Energy management: How does the LE300 lithium expansion battery from BOS work? *(December 4, 2020)*

The use of lithium batteries on yachts

Lithium batteries are on the advance in the yacht sector. This is not surprising, as they have long since become an everyday item in other areas. For example, they are installed in smartphones, tablets or notebooks. Their advantage over conventional batteries is that they require less space with the same capacity, are lighter and have a longer service life. Their only disadvantage is the very high purchase price, which is put into perspective by their comparatively long service life. Another important difference to the classic systems is that pure lithium systems require professional installation and complex charging technology. This system configuration is not trivial and should by no means be left to a layperson.

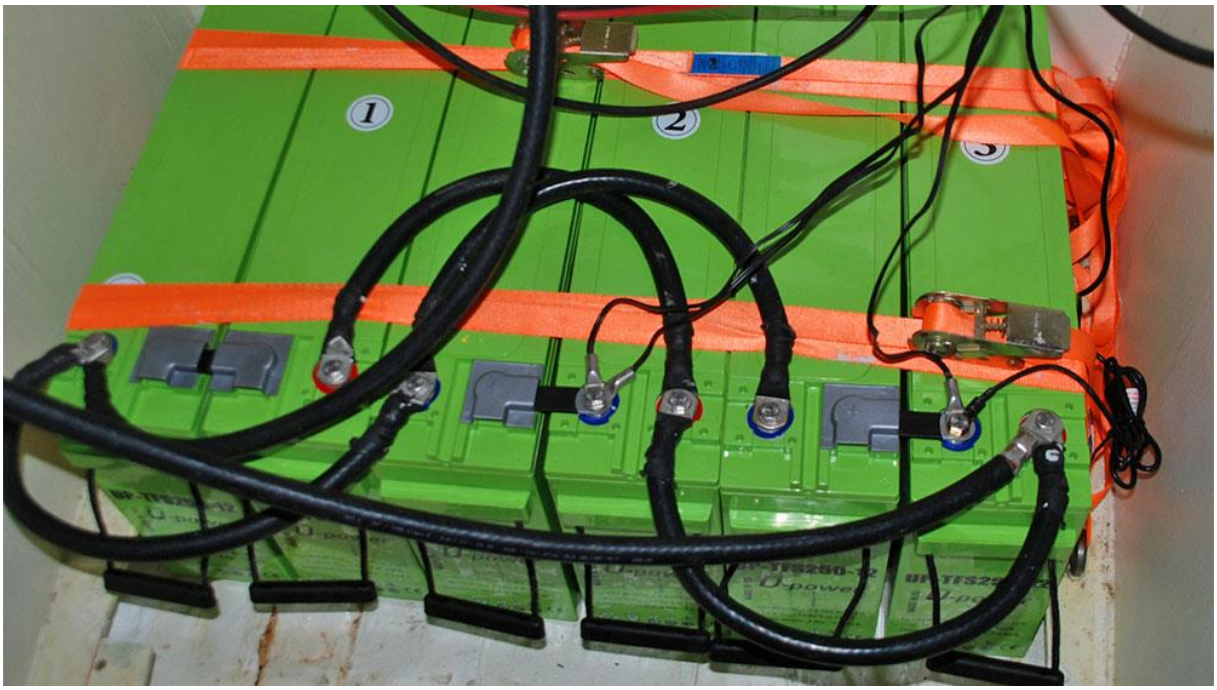
Blue water sailors want to be independent of shore power. © Sönke Roever

When looking at the sailors, it is noticeable that regatta and cruising sailors are more open to lithium batteries than blue water sailors. Blue water sailors in particular still have (unjustified?) reservations because they want reliable systems with easy

maintenance and uncomplicated repair options. For example, how do you replace a lithium battery in an infrastructurally weak area in the event of a defect if you cannot get an adequate replacement there? Instead, install lead batteries, which are found everywhere cars drive? Depending on the battery management system, this is a complicated or even impossible undertaking. And even if that is possible, there are considerable costs involved in shipping abroad - if it is possible at all, since lithium batteries involve the transport of dangerous goods. In short: AGM batteries are currently predominantly used in blue water sailors.

Is the LE300 BOS lithium battery an alternative?

