Jauch®
THE PULSE OF PROGRESS

Whitepaper

Properties and Advantages of Lithium Thionyl Chloride Batteries

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I. Structure of a Lithium Thionyl Chloride Battery

There are two different cell designs for lithium thionyl chloride batteries: spiral type and bobbin type. Spiral type batteries are particularly suitable for applications that require high pulse currents at irregular intervals. In contrast, bobbin type batteries are found most often in devices that require low power output over a long period of time.

Fig. 1 shows the cross-section schematic of the structure of a $LiSOCl_2$ battery. The housing is hermetically sealed, which ensures a high level of cell safety. The battery cover is firmly welded to the housing by laser. The positive electrode is insulated by a special glass–metal seal.

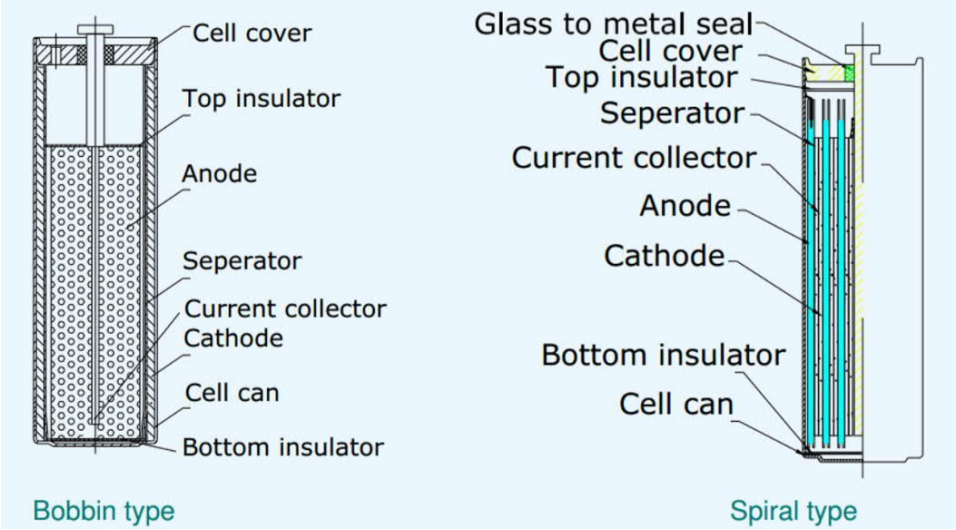


Fig. 1: Cell design of a lithium thionyl chloride battery: bobbin type (left), spiral type (right)

Jauch's portfolio includes bobbin type lithium thionyl chloride batteries, which are characterised by high cell safety and a long service life. Besides cylindrical cells, wafer cells are also available.

Cell chemistry

The anode consists of a lithium foil that is rolled against the inner wall of the cell casing. The electrolyte used for this is a solution of lithium tetrachloroaluminate (LiAlCl4) in thionyl chloride. The following chemical reactions take place during discharge:

Positive reaction: $2SOCl_2 + 4Li^+ + 4e^- \longrightarrow 4LiCl + S + SO_2$

Negative reaction: $Li \longrightarrow Li^+ + e^-$

Overall reaction: $2SOCl_2 + 4Li \longrightarrow 4LiCl + S + SO_2$

II. Advantages of Lithium Thionyl Chloride Batteries

Lithium thionyl chloride batteries cannot be recharged after a single discharge. In practice however, this aspect is of little importance due to the long service life of the cells. When power requirements are low, lithium thionyl chloride batteries provide power to applications for several months or even years before they need to be replaced.

