

FRIWO – The expert for Lithium-MnO₂ batteries

FRIWO

From industrial to space applications.
From standard to customised batteries.



Lithium-MnO₂ batteries

Lithium cells and batteries: Power custom made

The constantly growing market of more powerful electronic devices leads to an increasing demand for small, light weight and high performance batteries with a long lifetime.

These requirements can only be met with high energy lithium cells and batteries. Lithium batteries do have a significantly higher energy density compared to conventional batteries, as shown in the graphic. This high energy density allows to build powerful batteries with a very small volume.

FRIEMANN & WOLF is one of the leading manufacturers of hermetically sealed lithium cells and batteries in the world.

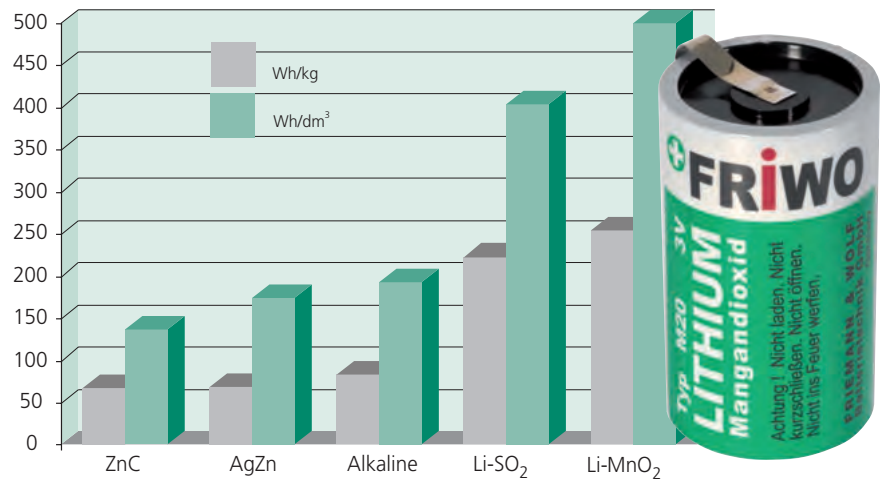
Applications

FRIEMANN & WOLF lithium batteries are used in applications, where high energy has to be supplied within limited space in a reliable way.

Even after long storage and under the harshest environmental conditions our batteries are always ready for use. Those applications are e.g. emergency transmitters, like EPIRBs, ELTs, PLBs and pipeline inspection- and communication devices, up to power supplies for manned space flights.

Production line

All lithium cells from FRIEMANN & WOLF are produced on **state-of-the-art fully automatic production lines**. This guarantees **short lead times with constantly high product quality** that also meets the strictest requirements of the space agencies.



Design and development

With our own, best equipped laboratories, experienced engineers and the use of 2D and 3D-CAD-systems, we are in the position to design, develop and produce **lithium cells and batteries according to special customer demands**. We always strive for **cost effective solutions** to the full satisfaction of our customers.

FRIEMANN & WOLF is **DIN EN ISO 9001 and DIN EN ISO 14001 certified**.

ISO 9001
ISO 14001
BUREAU VERITAS
Certification



FRIWO Lithium-MnO₂ batteries

Battery assembly

FRIEMANN & WOLF also offers a wide range of different lithium battery assembly solutions.

We can resort to more than **20 years experience** in the lithium battery assembly field. Our lithium batteries are used in military, in industry and in space applications.

Our lithium battery product line is comprised of cost effective standard batteries and also customised battery solutions designed and developed in co-operation with our customers.

Smart batteries

We also offer additional battery features, such as our **capacity gauge**. This gauge is completely designed by FRIEMANN & WOLF and is available in different versions, from „GO/NO GO“ up to fuel gauges that display the remaining capacity in the battery. This electronic circuit is self-activated when the battery is used. When the battery is not used the circuit drains less than 8 μ A which has virtually **no impact on the long shelf life** of the battery.

Safe batteries

In addition to the safety features of the cell itself the FRIWO batteries are

designed for instance with **fuses to protect against external short circuits** and with **blocking diodes against inadvertent charging**.

Our batteries meet the requirements of various military standards and also the strict safety standards of the space agencies.