Against this background, it is interesting that the German company BOS (Balance of Storage Systems) from Neu-Ulm has launched a Smart Battery System with the LE300 lithium battery, which on the one hand brings the advantages of lithium battery technology with it and on the other hand can be combined with classic AGM, GEL or lead battery banks.



Such an AGM battery bank can be combined with several LE300. © Daniel Müller

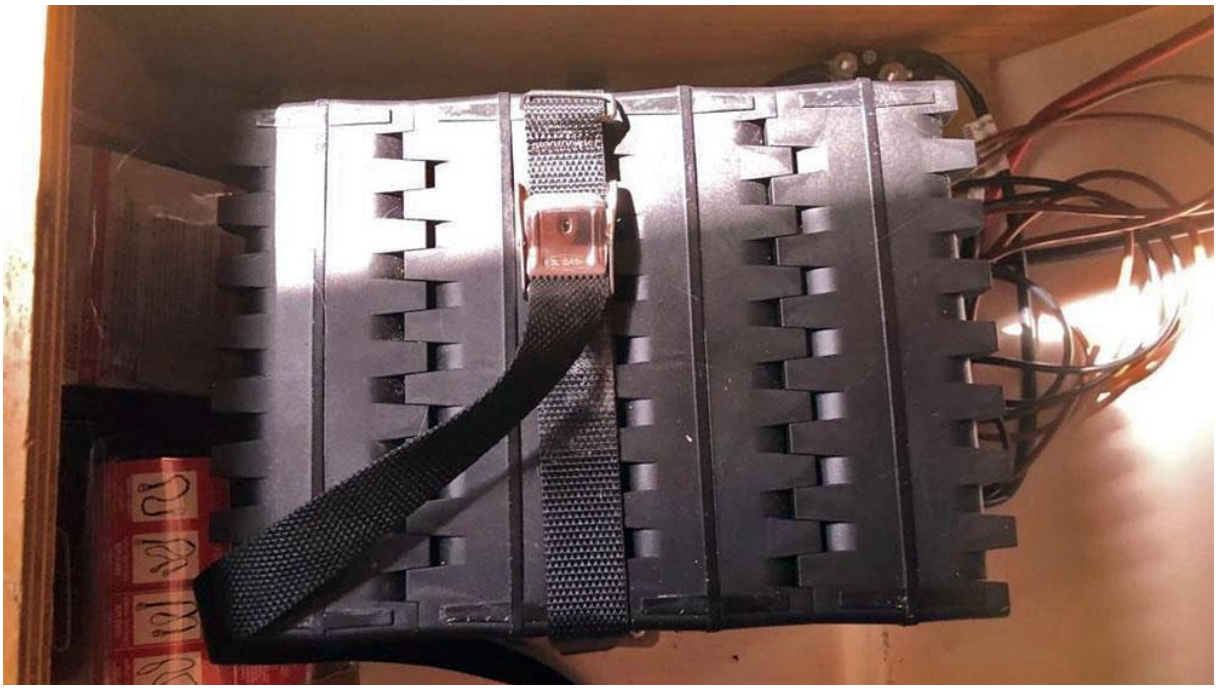
Note: For better readability, I will use the term lead battery in the following and also mean AGM or gel batteries or accumulators. Also, I don't make a distinction between a battery and a battery bank. The following applies to both. Only the total capacity of the system is relevant. The idea behind the LE300 is to offer a simple and uncomplicated solution for maintaining or increasing the performance and capacity of lead batteries on yachts. The BOS lithium battery is simply used together with new or existing 12 volt lead batteries by connecting it in parallel with the lead batteries. If a battery monitor is available, it can still be used. If necessary, if required, the settings for the total capacity must be adjusted in the device setup.

How is the LE300 BOS lithium battery used on yachts?

The LE300 concept has a modular structure. Each module has a capacity of 25.6 ampere hours (Ah). For a perfect balance of power, at least one LE300 should be used for every 100 Ah lead battery capacity, so that the lead system can be optimally supplied and maintained by the LE300. In principle, a 100 Ah lead battery can also be combined with up to twelve LE300. With a lead-acid battery capacity of 300 Ah, the manufacturer recommends using at least three LE300s in order to increase the service life of the lead-acid batteries. If several LE300 are used, they are connected in parallel.

