SALES PROGRAM AND
TECHNICAL HANDBOOK

VARTA PoLiFlex® Batteries
Superior Polymer Technology

CONTENTS

For latest technical data please refer to our data sheets which you will find on our website www.varta-microbattery.com.

1. GENERAL INFORMATION

VARTA Microbattery is a leading company in the field of batteries and provides professional support for customers with engineered design-in applications worldwide.
Quality, reliability, high performance and customer satisfaction are the main reasons for our leading position in the market.
VARTA Microbattery provides solutions to major OEM companies for high-tech applications such as note-book/PDA- bridging function, memory backup and real-time clock support in PCs/notebooks as well as main Power source for telecom devices, remote control devices, torches, domestic alarms, car alarms, medical equipment, consumer electronics and many more.
VARTA Microbattery produces all major chemistries in various form factors. We are well equipped with facilities for customized battery products.
We trust we will have an optimized battery solution for most application requirements.
VARTA Microbattery provides rechargeable batteries in these electro-chemical systems: Ni-MH, Li-Ion and Li-Polymer "VARTA PoLiFlex®".
For primary systems please see rear side.

SYSTEM HIGHLIGHTS OF VARTA PoLiFlex® BATTERIES:

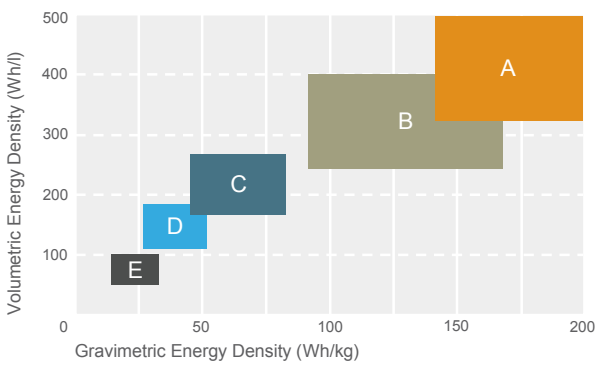
- Very slim – down to 2.2 mm (0.8 mm*) mm
- Excellent energy density
  up to 450 (incl. PCM) / 500 (pouch) mWh/l
  up to 195 mWh/g
- Flexible formfactor
- High cell voltage (3.7 V nom.)
- Low self-discharge
  <5% fully charged, 2% SOD (state of delivery)
  in the first month, less thereafter
- Charging technique compatible
  with Li-Ion (const. I / const. V)
- Good high-rate discharge capability
  up to 5 CA pulse loads (see specifications)
- Wide temperature range:
  Storage: -20…+60°C
  Discharge: -20…+60°C
  Charge: 0 … +45°C
- Good cycle-life
  (>500 full cycles typically)
- Good recovery of capacity after storage,
  even at elevated temperature
- UL listed/recognized
- Environmentally friendly
  0% lead, cadmium, mercury
  (ISO 14001 certified)
- ISO 9001 certified for design and manufacture
- VARTA Microbattery is a leader in the field of Polymer Batteries, received several awards for innovation and environment protection.

* please contact our sales staff

ENERGY DENSITY FOR RECHARGEABLE BATTERY SYSTEMS:

FIG. 1
Comparison of different rechargeable battery systems regarding their energy densities

A = Lithium Polymer
B = Lithium-Ion
C = Ni-MH
D = Ni-Cd
E = Lead



1.1 DEFINITIONS

BASICALLY

Unless otherwise stated the technical values and definitions are based on room temperature conditions (RT = 20°C ± 2°C).

SYSTEM – SPECIFIC DATA

The gravimetric energy density of the Li-Polymer system 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 of Li-Polymer cells is 3.7 V.

End of Discharge Voltage (V_E):
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: $C = I \cdot t$
I = constant discharge current
t = duration from the beginning of discharge until the end of discharge voltage is reached

Nominal Capacity:
The nominal 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 +20°C ± 2°C, and the final discharge voltage 3.0 V.

Typical Capacity:
The typical capacity is the average capacity at a discharge rate of 0.2 CA to a final discharge voltage of 3.0 V.

Available Capacity:
Li-Polymer cells deliver their nominal capacity at 0.2 CA. This assumes that charging and discharging is carried out as recommended. 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 are given as multiples of the nominal capacity (C) in ampères (A) with the term CA. Example:
Nominal capacity C = 1000 mAh
0.1 CA = 100 mA, 1 CA = 1000 mA

Nominal Discharge Current:
The nominal discharge current of a Li-Polymer cell is the 5 hour discharge current (0.2 CA). It is the current at which the nominal capacity of a cell is dicharged in 5 hours.
$I = \frac{C}{t} = \frac{C}{5} = 0.2$ CA when t = 5 h

1.2 FEATURES

VARTA PoLiFlex® 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 PoLiFlex® 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
Innovative product	It's NEW	Latest technology
High energy density	Lightweight	Best performance
Slim form factor	Design flexibility	Smaller / slimmer product
Excellent overall performance	Supports many various applications	Highly satisfying product under extensive conditions of use
Fully automated production in Germany	High reliability and quality	High reliability in the field
Complete pack solution	Supply of cells, electronics and assembly	"One Stop Shop"
Worldwide branch offices with technical support	Close customer relationship	Local contact, local knowledge - local language

TAB. 1
Features VARTA PoLiFlex® batteries

1.3 APPLICATIONS

VARTA PoLiFlex® batteries are especially suitable for modern electronic applications like mobile phones, PDAs, notebooks, MP3 players, security and telematic devices and many more.

These super-slim batteries are the ultimate power source for your electronic devices and make your products smaller, lighter and more attractive.

VARTA PoLiFlex® – outstanding performance and reliability, excellent quality along with great form flexibility.

VARTA PoLiFlex® – go for the new generation.

MP3 players / Consumer electronics

Notebooks / Tablet PCs

Mobile / Smart phones

PDAs / Navigation devices

FIG. 2 – 5: Application examples

1.4 GENERAL DESIGN AND APPLICATION CRITERIA

Choose the best suitable battery from our wide range of VARTA PoLiFlex® 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 batteries VARTA PoLiFlex® are equipped with our specially selected and carefully designed safety electronic modules which prevent the risks of hazards due to any foreseeable abuse / misuse.

You can choose a cell of the VARTA PoLiFlex® range for professional design-in between these boundaries:

Op. voltage	2.75	… 4.2 V
Capacity	360	… 1320 mAh
Height	2.2 (0.8*)	… 6.2 mm
Area (surface)	34 x 41	… 35 x 66 mm

* please contact our sales staff

The worldwide present VARTA Microbattery professional design-in team will be happy to assist you with further recommendations and will guide you through the whole cycle of your product life.

FIG. 6
VARTA PoLiFlex® Production in Ellwangen/Germany

1.5 CONSTRUCTION AND ELECTROCHEMICAL PROCESSES OF VARTA PoLiFLlex® BATTERIES

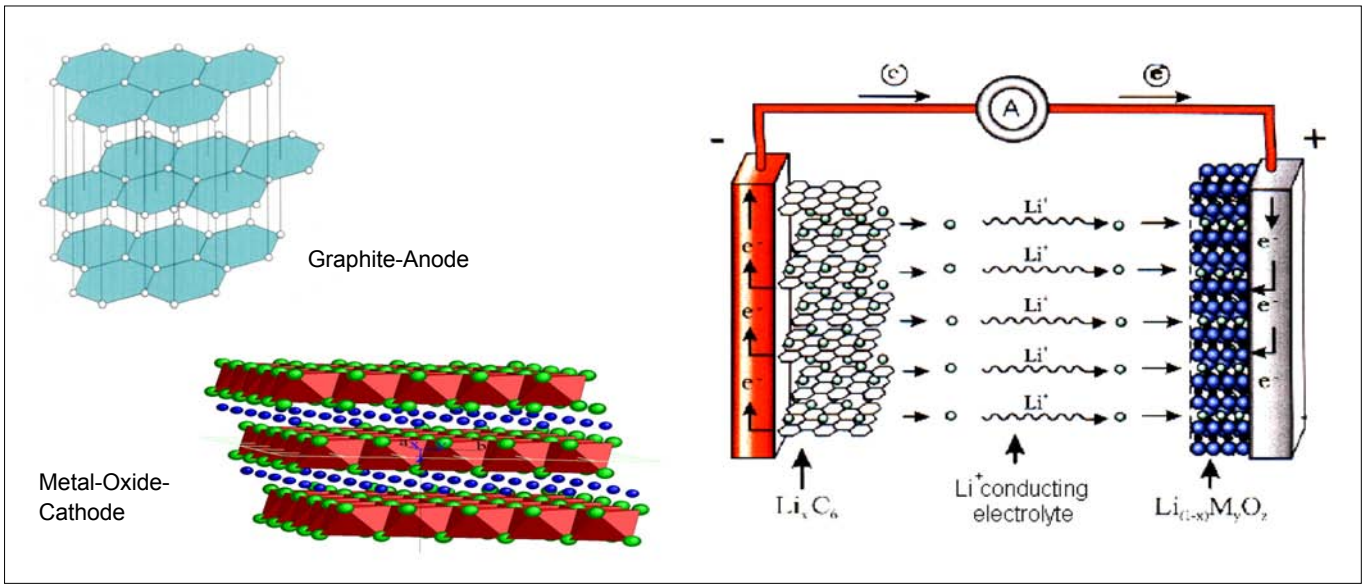


FIG. 7
Chemical reaction VARTA PoLiFlex® battery

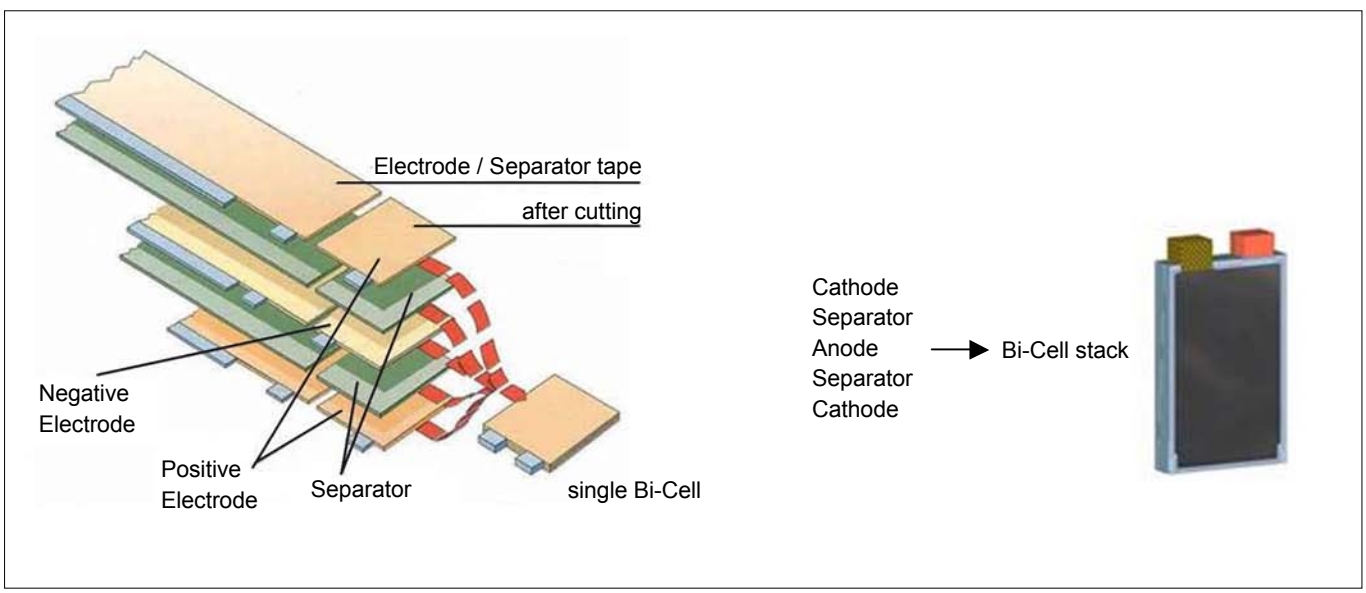


FIG. 8
Sectional view VARTA PoLiFlex® battery

2. ASSORTMENT

2.1 SPECIFICATION TABLE VARTA PoLiFlex®

	Battery PLF …										
Technical Data	084241 D (under development)	223452 D	263441 D	323450 D	443441 D	383562 D	523450 D	463759 D	423566 D	503759 D	503562 D
Type Number	66500	66210	66523	66221	66594	66355	66281	66641	66455	66663	66383
Typical Capacity (mAh)	55	360	370	590	660	980	1000	1170	1170	1300	1320
Nominal Voltage (V)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Nominal Capacity (mAh)	50	340	350	570	630	920	960	1130	1120	1250	1260
Dimension (max. at delivery)											
Length (mm)	41.2	52.2	41.2	49.4	41.2	61.4	49.4	58.7	66.2	58.7	62.2
Height (mm)	1	2.3	2.8	3.4	4.6	4.0	5.4	4.8	4.4	5.2	5.2
Width (mm)	42	34.0	34.0	34.0	33.8	35.0	34.0	37.0	35.0	37.0	35.0
Weight, approx. (g)	2	8.0	8.0	10.0	12.5	17.0	16.0	21.0	22.0	22.5	24.0
Charge method (const. I / const. V)											
Standard Charge	C/2	C/2	C/2	C/2	C/2	C/2	C/2	C/2	C/2	C/2	C/2
Fast Charge	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C
Operating Temperature											
Charging (°C)	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45
Discharging (°C)	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60
Storage	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +0°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%
Life Expectancy											
20°C (cycles)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)	>500 (>70% of Cmin)
Internal Impedance											
(mOhm)	<900@1kHz	<80@1kHz	<70@1kHz	<80@1kHz	<80@1kHz	<60@1kHz	<50@1kHz	<60@1kHz	<60@1kHz	<50@1kHz	<50@1kHz

TAB. 2
Technical data VARTA PoLiFlex® battery portfolio

2.2 SPECIFICATION TABLE VARTA PoLiFlex® (EASYPACK)

	EZ Pack …				
Technical Data	S-3.7V	M-3.7V	L-3.7V	L-3.7V	XL-3.7V
VKB Number	66590 711 099	66352 711 099	66380 711 099	66382 711 099	66382 712 099
Typical Capacity (mAh)	610	880	1100	1320	2640
Nominal Voltage (V)	3.7	3.7	3.7	3.7	3.7
Nominal Capacity (mAh)	580	850	1070	1260	2520
Dimension (max.)					
Length (mm)	43.7	64.7	64.7	64.7	64.7
Height (mm)	6.0	5.4	6.6	6.6	11.6
Width (mm)	35.6	36.8	36.8	36.8	36.8
Weight, approx. (g)	14	20	25	25	46.5
Charge method					
Fast Charge (mA)	580	850	1070	1260	1260
Operating Temperature					
Charging (°C)	0 to +45	0 to +45	0 to +45	0 to +45	0 to +45
Discharging (°C)	-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60
Storage	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >80%	1 year at -20 to +20°C >70%	1 year at -20 to +20°C >70%	1 year at -20 to +20°C >70%
Life Expectancy (typical)					
No. Of cycles (>70% of Cnom)	>500	>500	>500	>500	>500
Internal Impedance					
Internal Impedance (mOhm)@1kHz	approx. 150	approx. 120	approx. 110	approx. 110	approx. 110

TAB. 3
Technical Data VARTA EasyPack battery portfolio

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 the 1 C rate max. (e.g. a 1Ah battery can be charged with 1 A max.)