Space batteries

FRIEMANN & WOLF has been active in the design, development and manufacturing of batteries for space applications since 1972. These applications include satellites, launchers, rockets and in particular various projects for the **International Space Station (ISS)**.

Our batteries meet all the quality and safety requirements for manned space flights of the space agencies. FRIWO's huge lithium batteries with an energy of approx. 204 kWh (approx. 900 kg mass) were used 4 times for the ASTRO SPAS satellite being launched and retrieved by the STS (Space Shuttle).

We are working in close co-operation with major space agencies such as **NASA, ESA, NASDA**, e.g. **NASA contracted with FRIEMANN & WOLF** for the development and the production of huge size lithium batteries for the Crew Return Vehicle that brings the ISS crew back to earth in an emergency situation.

Based on this experience we will provide you with lithium batteries that will meet your space mission requirements, too.

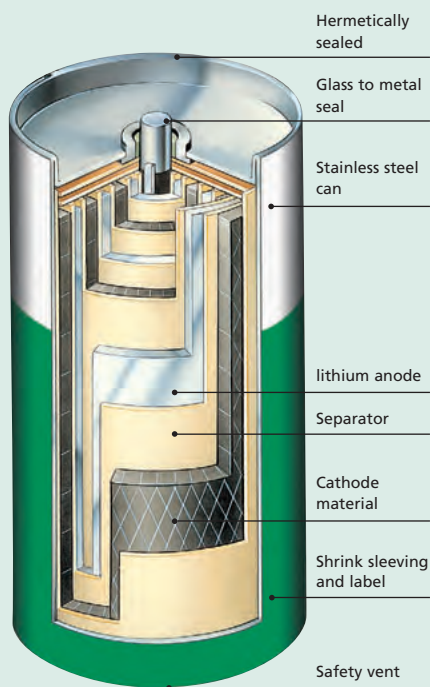


FRIWO Lithium-MnO₂ cell technology

Cells in this technology belong to the 3 V-Systems. They utilize metallic lithium for the anode and solid MnO₂ for the cathode. Typical characteristics are a high energy density up to 280 Wh/kg. They do not contain any aggressive or corrosive substances. More specific features are:

- hermetically sealed
- integrated safety vent
- forced discharge capability
- no internal cell pressure
- very low self discharge
- no „voltage delay“
- safe against deep discharge
- safe against reversion of polarity
- any installation position possible
- „safety shut down“ separator
- long shelf life up to 10 years
- non-toxic and non-corrosive electrolyte

Cell design



Anode

The anode is composed of a lithium foil, which incorporates a copper strip. This copper strip has the function of a current collector and a protection in case of cell reversal.

Cathode

The cathode is composed of a manganese dioxide paste which is pasted on a aluminium expanded grid, which undergoes a sintering process and is then rolled

led out to a certain thickness, depending on the cell type. Those cathodes have a very good electrical conductivity and a fine-pored surface.

Electrolyte

The electrolyte of Li-MnO₂ cells is composed of organic solvents, mainly ethers. This electrolyte is liquid at room temperature and normal pressure. Cells are filled with electrolyte by creating a vacuum inside the cell. Compared to other primary lithium battery systems, the Li-MnO₂ electrolyte is neither toxic, nor corrosive.

Cell cans

The cell cans are made of stainless steel. These cans have a non-reversible safety vent, which opens under abuse conditions (in case cell internal temperature and/or cell internal pressure is beyond predefined limit values). This is another important safety feature of the FRIWO Li-MnO₂ cells.

Separator

Separation between anodes and cathodes is made by a shutdown separator, which provides an important safety feature of these cells. This separator is composed of three layers: One Polyethylene layer is sandwiched by two layers of polypropylene. The shutdown separator operates when the melting point of polyethylene (approx. 132 °C) is reached. The pores of the separator close and the ionic transfer stops.

The FRIWO Li-MnO₂ cells are balanced design cells (stoichiometric usage of active components of both electrodes). These cells stay safe even when they are over-discharged or when the polarity is changed. This allows to use these batteries in a wide range of applications, which are safety sensitive.