The LE300 module has 25.6 ampere hours. © Sönke Roever

Each module is 22.9 centimeters high, 17.5 centimeters wide and 6.7 centimeters deep. It's compact. Basically, there is no need to speak of length, width and height, as there is no “top” or “bottom” on the LE300. The battery can be installed in any position, which should be particularly important on small yachts, where the use of space is sometimes difficult. A LE300 module weighs 3.4 kilograms and consists of a lithium iron phosphate battery (LiFePO4). In recent years there have been reports of burning or even exploding lithium batteries. With batteries of the type LiFePO4 there is no such risk under conditions that are common on a yacht. The modules are available in pre-assembled units made up of blocks of one, two, four or six. A total of up to 24 modules can be easily connected in parallel in a 12-volt electrical system. If there are more than 24 modules, a specialist should check the installation.



Here a block of 4 LE300 modules was installed on a yacht. © Elna

24 modules are far more modules than are required in the yacht sector. That would be around 600 Ah with LE300 modules in addition to the existing lead battery capacity. As a rule, the typical blue water ship has a lead battery capacity of between 500 and 1,000 Ah with an on-board voltage of 12 volts. Perhaps another example that allows you to better imagine the weight and space advantages of a lithium battery over an AGM battery. Six LE300 roughly have the volume of a 100 Ah AGM battery. The LE300 block of six weighs 20.4 kilograms and a 100 Ah battery weighs around 24 kilograms. However, if possible, an AGM battery should only be discharged to 50 percent of its capacity. This gives us roughly 50 Ah usable energy at a weight of 24 kilograms. So an ampere hour weighs around 500 grams.

The LE300 modules are available in blocks of 1, 2, 4 or 6. © BOS

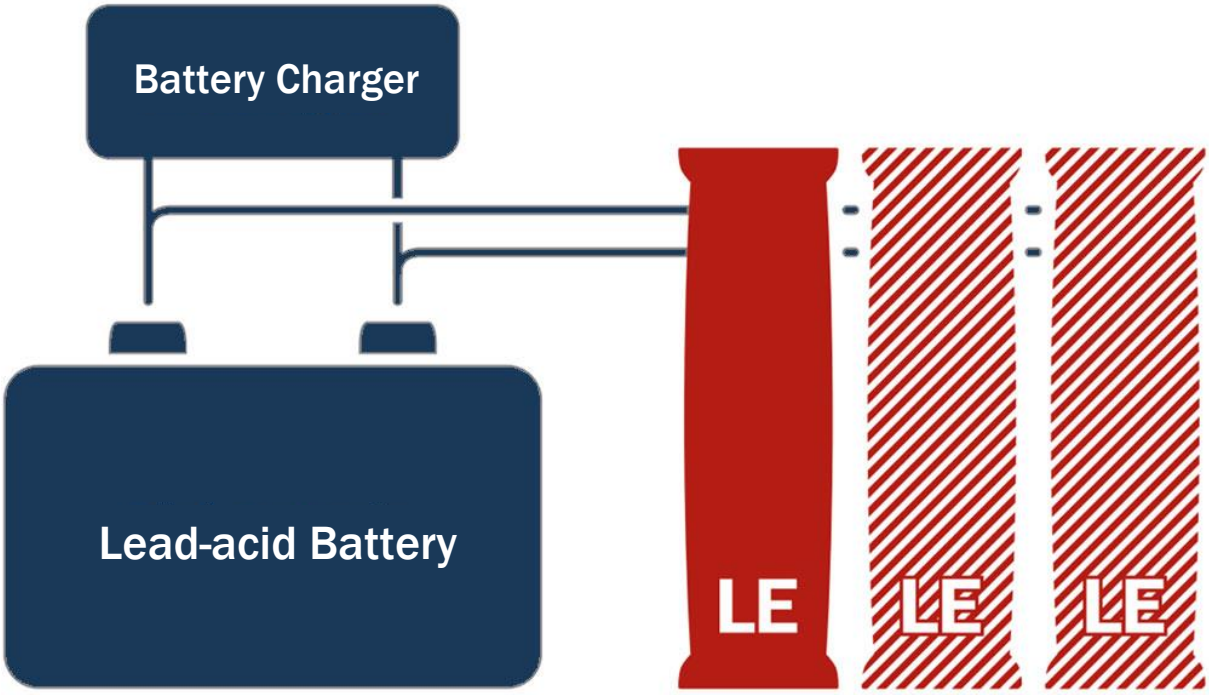
The LE300 six-block has a capacity of 153.6 Ah (six times 25.6 Ah). Realistically, 90 percent of this is available for withdrawal. This brings us to 138 Ah with roughly the same volume and a weight of 20.4 kilograms. That is four kilos less. The equivalent of one ampere hour weighs around 150 grams, which is 70 percent weight savings compared to a lead-acid battery.