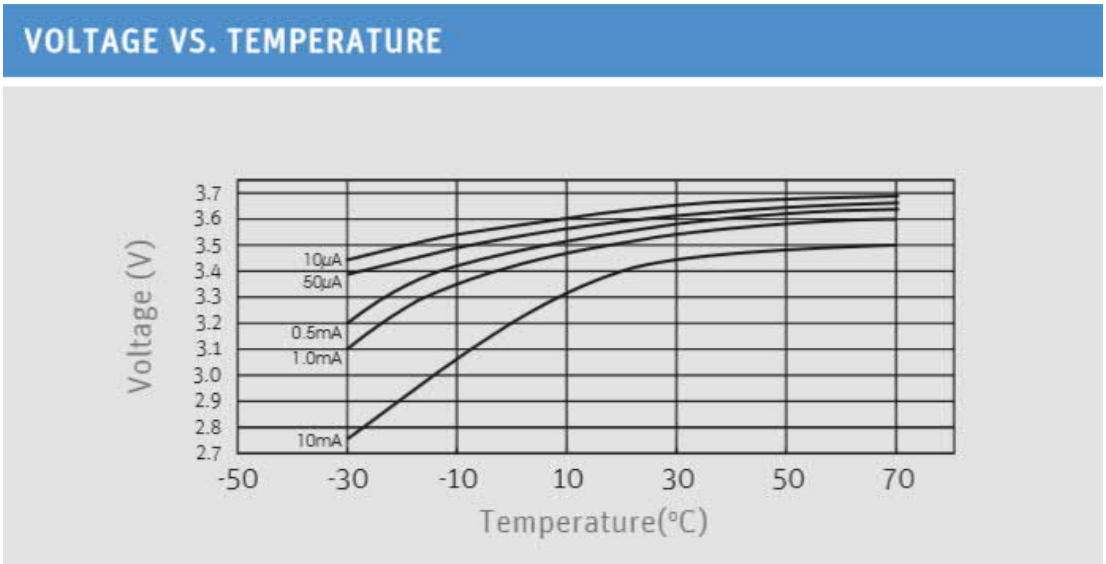
Energy density

Lithium thionyl chloride batteries have the highest energy density of all primary cells. Up to 650 Wh/Kg is possible. This high energy density ensures an extremely long service life.

Cell voltage

The maximum cell voltage of lithium thionyl chloride batteries is 3.6 volts. There is currently no primary cell on the market, regardless of cell chemistry, which has a higher value in this respect.
The cell voltage level depends on the ambient temperature and the demanded load current. The higher the demanded current, the lower the cell voltage (Fig. 2)

If the ambient temperature increases, the cell voltage of the battery also increases (Fig.2). Lithium thionyl chloride batteries are suitable for use in a temperature range from -55°C to 85°C. Particularly noteworthy is the performance of this chemistry at low temperatures. Even at double-digit negative temperatures, the cells deliver



a consistently high voltage.

Fig. 2: The operating voltage of a $LiSOCl_2$ battery depends upon the load current and the ambient temperature. Here is an example of an ER14250J-S battery

At a constant ambient temperature and a constant load current, lithium thionyl chloride batteries have a very high operating voltage compared to other cell chemistries, which is kept constant over almost the entire discharge period (Fig. 3).

