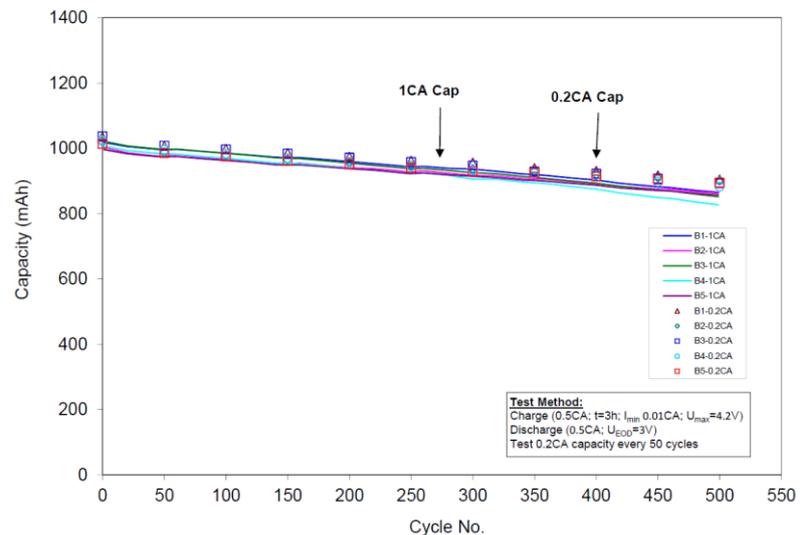
Discharge (0.2C; UEOD = 3.0V) at the following temperatures:
60°C, 40°C, RT, 0°C, -10°C, -20°C
Starting with 0.2C at -20°C; always charging at RT after 4h rest time



LPP 523450 S Cycling at 20°C

Test Conditions:

- d) Capacity charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V) discharge (1.0C; UEOD = 3.0V) Determination of the 0.2C capacity (discharge 0.2C; UEOD = 3.0V) after charging each 50 cycles
- e) Impedance measurements before and after cycling reference impedance according to specification of cell.
- f) Thickness measurement before and after cycling reference thickness according to specification of cell-



4.3 Technical Cell Data: LPP 503759 8HH

Relevant for the following model:

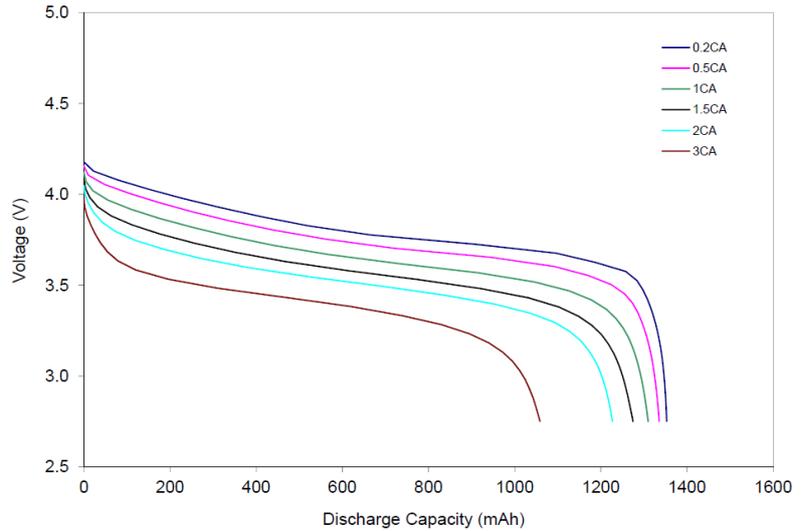
- ▶ **1/LPP 503759 8HH PCM W**
P/N: 56427 201 020

LPP 503759 8HH Discharge Profile

Test Conditions:

- 1 – 3 cycles Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 1.0C
UEOD = 3.0V
- 2 – 1 cycle Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 0.2C
UEOD = 3.0V