Due to its design, the LE300 is intended as a consumer battery. Their characteristics are intended to deliver an approximately uniform current over a long period of time. So-called starter batteries are also used on board to start the engine, the bow thruster or the anchor winch. These are intended to deliver the highest possible current in a short time. Since this does not correspond to the characteristics of the LE300, I still recommend the use of lead batteries at this point. However, a LE300 could also be connected in parallel here, for example, to maintain a rarely used anchor winch battery - also to prevent self-discharge.

Each LE300 can be charged or discharged with 12.5 amps. If, for example, four LE300 are used, this results in a maximum current draw of 50 amperes plus the possible energy output from the existing lead battery. Overall, 90 percent of the 25 Ah per module - i.e. 23 Ah - can be drawn. When the lower limit is reached, the LE300 switches off until it is recharged.

How is the BOS lithium battery LE300 connected?

It is easy to connect. Both, the existing charging technology and the lead batteries remain on board - the system is simply supplemented by connecting the LE300 in parallel. The plus cable goes to the plus pole of the lead battery and the minus cable of the LE300 is connected to the minus pole. This simple assembly makes it theoretically possible to use the system flexibly and, for example, to switch between two boats.



Connection diagram for LE300 modules. © BOS

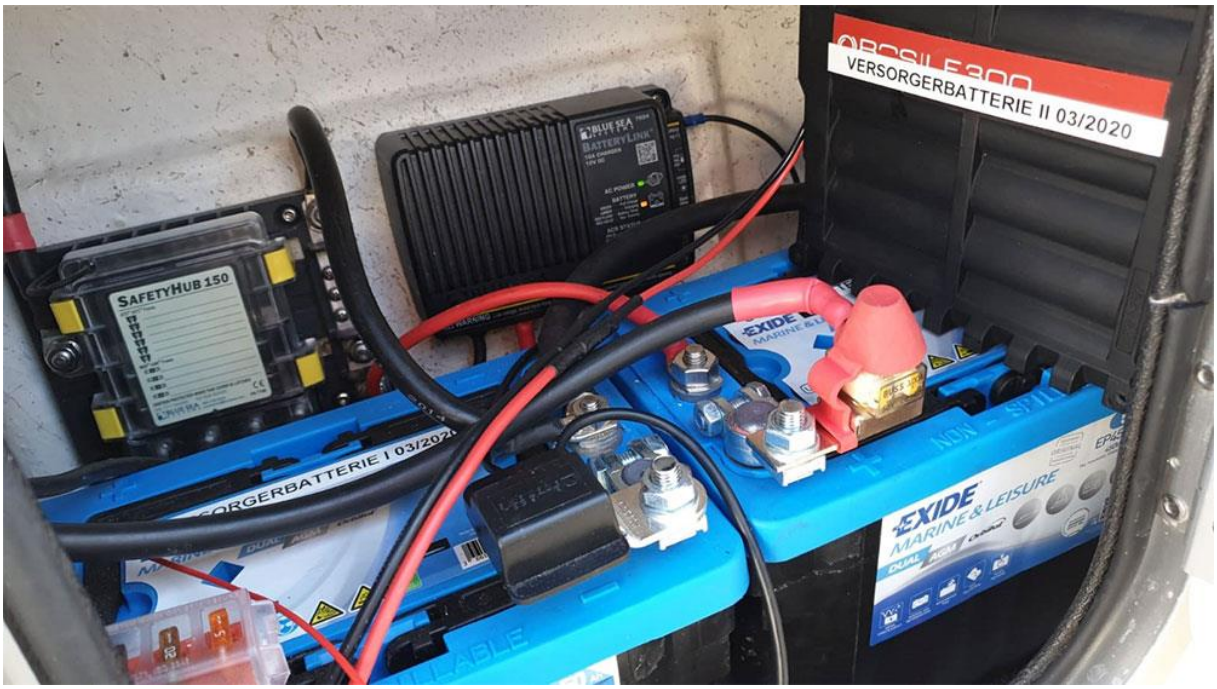
If several LE300 modules are used, they are simply connected in parallel. This is possible because every LE300 has its own battery management system (BMS). This means that nothing has to be networked, even with several modules. The modules determine independently that there are more LE300 in the system.