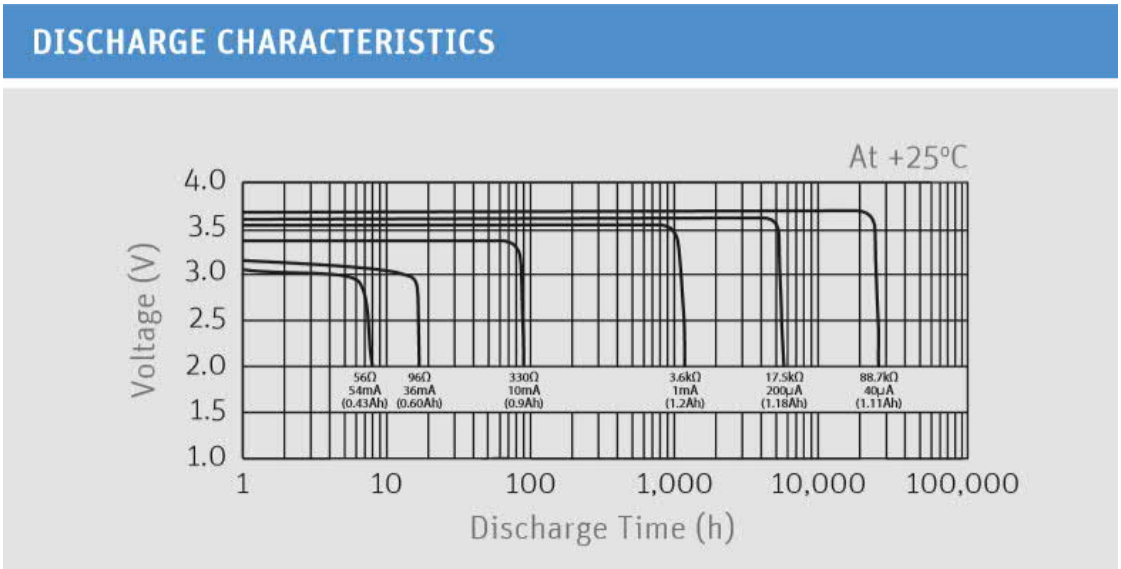


Fig. 3: Under stable environmental conditions, the operating voltage of a $LiSOCl_2$ battery remains at a consistently high level. Here is an example of an ER14250J-S battery

Excellent shelf life

Lithium thionyl chloride batteries are not only extremely durable during use, but also have an excellent shelf life. At a storage temperature of 20°C the self-discharge rate is only about 1% per year. With increasing storage time, however, the passivation of the cell increases.

III. Passivation and De-Passivation

Unlike all other lithium primary cells, within the lithium thionyl chloride cell there is a chemical reaction between the lithium anode and the electrolyte. As a result, a protective film of lithium chloride crystals forms over the lithium anode, which impedes the flow of ions between anode and cathode. This is called “passivation” of the cell. The longer a $LiSOCl_2$ battery is stored and the higher the storage temperature, the stronger this passivation effect is.

When the battery is used, the protective film over the lithium anode hinders the flow of the current, which can cause a sudden drop in the operating voltage. With continuous operation, the protective film is gradually eroded and the operating voltage increases to the usual voltage value. If no power is demanded from the battery for a prolonged period of time, the passivation protective film forms again.

The extent of the voltage delay described above depends upon the duration of storage, the temperature during storage, the demanded discharge current and some mechanical aspects (Fig. 3). At low discharge currents (A, B), there is usually only a slight voltage drop. Problems occur if a lithium thionyl chloride battery is immediately subjected to high discharge currents after a long storage period (C). In such a case, this may cause the voltage to drop below the cut-off voltage.

To avoid this, many lithium thionyl chloride batteries are equipped with a “wake-up” function. This is a powerful capacitor that is connected with the battery in parallel to compensate for the initial voltage delay.

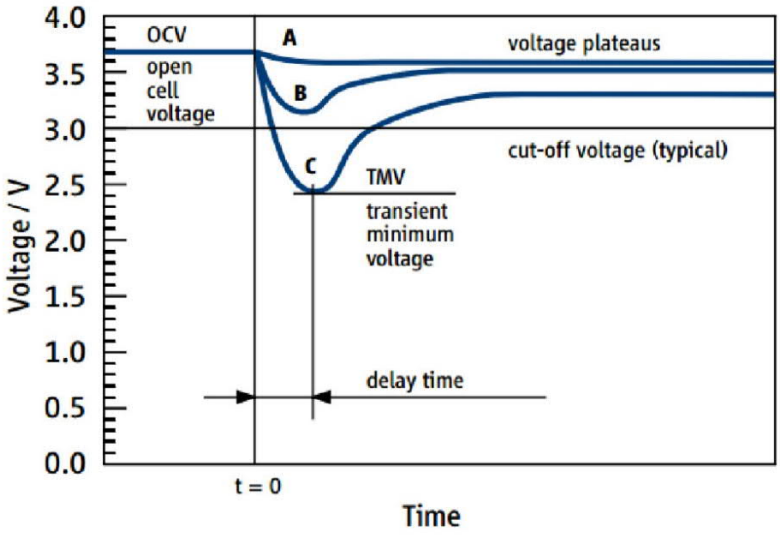


Fig. 3: The higher the demanded current when the battery is used, the more pronounced the voltage delay is. Therefore, $LiSOCl_2$ batteries are particularly suitable for applications that have a constant, low power consumption.

