Primary Lithium Cylindrical Cells
Lithium-Thionyl-Chloride
Li/\text{SOCl}_2

Sales Program and Technical Handbook
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The VARTA Microbattery lithium thionyl chloride cell chemistry offers an excellent shelf life, good low-current capability, a wide operating temperature range and availability in cylindrical cell designs. Potential design-in applications for these products are electronic, telecommunication, metering, safety, security, instrumentation, industrial and other portable equipment use. Based on the outstanding cell performance and reliability of these products, they have been able to meet and exceed the requirements of our customer base worldwide.

Advantages for VARTA Microbattery Li/SOCl₂ Cells

- High open circuit and load voltage (above 3.6 volts per cell)
- High energy density (760 Wh/kg and 1250 Wh/l)
- High capacity cell construction
- Operation over a wide temperature range
- Flat discharge profile under low to medium current applications
- Low self discharge (less than 1% per year at RT)
- Superior shelf life and operational life (Up to 15 years and more)
- UL Recognition
- Ability to provide a variety of laser welded termination tabs for all cell types

Li/SOCl₂ has the biggest energy density among primary Batteries
VARTA Microbattery offers a complete range of primary lithium cylindrical and button cells for metering memory back-up and portable applications worldwide. The cylindrical lithium thionyl chloride cell configurations offer the high-capacity bobbin construction. The bobbin construction is targeted at low to moderate power requirements, dedicated for applications requiring up to a 15 years operational life at 20°C.

1.1 CONSTRUCTIONS OF LITHIUM THIONYL CHLORIDE CELLS

Bobbin Type

Bobbin type battery is consisted of anode rolled against innersurface of case, separator and cathode of cylinder shape. Cathode current collector is connected with cathode of porous carbon mixture from the center of battery. As bobbin type battery has structure of containing maximum active material (lithium and SOCl₂) weight, it has huge energy density. Also, due to its structure of small reaction area and excellent in heat emission characteristics, short circuit current is limited and accordingly, it has excellent characteristics in safety.

Mechanism of VARTA Lithium Battery

Anode surface structure of VARTA lithium (Li/SOCl₂) battery can be different in case of storage (Open Circuit) and discharge (Closed Circuit) based on Figure. Passivation film was formed by itself on the surface of lithium (anode) in open circuit and this is LiCl film which is created by chemical reaction between lithium that reactivity is very big and SOCl₂. LiCl film which has insulating characteristic provide excellent storage ability to battery because it block auto reaction of Li and SOCl₂. In case of discharge, reaction products of LiCl, SO₂ and S is created caused by chemical reaction, LiCl and S in a solid phase deposited to porous carbon cathode. Therefore, cathode should provide enough pore space till completion of discharge and efficient structural design is required because speed of reaction products deposition is different according to discharge current. Li/SOCl₂ battery has nature that inner pressure is not increased until end of discharge since SO₂ that is in a gas phase is dissolved to electrolyte.

Figure: Mechanism for reaction of Li/SOCl₂
1.2 CHARACTERISTICS

Main Applications

Both mechanical and electrical properties, together with reliability, ensure that VARTA Microbattery lithium thionyl chloride batteries meet the requirements of modern electronics. They are therefore ideally suited as power sources for the long term supply of microelectronic security. Due to their extended energy density and high voltage level they are ideally suited as power sources for metering medical home and office security systems.

Main Characteristics

- Long life expectancy and long operational life
- Low self discharge rate
- High energy density (up to 1280Wh/l)
- High cell voltage (3.6V)
- Wide temperature range (-55 to +85°C)
- High operating safety
- High reliability

- Resistance to corrosion with stainless steel case
- No leakage problems
- Non flammable electrolyte
- Inorganic electrolyte
- Non pressurized
- Corrosive electrolyte

Transient Minimum Voltage (TMV)

Lithium thionyl chloride battery has very low self discharge rate than other conventional batteries. That is due to the passivation layer formed on the lithium surface as explained above. This layer effectively prevents the self-discharge of the lithium as it is non-conductive. Therefore, this layer should be broken at the initial stage of discharge to allow lithium ion to flow.