In order to avoid overcharging along with damaging the battery or even hazardous situations, the charging voltage has to be limited strictly with 4.2 V per cell in a narrow tolerance of ± 50 mV.

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 VARTA PoLiFlex® cell using the 1 C I/V – charging.

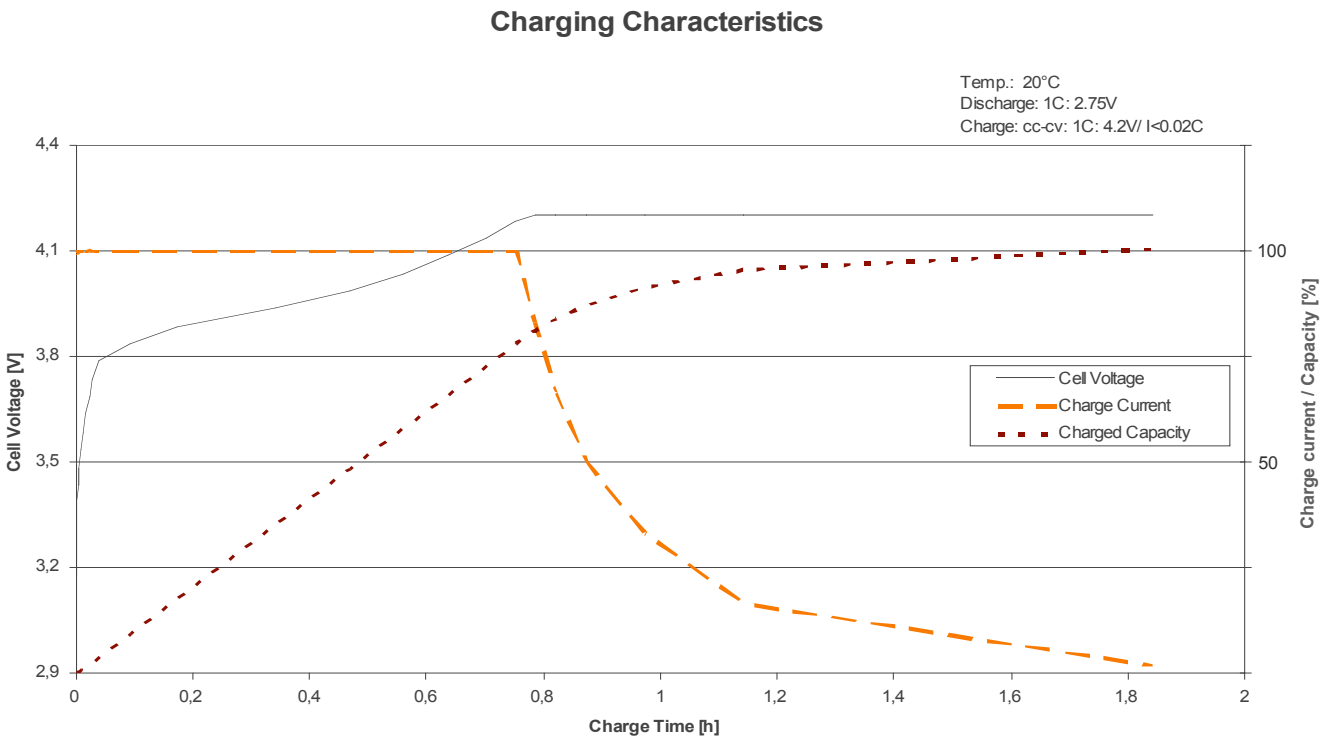


FIG. 9
Cell charging characteristics

3.2 DISCHARGING

Due to their low impedance VARTA PoLiFlex® batteries are capable of providing very high levels of current.

In order to obtain still a sufficiently high capacity efficiency a continuous discharge current of 2C should not be exceeded. However short current impulses of substantially higher levels are obtainable. Since all VARTA PoLiFlex® batteries are delivered with a safety-circuit the max. current rating established in the electronic module 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 unuseable permanently.

Please ask our experts for details of the safety-parameters built into our modules which are set differently depending on the type designation.

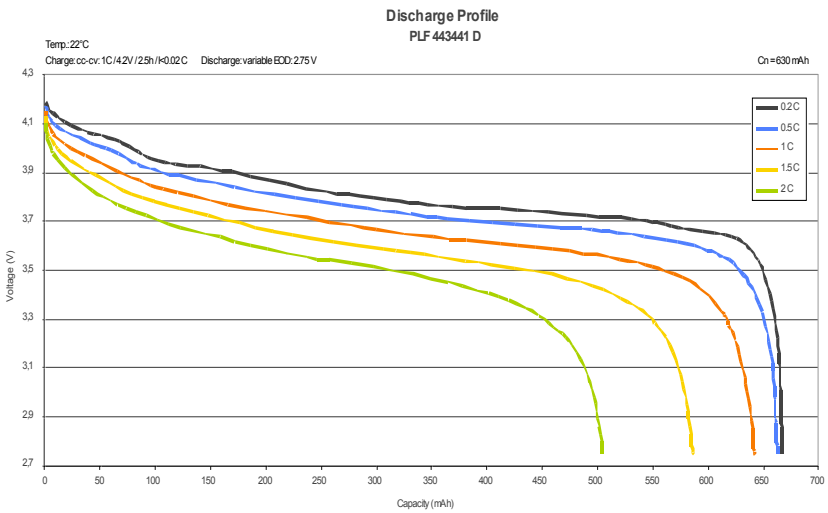


FIG. 10
Typical discharge curves with the C rates as parameter

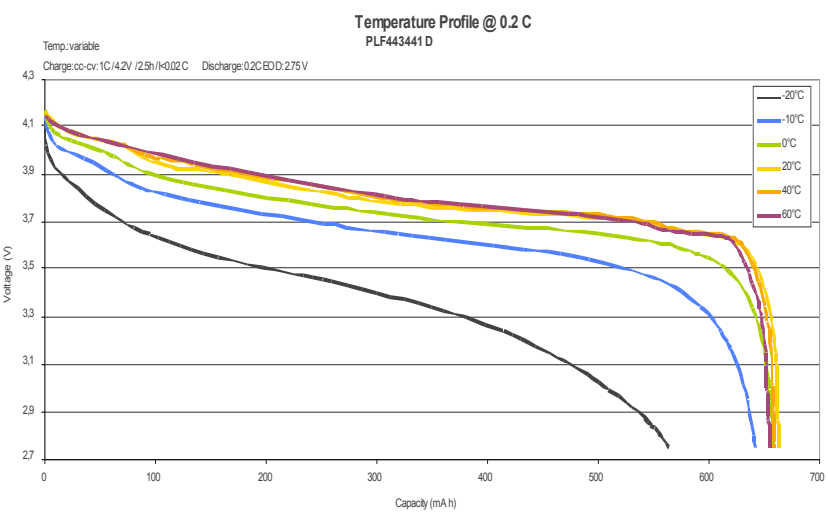


FIG. 11
Typical discharge at 0.2 C with the temperature as parameter

4. INDIVIDUAL SPECIFICATIONS

4.1 VARTA PoLiFlex® PLF 223452 D

Mechanical:	Height	2.3 mm
(max. at delivery)	Width	34.0 mm
	Length	52.2 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	<80 mΩ @ 1kHz (cell)	

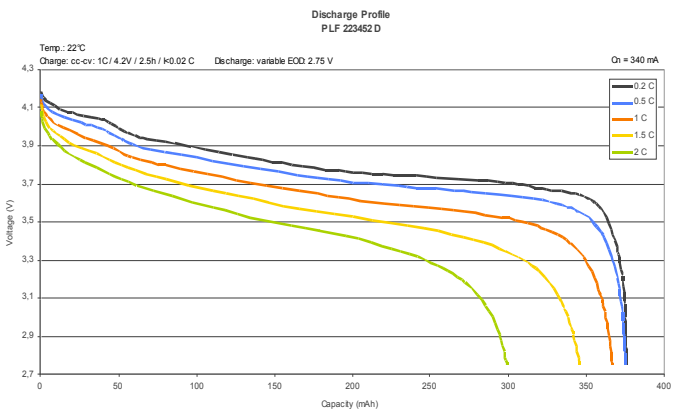


FIG. 12
Discharge Profile

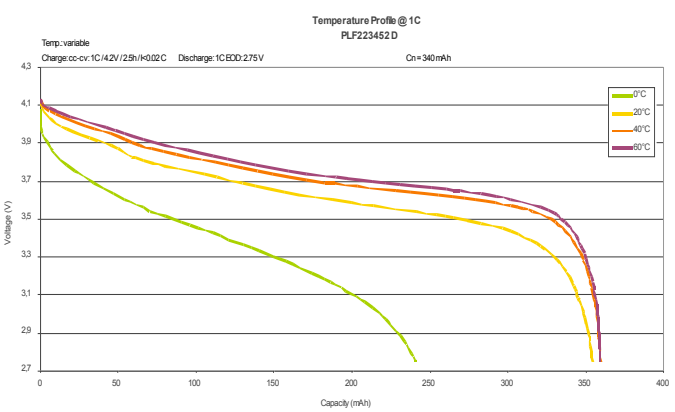


FIG. 13
Temperature Profile @ 1C

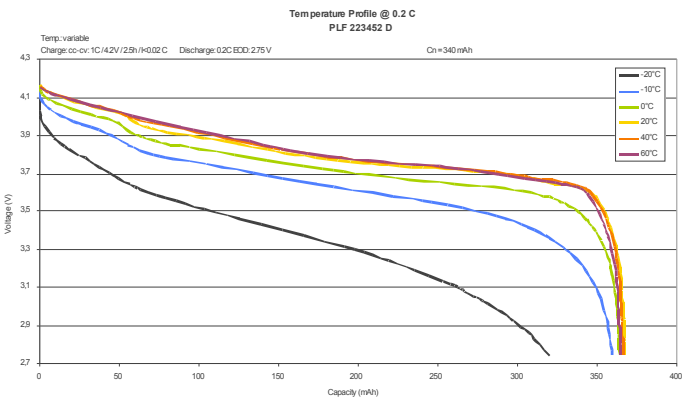


FIG. 14
Temperature Profile @ 0.2 C

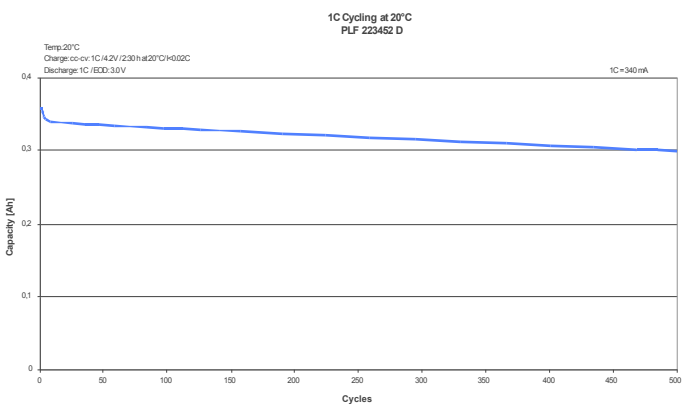


FIG. 15
Cycle life @ 20°C

4.2 VARTA PoLiFlex® PLF 263441 D

Mechanical:	Height 2.8 mm
	Width 34.0 mm
	Length 41.2 mm
Temperature Charging:	0 to +45°C
Temperature Discharging:	-20 to +60°C
Temperature Storage:	1 year at -20 to +20°C >80%
Life expectancy:	>500 cycles (>70% of Cmin)
Impedance:	approx. 70@1kHz
UL Approval:	Recognition
CE Certification	

