

LITHIUM EXTENSION BATTERY

LE300

Installation & User Manual



EN

User Manual Version No. 98803201
Release date: August 2018; Revision 12

BOS BALANCE OF STORAGE SYSTEMS AG / BEIM MÜHLBACH 3 / 89171 ILLERKIRCHBERG / GERMANY
PHONE: +49 (0) 731 72 54 41 07 / MAIL: CONTACT@BOS-AG.COM / WEB: WWW.BOS-AG.COM

LE300

TABLE OF CONTENTS

1	GENERAL INFORMATION	2
2	TECHNICAL SPECIFICATIONS	6
3	OVERVIEW	8
4	SYSTEM FUNCTIONS	9
5	INSTALLATION	11
6	COMMISSIONING	14
7	DISPLAY & OPERATION	15
8	TROUBLESHOOTING AND FAQ	16
9	MAINTENANCE	17
10	STORAGE	18
11	TRANSPORTATION	18
12	WARRANTY & LEGAL NOTES	19
13	RECYCLING INFORMATION	20

Package Contents

- User manual
- Device LE300 Lithium Extension Battery Art. No. 12000001
- Power cable connector RAST 5 with 20 cm cable and 2x WAGO clamp Art. No. 97904600
- Spare part fuse KFZ-Mini 20 A (1x) Art. No. 96915600

Optional accessories

- RS485 parallel connection cable Art. No. 97905000
- Parallel mechanic mounting kit (threaded bolt and nuts, for max. 6 LEs in parallel) Art. No. 1200080

1. GENERAL INFORMATION

Thank you for purchasing a high quality, German made product from BOS Balance of Storage Systems AG. We worked according to strict engineering standards in order to deliver valuable energy services for our customers. In case of technical problems or comments of any kind, please contact the local distributor for support.

LE300 Lithium Extension Battery is a fully scalable solution to enhance performance and add capacity to lead acid batteries in solar and any other kind of energy storage systems. They can be used with new or existing **12 V** lead acid batteries. Just stack them in parallel to meet your specific system specs.

As all BOS AG hybrid battery systems, the **LE300 Lithium Extension Battery** takes most of the charging cycles while the lead acid battery provides inexpensive backup capacity. The lead acid battery is charged with higher priority and the **LE300** takes all surplus energy. This helps to increase the lead acid battery life.

The system recognizes the lead acid battery voltage and automatically starts to support the lead acid battery with a maximum current of **12.5 A** per unit. Bigger loads get supplied by the lead acid and the **LE300** in parallel, resulting smaller currents for the whole system.

LE300

Safety instructions

- Please read and understand the whole user manual before installation and usage of the LE300 Lithium Extension Battery.
- Only connect to 12 VDC batteries of the following types:
 - Lead storage batteries with liquid electrolytes
 - Sealed lead acid batteries – GEL or AGM
- Use the device only in combination with a lead acid battery and a lead acid charge controller, do NOT connect loads or power sources directly to the lead acid battery nor to the LE300 device.
- Lead acid batteries can generate explosive gases during operation. Never smoke, allow flames or sparks near the battery. Make sure to keep sufficient ventilation around the battery and read the lead acid battery user manual.
- Do NOT use with nickel cadmium batteries, nickel metal hydride batteries or other battery types.
- Do NOT mix up the + (plus) and - (minus) poles of the battery.
- Do NOT connect anything to a damaged battery. It could heat up, catch fire or explode.
- Do NOT open the battery pack. Danger of short-circuiting. Opening the LE300 device voids any and all warranty claims.
- Best operating temperature is between 15 and 20 °C. Higher temperatures shorten the lifespan of the batteries. Do NOT place device in direct sunlight!
- Protect the LE300 against heat (e.g. prolonged sun exposure) and fire and from water. Do NOT store or operate the LE300 near hot or flammable objects.
- Install this device step by step as written in this manual for best results.
- After installation, the device needs to be fully charged.
- Do NOT charge the device over an extended period, if the device is unused.
- After prolonged storage period, it may be necessary to charge and discharge the device numerous times to achieve the full performance capability.
- Follow all safety precautions during installation of device & handling batteries.
- Improper handling of batteries may introduce a risk of battery explosion.
- Keep batteries away from children & animals.
- During handling of batteries no smoking or exposure to naked light & fire.
- Wear eye protection during installation process.
- When working with a battery and LE300, remove all personal metal items like watches, rings, necklaces and bracelets. Metal items in contact with the battery terminals might cause a short circuit with a very high electric current, which may heat up and melt nearby objects and cause severe burns.
- Keep the LE300 not being used away from paper clips, coins, keys, nails, screws or other small metal objects, that can make a connection from one terminal to another. Shorting the battery-pack terminals together may cause burns or a fire. For short-circuiting damage caused in this manner, any and all warranty claims shall be invalid.