In the process, the layer adds to internal resistance, causing a momentary voltage drop, which is called TMV (Transient Minimum Voltage). The voltage of cells kept under proper conditions immediately recovers to normal operational voltage after TMV. TMV varies depending on the thickness and density of the passivation layer. The higher the discharge current gets, the lower TMV becomes. The passivation layer makes the shelf life longer by effectively preventing self-discharge but it brings about TMV. Thus, this must be fully considered, when the device is designed.
Pulse Curve of Li/SOCl₂ Battery

<table>
<thead>
<tr>
<th>Current (mA)</th>
<th>Capacity (Ah)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+60</td>
<td>17,500</td>
</tr>
<tr>
<td>+20</td>
<td>15,000</td>
</tr>
<tr>
<td>-20</td>
<td>11,000</td>
</tr>
</tbody>
</table>

When using additional power source such as Super Capacitor

TMV of Li/SOCl₂ is very changeable depending on status of Passivation Film (thickness, structure). In this reason, checking power profile, cut-off voltage and working temperature range of application are required to suggest right battery solution. In case that high pulse current is required, using additional power source such as super capacitor could be one of considerable solution.

Discharge Capacity of Li/SOCl₂ Battery

The figure shows the capacity as the discharge current about ER-D. The capacity efficiency of Li/SOCl₂ battery is decreased based on the standard discharge currents the figure shows, in high rate discharge or low rate discharge.

In case of the use in low rate range, available capacity of lithium battery is decreased by accumulated self-discharge loss due to long discharge period and the main reason of ending discharge is because of depletion of lithium or SOCl₂. In addition, available capacity of lithium battery can be dramatically decreased at high-temperature condition because temperature affects self-discharge rate in proportion.
1.3 APPLICATIONS

Utility Meters

Electricity Meters, Gas Meters, Water Meters, Calorimeters, Automatic Meter Reading (AMR).

Safety/Security Systems


Automotive Electronics


Asset Tracking

Automation

Memory back-up, Intelligent Interfaces, Personal Computers, Intelligent Typewriters, Address Printers, Envelopment Franking Machines, Cash Points, Scales, Copy Machines, Cash Register.

Vending Machines

Ticket Vending Machines, Newspaper Vending Machines, Cigarette Vending Machines, Sweet Vending Machines, Drink Vending Machines, Parking Meter.

High End Consumer

Audio and Video Memory back-up and RTC, Video Games, Gambling Machines, SCUBA Diving Meters, Altimeters, Marine Electronics, Ski Bindings, Portable Timing Units for sports events, Pigeon Flight Time Recorders.

Industrial/Medical Instrumentation

2. LITHIUM THIONYL CHLORIDE CELLS

Key Characteristics

- High and stable operating voltage
- Low self-discharge rate (less than 1% after 1 year of storage at + 20°C)
- Bobbin type
- Non-flammable inorganic electrolyte
- Hermetic glass-to-metal sealing
- UL recognized (file number MH13654(N))
- Size 1/2 AA, AA non-restricted for transport
- Size C, D class 9 restricted for transport
2.1 TYPES TECHNICAL DATA

ER 1/2 AA

Performance Data

**Continuous Discharge at 20°C**

<table>
<thead>
<tr>
<th>Current (mA)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>3.8</td>
</tr>
<tr>
<td>0.4</td>
<td>3.6</td>
</tr>
<tr>
<td>0.6</td>
<td>3.4</td>
</tr>
<tr>
<td>0.8</td>
<td>3.2</td>
</tr>
<tr>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>1.4</td>
<td>2.6</td>
</tr>
</tbody>
</table>

**Capacity vs. Current**

<table>
<thead>
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<th>Current (mA)</th>
<th>Capacity (Ah)</th>
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<tbody>
<tr>
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<td>6.4</td>
</tr>
<tr>
<td>0.6</td>
<td>5.8</td>
</tr>
<tr>
<td>0.8</td>
<td>5.2</td>
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<tr>
<td>1.0</td>
<td>4.6</td>
</tr>
<tr>
<td>1.2</td>
<td>4.0</td>
</tr>
<tr>
<td>1.4</td>
<td>3.4</td>
</tr>
</tbody>
</table>

**Discharge Current vs. Duration Time**

<table>
<thead>
<tr>
<th>Discharge Current (mA)</th>
<th>Discharge Duration Time (h)</th>
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</thead>
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<tr>
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<td>50,000</td>
</tr>
<tr>
<td>0.6</td>
<td>25,000</td>
</tr>
<tr>
<td>0.8</td>
<td>10,000</td>
</tr>
<tr>
<td>1.0</td>
<td>5,000</td>
</tr>
<tr>
<td>1.2</td>
<td>2,500</td>
</tr>
<tr>
<td>1.4</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Type Number: 7126
Designation IEC: 14250
System: Primary Li-Thionyl Chloride/Li-SOCl₂

UL Recognition: MH 18384
Nominal Voltage: 3.6 V
Typical Capacity C: 1200 mAh
(Load 2 mA, at 20°C, down to 2 V)

Continuous discharge current: max. 20 mA
(to get 50% of nom. cap. @+20°C, down to 2 V)
Pulse discharge current*: max. 80 mA