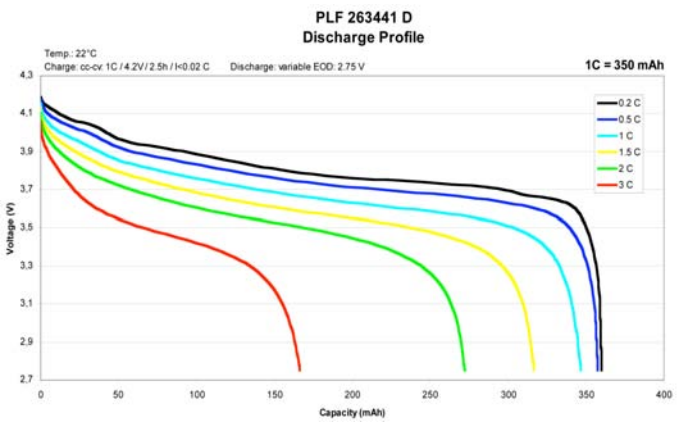


FIG. 16
Discharge Profile

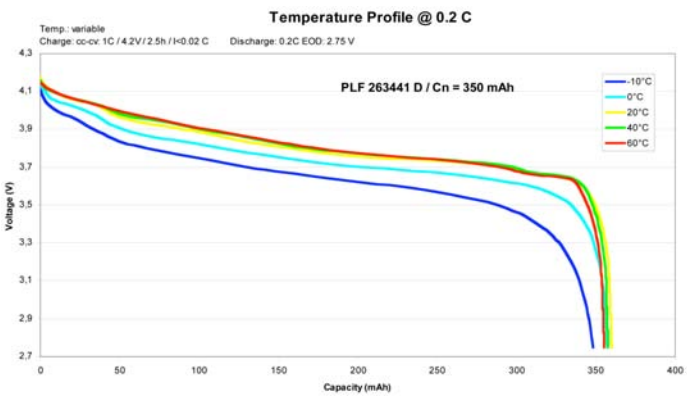


FIG. 18
Temperature Profile @ 0.2 C

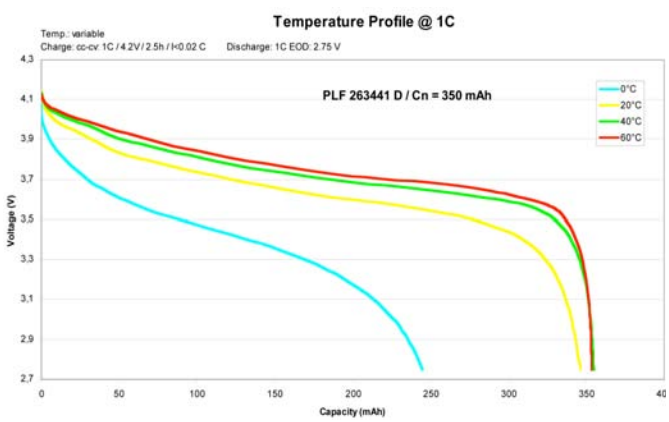


FIG. 17
Temperature Profile @ 1C

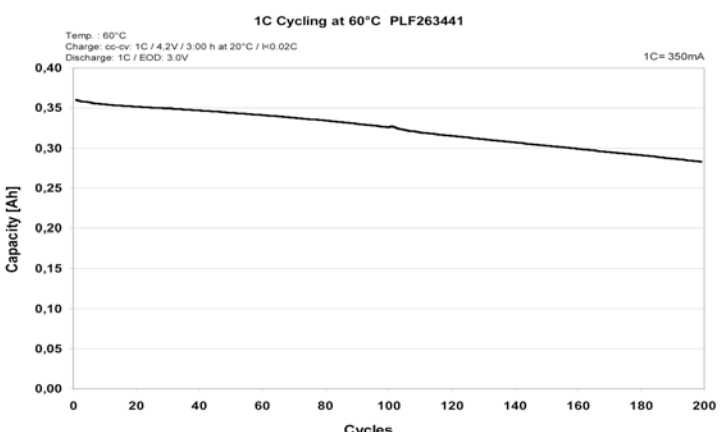


FIG. 19
Cycle life @ 60°C

4.3 VARTA PoLiFlex® PLF 323450 D

Mechanical:	Height	3.4 mm
(max. at delivery)	Width	34.0 mm
	Length	49.4 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 80@1kHz	
UL Approval:	Recognition	
CE Certification		

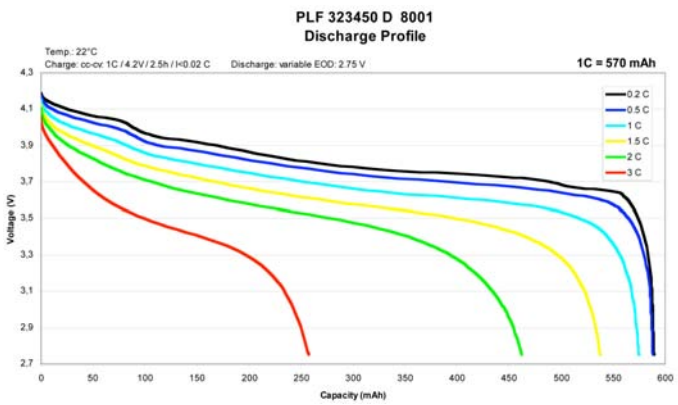


FIG. 20
Discharge Profile

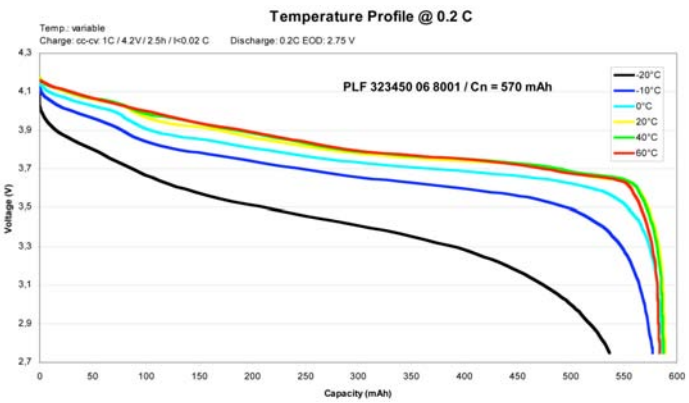


FIG. 22
Temperature Profile @ 0.2 C

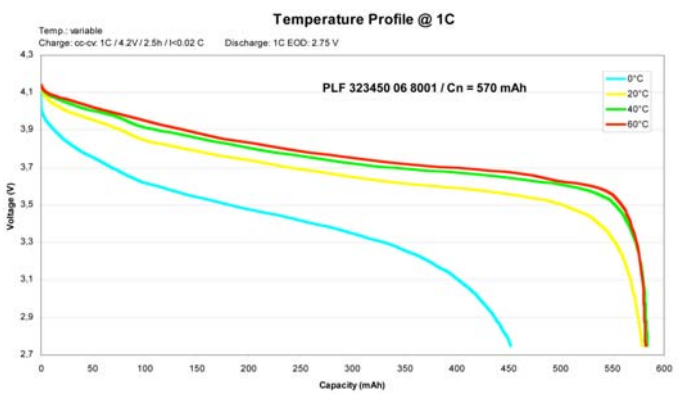


FIG. 21
Temperature Profile @ 1C

4.4 VARTA PoLiFlex® PLF 443441 D

Mechanical:	Height	4.6 mm
(max. at delivery)	Width	33.8 mm
	Length	41.2 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	<70 mΩ @ 1kHz (cell)	

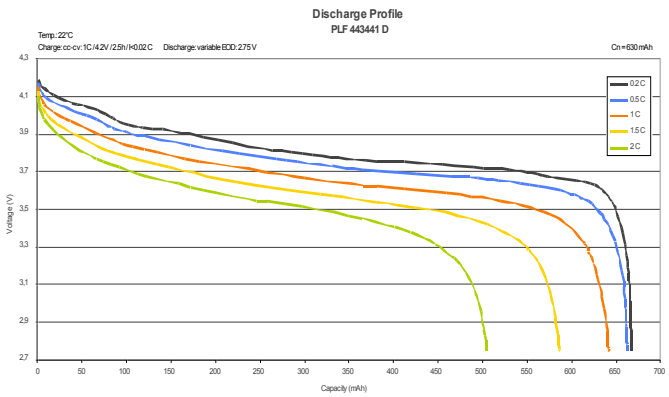


FIG. 23
Discharge Profile

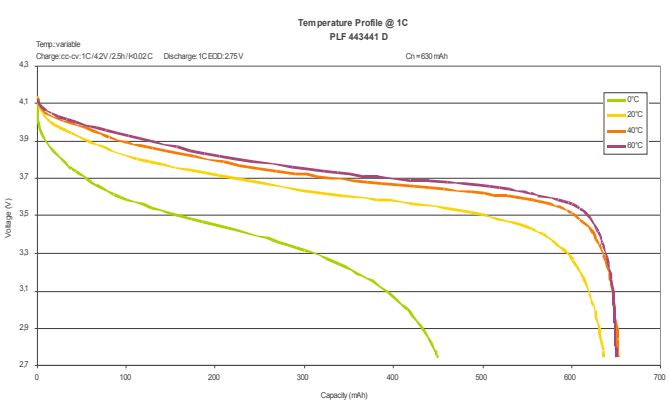


FIG. 24
Temperature Profile @ 1C

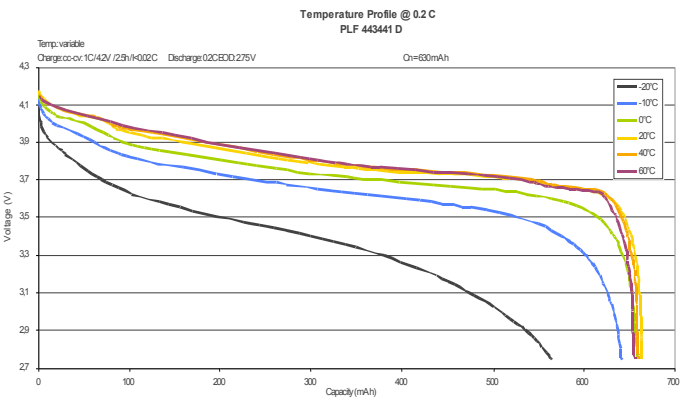


FIG. 25
Temperature Profile @ 0.2 C

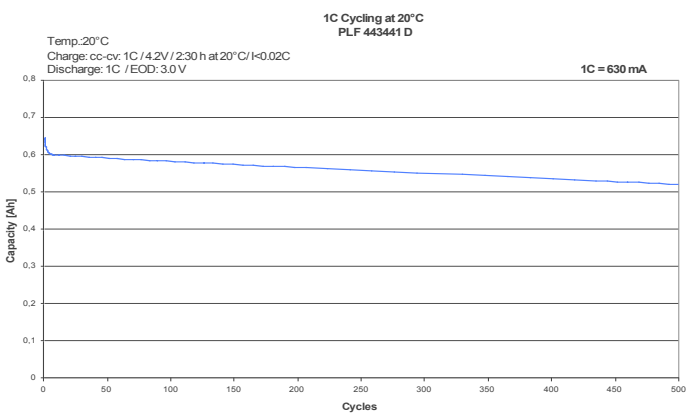


FIG. 26
Cycle life @ 20°C

4.5 VARTA PoLiFlex® PLF 383562 D

Mechanical:	Height	4.0 mm
(max. at delivery)	Width	35.0 mm
	Length	61.4 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	<70 mΩ @ 1kHz (cell)	

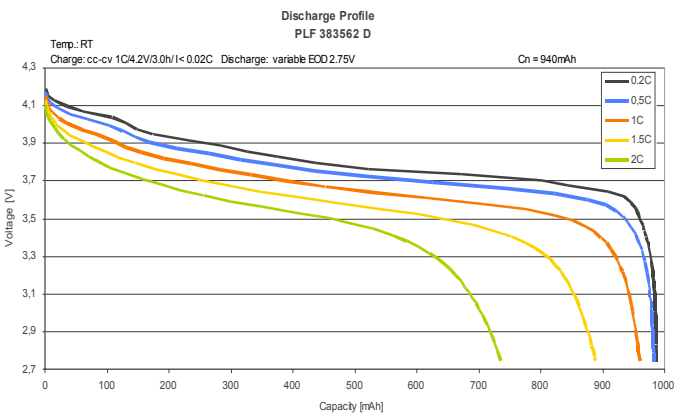


FIG. 27
Discharge Profile

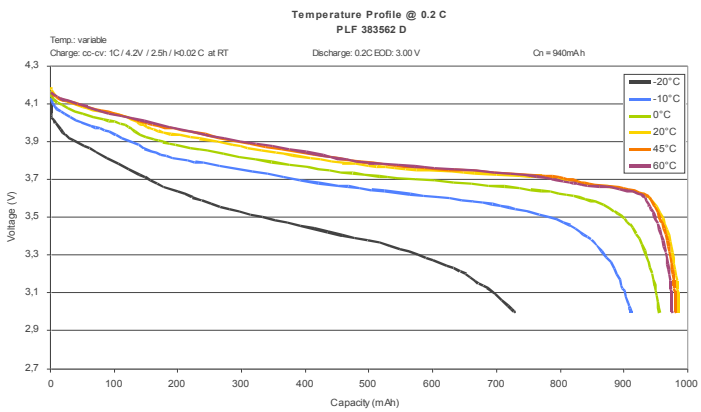


FIG. 29
Temperature Profile @ 0.2 C

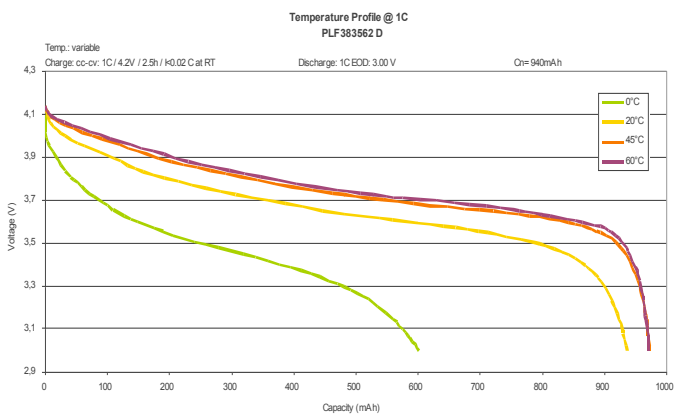


FIG. 28
Temperature Profile @ 1C

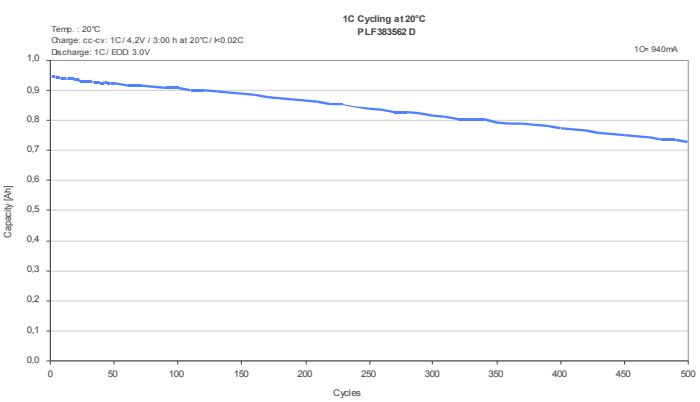


FIG. 30
Cycle life @ 20°C

4.6 VARTA PoLiFlex® PLF 523450 D

Mechanical:	Height	5.4 mm
(max. at delivery)	Width	34.0 mm
	Length	49.4 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	<80 mΩ @ 1kHz (cell)	