How error-prone is the LE300 system?

If a LE300 module fails, the lead-acid battery system behaves as if the LE300 were not there. If several LE300 modules are combined, all other modules continue to work normally if one fails. In addition, each module is protected against overcurrent, overvoltage, deep discharge, short circuit and reverse polarity. This means that almost no mistakes can be made during installation. Nevertheless, it should not be omitted that the electrical system should always be installed by specialists.

Important: In the case of longer cable lengths between the LE300 and the lead battery, the cable should also be secured and laid in protective cable conduits. It is also important to ensure that the dimensions are adequate.

In addition, BOS has had the LE300 certified for breaking / vibration resistance and extreme temperatures. Therefore, it can also be used in the motor vehicle, motorhome or off-road sector. This also means that the circuit board is protected from moisture.



The combination of lead batteries and LE300 lithium block on board a yacht. © Elna

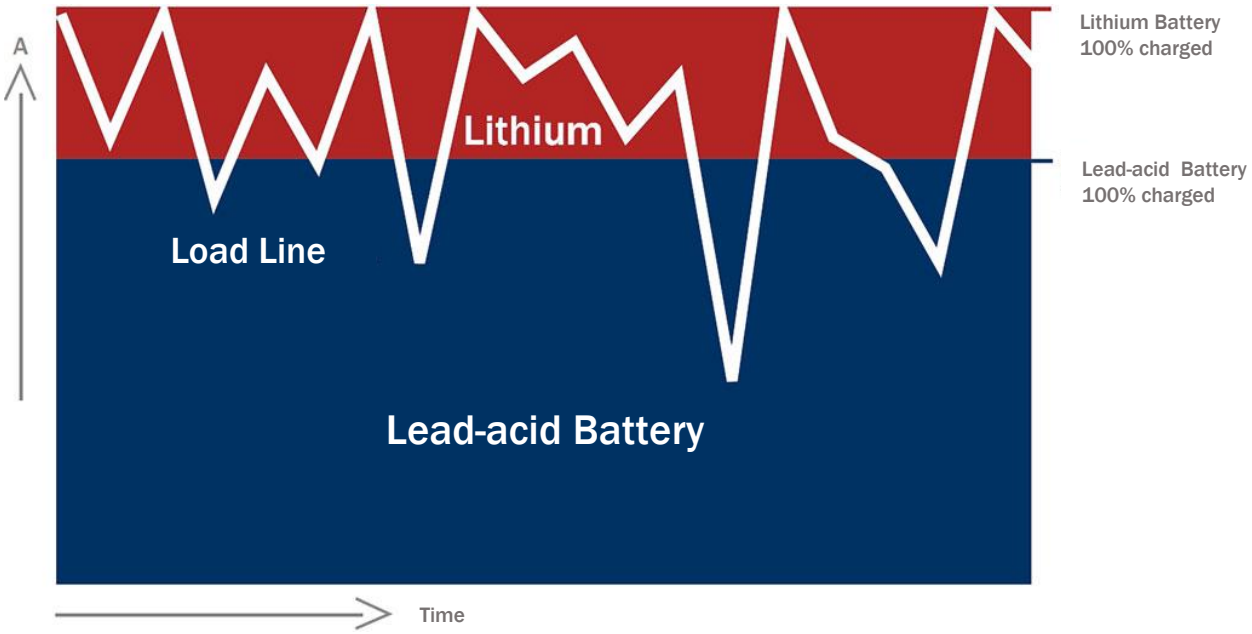
The LE300 system in practice

In principle, it is important to consider whether only classic lead batteries, only lithium batteries or a mixture in combination with the LE300 should be used on board. A pure lead battery has some disadvantages compared to the lithium battery in terms of weight and size, the removable ampere hours, self-discharge, service life or the installation position. On the other hand, it is very cheap to buy in comparison.