Weight (approx.): 9.0 g
Volume: 4.2 ccm
Coding: Date of Manufacturing Year/Month

Temperature Ranges
Operating: min. -55°C max. 85°C

Dimensions
Diameter (A): min. 14.00 max. 14.60
Height (B): 24.10 min. 25.10
Shoulder Diameter [L]: 4.10 min. 4.50
Shoulder Height [M]: 0.80 min. 1.20
Li metal content: approx. 0.30 g

*Max. pulse current/0.1 second pulses, drained every 2 min at +20°C from undischarged cells with 10 μA base current, yield voltage readings above 3 V. The readings may vary according to the pulse characteristics, the temperature and the cell's previous history. Fitting the cell with a capacitor may be recommended in severe conditions.

WARNING: Fire, explosion and severe burn hazard. Do not recharge, crush, disassemble, heat, above 100°C (212°F), incinerate, short circuit or expose contents to water. Keep battery out of reach of children and in original package until ready to use. Dispose of used batteries properly.

Internal resistance may rise versus time, especially in case of exposure to elevated temperature.

This data was made on basis of nominal capacity for the purpose of enabling users to forecast approximate life time. In order to calculate precise life time under various environments, we recommend you to consult VARTA Microbattery GmbH. In case where the products are improved, the specifications described herein are subject to change.
**Type Number**.................. 7106
**Designation IEC** ............... 14500
**System** ........................ Primary Li-Thionyl Chloride/Li-SOCl₂

**UL Recognition** ............... MH 13654
**Nominal Voltage** .............. 3,6 V
**Typical Capacity C** ............ 2500 mAh
(Load 2 mA, at 20°C, down to 2 V)

**Continuous discharge current**  max. 60 mA
(to get 50% of nom. cap +20°C, down to 2 V)

**Pulse discharge current*** ...... max. 150 mA

**Weight (approx.)** ............ 16,0 g
**Volume** .......................... 8,5 ccm
**Coding** .......................... Date of Manufacturing
**Year/Month** ........................

**Temperature Ranges**  min.  max.
**Operating** ...................... -55°C  85°C

**Dimensions**  min.  max.
**Diameter (A)** ................... 14,00  14,60
**Height (B)**  ...................... 50,00  50,50
**Shoulder Diameter [L]** ......... 4,60  4,80
**Shoulder Height [M]** ........... 0,90

**Li metal content** ............... approx. 0,62 g

*Max. pulse current/ 0,1 second pulses, drained every 2 min at +20°C from undischarged cells with 10 μA base current, yield voltage readings above 3 V. The readings may vary according to the pulse characteristics, the temperature and the cell’s previous history. Fitting the cell with a capacitor may be recommended in severe conditions.

**WARNING:** Fire, explosion and severe burn hazard. Do not recharge, crush, disassemble, heat, above 100°C (212°F), incinerate, short circuit or expose contents to water. Keep battery out of reach of children and in original package until ready to use. Dispose of used batteries properly.

Internal resistance may rise versus time, especially in case of exposure to elevated temperature.

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Lithium-Thionyl-Chloride Cells

Performance Data

Continuous Discharge at 20°C

Capacity vs. Current

Discharge Current vs. Duration Time

Type Number .................. 7110
Designation IEC ................. ER 17500
System .......................... Primary Li-Thionyl Chloride/Li-SOCl₂

UL Recognition .................. MH 18384
Nominal Voltage ................. 3.6 V
Typical Capacity C .............. 3650 mAh
(Load 3 mA, at 20°C, down to 2 V)
Continuous discharge current max. 70 mA
(to get 50% of nom. cap +20°C, down to 2 V)
Pulse discharge current* ...... max. 160 mA
Weight (approx.) .................. 24,0 g
Volume .......................... 14,0 ccm
Coding ......................... Date of Manufacturing
Year/Month

Temperature Ranges
Operating ......................... min. -55°C max. 85°C

Dimensions
Diameter (A) ..................... min. 16,20 max. 16,80
Height (B) ........................ min. 50,00 max. 50,50
Shoulder Diameter [L] .......... min. 4,10 max. 4,50
Shoulder Height [M] .......... min. 0,50 max. 0,90
Li metal content ................ approx. 0,97 g

*Max. pulse current/0,1 second pulses, drained every 2 min at +20°C from undischarged cells with 10 μA base current, yield voltage readings above 3 V. The readings may vary according to the pulse characteristics, the temperature and the cell’s previous history. Fitting the cell with a capacitor may be recommended in severe conditions.