De-passivation

As described above, the passivation layer of a lithium thionyl chloride battery usually dissipates during use.

Depending on the external storage conditions and duration, manual de-passivation may be necessary. If the batteries (bobbin type) are not older than six-to-twelve months, the passivation protective layer can be broken by a short circuit lasting only a few seconds. However, to avoid damaging the battery, this procedure should only be carried out after prior consultation with Jauch Quartz GmbH.

Important: Even if a battery has already been successfully de-passivated, the passivation layer will form again if no power is demanded from the battery for a longer period of time. For this reason, specific de-passivation currents are defined for each battery type. For an ER14505J battery, for example, a continuous load current of 30 µA is recommended. It is also possible to apply a weekly pulse current of 20mA over a duration of 10 seconds, or a monthly pulse current of the same intensity over a duration of 60 seconds.

IV. Typical Areas of Application

Lithium thionyl chloride batteries from Jauch are suitable for all applications that require low currents over long periods of time. Due to their outstanding cell performance at very high or very low temperatures, lithium thionyl chloride batteries are used in numerous applications with demanding temperature profiles:

Metering

Electricity, gas, water and heat meters; heat allocators; automatic remote meters; oscilloscopes

Positioning and navigation

Electronic toll collection and tolling equipment; GPS tracking devices for people and animals; maritime buoys; deep-sea hazard alerts; altimeters; avalanche rescue transmitters

Monitoring and security

Electronic door locks and safes; identification systems; alarm systems; smoke detectors; burglar alarms

Industrial automation
Controllers; process controllers; industrial PCs; mobile data carriers; telemetry

Office automation
Back-up storage; computer terminals; electronic scales; postage meters; ATMs

Medical equipment
Implantable devices; infusion pumps; dosing

Automotive systems
Tyre pressure monitoring; engine and brake monitoring; digital tachographs; belt tensioners

High-end consumer goods
Time recording systems for sporting events; diving computers; set-top boxes

V. Notes on Handling, Safety and Transport

Lithium thionyl chloride batteries contain hazardous and harmful materials. Improper handling of the batteries can, in the worst case, lead to explosions, fire and the formation and escape of harmful gases from the battery. For this reason, please be sure to observe the following safety instructions. Please also ensure that anyone in your company who comes into contact with lithium thionyl chloride batteries receives these instructions. The same applies to customers and external service providers, e.g. from the waste management sector.

Assembly of bobbin cells
If several bobbin cells are connected in parallel to form a battery pack, there may be capacity equalisation between the individual cells. Higher capacity cells charge lower capacity cells so that all cells are at the same voltage level.

With rechargeable lithium-ion cells, this process is unproblematic and even desirable. However, lithium thionyl chloride batteries are primary batteries and cannot be charged. Even an attempt to do so can seriously damage the cell. For this reason, when assembling a lithium thionyl chloride battery pack, it is essential to use a reverse current blocking diode or a protective resistor in series. For example, a Schottky diode with low reverse current is recommended, in which case the voltage loss of the Schottky diode must be taken into account.

Certifications
The entire product line is certified in accordance with IEC60086-4. In addition, Jauch batteries have undergone various stress and safety tests and are certified in accordance with UL1642. The product line also meets the requirements of the UN 38.3 Transport Test. They also comply with the European ATEX directive provisions, allowing the batteries to be used in potentially explosive atmospheres.

Storage
Lithium thionyl chloride batteries should not be exposed to direct sunlight. Furthermore, you should not store the batteries in hot and/or humid areas. Rainwater or other adverse environmental conditions can also damage the batteries.

Transport and shipping

If you ship the lithium thionyl chloride battery bundled with a product, protect the battery – especially the positive terminal – from shocks and vibrations that may occur during transport by using air cushions or similar safeguards.

Special care should be taken when shipping lithium thionyl chloride batteries with surge arresters. The arresters can kink and make contact with other during transport, causing a short circuit. To prevent this from happening, it is recommended to transport these in trays.