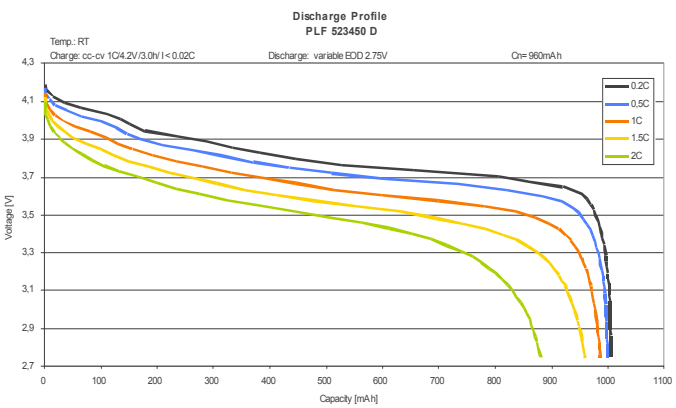


FIG. 31
Discharge Profile

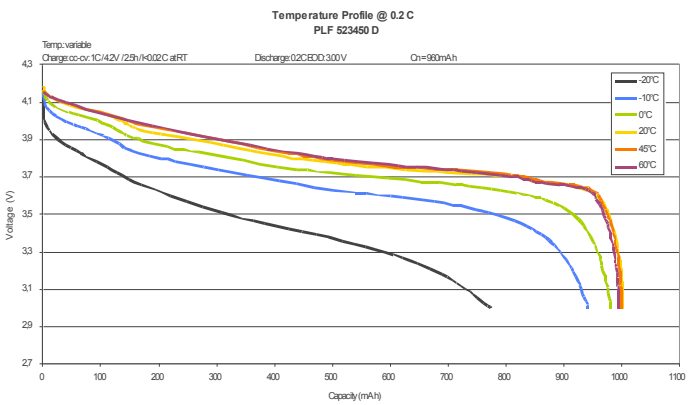


FIG. 33
Temperature Profile @ 0.2 C

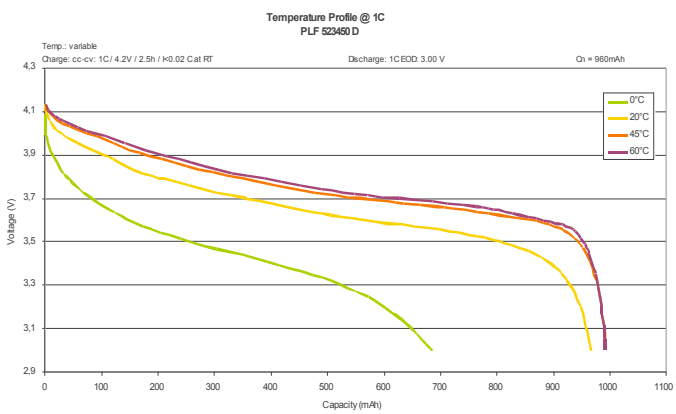


FIG. 32
Temperature Profile @ 1C

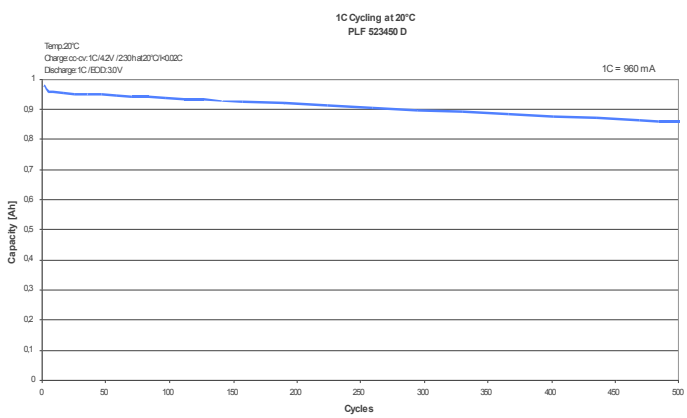


FIG. 34
Cycle life @ 20°C

4.7 VARTA PoLiFlex® PLF 463759 D

Mechanical:	Height	4.8 mm
(max. at delivery)	Width	37.0 mm
	Length	58.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	<55 mΩ @ 1kHz (cell)	

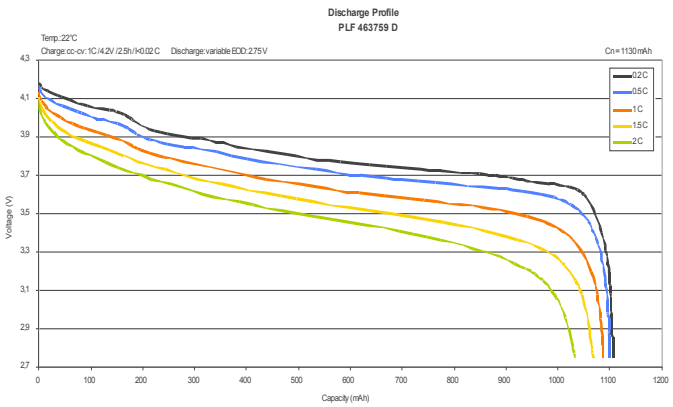


FIG. 35
Discharge Profile

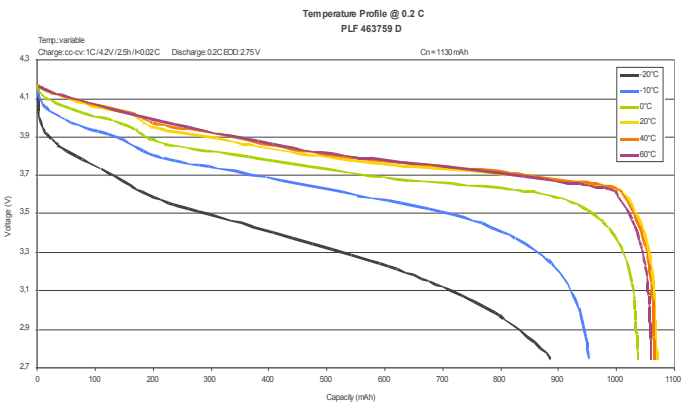


FIG. 37
Temperature Profile @ 0.2 C

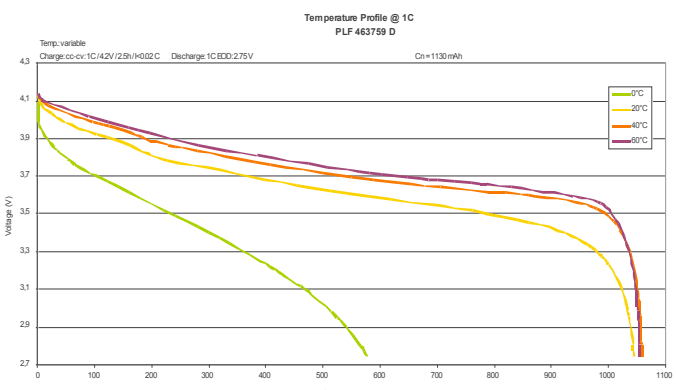


FIG. 36
Temperature Profile @ 1C

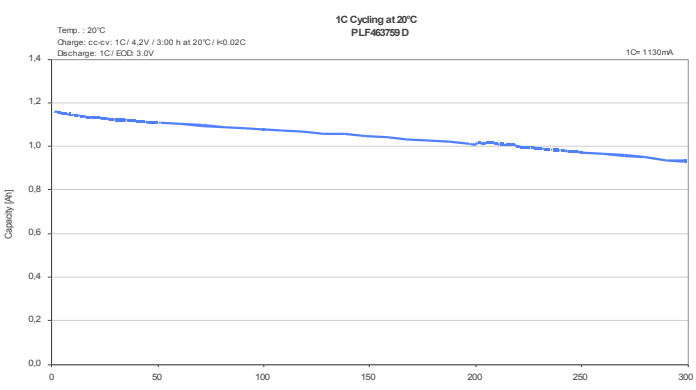


FIG. 38
Cycle life @ 20°C

4.8 VARTA PoLiFlex® PLF 423566 D

Mechanical:	Height	4.4 mm
(max. at delivery)	Width	35.0 mm
	Length	66.2 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 60@1kHz	
UL Approval:	Recognition	
CE Certification		

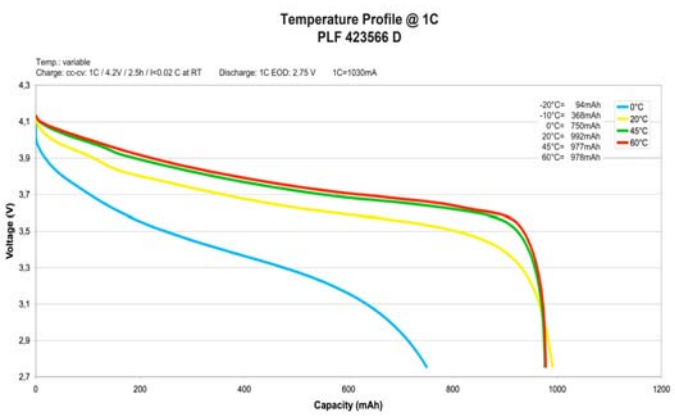


FIG. 39
Temperature Profile @ 1C

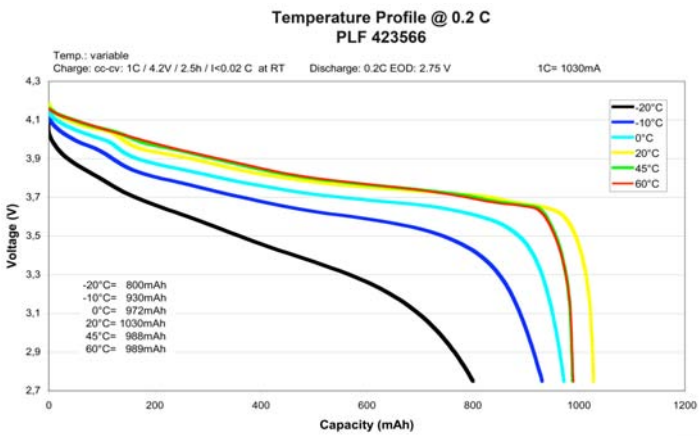


FIG. 40
Temperature Profile @ 0.2 C

4.9 VARTA PoLiFlex® PLF 503759 D

Mechanical:	Height	5.2 mm
(max. at delivery)	Width	37.0 mm
	Length	58.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 50@1kHz	
UL Approval:	Recognition	
CE Certification		

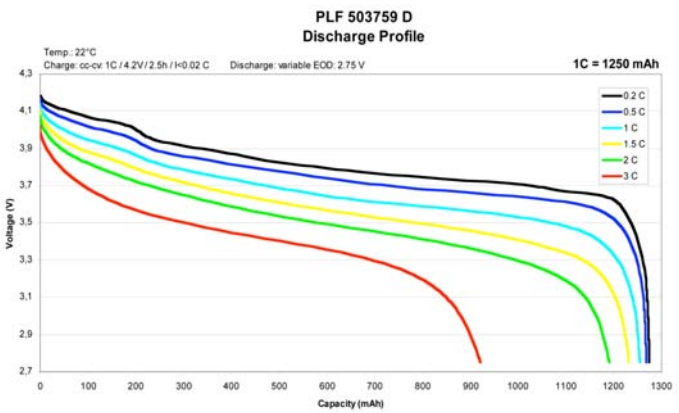


FIG. 41
Discharge Profile

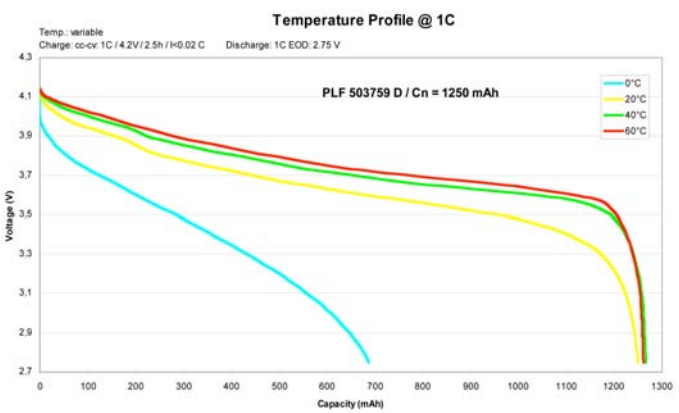


FIG. 42
Temperature Profile @ 1C

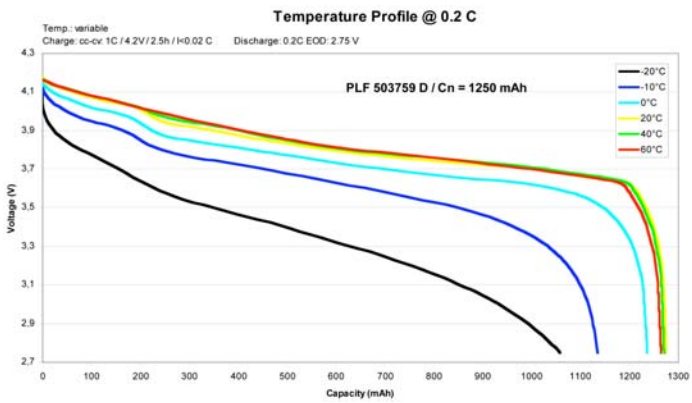


FIG. 43
Temperature Profile @ 0.2 C

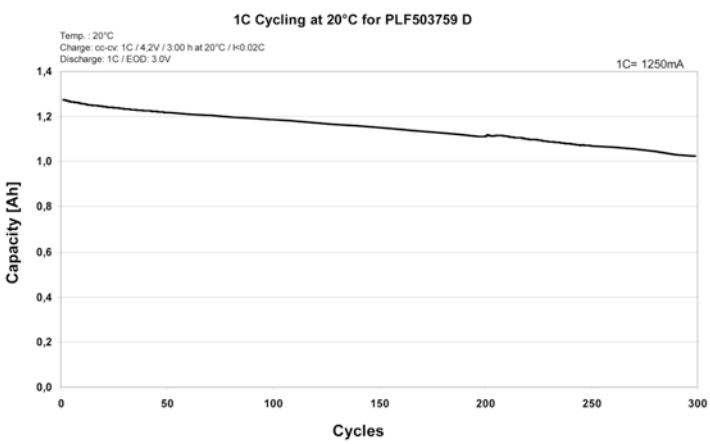


FIG. 44
Cycle life @ 20°C

4.10 VARTA PoLiFlex® PLF 503562 D

Mechanical:	Height	6.6 mm
(max. at delivery)	Width	36.8 mm
	Length	64.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 110@1kHz	
UL Approval:	Recognition	
CE Certification		