WARNING: Fire, explosion and severe burn hazard. Do not recharge, crush, disassemble, heat, above 100°C (212°F), incinerate, short circuit or expose contents to water. Keep battery out of reach of children and in original package until ready to use. Dispose of used batteries properly.

Internal resistance may rise versus time, especially in case of exposure to elevated temperature.

This data was made on basis of nominal capacity for the purpose of enabling users to forecast approximate life time. In order to calculate precise life time under various environments, we recommend you to consult VARTA Microbattery GmbH. In case where the products are improved, the specifications described herein are subject to change.
ER C

Type Number ......................... 7114
Designation IEC ......................... 26500
System ............................... Primary Li-Thionyl Chloride/Li-SOCl₂

UL Recognition ......................... MH 13654
Nominal Voltage ........................... 3,6 V
Typical Capacity C ......................... 8500 mAh
(Load 4 mA, at 20°C, down to 2 V)
Continuous discharge current .... max. 80 mA
(to get 50% of nom. cap +20°C, down to 2 V)
Pulse discharge current* .......... max. 180 mA
Weight (approx.) ......................... 50,0 g
Volume .................................. 26,5 ccm
Coding ................................... Date of Manufacturing Year/Month

Temperature Ranges ........................... min. max.
Operating .............................. -55°C  85°C

Dimensions ............................... min. max.
Diameter (A) ......................... 25,30  25,90
Height (B) .............................. 49,80  50,50
Shoulder Diameter [L] .......... 4,10  4,50
Shoulder Height [M] ............... 2,20  2,80
Li metal content ..................... approx. 2,18 g

*Max. pulse current/0,1 second pulses, drained every 2 min at +20°C from undischarged cells with 10 μA base current, yield voltage readings above 3 V. The readings may vary according to the pulse characteristics, the temperature and the cell's previous history. Fitting the cell with a capacitor may be recommended in severe conditions.

WARNING: Fire, explosion and severe burn hazard. Do not recharge, crush, disassemble, heat, above 100°C (212°F), incinerate, short circuit or expose contents to water. Keep battery out of reach of children and in original package until ready to use. Dispose of used batteries properly.

Internal resistance may rise versus time, especially in case of exposure to elevated temperature.

This data was made on basis of nominal capacity for the purpose of enabling users to forecast approximate life time. In order to calculate precise life time under various environments, we recommend you to consult VARTA Microbattery GmbH. In case where the products are improved, the specifications described herein are subject to change.
Type Number ...................... 7120
Designation IEC .................. 33600
System ............................ Primary Li-Thionyl
Chloride/Li-SOCl₂

UL Recognition ................... MH 13654
Nominal Voltage .................. 3,6 V
Typical Capacity C ............... 19000 mAh
(Load 2 mA, at 20°C, down to 2 V)
Continuous discharge current .. max. 100 mA
(to get 50% of nom. cap +20°C, down to 2 V)
Pulse discharge current* ....... max. 250 mA
Weight (approx.) .................. 100,0 g
Volume ............................ 53,6 ccm
Coding ............................. Date of Manufacturing
Year/Month

Temperature Ranges .......... min.  max.
Operating .......................... -55°C  85°C

Dimensions ...................... min.  max.
Diameter (A) ...................... 33,20  33,80
Height (B) ......................... 58,70  59,70
Shoulder Diameter [L] .......... 4,10  4,50
Shoulder Height [M] ............. 1,50  2,50
Li metal content ............... approx. 4,90 g

*Max. pulse current / 0,1 second pulses, drained every 2 min at +20°C from
undischarged cells with 10 μA base current, yield voltage readings above 3 V.
The readings may vary according to the pulse characteristics, the temperature
and the cell’s previous history. Fitting the cell with a capacitor may be recom-
ended in severe conditions.

WARNING: Fire, explosion and severe burn hazard. Do not recharge, crush,
disassemble, heat, above 100°C (212°F), incinerate, short circuit or expose
contents to water. Keep battery out of reach of children and in original
package until ready to use. Dispose of used batteries properly.

Internal resistance may rise versus time, especially in case of exposure to
elevated temperature.