Handling

If you are using $LiSOCl_2$ size C or D batteries, make sure that the positive terminal of the battery is facing up, or at least to the side, when designing your battery compartment. Otherwise, the liquid electrolyte may not be distributed properly within the battery.

When processing batteries with surge arresters, it is recommended to bend the arresters at a minimum distance of 3 mm from the cell. Otherwise, there is a risk of accidentally breaking the arresters.

In principle, installation, removal and disposal of the battery should be carried out by a technician who has been properly trained in the use of lithium thionyl chloride batteries.

Disposal

The proper disposal of lithium thionyl chloride batteries is regulated by national legislation. Please follow the regulations valid in your country.

In addition, when disposing of the battery, make sure that the negative and positive terminals are completely shielded with insulating tape or other insulating material. Finally, even discharged batteries have a residual electrical capacity, so that if the poles come into contact with metal, short circuits or similar events can occur.

Further safety instructions

Do not charge!

Never try to charge a lithium thionyl chloride battery! This can lead to short circuits and gas formation within the battery.

Do not drop!

A fall can damage the glass seal over the positive terminal of the battery. This can cause liquid to leak from the battery and harmful gases to be produced. In general, there is a risk of damaging the glass seal when strong external forces act on the positive terminal.

Avoid short circuits and forced discharges!

Never expose the battery to excessive heat!

As the outside temperature rises, the internal pressure of the battery increases. Therefore, never expose the battery to temperatures above 100°C. You should also take special care when soldering, as the heat generated can damage the insulating material of the battery. If you solder the battery directly to a device, do not solder to the housing, but only to clips or cables. Even in this case, the temperature of the soldering iron must be below 350°C and the soldering time less than five seconds.

Never try to deform or disassemble the battery!

Never use different battery types together in the same application!

Never use different battery types or batteries from different manufacturers together in the same application. If you wish to use two or more batteries in series or parallel in your application, please contact Jauch Quartz GmbH in advance.

Never touch the electrodes of the battery!

Avoid contacting the battery electrodes with your fingers or other parts of your skin. The moisture on your skin can cause the battery to discharge, creating chemical substances that can cause chemical burns. Under no circumstances should you swallow the battery.

Beware of leaking battery fluid!

If the battery housing is damaged, battery fluid may leak from the cell. Do not allow battery fluid to come in contact with your eyes or mouth! If this happens, rinse your eyes or mouth thoroughly with plenty of water and seek medical attention immediately.

VI. Battery Technology at Jauch

Founded in 1954, Jauch Quartz GmbH has been active in the battery industry since 1976. Since 2003, the company has increasingly specialized in lithium battery technology and has successively expanded its product portfolio in this area. In its in-house test centre, Jauch develops customer-specific battery packs, configures the corresponding protection electronics and also takes care of necessary certifications.

Jauch is certified in accordance with DIN EN ISO 9001:2015. Batteries and battery packs therefore meet the highest international production and quality standards. All products comply with RoHS and REACH standards and are free of lead and conflict minerals.

Jauch have been supplying batteries for nearly 40 years into industry and have built up valuable expertise during this time. In addition to the company headquarters in Villingen-Schwenningen, Jauch has additional branches in France, Great Britain, USA and Mexico. Together with worldwide distribution partners, this enables personal customer service around the globe.

In the field of primary batteries, Jauch offers a wide range of different designs and sizes. The product range of the Jauch private label includes lithium button cells as well as lithium manganese dioxide ($LiMnO_2$) and lithium thionyl chloride batteries ($LiSOCl_2$).