Maximum Discharge Current taken from the product specification

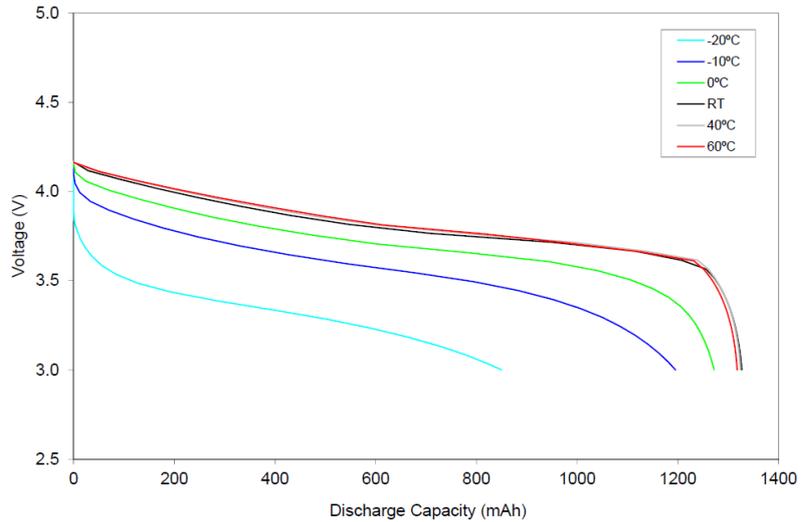


LPP 503759 8HH Temperature Profile @ 1C

Test Conditions:

Charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V at room temperature)
4h rest at the below mentioned temperatures

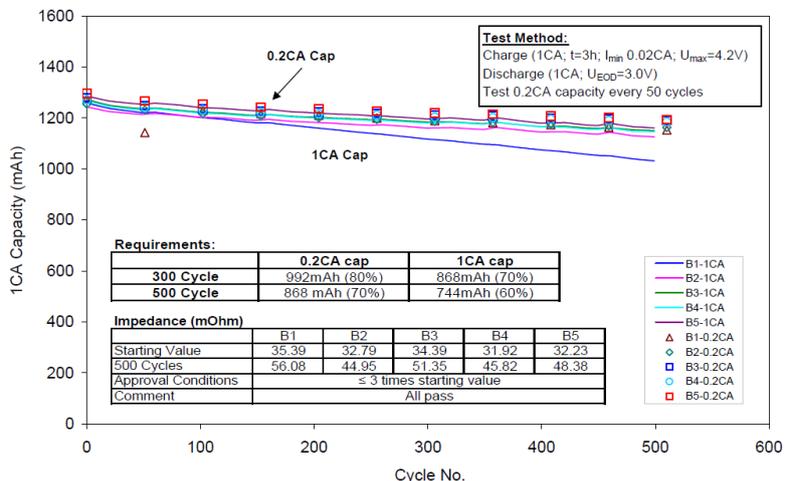
Discharge (0.2C; UEOD = 3.0V) at the following temperatures:
60°C, 40°C, RT, 0°C, -10°C, -20°C
Starting with 0.2C at -20°C; always charging at RT after 4h rest time



LPP 503759 8HH Cycling at 20°C

Test Conditions:

- a) Capacity
charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V)
discharge (1.0C; UEOD = 3.0V)
Determination of the 0.2C capacity (discharge 0.2C; UEOD = 3.0V) after charging each 50 cycles
- b) Impedance measurements before and after cycling reference impedance according to specification of cell.
- c) Thickness measurement before and after cycling reference thickness according to specification of cell-



4.4 Technical Cell Data: LPP 443441 S

Relevant for the following model/s:

- ▶ **1/LPP 443441 S PCM W**
P/N: 56455 201 012

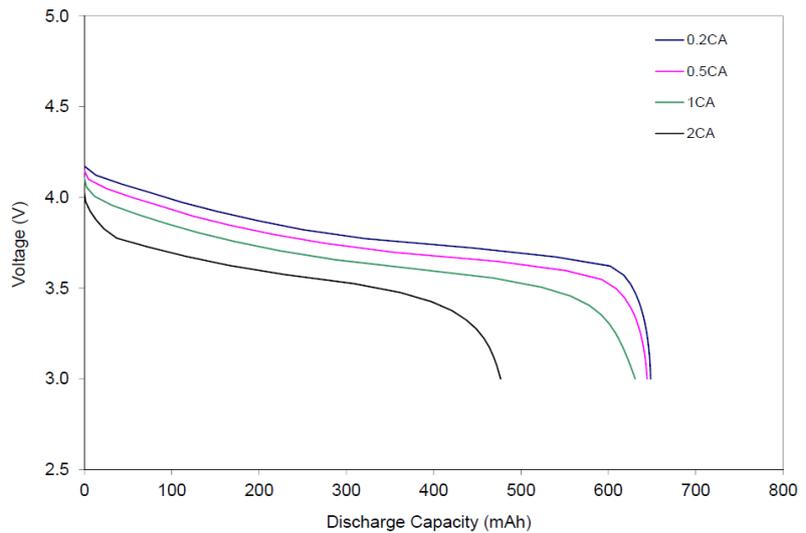
- ▶ **EasyPack S**
P/N: 56455 701 099

LPP 443441 S Discharge Profile

Test Conditions:

- 1 – 3 cycles Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 1.0C
UEOD = 3.0V
- 2 – 1 cycle Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 0.2C
UEOD = 3.0V

Maximum Discharge Current taken from the product specification

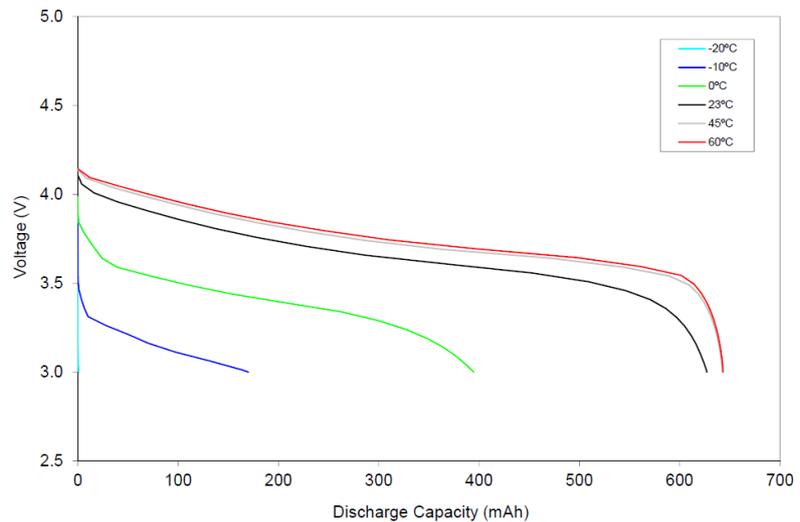


LPP 443441 S Temperature Profile @ 1C

Test Conditions:

Charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V at room temperature)
4h rest at the below mentioned temperatures

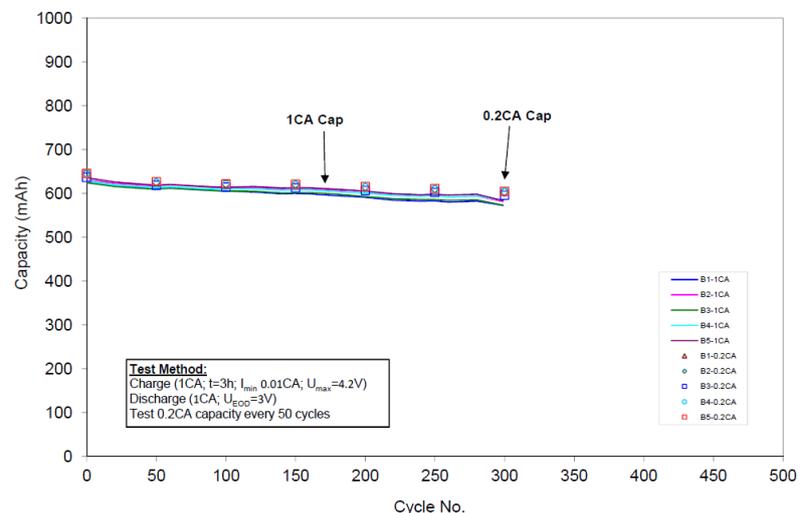
Discharge (0.2C; UEOD = 3.0V) at the following temperatures:
60°C, 40°C, RT, 0°C, -10°C, -20°C
Starting with 0.2C at -20°C; always charging at RT after 4h rest time



LPP 443441 S Cycling at 20°C

Test Conditions:

- a) Capacity
charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V)
discharge (1.0C; UEOD = 3.0V)
Determination of the 0.2C capacity (discharge 0.2C; UEOD = 3.0V) after charging each 50 cycles
- b) Impedance measurements before and after cycling reference impedance according to specification of cell.
- c) Thickness measurement before and after cycling reference thickness according to specification of cell-



4.5 Technical Cell Data: LPP 423566 BE

Relevant for the following model/s:

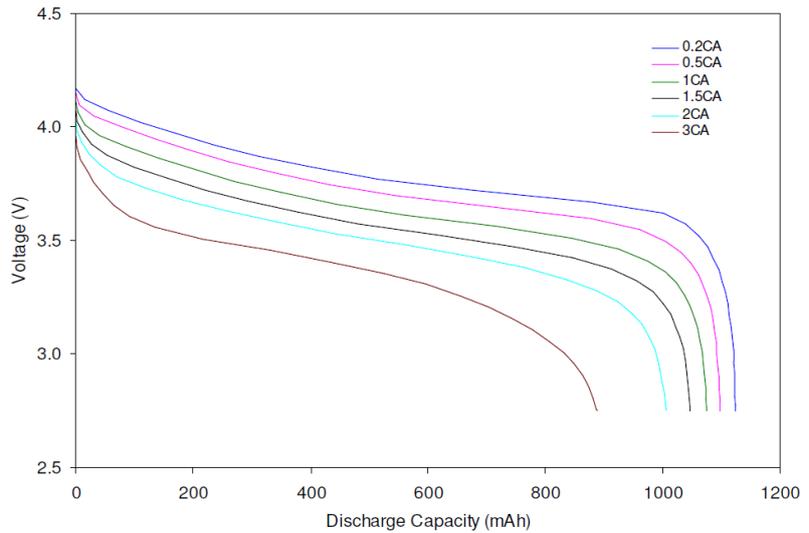
- ▶ 1/LPP 423566 BE NTC W
P/N: 56437 201 012

LPP 423566 BE Discharge Profile

Test Conditions:

- 1 – 3 cycles Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 1.0C
UEOD = 3.0V
- 2 – 1 cycle Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 0.2C
UEOD = 3.0V

Maximum Discharge Current taken from the product specification

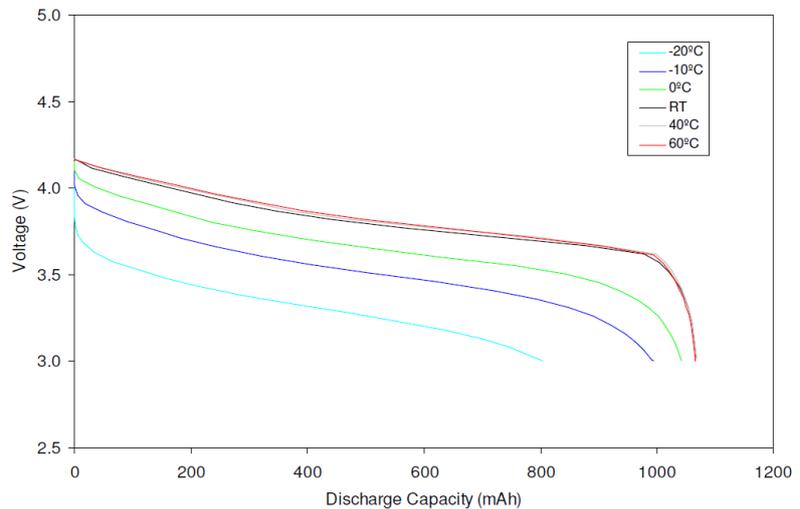


LPP 423566 BE Temperature Profile @ 1C

Test Conditions:

Charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V at room temperature)
4h rest at the below mentioned temperatures

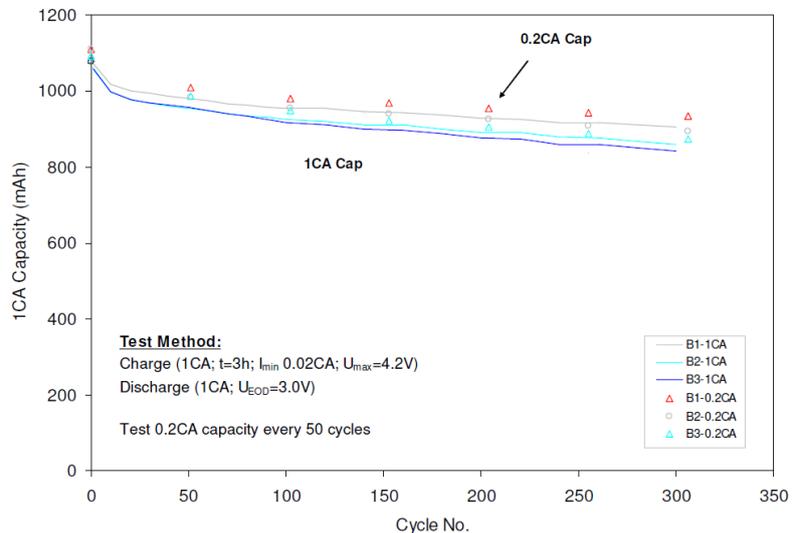
Discharge (0.2C; UEOD = 3.0V) at the following temperatures:
60°C, 40°C, RT, 0°C, -10°C, -20°C
Starting with 0.2C at -20°C; always charging at RT after 4h rest time