This data was made on basis of nominal capacity for the
purpose of enabling users to forecast approximate life
time. In order to calculate precise life time under various
environments, we recommend you to consult VARTA
Microbattery GmbH. In case where the products are
improved, the specifications described herein are subject
to change.
2.2 ASSEMBLIES

ER 1/2 AA

Standard Battery Assembly Version Overview

<table>
<thead>
<tr>
<th>Article Designation</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER 1/2 AA S PCBd 10.0 N &quot;S&quot;</td>
<td>7126 211 013</td>
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<tr>
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<td>7126 211 302</td>
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<tr>
<td>ER 1/2 AA S PCBd 7.5 N &quot;S&quot;</td>
<td>7126 211 382</td>
</tr>
<tr>
<td>ER 1/2 AA S WC &quot;S&quot;</td>
<td>7126 211 390</td>
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<td>ER 1/2 AA S ST &quot;S&quot;</td>
<td>7126 311 301</td>
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<td>ER 1/2 AA S CD &quot;S&quot;</td>
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<tr>
<td>ER 1/2 AA S PCBd &quot;S&quot;</td>
<td>7126 711 301</td>
</tr>
</tbody>
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Scheme

Battery Dimension

ER 1/2 AA S PCBd 10.0 N "S"
Single Double Tag Version

ER 1/2 AA S PCBd 10.0 - EAN "S"
Single Double Tag Version

ER 1/2 AA S PCBd 7.5 "S"
Single Double Tag Version
ER 1/2 AA S PCBD 7.5 N "S"
Single Double
Tag Version

ER 1/2 AA S WC "S"
With sleeve and
wires connector

ER 1/2 AA S ST "S"
Single Tag Version

ER 1/2 AA S CD "S"
Contact Disc + wire

ER 1/2 AA S PCBS "S"
Single Tag Version
ER AA

Standard Battery Assembly Version Overview

<table>
<thead>
<tr>
<th>Article Designation</th>
<th>Order No.</th>
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<td>7106 211 302</td>
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<td>ER AA S PCBS 10.0 N &quot;S&quot;</td>
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</tr>
<tr>
<td>ER AA S PCBD 7.5 N &quot;S&quot;</td>
<td>7106 211 382</td>
</tr>
<tr>
<td>ER AA S WC &quot;S&quot;</td>
<td>7106 211 390</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>ER AA S PCBS &quot;S&quot;</td>
<td>7106 711 301</td>
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</table>

Battery Dimension

ER AA S PCBD 10.0 "S"
Single Double
Tag Version

ER AA S PCBD 7.5 "S"
Single Double
Tag Version

ER AA S PCBD 10.0 N
Single Double
Tag Version

ER AA S
Shrink Sleeve
Version
ER AA S PCBD 7.5 N "S"
Single Double Tag Version

ER AA S WC "S"
With sleeve and wires connector

ER AA ST "S"
Single Tag Version

ER AA S CD "S"
Contact Disc + wire

ER AA S PCBS "S"
Single Tag Version
ER A

Standard Battery Assembly Version Overview

<table>
<thead>
<tr>
<th>Article Designation</th>
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<tr>
<td>ER A S WC &quot;S&quot;</td>
<td>on request</td>
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<tr>
<td>ER A S ST &quot;S&quot;</td>
<td>on request</td>
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<tr>
<td>ER A S CD &quot;S&quot;</td>
<td>on request</td>
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<tr>
<td>ER A S PCBS &quot;S&quot;</td>
<td>on request</td>
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</tbody>
</table>

Battery Dimension

ER A S PCBD 10.0 "S"
Single Double
Tag Version

ER A S PCBD 7.5 "S"
Single Double
Tag Version

ER A S PCBD 10.0 N "S"
Single Double
Tag Version

ER A S Shrink Sleeve Version
Lithium-Thionyl-Chloride Cells

ER A S PCBD 7.5 N "S"
Single Double Tag Version

ER A S WC "S"
With sleeve and wires connector

ER A ST "S"
Single Tag Version

ER AA S CD "S"
Contact Disc + wire

ER A S PCBS "S"
Single Tag Version
ER C

Standard Battery Assembly Version Overview

<table>
<thead>
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<th>Article Designation</th>
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<td>ER C ST</td>
<td>7114 301 301</td>
</tr>
<tr>
<td>ER C CD</td>
<td>7114 501 301</td>
</tr>
</tbody>
</table>

Battery Dimension

ER C ST
Solder Tag Version

ER C CD
Contact Disc + wire

Scheme

ER C S
Shrink Sleeve Version
ER D

Standard Battery Assembly Version Overview

<table>
<thead>
<tr>
<th>Article Designation</th>
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</tr>
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<td>ER D ST</td>
<td>7120 301 301</td>
</tr>
<tr>
<td>ER D CD</td>
<td>7120 501 301</td>
</tr>
</tbody>
</table>

Battery Dimension

ER D ST
Solder Tag Version

ER D CD
Contact Disc + wire

Scheme

ER D S
Shrink Sleeve Version
3. GENERAL DESIGN CHARACTERISTICS

3.1 CELL ORIENTATION

According to the cell orientation, the capacity during discharge can be affected because of the different position of electrolyte and amount against lithium and cathode. There are three possible cell orientations when the cell is installed to the applied device as figure among.