VII. Overview of Jauch-Batteries

Cylindrical cells (bobbin type)						
Type	Size	Cell voltage (V)	Capacity (Ah)	Discharge current (mA)	Temperature range	Lithium content (g)
ER14250J	1/2AA	3.60	1.2	0.5	-55°C to +85°C	0.31
ER14335J	2/3AA	3.60	1.65	1.3	-55°C to +85°C	0.43
ER14505J	AA	3.60	2.7	1	-55°C to +85°C	0.69
ER17505J	A	3.60	3.6	3	-55°C to +85°C	0.93
ER18505J	A	3.60	4.0	3	-55°C to +85°C	0.98
ER26500J	C	3.60	8.5	4	-55°C to +85°C	2.20
ER34615J	D	3.60	19.0	2	-55°C to +85°C	4.92

Wafer cells					
Type	Size	Cell voltage (V)	Capacity (Ah)	Discharge current (mA)	Temperature range
ER32L65J	1/10D	3.6	1.0	1.0	-55°C to +85°C
ER32L100J	1/6D	3.6	1.7	1.0	-55°C to +85°C
ER2450T		3.6	0.5	0.3	-55°C to +125°C

VIII. Cell Configurations

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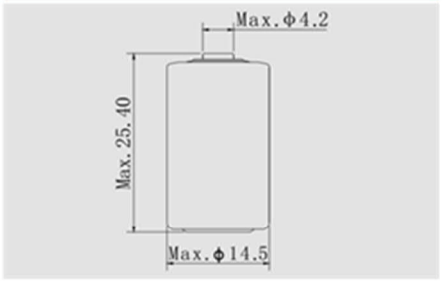

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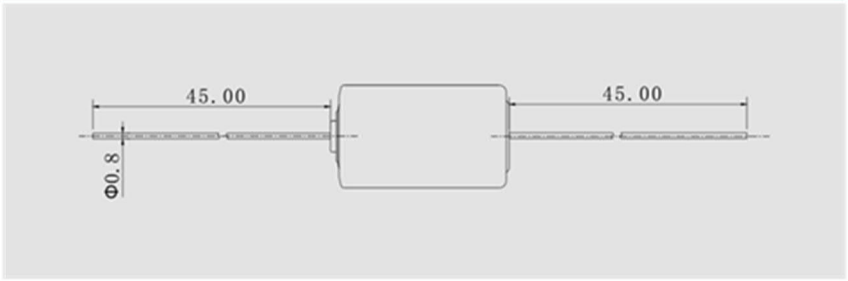

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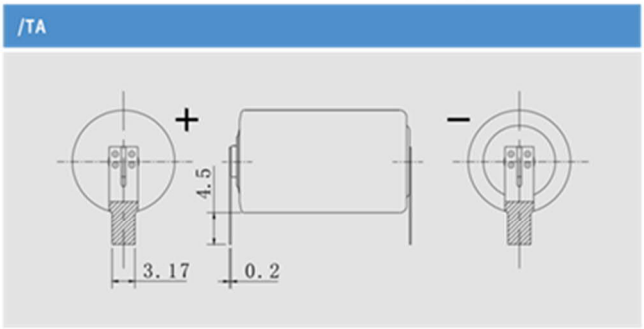

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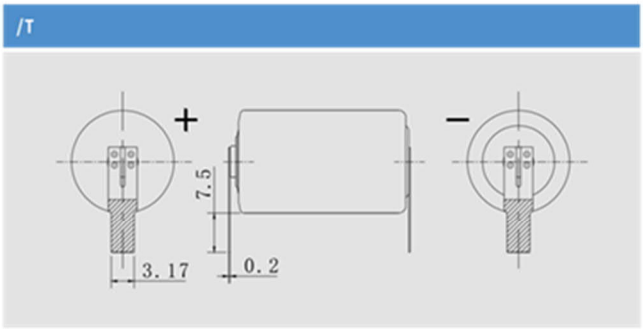

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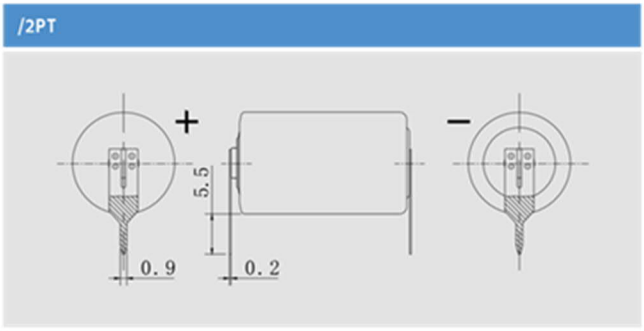