FRIWO Li-MnO₂-cells are primary cells and not rechargeable. Do not (never) charge cells and batteries.

General Li-MnO₂ System Performance Features

- Open Circuit Voltage: 3.3 V
- Nominal Voltage: 3.0 V
- Recommended Cut-off Voltage: 2.0 V
- Rate capability: 10 hour discharge (standard cells)
Up to 4 hour discharge (high rate cells)
- Operating temp. range: -40 °C to +70 °C
- Storage temp. range: -55 °C to +70 °C
- Safety by design: (safety vent, shut-down separator, balanced design)
- High energy density per cell: up to 280 Wh/kg
up to 580 Wh/dm³
- Shelf Life: up to 10 years
- No voltage delay



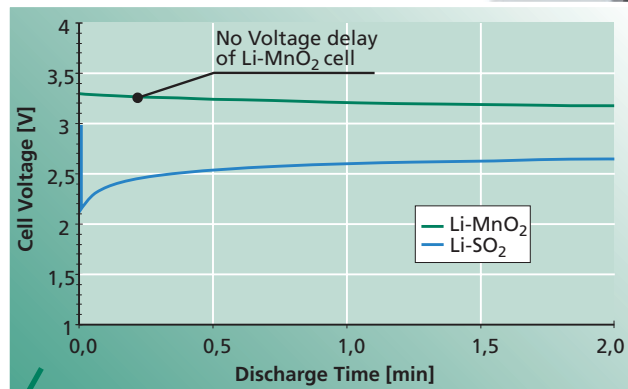
Hermetically sealed cells = long shelf life

Cells are laser welded and have glass to metal seals. This design ensures that *cells are hermetically sealed which helps to guarantee a long shelf life of up to 10 years with a minimum loss of overall performance.*

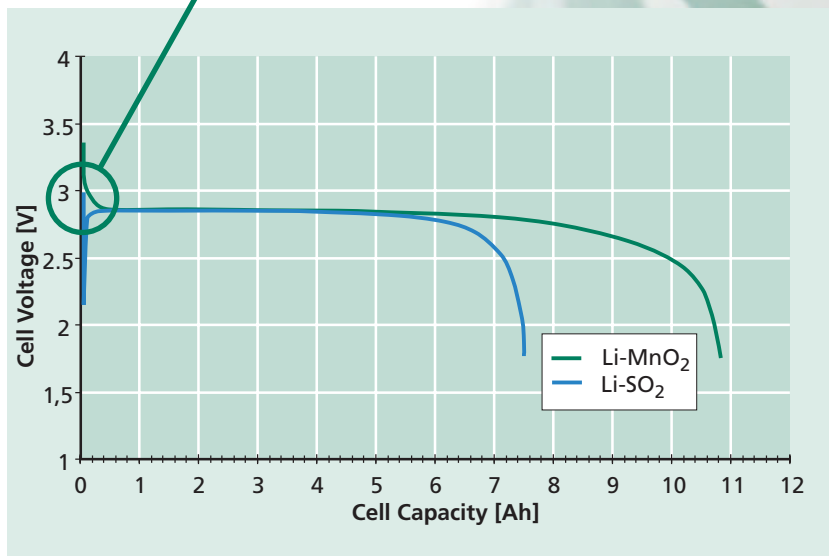
Absolutely safe

All cells *are absolutely* safe in the case of forced discharge and cell reversal. Under abuse conditions, e.g. extreme heating due to short circuit, an *integrated safety vent* opens. The *Li-MnO₂*-system has the advantage of *not releasing any toxic or aggressive substances*, so that there is no danger for man and environment. The *safety of the Li-MnO₂ high rate cells* is increased by using a *shut-down-separator* that limits the output current in case of a short-circuit.

Voltage transient at the beginning of discharge



Discharge of lithium (D-size) cells at +23 °C and a C/20 load.