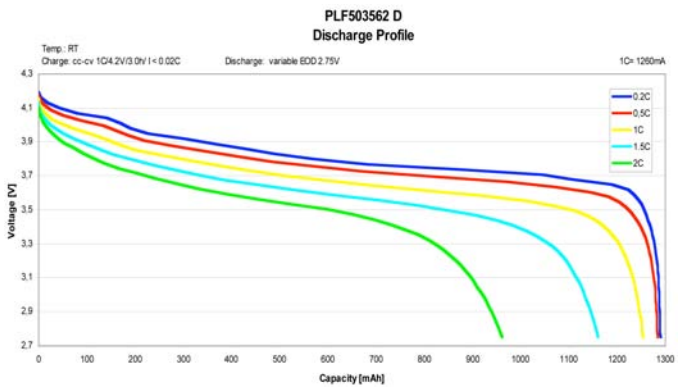


FIG. 45
Discharge Profile

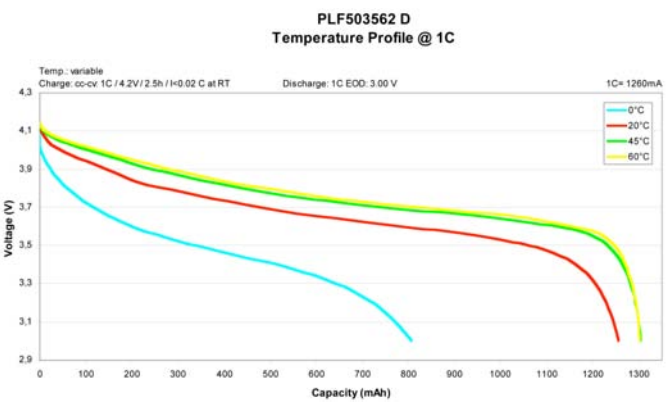


FIG. 46
Temperature Profile @ 1C

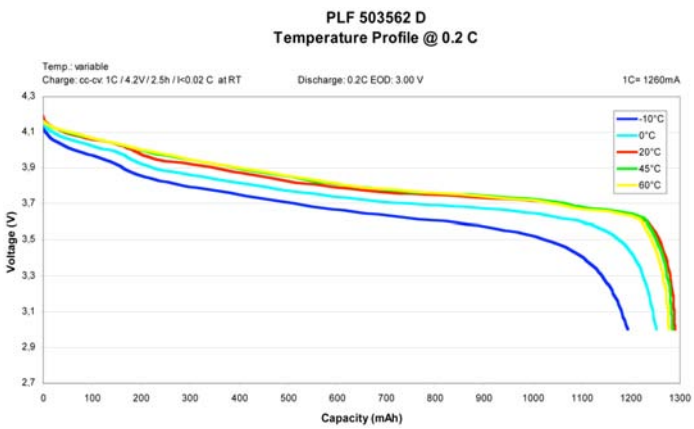


FIG. 47
Temperature Profile @ 0.2 C

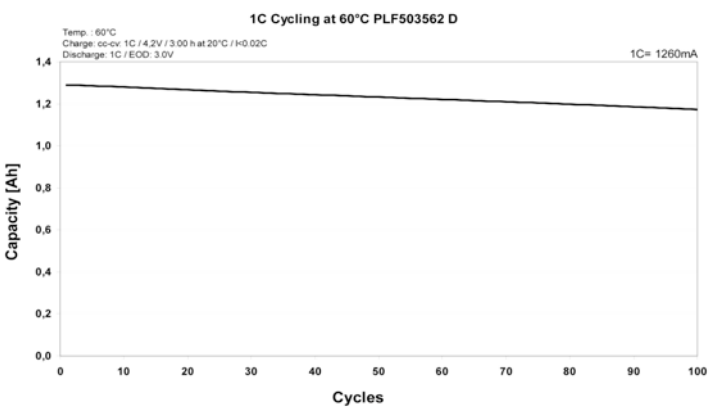


FIG. 48
Cycle life @ 20°C

4.11 EASYPACK S-3.7V (610 mAh)

Mechanical:	Height	6.0 mm
(max. at delivery)	Width	35.6 mm
	Length	43.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 150@1kHz	
UL Approval:	Recognition	
CE Certification		

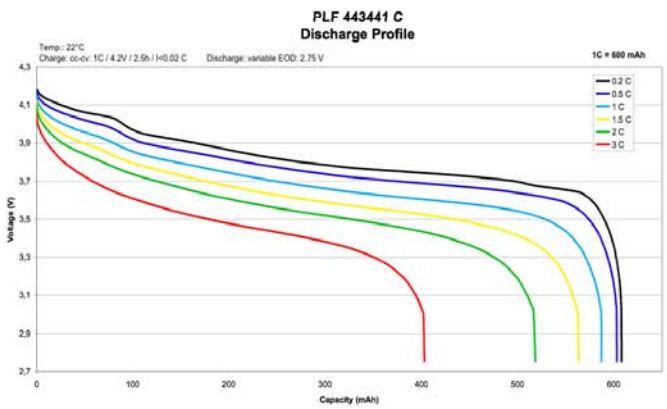


FIG. 49
Discharge Profile

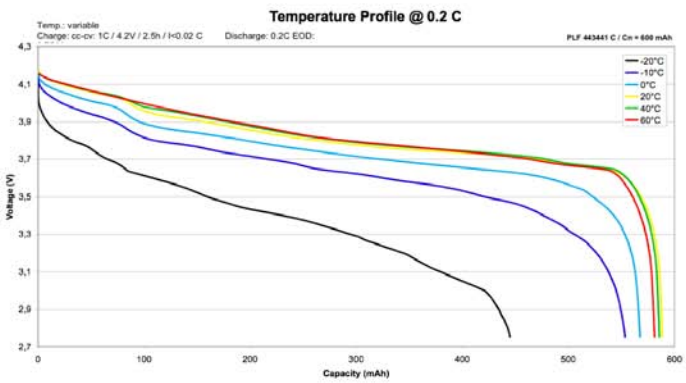


FIG. 51
Temperature Profile @ 0.2 C

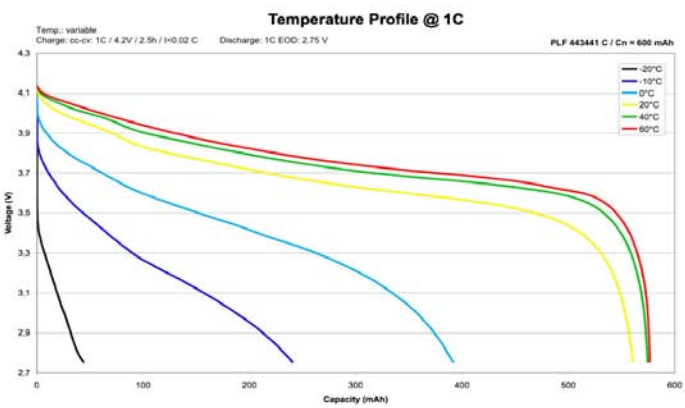


FIG. 50
Temperature Profile @ 1C

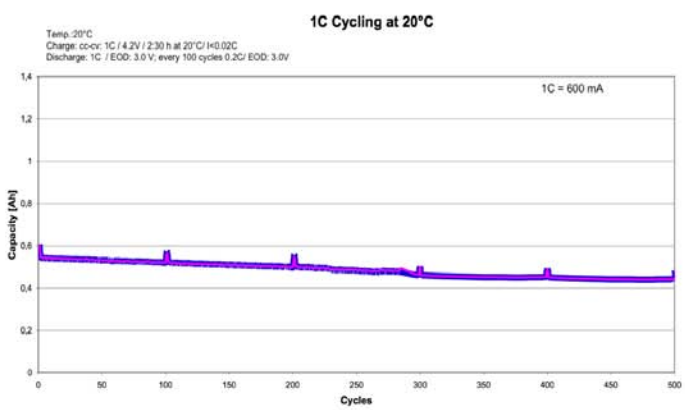


FIG. 52
Cycle life @ 20°C

4.12 EASYPACK M-3.7V (880 mAh)

Mechanical:	Height	5.4 mm
(max. at delivery)	Width	36.8 mm
	Length	64.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 120@1kHz	
UL Approval:	Recognition	
CE Certification		

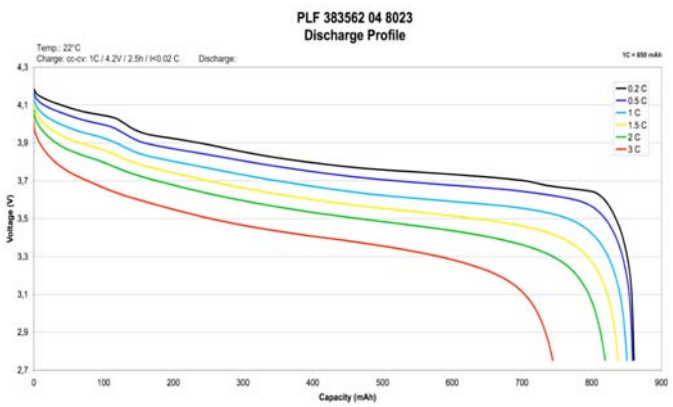


FIG. 57
Discharge Profile

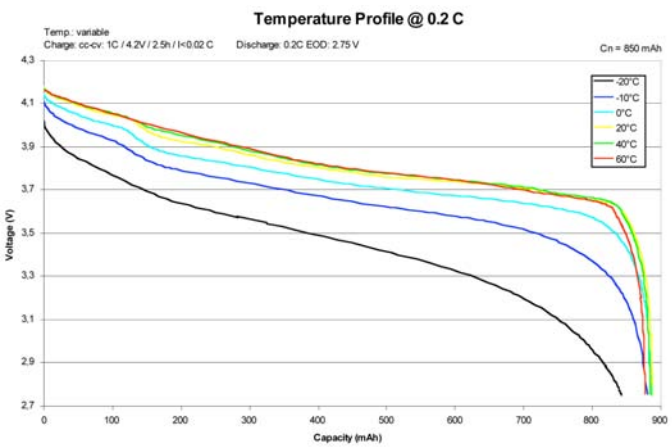


FIG. 59
Temperature Profile @ 0.2 C

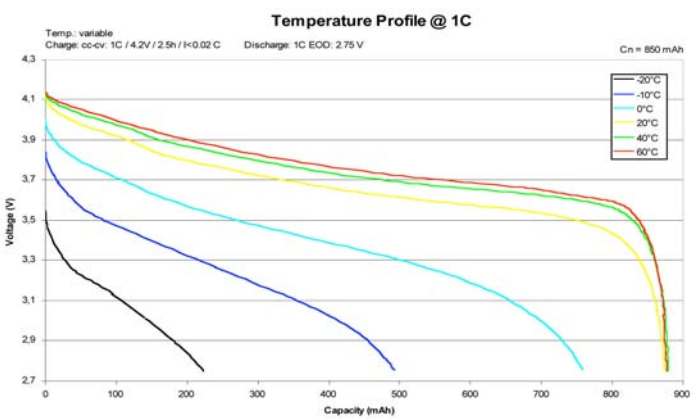


FIG. 58
Temperature Profile @ 1C

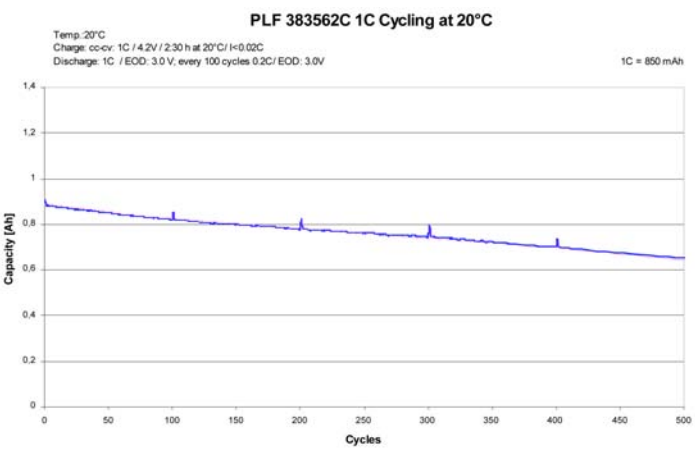


FIG. 60
Cycle life @ 20°C

4.13 EASYPACK L-3.7V (1100 mAh)

Mechanical:	Height	6.6 mm
(max. at delivery)	Width	36.8 mm
	Length	64.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 110@1kHz	
UL Approval:	Recognition	
CE Certification		