Conversely, the lithium battery only offers advantages over the lead battery at this point - but not in terms of price. Whereby this is put into perspective a bit if we include the service life.

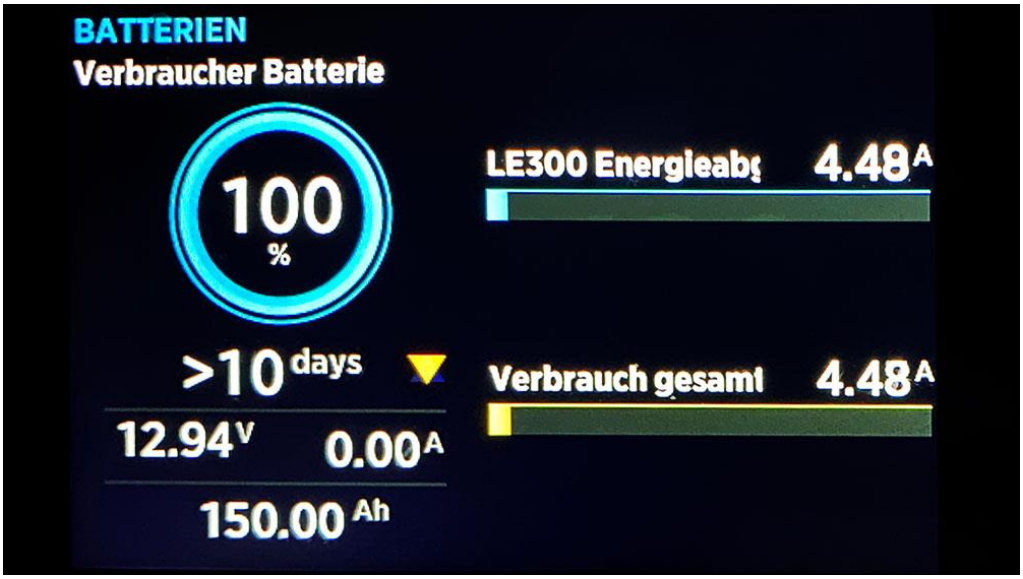
The idea behind the LE300 is to combine the advantages of both systems. It is about keeping the financial investment manageable and at the same time using the advantages of lithium technology without having to carry out a complicated installation on board or possibly disposing of the old, still good batteries when the capacity is no longer sufficient.

Think of it as having two tanks that are connected. As long as the lithium tank is still full, it is preferable to use it. Only when it is empty is the lead tank tapped. Conversely, the lead tank is always charged first and the lithium tank only refilled when it is full. It's a bit like a battery bank as we know it from smartphones. A kind of uncomplicated "reserve".



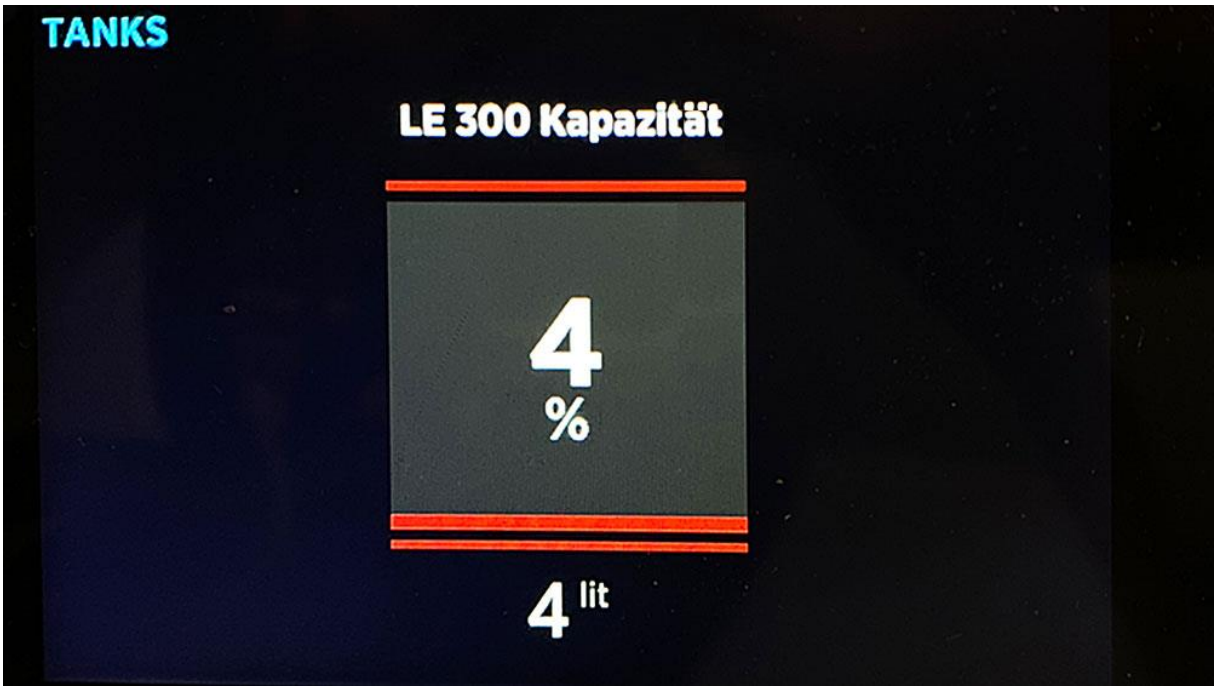
The LE300 buffers the lead battery. © BOS