LPP 423566 BE Cycling at 20°C

Test Conditions:

- a) Capacity charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V) discharge (1.0C; UEOD = 3.0V) Determination of the 0.2C capacity (discharge 0.2C; UEOD = 3.0V) after charging each 50 cycles
- b) Impedance measurements before and after cycling reference impedance according to specification of cell.
- c) Thickness measurement before and after cycling reference thickness according to specification of cell-



4.6 Technical Cell Data: LPP 503562 S

Relevant for the following model/s:

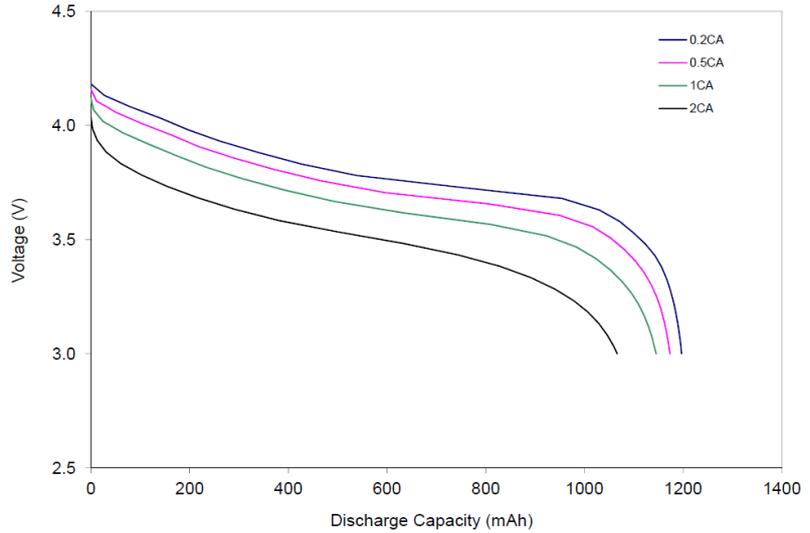
- ▶ **2P/LPP 503562 S PCM WC**
P/N: 56456 302 012
- ▶ **1/LPP 503562 S PCM W**
P/N: 56456 201 012
- ▶ **EasyPack L**
P/N: 56456 701 099
- ▶ **EasyPack XL**
P/N: 56456 702 099

LPP 503562 S Discharge Profile

Test Conditions:

- 1 – 3 cycles Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 1.0C
UEOD = 3.0V
- 2 – 1 cycle Charge 1.0C; tmax = 3h; Imin = 0.02C; 4.2V
Discharge 0.2C
UEOD = 3.0V

Maximum Discharge Current taken from the product specification

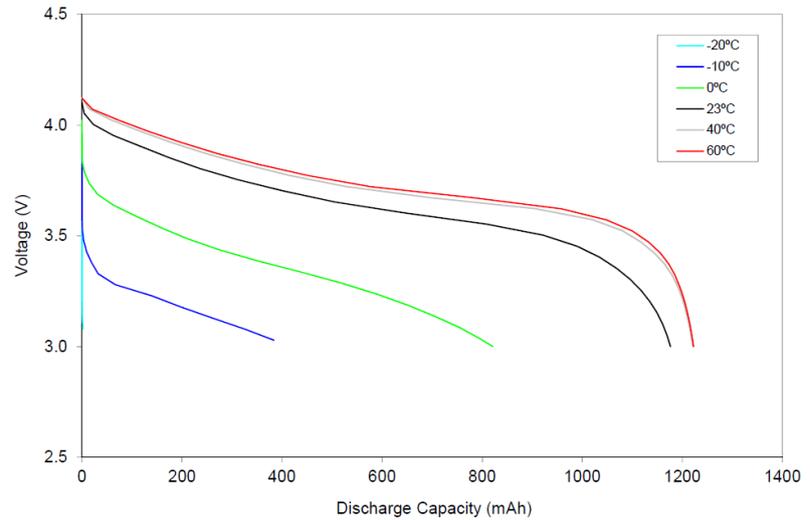


LPP 503562 S Temperature Profile @ 1C

Test Conditions:

Charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V at room temperature)
4h rest at the below mentioned temperatures

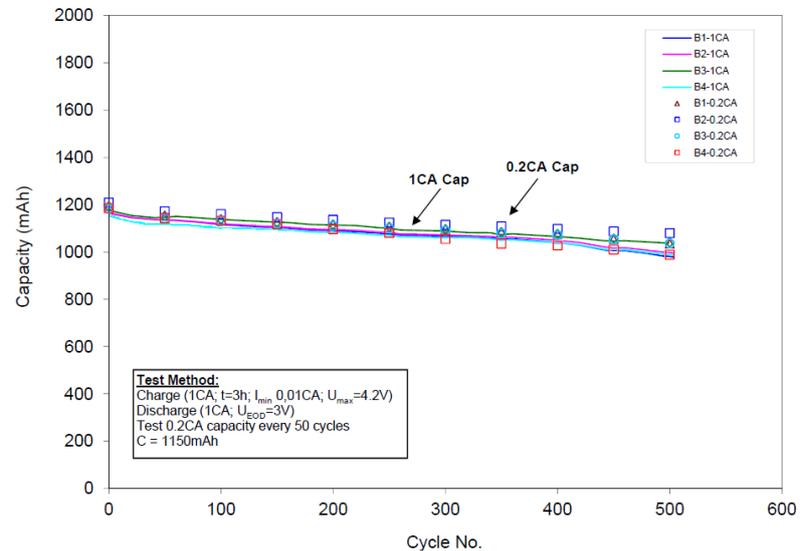
Discharge (0.2C; UEOD = 3.0V) at the following temperatures:
60°C, 40°C, RT, 0°C, -10°C, -20°C
Starting with 0.2C at -20°C; always charging at RT after 4h rest time



LPP 503562 S Cycling at 20°C

Test Conditions:

- a) Capacity charge (1.0C; t = 3h; Imin 0.02C; Umax = 4.2V) discharge (1.0C; UEOD = 3.0V) Determination of the 0.2C capacity (discharge 0.2C; UEOD = 3.0V) after charging each 50 cycles
- b) Impedance measurements before and after cycling reference impedance according to specification of cell.
- c) Thickness measurement before and after cycling reference thickness according to specification of cell-



5. Reliability and Life Expectancy

VARTA CellPac LITE batteries combine maximum safety with top-performance and reliability.

Cycle life is expected to be 300-500 cycles with a remaining capacity of approximately 70% - 80%, depending on exact model.

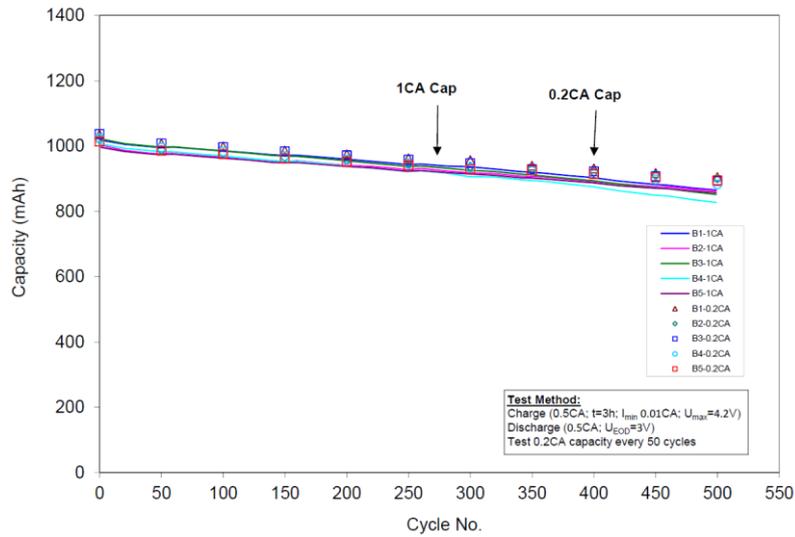


Fig. Typical cycle-life at room temperature (20°C) LPP 523450 S

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