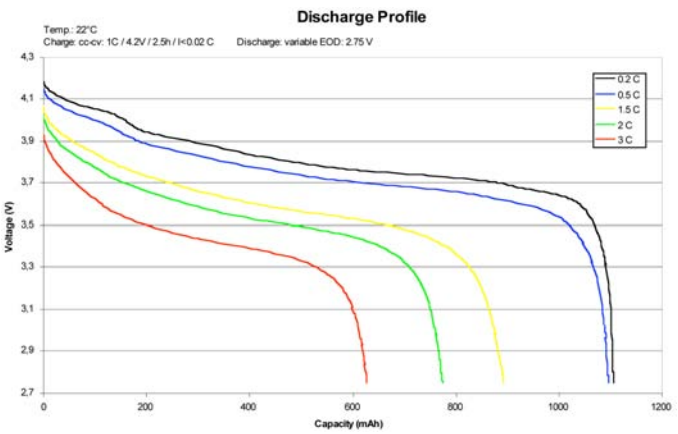


FIG. 61
Discharge Profile

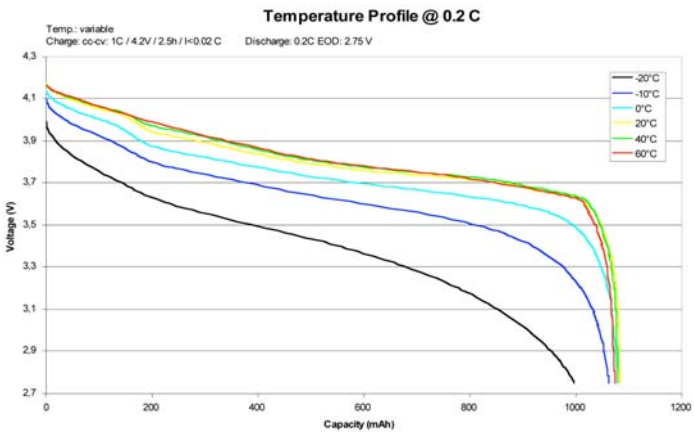


FIG. 63
Temperature Profile @ 0.2 C

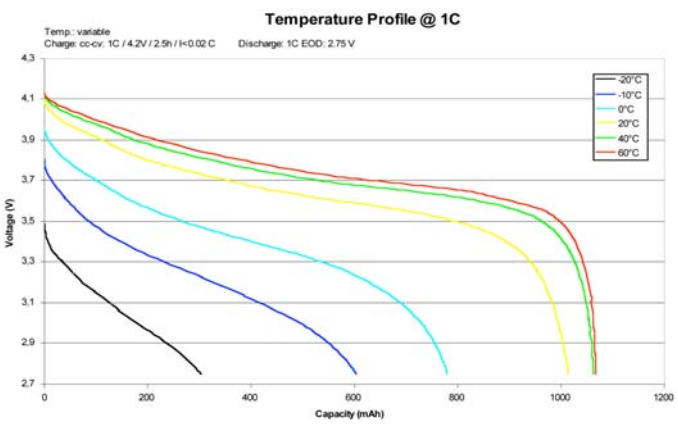


FIG. 62
Temperature Profile @ 1C

4.14 EASYPACK L-3.7V (1320 mAh)

Mechanical:	Height	6.6 mm
(max. at delivery)	Width	36.8 mm
	Length	64.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 110@1kHz	
UL Approval:	Recognition	
CE Certification		

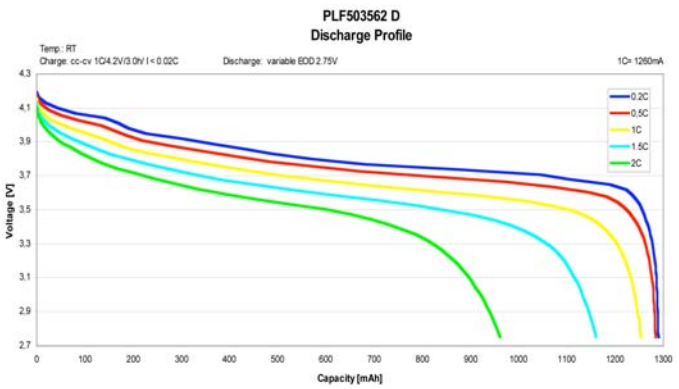


FIG. 64
Discharge Profile

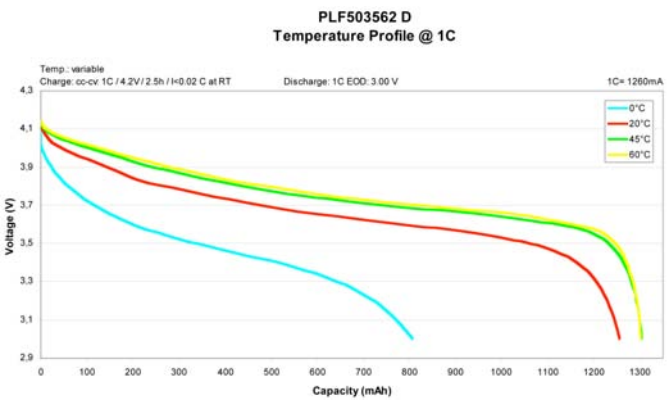


FIG. 65
Temperature Profile @ 1C

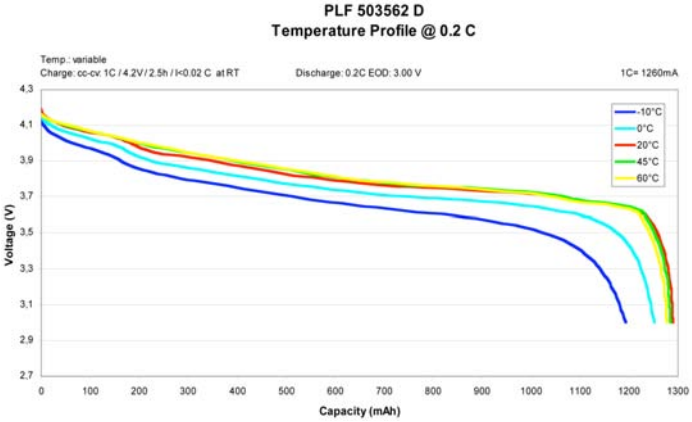


FIG. 66
Temperature Profile @ 0.2 C

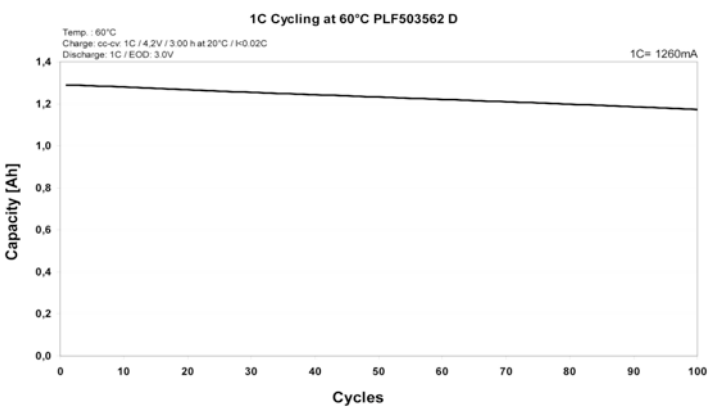


FIG. 67
Cycle life @ 20°C

4.15 EASYPACK XL-3.7V (2640 mAh)

Mechanical:	Height	11.6 mm
(max. at delivery)	Width	36.8 mm
	Length	64.7 mm
Temperature Charging:	0 to +45°C	
Temperature Discharging:	-20 to +60°C	
Temperature Storage:	1 year at -20 to +20°C >80%	
Life expectancy:	>500 cycles (>70% of Cmin)	
Impedance:	approx. 110@1kHz	
UL Approval:	Recognition	
CE Certification:	yes	

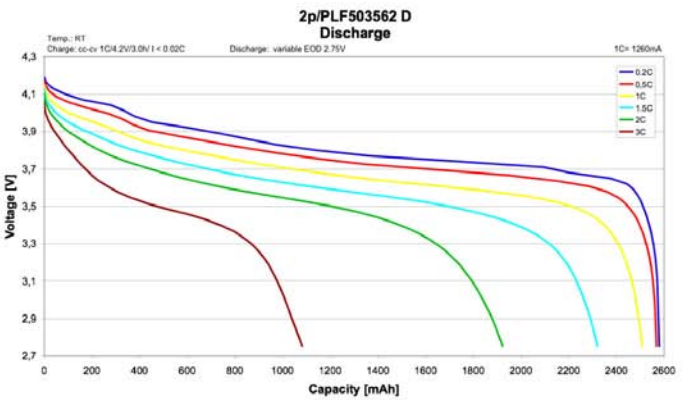


FIG. 68
Discharge Profile

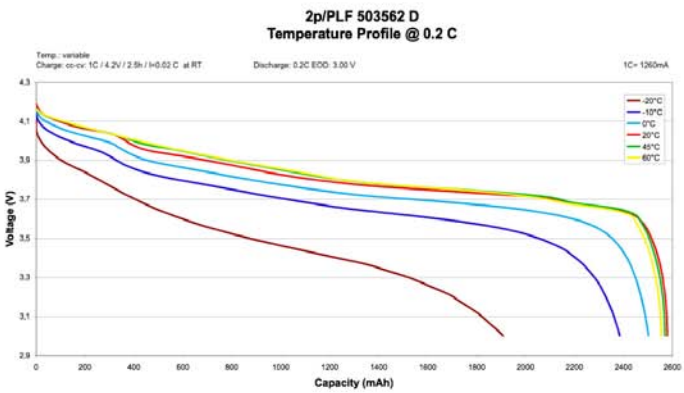


FIG. 70
Temperature Profile @ 0.2C

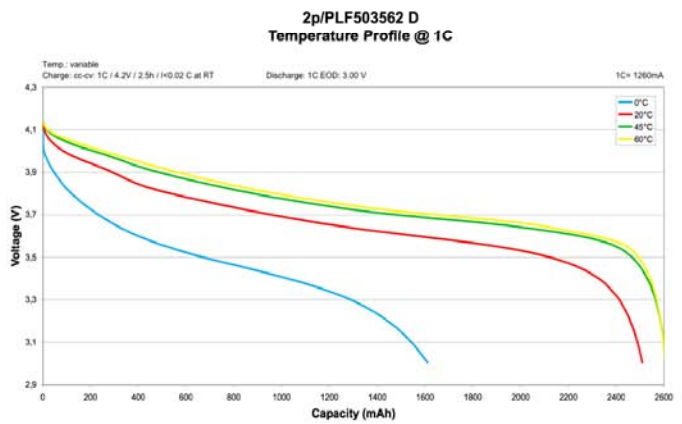


FIG. 69
Temperature Profile @ 1C

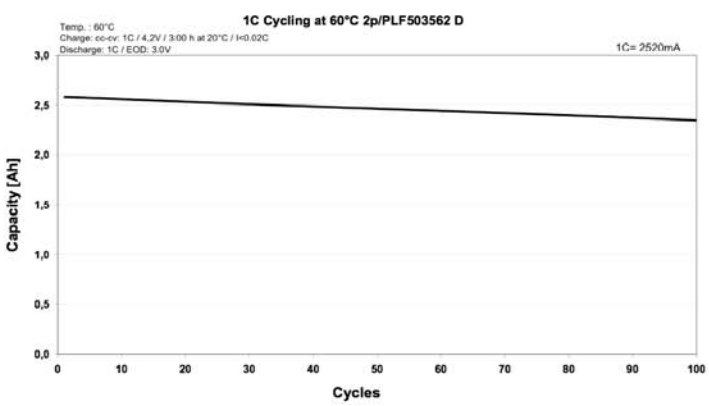


FIG. 71
Cycle life @ 20°C

5. RELIABILITY AND LIFE EXPECTANCY

VARTA PoLiFlex® batteries together with the VARTA EasyPack range represent the state of the art technology in Polymer batteries.

They combine maximum safety with top-performance and reliability.

Cycle life is expected to be 500 cycles with a remaining capacity of >70%. Even at elevated temperature the VARTA PoLiFlex® cells show excellent performance and very little swelling.

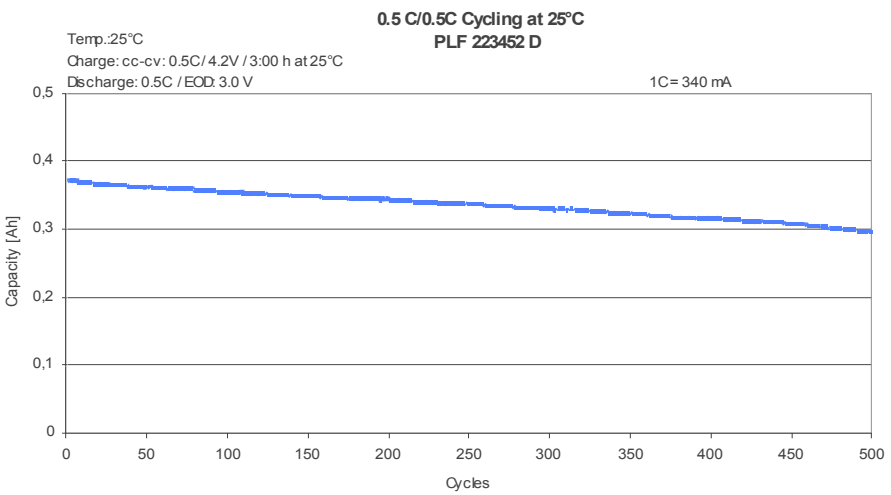


FIG. 72
Typical cycle-life at room temperature
VARTA PoLiFlex® PLF 223452 D

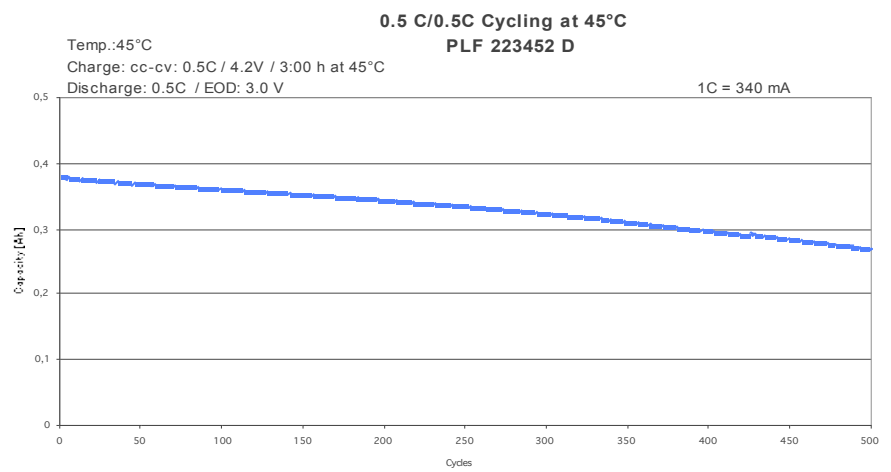


FIG. 73
Typical cycle-life at 45°C
VARTA PoLiFlex® PLF 223452 D

6. STORAGE

VARTA PoLiFlex® batteries are delivered in a state of charge which gives the best of long-term storage performance being approx. 60 % of their full capacity. This enables the best conditions for long term storage.