In other words: The LE300 is always the first to be discharged. The LE300 is only empty when the voltage in the vehicle electrical system falls below 12.8 volts. At 12.8 volts, a “healthy” lead-acid battery is usually 100 percent charged. Only now does the lead battery begin to give off energy. Conversely, the LE300 only takes up energy again when the lead-acid battery is sufficiently charged.



A current of 4.48 amperes flows here, which is completely buffered by the LE300. © Sönke Roever

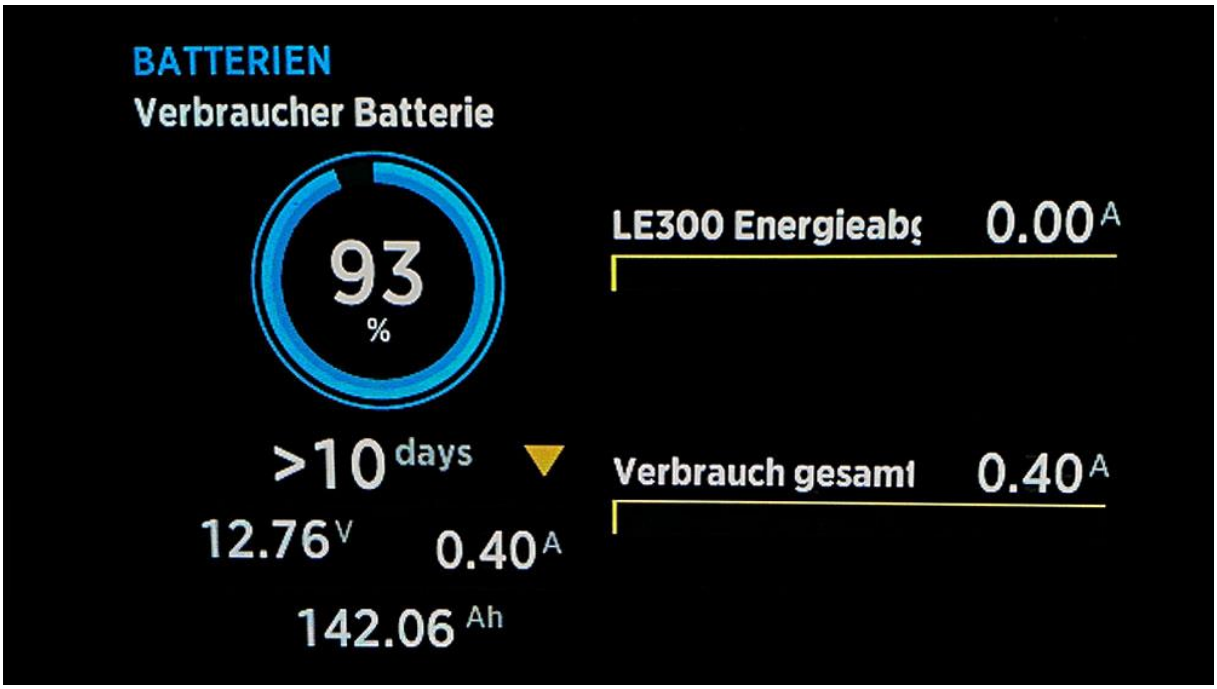
Even more: The integrated BMS of the LE300 monitors and "maintains" the lead-acid battery in this way, so that its service life is increased. Normally, lead batteries on board blue water yachts have an average lifespan of three to seven years (depending on type and care). This can be increased significantly by using the LE300.