- Under upright installation, the capacity is not affected whether discharge current is high, nominal or low.

- Under horizontal installation, the capacity of smaller size (1/2 AA, AA, A) is not affected whether discharge current is high, nominal or low. The capacity of bigger size (C, D) cannot be affected when discharge current is low or normal but it can be affected when discharge current is high. (About 15~30% of capacity reduction at higher discharge current will be expected.)

- Under upside down installation, the capacity of smaller size (1/2 AA, AA, A) is less affected whether discharge current is high, nominal or low. However, the capacity of bigger size (C, D) especially at higher discharge current is affected. Under upside down installation, the lithium and cathode is located in a fixed area whereas the electrolyte falls to the bottom in this case. At the top of the cell there is a space leaving an area of the anode and cathode, not covered by the electrolyte. Bigger size cells have a bigger empty space, so the capacity decrease in upside down installation is higher than in cells of smaller size. (About 20~40% of its capacity at same higher discharge current.)
3.2 CIRCUIT DESIGN FOR MEMORY BACK-UP

VARTA lithium batteries are recognized and accepted by UL with file No. MH28122. Underwriter’s Laboratories (UL) recommends the following circuit design requirements to use VARTA lithium batteries.

VARTA lithium cells should not be connected in series with an electrical power source that would increase the forward current through the cells. Figure among is a generally recommended circuit design for memory back-up using VARTA lithium batteries.

![General Circuit Design of Memory Back-up](image)

The circuit for these cells shall include one of followings:
- Two suitable diodes or the equivalent are connected in series with the cells to prevent any reverse (charging) current. The second diode is used to provide protection in the event that one should fail. Quality control, or equivalent procedures, shall be established by device manufacturer to insure the diode polarity is correct for each unit, or
- A blocking diode or the equivalent to prevent any reverse (charging) current and a resistor to limit the current in case of a diode failure. The resistor should be sized to limit the reverse (charging) current to the maximums shown below.

The storage, handling, and disposal of these cells should be in accordance with the “Warning Notice” which is printed on VARTA cells as follows:

“WARNING: Fire, explosion, and severe burn hazard. Do not recharge, crush, disassemble, heat above 100°C (212°F), incinerate, or expose contents to water.”
3.3 CAPACITOR SUPPORT

It is normal that the internal resistance of a lithium battery can be increased after long storage without an appropriate discharge rate or very irregular but higher pulse discharge. The internal resistance can also be dramatically increased when the discharge with smaller continuous load is performed for several years (around 80% of capacity discharge). The full capacity of the lithium battery cannot be supplied by the end of lifetime because the operating voltage can drop caused by increased internal resistance under long discharge. In addition, under higher current levels Voltage Delay Curves or under lower operating temperatures, TMV drop can be severe and operating voltage can be reduced. In that case, VARTA recommends using batteries with capacitor support to maximize performance by the end of service life.

![Typical Design of Capacitor Support](image)

Formula to choose capacitor value can be suggested by capacitor manufacturers as follows;

**Type of Capacitor:** Electrolytic capacitor, Super Capacitor, Gold Capacitor

**Formula for Capacitor Size:**

\[ C = \frac{U}{R} \times t \times \frac{\Delta V}{\Delta t} \]

- **C:** Capacitor
- **U:** Basic voltage (working voltage under basic current)
- **R:** Internal resistance of capacitor C (mΩ value with small effect)
- **t:** Backup time
- **\Delta V:** Allowed voltage drop

In actual case, customers shall choose a capacitor size with about 2 times of the above calculation to cover various environmental conditions sufficiently. There is some leakage current in the capacitor and it could be related to the consumption of battery capacity. It is normally small but must be taken into account against battery capacity.
3.4 BATTERY ASSEMBLY

The work of battery assembly requires experience. Customers who are not qualified in battery assembly should not attempt to assemble batteries. Especially, Li-SOCl₂ batteries which have a glass-to-metal sealing around the head terminal and a bottom insulator inside the bottom case, so careful assembly is necessary to avoid any mechanical damage or problem. VARTA cannot take any responsibility for quality problems caused by incorrect battery assembly. Therefore, please let VARTA or a qualified assembler assemble batteries for you.
VARTA provides batteries with various terminal types to mount cells to printed circuit boards by soldering. VARTA's terminals are made of nickel and some are pre-soldered with SnPb around the tips of the terminal for easier soldering.

Following are the available soldering methods. More information can be available upon request.

**Hand Soldering**

Using manual soldering iron by skilled persons.

**Precautions**
- Do not allow soldering iron to contact the body of the battery because of higher generation of battery heat.
- Finish the soldering work on a termination within a short period of time (max. 5 sec.)
- Do not overheat battery during soldering.