Most serious storage condition for all rechargeable Li-Ion/Polymer/VARTA PoLiFlex® cells and batteries is the fully charged state (CC/CV 4.2 V, 3h). This state leads to a selfdischarge (retention capacity) and to a certain irreversible capacity loss depending on the temperature during storage (recovering capacity).

Trickle charge, like in aqueous battery systems (Ni-Cd, Ni-MH), is not necessary due to the very low self discharge. Continuous charging will cause to performance loss.

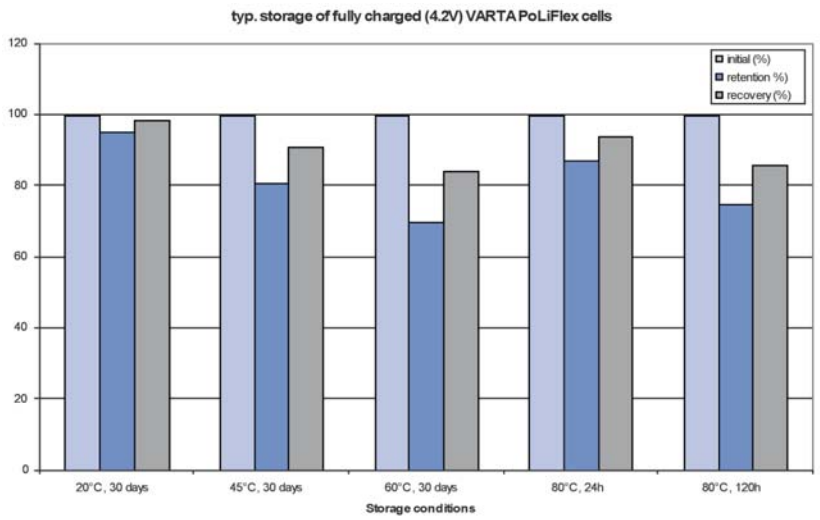


FIG. 74
Retention and recovery capacity after various – even abusive – storage conditions

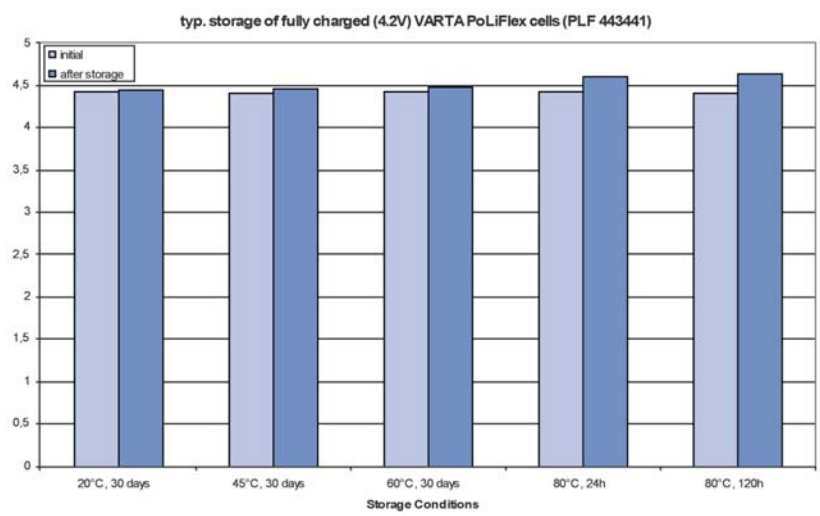


FIG. 75
Cell height after various – even abusive – storage conditions

7. SAFETY

All VARTA PoLiFlex® batteries as well as VARTA EasyPacks are equipped with an electronic module for protection against malfunction of charging and discharging, misuse and abuse.

Moreover, VARTA PoLiFlex® electrochemistry is designed by selecting ingredients and components which provide the best of performance data combined with excellent inherent safety features for usage within reasonable boundaries of specifications.

To cope with any forseeable abuse of our batteries, we have implemented a number of safety criteria which are usually multi-redundant with a carefully designed application device, a charging circuitry in particular.

It is VARTA Microbattery's policy to have all new cells tested and listed/recognized by UL (a worldwide acting, non-profit organisation in the field of consumer safety protection), according to the standard UL 1642. Relevant testing requirements, which represent to us the minimum level of safety testing, are given in the table below:

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Test	Description	Required results
Abnormal Charging Test	- Charging Current I: 3 times max. allowed charging current - Charging Voltage U: PoLiFlex cells: 4.8 V - Charging Time t: t = 2.5 C / I, (Current in CA) – at open voltage - t = 12 h – at limited charging voltage (manufacturer specification) - If necessary additional saftey elements according to UL file Testing Conditions: - Test at RT - Cell in discharged state (3.0 V after 1.0 C discharge) - An integrated overcurrent or overtemperature safety element is not allowed to be activated (the maximum load has to be chosen) - The cell will be connected in series with a direct current source and a charging current is applied	no bursting, no fire
Short Circuit Test	Testing Conditions: - Test at RT - Cell used in charged state (3 h with 1.0 CA to 4.2 V, I_{min} 0.02 C) - Cell is shortened in the test with a maximum resistance of 100 mOhm (to be documented)	no bursting, no fire Max. temperature 150°C
Voltage Reversal Charge Test (according to UN Manual 38.3)	Testing Conditions: - Test at RT - Cell in discharged state (3.0 V after 1.0 C discharge) - 1 C; 12 V until cell temperature is back at RT (t_{max} = 1h)	no bursting, no fire Max. temperature 75°C
Heating Test	Testing Conditions: - Charge conditions: cell fully charged (according to UL 1642) 3h / 4.25 V (1 C) - Heating of the cell in the temperature box to 130°C (D 5°C/min +/- 2°C) - 10 minutes holding time at 130°C	no fire, no rupture

TAB. 4
Required safety tests for VARTA PoLiFlex® cells

8. TRANSPORTATION OF VARTA PoLiFlex® CELLS AND BATTERIES

In general, lithium batteries are subjected to transport regulations depending on the means of transportation. But all batteries sold by VARTA Microbattery which are listed in this handbook are not subjected to the transport regulations of dangerous goods, because they fulfill the following requirements (Special provisions ADR 188, IATA A45, IMDG 188):

- The batteries contain not more than 1.5 g lithium equivalent per cell respectively 8 g lithium equivalent per battery.
- The batteries passed the safety tests according to clause 38.3 of the UN Manual of Test and Criteria.
- The batteries are isolated in the packaging to avoid short circuits.
- The packs are marked with a warning notice that clearly states that the pack contains rechargeable lithium batteries and must be quarantined, inspected and repacked if damaged.
- The total mass does not exceed 30 kg per pack.

Used lithium batteries have to be handled like fresh ones.

We do not recommend to weld terminals to the batteries; this should only be done by qualified personnel with the proper equipment.

9. PROPER USE AND HANDLING

Preface

Lithium batteries provide a high energy density which is often combined with a high rate capability to the benefit of the customer. Due to this excellent performance properties, Lithium batteries contain a certain safety risk. If short-circuited, heat and sometimes sparks may be generated. Mistreatment outside of the recommended limits can cause gas generation, leakage and fire.
This guideline "Handling Precautions and Prohibitions for VARTA PoLiFlex® batteries and general supply notices" shall be applied to all VARTA PoLiFlex® batteries and their component cells, which are manufactured by VARTA Microbattery GmbH. It shall be brought to the attention of all persons who handle the batteries.

Note: The customer is requested **to contact VARTA Microbattery GmbH in advance**, if and when the customer needs other applications or operating conditions than those described in this document, because additional tests and experiments may be necessary to verify performance and safety under such conditions. VARTA Microbattery GmbH shall not be responsible for safety, performance, functionality, compatibility or fitness for a particular purpose unless such features have been expressly communicated and described in the specification.
Note: VARTA Microbattery GmbH will take **no responsibility** for any accident when the cell is used under **other conditions than those described in this guideline**.
Note: VARTA Microbattery GmbH will inform, in a written form, the customer of improvement(s) regarding proper use and handling of the cell, if it is deemed necessary.
Note: Do not modify cells or batteries without prior written approval by VARTA.

1. Charging

1.1 CHARGING CURRENT

Charging current should **not exceed maximum charge current** specified in the Data Sheet. Charging with higher current than recommended may cause damage to cell performance and safety features, and can lead to **heat generation or leakage**.

1.2 CHARGING VOLTAGE

Charging at above 4,250 V, which is the absolute maximum voltage, is strictly prohibited. The charging has to be done according to the data sheet. The charger shall be designed to conform with this condition. Use specified charger only. Charging with higher voltage than specified may cause damage to cell performance and safety features, and can lead to **fire, heat generation or cell leakage**.

1.3 CHARGING TEMPERATURE

The cell shall be charged within the range of specified temperatures in the Data Sheet. If the cell is charged at a temperature out of the specified range, **leakage, heat generation, or other damages** may occur.
Repeated charging and discharging at high and low temperature may cause degradation of cell performance even within the specified temperature range.

1.4 PROHIBITION OF REVERSE CHARGING

Reverse charging is prohibited. The cell shall be connected correctly. The polarity has to be confirmed **before connecting** any wires. If the cell is connected improperly, it can not be charged. Reverse charging may cause damage to the cell(s) and may lead to a loss of cell performance and cell safety, which can lead to **heat generation or leakage**.

2. Discharging

2.1 DISCHARGE CURRENT

The cell shall be discharged at **less than the maximum discharge current** specified in the Data Sheet. High discharge current may reduce the discharging capacity significantly, or cause **overheating**.

2.2 DISCHARGE TEMPERATURE

The cell shall be discharged within the temperature range that is specified in the Data Sheet.

2.3 OVERDISCHARGING

It should be noted that the cell(s) will be overdischarged if the cell(s) is/are **not used for a long time**. In order to prevent overdischarging, the cell(s) shall be charged periodically to maintain about 3 V to 3,8 V.
Overdischarging may cause loss of cell performance, or damage battery function. The application device shall be

9. PROPER USE AND HANDLING

equipped with a device to prevent further discharging exceeding a **cutoff voltage** specified in the data sheet. Also the charger shall be equipped with a device to control the recharging procedures as follows: In case of overdischarging, the cell(s)/battery pack shall start with a low current (0,01 - 0,07 CmA) for 15-30 minutes, i.e. precharging, before rapid charging starts. The charging according to the Data Sheet shall be started after the individual cell voltage has risen above about 3 V within 15-30 minutes, which can be determined and controlled by the use of an appropriate timer for precharging.
In case the individual cell voltage does not rise to about 3 V within the pre-charging time, the charger shall have functions to stop the further continuous charging and display that the cell(s)/pack is in an abnormal state.

3. Protection Circuit Module (PCM)

3.1 The cell(s)/battery pack shall be provided with a **PCM** which can protect cell(s)/battery pack properly, e.g. in case of failing Charge Control Circuit.
3.2 PCM shall have functions of (i) overcharging prevention, (ii) overdischarging prevention, and (iii) over current prevention, to maintain safety and prevent significant deterioration of cell performance. The overcurrent can occur by external short circuit.
3.3 OVERDISCHARGE PROHIBITION
Overdischarge prevention function shall work to minimize a dissipation current to avoid further drop in cell voltage below 2,5 V or less per cell in either cell of the battery pack. It is recommended that the dissipation current of PCM shall be designed to be minimized to 0,5 micro-amperes or less after the over-discharge prevention function activates. The protection function shall monitor each cell of the battery pack for controlling current at all times.

4. Application

For the batteries approved by UL (File MH13654) the intended use is at ordinary temperatures where anticipated high temperature excursions are not expected to exceed 70°C. Nevertheless under reasonably foreseeable misuse conditions at temperatures up to 85°C over 4 hours no safety risk occurs.

4.1 USER REPLACEABLE APPLIANCES
VARTA PoLiFlex® batteries can be used as user replaceable batteries if the following conditions are fulfilled:

- The end product must be designed to prevent reverse polarity installation of the battery, or if the battery is reversed, the short or open circuiting of any protective component, one component at a time, shall not result in forced discharge of the battery.
- The end product shall contain a permanent marking adjacent to the battery stating the following or equivalent:
  "Replace battery with (Battery Manufacturer's name or endproduct manufacturer's name), Part No. (…) only. Use of another battery may present a risk of fire or explosion. See owner's manual for safety instructions" or "The battery used in the (End Product Name) must be replaced at (End product manufacturers's) service center only."
  If it is not feasible to include the above marking on the device, the marking may be included in the operating (or safety) instructions providing the battery compartment is marked with the following: "See operating (or safety) instructions for type of battery to be used."
- The instruction manual supplied with the end product shall also contain the above warning notice along with instructions to the user as to where replacement batteries can be obtained. The instruction manual shall also contain the following additional warning notice and information:
  - Caution: The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not disassemble, heat above 100°C (212°F) or incinerate.
  - Complete instructions as to how to replace the battery ending with the statement: "Dispose of used battery promptly. Keep away from children."

4.2 TECHNICIAN REPLACEABLE APPLIANCES
If the conditions 4.1 a) - c) are not fulfilled VARTA PoLiFlex® batteries can be used only in devices where servicing of the battery cirrcuit and replacement of the lithium battery will be done by a trained technician.