Here the LE300 was almost completely discharged. © Sönke Roever

But it would be wrong to claim that pure lithium battery systems, such as those available from various well-known manufacturers, are not also justified. These make sense if a very good service network can be expected on the route. Above all, however, some parameters must be taken into account for safe installation and any repairs. Due to the complex installation, additional, cost-intensive "peripheral devices" are currently required, such as cut-off relays. In addition, almost all manufacturers recommend installation and maintenance by trained specialists. That could be difficult, at least on a long journey.

Even more: all lithium batteries on the market have to switch off under certain conditions. Temperatures around freezing point are a condition for shutdown. This can play a role depending on the itinerary. The exact switch-off temperature varies depending on the manufacturer. This also applies to the LE300, which, however, has a built-in heater. The “heating” means that the LE300 can be charged between -5 degrees Celsius and 55 degrees Celsius. For the reverse discharge, a temperature range of -10 degrees Celsius and 60 degrees Celsius cell temperature applies. Here, too, the lead battery can take over again in extreme cases.



Another example: The LE300 is empty and no longer buffers. Instead, the consumer battery is now slowly discharging. © Sönke Roever

And last but not least, the LE300 can also be used excellently in winter storage for the maintenance of existing lead batteries. The lead batteries no longer have to be removed or recharged several times in winter. The LE300 is simply connected in parallel and then automatically buffers the lead battery with the required trickle charge - provided that no consumers are active. You should only look at permanently low temperatures below -10 ° C or if the LE300 is empty after 23Ah discharge.

Conclusion

A reliable battery system is needed, especially in cruising sailing, in which batteries can be easily exchanged and / or retrofitted. However, it is even more important to get the ship ready to sail again quickly in the event of a defect in poorly developed areas.

The German company BOS developed the LE300 specifically for the requirements in border areas and took possible failure scenarios into account. The main attraction of the Smart Battery System is that the efficiency and service life of the overall system are improved because the LE300 takes over most of the charging cycles, while the lead battery functions as an inexpensive backup storage device. In addition, the lead-acid battery is charged with a higher priority, with the lithium battery taking over the excess energy. When discharging, the lithium battery is primarily discharged. Larger loads are supplied by the lead battery and the lithium battery in parallel, which means that both batteries are loaded with less current.

This means that the life of the lead battery is significantly extended. In addition, the modules are also suitable for subsequent battery capacity expansion.

This is how it should be: anchor energetically independent in a bay. © Elna

Finally, it should also be mentioned that blue water expert Sönke Roever tried out the LE300 on a North Sea cruise on board a cruising yacht. His conclusion:

“The installation is actually as easy as described. The manufacturer brought a 6-block LE300 to the ship and we connected it within 15 minutes. We did not install it permanently because we only wanted to test it. Instead, we secured the block with lashing straps. We were able to follow the charging and discharging currents and voltages precisely using a battery monitor supplied for the test. The LE300 takes charge current when the lead batteries are sufficiently charged and emits energy in proportion to the load. In this way, on the one hand, the capacity of the system can be increased in a modular fashion and, on the other hand, the lead battery is conserved. Even more: If batteries fail, they can be replaced by classic batteries, as there is no complicated wiring or charging technology. In short: The LE300 from BOS is a very well thought-out and coherent system for me. "

Article by Arne Gründel

Arne Gründel is sales manager at ELNA GmbH, which primarily deals with radio technology for professional shipping and advises and supplies specialist retailers in the water sports sector under the name Ferropilot. Arne Gründel has been sailing on the North and Baltic Seas since childhood. For several years he has been chartering yachts as a skipper with friends or family in Croatia and on the Baltic Sea.