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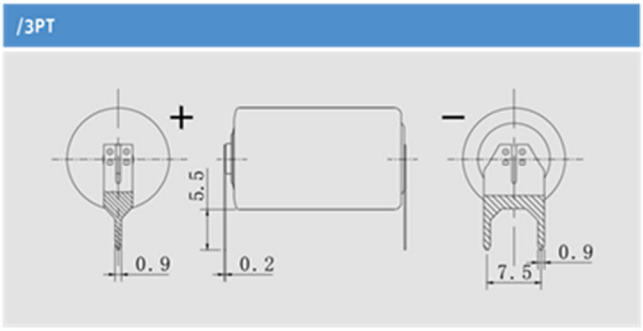

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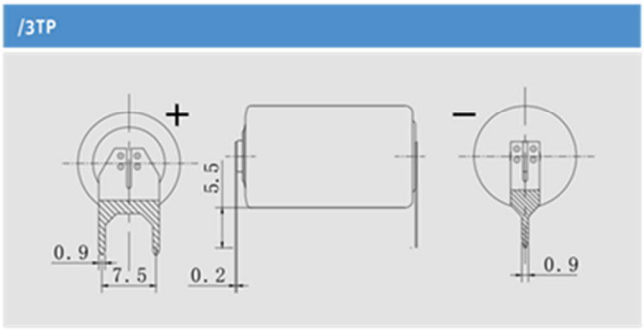

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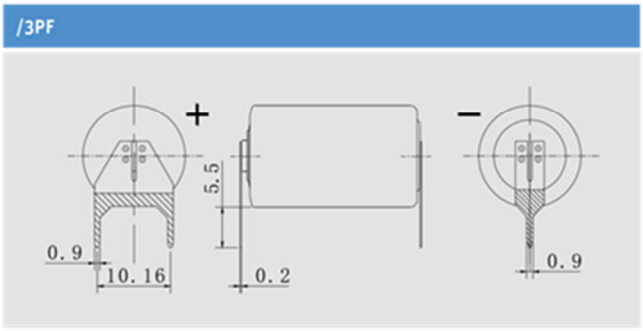

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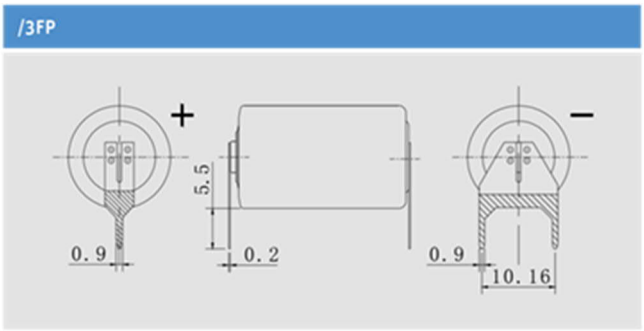

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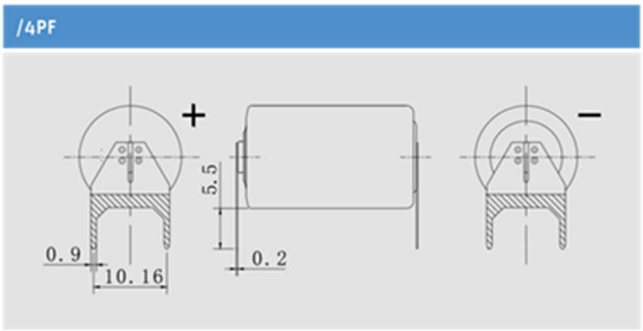

The author

Dr. Jürgen Heydecke is an acknowledged expert in his field with decades of experience at home and abroad. Throughout his working life he has been involved with different battery chemistries and he knows the requirements of the industry like few others. In 2009 he and his partner set up Batteries and Powersolutions GmbH (BAPS). Since the merger with Jauch Quartz GmbH in 2018, Jürgen Heydecke has acted as technical director of the newly-established Jauch Battery Solutions GmbH and also leads seminars at the Jauch Battery Academy.

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