9. PROPER USE AND HANDLING

5. Storage

The cells shall be stored within a **proper temperature range** as specified in the Data Sheet. The state of charge shall be 50% of the nominal capacity; open circuit voltage OCV about 3,8 V. When stored for a long time, care has to taken that the battery voltage does not drop below the cut-off voltage due to self discharge (see 2.2).

6. Others

6.1 CELL CONNECTION

Soldering of wires **directly to the cell** is strictly prohibited. Tabs with presoldered wiring shall be welded to the cells. Direct soldering may cause damage of components, such as separator and insulator, by heat.

6.2 ULTRASONIC WELDING OF BATTERY PACK CASING

Ultrasonic welding of plastic lid to the plastic casing can be applied. However, the welding shall be done **avoiding the application of ultrasonic wave power directly to the cells and the PCM electronic**. Otherwise it may cause serious damage to the cells and/or PCM electronics.

6.3 PREVENTION OF SHORT CIRCUIT WITHIN A BATTERY PACK

Enough **insulation layer(s)** between wiring and the cells shall be used to maintain multiple safety protection. The battery pack shall be designed to prevent short circuits within the battery pack. This is because that short circuits within the pack may cause **generation of smoke or fire**.

6.4 ASSEMBLY

- Important!! Always avoid any possible contact of softpack/safety module with sharp objects, corners, or points which could puncture or damage it.
- Avoid applying mechanical stress (such as tension, pressure, or rubbing) to cell itself and softpack/safety module during assembly. Do not remove, disassemble any component from the original VARTA supply configuration.
- Assembly and finishing processes to be done only with ESD protection conditions.
- Do not subject softpack/safety module to higher temperatures than specified in datasheet provided.
- Do not subject softpack/safety module to ultrasonic weld process vibration or energy.
- Avoid accidental shortcircuit of softpack/safety module during assembly and finishing processes.
- Avoid accidental mechanical damage to softpack/safety module during assembly and finishing processes.
- Packaging for softpack/safety module assembly to be only with ESD-safe (anti-static) material

6.5 PROHIBITION OF DISASSEMBLY

- Never disassemble the cells.
- **Disassembling cells** may cause an internal short circuit in the cell, which could further **cause gassing, fire, or other problems**.

  Harmful Electrolytes:

  An electrolyte which leaks out from the cells is harmful to the human body. If the electrolyte comes into contact with the skin, eyes or others parts of body, the electrolyte shall **be flushed immediately with fresh water. Seek medical advice from a physician**.

6.6 PROHIBITION OF SHORT CIRCUIT

Never short circuit the cells. It causes generation of very high currents resulting in heating of the cells, which may cause electrolyte **leakage, gassing or fire**. An appropriate circuitry with PCM shall be employed to prevent accidental short circuit of the battery pack.

6.7 PROHIBITION OF DUMPING OF CELLS INTO FIRE

Never incinerate nor dispose of cells into fire.

6.8 PROHIBITION OF CELLS IMMERSION INTO LIQUID SUCH AS WATER

The cells shall never be soaked with liquids such as water, sea water, drinks such as soft drinks, juices, coffee or others.

6.9 BATTERY CELLS REPLACEMENT

The battery replacement shall be done **only by either cell supplier or device supplier** and never be done by the user.

6.10 PROHIBITION OF USE OF DAMAGED CELLS

Cells have a chance to be damaged during shipping by shocks, or other causes. If any abnormal features of the cells are found such as: damage to a plastic envelope of the cell, deformation of the cell container, smell of electrolyte, an electrolyte leakage, or other abnormalities, the cells **shall not be used any more**. Cells with a smell of electrolyte or leakage shall be kept away from fire to avoid **ignition**.

9. PROPER USE AND HANDLING

6.11 GENERAL SUPPLY NOTICES AND RESPONSIBILITIES

The customer agrees to manufacture, assemble, sell, transport and/or dispose of the Finished Products so that the health and safety of people, including workers and general public, and environmental protection can always be cared by applying the standard to be determined in compliance with the requirements therefore of the laws and regulations in the countries where the Finished Products are sold. The customer shall be solely responsible for health, safety and environmental matters arising from its manufacture, assembly, sales, use, transportation and/or disposal of the Finished Products, and shall defend, indemnify, and hold VARTA Microbattery GmbH, its subsidiaries, and customers, and its and their respective representatives and employees harmless from and against all costs, liabilities, claims, lawsuit, including but not limited to attorney's fees, with respect to any pollution, threat to the environment, or death, disease or injury to any person or damage to any property resulting, directly or indirectly, from the manufacture, assembly, purchase, sales, use, operation, transportation or disposal of the Finished Products; except to the extent that the customer shall be exempted from such obligation if and so long as the cause of such damage is attributable directly and solely to VARTA Microbattery GmbH.

6.12 BATTERY PACK STRUCTURE

- Protection circuit shall be isolated from the cell to diminish damage from any electrolyte leakage which may occur by mishap. The battery pack shall as much as possible be designed to not allow leaked electrolyte access to protection circuit.
- Battery case material tolerance for electrolyte shall be considered when battery case material is selected.

6.13. PROTECTION CIRCUIT MODULE DESIGN

- Electrolyte has corrosive characteristics. Protection circuit module may not work correctly if exposed to electrolyte.
- These points should be considered in protection circuit module design. Main wiring patterns shall be separated from each other as much as possible. Conductive patterns and connection terminals that are possible to be short-circuited by electrolyte leakage should be separated from each other as much as possible. Another method is coating the whole surface of the module by conformal coating material.
- PCM contains CMOS devices! Make sure ESD protected work-space is used when handling PCMs.

7. Marking

The customer shall prepare comprehensive instructions and appropriate markings for end users.
The battery packs shall be provided with **packing and handling, or safety instructions** regarding cell usage, storage, and replacement, and shall be marked with information in accordance with applicable regulations. **The prohibitions mentioned in this document, regulations in UL 1642 (and other specifications) shall be clearly explained to the users**.
The markings shall also be done in accordance with requirements based on guidelines for rechargeable Lithium Ion batteries for maintaining safety of the cells.
Example for marking according to the UL 1642 regulation:

- Mark the manufacturer's name, business name or trademark, and specified model name.
- Use the word "Warning" or "Caution" and indicate the statement "Potential for Fire or Burning. Do Not Disassemble, Crush, Heat, or Burn" or equivalent.
- Final product shall be marked with following statement or equivalent: "Replacement may only be made with Battery Pack specified by the final product manufacturer, with correct Part Number. Fire or burning may occur if the customer uses Battery Pack other than specified by the final product manufacturer. The customer shall refer to the handling instruction issued by the final product manufacturer."

If it is not possible to mark the warnings mentioned above on the final products, the final product manufacturer shall mark and print the warnings in the handling or maintenance instructions or manuals of the products.
Specially the marking shall contain the advices in 4.1 and 4.2 according to the type of usage.

10. BATTERY ASSEMBLY

10.1 DESIGN GUIDELINES FOR VARTA PoLiFlex® BATTERY PACKS

In general, we strongly recommend for any design-in to consult VARTA sales engineer. For applications in medical, military and intrinsic safe environment consult VARTA for approval.

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

For the battery design-in process VARTA Microbattery has specified the following Design Guidelines to guarantee high quality, best performance, safety and optimal design for battery packs created with VARTA PoLiFlex® cells, made for the new generation of modern electronic portable devices:

PCM

It is recommended to use VARTA PoLiFlex® soft packs with a suitable PCM (with which all cells are already equipped when leaving VARTA Microbattery) for further assembly. If another PCM needs to be used please contact our sales staff; we recommend to let review the suitability by our engineers.

Passive Safety Elements

As secondary protection a passive safety element like PTC, Thermofuse or Current Fuse should be used.

Battery Design

For plastic casing packs sealed by ultrasonic welding a final test of the safety function of the electronic is strictly recommended.

Multicell Configurations

The recommended maximum number of cells in series is 2 for any standard configuration, but need a special PCM for 2 cells in series to be controlled. For any higher number of cells in series please consult our sales staff.

The number of possible cells in parallel is 2 for any standard configuration. Higher numbers are possible; in this case, too, please contact your respective sales engineer at VARTA Microbattery.

For these multicell applications cells should be matched in regard to capacity, OCV and internal impedance. Each cell should be equipped with 1 Thermofuse / Polyswitch as passive protection unless the secondary protection is built into the PCM.

For further information please see also the previous chapter “Proper Use and Handling” in this handbook.

FIG. 76
VARTA PoLiFlex® battery assembly with plastic case

11. APPLICATION CHECK LIST

Name of sales person:	**Company/Branch:**	**Date:**

PROJECT DATA:

Customer:	OEM: ❑	CEM: ❑ (who is OEM?)	
Application:		Project name:	
Number of batteries/cells per year:		Target price:	
Competion:		Product type:	Price:
New design:		Replacement: ❑ (type, manufacturer, specification)	

PROJECT TIMING:

Prototypes:		Ramp up:	
Mass production:		Product life-time:	

DISCHARGE CONDITIONS:

Voltage:	U_{max}:	U_{min}:	U_{cutoff}:
Current:	I_{max}:	I_{min}:	$I_{average}$:
Current/Impulse profile (durations, cycles, pauses):			
Operating time required:			
Operating temperature:	T_{max}:	T_{min}:	$T_{average}$:
Temperature profile (durations at min./max. temperature):			

CHARGE CONDITIONS:

Standard Charge Current:	Time:	accelerated charge
Smart battery needed: Yes / No	Type:	.
Smart charger available: Yes / No	Type:	
Further information on charging (preferred charging method!):		

11. APPLICATION CHECK LIST

STORAGE CONDITIONS:

Storage temperature:	T_{max}:	T_{min}:	$T_{average}$:
Storage time:		Relative humidity:	
Life expectancy: in operation: number of cycles		in storage: number of months:	

CONSTRUCTIONAL AND MECHANICAL REQUIREMENTS / MARKING:

Space available:	Length (mm):	Width (mm):	Height (mm):
Requested battery form:		Requested terminals:	
Plastic Housing: Yes / No	Softpack; Yes / No	Contacts/Wire connector: Type	
Label:			
Customer specific Marking/Labeling required:			

QUALIFICATION OF THE BATTERY:

Required approvals/certifications
Required certification (each UL1642):

FIG. 77
The VARTA PoLiFlex® automated battery production in Ellwangen/Germany.

Product Portfolio

Primary Batteries					
	VARTA CardPower (Li-Polymer)		Lithium Cylindrical Cells		Zinc Air Cells
	Alkaline Batteries		Lithium Button Cells		Silver Oxide Button Cells
Rechargeable Batteries					
	VARTA PoLiFlex® (Li-Polymer)		Ni-MH Button Cells (V...H / HR / HT / HRT)		Cylindrical & Prismatic Li-Ion & Ni-MH Cells

Global Contacts

Germany
VARTA Microbattery GmbH
Daimlerstraße 1
73479 Ellwangen, Germany
Tel (+49) 79 61 921 - 0
Fax (+49) 79 61 921 - 553

Asia Pacific
VARTA Microbattery Pte. Ltd.
300, Tampines Avenue 5, #05-01,
Tampines Junction, 529653 Singapore
Tel (+65) 6 260 58 01
Fax (+65) 6 260 58 12

China
Hongkong
VARTA Microbattery Pte. Ltd.
Rm. 1702-3, 17/F., Fullerton Centre,
19 Hung to Road, Kwun Tong,
Kowloon, Hongkong
Tel (+852) 28 98 83 73
Fax (+852) 28 97 76 09

Beijing
VARTA Microbattery Pte. Ltd.
Room 05, 11/F., Xinyi Commercial Building
No. 3A Xinyijiayuan,
Chongwenmenwai Avenue,
Chongwen District, Beijing
China 100062
Tel (+86) 10 67 09 60 57, 67 09 60 58
Fax (+86) 10 67 09 60 59

Shanghai
VARTA Microbattery (Shanghai) Co. Ltd.
Block 3, Shanghai Pudong Chuansha
Industrial Park,
No. 6999 Chuansha Road,
Pudong New Area,
201202 Shanghai, China
Tel (+86) 21 58 59 83 85
Fax (+86) 21 58 59 33 13

Japan
VARTA Microbattery Pte. Ltd.
1-6-12 Kyobashi, chuo-ku,
Tokyo 104-0031, Japan
Tel (+81) 3 35 67 81 71
Fax (+81) 3 35 67 81 75

South Korea
VARTA Microbattery Pte. Ltd.
411-1 KCAT Bldg.,
159-6 Samsung-dong, Kangnam-gu,
Seoul 135-728 Korea
Tel (+82) 2 551 53 45
Fax (+82) 2 551 53 44

Taiwan
VARTA Microbattery Pte. Ltd.
200 A Room, 2/F World Trading Building,
50 Hsin Shen S. Rd., Section 1
Taipei 100, Taiwan
Tel (+886) 2 33 93 15 57
Fax (+886) 2 33 93 15 56

Scandinavia and Finland
VARTA Microbattery Nordic
Langebjergvaenget 8 B, 1.TV
DK-4000 Roskilde, Denmark
Tel (+45) 24 24 80 00
Fax (+45) 46 75 01 50

America
VARTA Microbattery, Inc.
1311 Mamaroneck Avenue, Suite 120,
White Plains, NY 10605, USA
Tel (+1) 914 592 25 00
Fax (+1) 914 345 04 88

UK and Ireland
VARTA Microbattery GmbH
17 Progress Business Centre,
Whittle Parkway, Slough SL 1 6DQ, GB
Tel (+44) 16 28 60 79 30
Fax (+44) 16 28 60 79 39

France
VARTA Microbattery SARL
12 - 14, Rue Raymond RIDEL,
92250 La Garenne Colombes, France
Tel (+33) 1 47 84 84 54
Fax (+33) 1 47 84 28 32

Italy
VARTA Microbattery Italia
Stradone S. Fermo, 19,
37121 Verona, Italy
Tel (+39) 045 800 16 15
Fax (+39) 045 59 18 78

Distributors
Internet

Distributors and representations in all major countries world wide. Consult our Webpage.
For e-mail contact please visit: **http://contact.varta-microbattery.com**
For more information please visit our website: **www.varta-microbattery.com**