Specific properties

Comparison of specific properties of Li-MnO₂, Li-SOCl₂ and Li-SO₂ systems (spiral cells, D-size)

	Li-MnO ₂ (FRIWO M20 HR)	Li-SOCl ₂	Li-SO ₂
Cathode	solid	liquid	liquid
Voltage	3.3 V	3.6 V	3.0 V
Weight	117 g	100 g	85 g
Capacity at 250 mA @ +20 °C	11.5 Ah	13.0 Ah	7.8 Ah
Capacity at 2 A @ +20 °C	10.5 Ah	8.0 Ah	7.5 Ah
Capacity at 2 A @ -20 °C	8.0 Ah	4.8 Ah	6.0 Ah
Power Capability	medium	higher	lower
Voltage Delay	no	yes	yes
Self discharge	low	low	medium
Operating temperature	-40 ... +70 °C	-40 ... +85 °C	-40 ... +70 °C
Safety vent	Yes	Yes	Yes
Safety concerns	flammable	SOCl ₂ gas	SO ₂ gas
Transportation	class 9	class 9	class 9
Unit price	higher	medium	lower

Large variety of cells

The table gives a survey of our standard cell product line. Other cell types are available upon request. Please ask for detailed data sheets on each individual cell.

Cell Type	Nominal capacity (2.0 V cut off) [Ah]	Max. continuous current* [mA]	Dimensions Ø h		Weight [g]	Approved acc. to Mil. Std. VG 96915 part
			[mm]	[mm]		
M 49	1.6 (80 mA)	300	22.5	32	24	177
M 52 HR	4.5 (0.8 A)	1200	26.0	51	59	170
M 20	10.5 (0.5 A)	2000	34.0	61	115	154
M 20 HR	10.5 (2.0 A)	2500	34.0	61	117	154
M 24 HR	20.0 (2.0 A)	4000	33.5	111	201	175
M 62	33.0 (1.6 A)	5000	42.0	133	355	space

* higher discharge rates can be achieved under certain conditions



Overview of FRIWO Lithium battery range

The following table shows a selection of typical batteries of our product line. Please contact us for separate data sheets for these and also for other batteries. We would be happy to assist you in the design and production of batteries tailor-made to your specific requirements.

Battery Type	System	Nominal Voltage [V]	Capacity [Ah]	Dimensions [mm]	Application
3.M 52 HR	Li-MnO ₂	9.0	4.5 (0.8 A)	78,5 x 65 x 33	Radio SEM 52 NSN: 6135-12-308-9723
3.M 52 HR	Li-MnO ₂	9.0	4.5 (0.8 A)	78,5 x 65 x 33	Radio SEM 91/93 NSN: 6135-12-355-0737
3.M 52 HR	Li-MnO ₂	9.0	4.5 (0.8 A)	75 x 54 x 37	Radio MR 509 NSN: 6135-12-353-2558
3.M 52 HR	Li-MnO ₂	9.0	4.5 (0.8 A)	dia. 26 x 154	emergency radio unit
4.M 52 HR	Li-MnO ₂	12.0	4.5 (0.8 A)	105 x 50 x 43	ABC-protective equipment NSN: 6135-12-322-9102
6.M 52 HR	Li-MnO ₂	18.0	4.5 (0.8 A)	121 x 106 x 39	medical technology
6.M 20	Li-MnO ₂	18.0	10.5 (0.5 A)	191 x 72 x 38	Radio SEM 70 NSN: 6135-12-309-8604
6.M 20	Li-MnO ₂	18.0	10.5 (0.5 A)	125 x 90 x 80	Military
2 x 6.M 20	Li-MnO ₂	18.0	20 (4.0 A)	223 x 147 x 50	Battery Power Unit
5.M 20	Li-MnO ₂	15.0	10.5 (0.5 A)	dia. 110 x 100	ABC-protective equipment NSN: 6135-12-310-5164
6.M 49	Li-MnO ₂	18.0	1.6 (80 mA)	78 x 56 x 37	PLB-MR 506 NSN: 6135-12-339-9599
10.M 20	Li-MnO ₂	33.0	10.5 (0.5 A)	109 x 68 x 162	ABC-protective equipment NSN: 6135-12-339-0295
3.M 20	Li-MnO ₂	9.0	10.5 (0.5 A)	69 x 64 x 62	EPIRB
10.M 24	Li-MnO ₂	33.0	20.0 (2.0 A)	184 x 133 x 72	Thermal Sight System NSN: 6135-12-329-3740