**Wave Soldering**

Using automatic soldering baths on a mass-production line.

**Precautions**
- Do not drop cells in the solder bath.
- Keep the temperature of solder bath within 260~280°C.
- Dipping time shall be within 5 sec.
- Do not overheat battery during soldering.
4. SAFETY

4.1 GENERAL

Basically, VARTA lithium batteries are safely designed to endure various environmental conditions. The design of the hermetically seal rim and the glass-to-metal welding can give the battery high endurance in various environmental conditions such as variant temperatures, humidity and vibration. Also, the position of lithium against the inner wall of the cell case makes heat dissipated to the outside easier when inside heat is generated. Therefore, there is no concern over safety when the suggested cautions are followed during usage, handling or storage.

However, there might be some possibilities of mishandling or misuse by the customer. Thus, following simulation tests have been performed. The test conditions are based on the procedures of the UL standard tests and Military Standards for environmental and safety testing. The abnormal test is only carried out to check the behavior of the batteries under misuse conditions and make certain the batteries react in a safe manor.
### 4.2 SAFETY TESTS

**UL-Recognition**

All VARTA Microbattery Lithium Cells and Batteries listed below are recognized by Underwriters Laboratories Inc. under UL-file number MH13654.

The cells are marked with the Recognized Component Mark.

Underwriters Laboratories requires for lithium cells/batteries a circuit, which must contain a protective component to prevent charging. In case of diode failure a current limiting resistor must be chosen according to the values listed in Table below, which are the maximum safe reverse currents according UL 1642 Test in order to prevent fire or explosion. (These are not the maximum continuous reserve currents in a regular use. Refer to Design-in considerations in Section 3).

For safety tests of the cells, “UL” requires either an additional diode, or a resistor, limiting the current to a safe level as “portable”. (See also Section 3.2)

It should be noted that the value of the resistor has to be calculated using the higher power supply voltage – not the battery voltage.

The supply voltage to the load can be calculated by the battery voltage drop across the diode and the resistor.

Please also pay attention to the Safety Guidelines given in the safety data sheet (Section 4.3).

#### Printed Circuit Board Mounting

Never solder on the body of the battery directly, use a battery equipped with PC-mount terminals. When using automatic soldering apply 260–280°C within 5 seconds. Make sure that the battery is not suspended or dropped into the soldering bath.

Do not heat above 80°C to avoid leakage caused by deterioration in the battery’s performance.

<table>
<thead>
<tr>
<th>Model</th>
<th>Primary Type (a)</th>
<th>Max. Abnormal Charging Current, mA</th>
<th>Max. Charge Voltage</th>
<th>Replacement (b), (c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER 1/2 AA</td>
<td>Lithium/thionyl chloride</td>
<td>15</td>
<td>4.2</td>
<td>Technician</td>
</tr>
<tr>
<td>ER AA</td>
<td>Lithium/thionyl chloride</td>
<td>15</td>
<td>4.2</td>
<td>Technician</td>
</tr>
<tr>
<td>ER A</td>
<td>Lithium/thionyl chloride</td>
<td>60</td>
<td>4.2</td>
<td>Technician</td>
</tr>
<tr>
<td>ER C</td>
<td>Lithium/thionyl chloride</td>
<td>15</td>
<td>4.2</td>
<td>Technician</td>
</tr>
<tr>
<td>ER D</td>
<td>Lithium/thionyl chloride</td>
<td>150</td>
<td>4.2</td>
<td>Technician</td>
</tr>
</tbody>
</table>

(a) These cells and batteries are not rechargeable. The circuit containing these cells or batteries is to contain a protective component which prevents charging. The circuitry is to include a current-limiting component intended to protect the cell or battery, in the event the protective component malfunctions, from a charging current in excess of the maximum abnormal charging current indicated.

(b) Technician – These cells and batteries are intended for use in applications subject to replacement only by a trained service.

(c) The Max. Charge Voltage noted in the column is the maximum voltage employed during the abnormal charging test of the secondary lithium cell. However, the maximum recommended charging voltage for lithium cells is 4.2 V, unless indicated otherwise in the individual Recognitions.

Marking: Company name, model designation, date of manufacture and the Recognized Component Mark on the individual cell/battery or the smallest shipping container.
4.3 SAFETY GUIDELINES


4.4 TRANSPORTATION

The exemptions from dangerous goods regulations are only applicable with respect to the delivery form in which the products are dispatched by VARTA Microbattery. Any re-packaging or assembly of cells is in the responsibility of the customer. Especially in the case of lithium systems new safety tests may be necessary; note that the maximum amount of lithium according to special provisions 188 (ADR/RID/IMDG-Code) or Packaging Instruction 968 Sections IB or II (IATA) may be exceeded as a consequence of assembly.

The given emergency number is only valid for transports initiated by VARTA Microbattery.
4.5 OEM – APPLICATION CHECK LIST

1. PROJECT INFORMATION

<table>
<thead>
<tr>
<th>From (Writer)</th>
<th>Sales Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Application</td>
</tr>
<tr>
<td>Name of the project</td>
<td>Country</td>
</tr>
</tbody>
</table>

2. MARKETING DATA

<table>
<thead>
<tr>
<th>Yearly expectation of sales</th>
<th>Per batch of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated selling price</td>
<td>Expected data of first order</td>
</tr>
<tr>
<td>Lifetime of the project</td>
<td>Start of volume production</td>
</tr>
</tbody>
</table>

Competitors

<table>
<thead>
<tr>
<th>Yes ☐</th>
<th>No ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution of existing product</td>
<td>Which</td>
</tr>
</tbody>
</table>

Comments

3. WHAT IS REQUIRED?

<table>
<thead>
<tr>
<th>Feasibility study, preliminary proposal</th>
<th>Yes ☐</th>
<th>No ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical proposal</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Preliminary drawing</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Samples to run electric tests</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Samples (with dummy cells)</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Prototypes (for qualification by the customer)</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Preliminary cost estimation (+/- 20%)</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Development and industrial cost estimation</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Product cost estimation (+/- 5%)</td>
<td>Yes ☐</td>
<td>No ☐</td>
</tr>
</tbody>
</table>
4. TECHNICAL REQUIREMENTS

4.1. Storage before use

<table>
<thead>
<tr>
<th>Duration</th>
<th>Temperature min.</th>
<th>Average</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Humidity

4.2. Storage into the device before operating

<table>
<thead>
<tr>
<th>Duration</th>
<th>Temperature min.</th>
<th>Average</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Humidity

4.3. Specific tests prior incorporation


4.4. Electric data

<table>
<thead>
<tr>
<th>Required minimum life time in use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum voltage</td>
</tr>
<tr>
<td>Nominal capacity</td>
</tr>
<tr>
<td>Cut off voltage</td>
</tr>
<tr>
<td>Required minimum capacity</td>
</tr>
</tbody>
</table>
| Current profile (average current, current pulse strength, pulse duration, pulse rate…)
| Others                            |

4.5. Climatic data

<table>
<thead>
<tr>
<th>Operating temperature min.</th>
<th>Average</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Humidity

Others
4.6. Mechanical data (vibration, drop, bump, shock, …)

Mention the applicable specification and enclose the document if necessary.

4.7. Available dimensions: (weight, volume, if possible enclose the user drawing of the prospect)

4.8. Assembly (describe or enclose a drawing)

4.9. Applicable specifications / standards

<table>
<thead>
<tr>
<th>UL</th>
<th>BS UN</th>
<th>IEC86-4</th>
<th>Other</th>
</tr>
</thead>
</table>

Reference and issue

4.10. Reliability level – Guarantees

4.11. Labeling and Packaging

VARTA standard labeling and packaging

Customised labeling (enclose the customer specification)

Customised packaging (enclose the customer specification)

4.12. Attached documents

<table>
<thead>
<tr>
<th>Samples</th>
<th>Competitor samples</th>
<th>Drawing</th>
<th>Specification of the customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copy of specific standards</td>
<td>Samples of connector</td>
<td>Samples of specific components</td>
<td>Other</td>
</tr>
</tbody>
</table>

4.13. Additional information
## VARTA Microbattery GmbH Product Portfolio

<table>
<thead>
<tr>
<th>Primary Batteries</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium-Manganese Cells</td>
<td>Lithium-Thionyl-Chloride Cells</td>
<td>Zinc Air Cells</td>
<td>Alkaline Batteries</td>
</tr>
<tr>
<td>Lithium Button Cells</td>
<td>Silver Oxide Button Cells</td>
<td>Nickel Zinc Button Cells</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rechargeable Batteries</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Li-Ion Button Cells</td>
<td>CoinPower</td>
<td>NIMH Button Cells (V...H / HR / HT / HRT)</td>
<td>NIMH Cylindrical</td>
</tr>
<tr>
<td>Li-Ion &amp; Li-Polymer Batteries</td>
<td>Li-Power Packs CellPac PLUS CellPac BLOX</td>
<td>Li-Power Packs Engion BIKE</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hydrogen Gas Generating Cells</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VARTA H₂ Cells</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Contact

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