- Use electrically insulated tools for connecting cables.
- The mounting and the electrical connection may only be carried out by trained specialists.
- Use only properly functioning test equipment with this device.
- Internal voltage of device may be higher than the rated level, take care to avoid being zapped during installation.
- Keep this document in a safe place for the entire service life of the device. Pass the document on to subsequent owners and operators of the device.
- Incorrect operation can damage system components.
- The device must not be connected to a lead acid battery if it has a damaged casing.
- Factory labels and markings must never be altered, removed or rendered unreadable.
- This device contains sensitive electronics, so take care during installation and use.
- Consider all relevant official safety instructions during transportation of the device. Safety instructions might vary depending on the mode of transport and on local country regulations.
- Check the recycling information at the end of the user manual for disposal of device.

Application Scope

- The primary application of the LE300 is the stationary storage of renewable energy in the area of solar energy.
- This device is for residential, recreational & small commercial operations.
- This device is for operation with 12 V lead acid batteries only. A lead acid charge controller is needed for correct operation.
- The device is not permitted to be mounted in outdoors, underside, engine compartment or exposed areas of interior spaces (e.g. side pockets in the trunk, outer wet chamber, spare wheel recess).
- Failure to follow this precaution can cause damage to this device and the energy source to which it is connected.
- Consult authorized supplier if device is to be connected in nonstandard configuration.
- Sizing of lead acid battery needs to fit to the overall system design. For long lifetime lead acid battery must frequently be charged to 100%.
- If sizing of the system is not done within the specification warranty becomes void.
- The battery connection in the KFZ range need to be chosen <3 m.
- Failure to comply with correct product usage or neglecting the user manual, the warranty and guarantee becomes void.

LE300

2. TECHNICAL SPECIFICATIONS

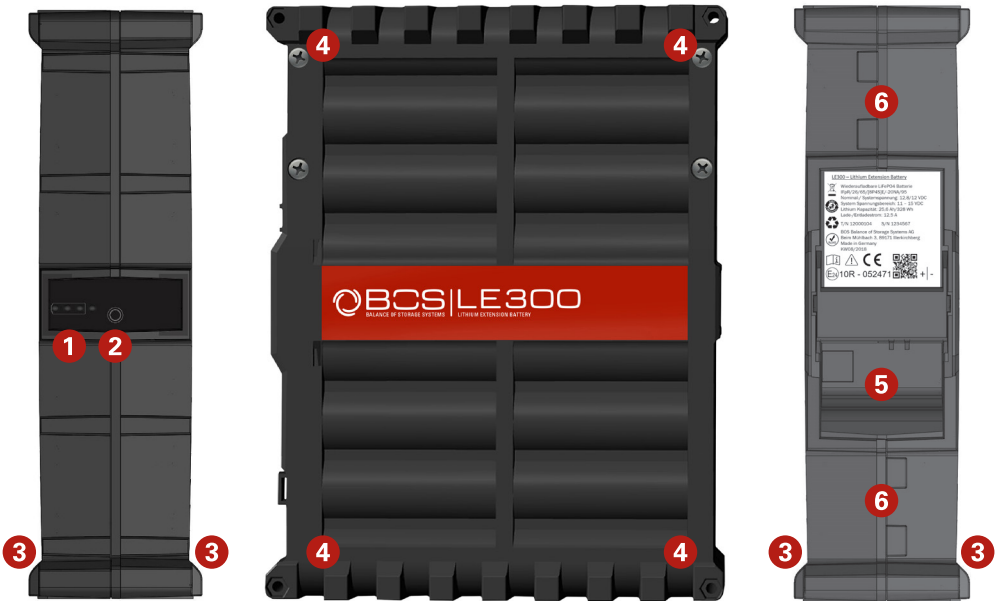
System voltage	12 VDC
Nominal voltage	12.8 VDC
Voltage range	11 - 15 VDC
Battery packs used in LE300	IFpR/26/65 [8p/4s] E/-20NA/95 LiFePO ₄ rechargeable battery
Nominal lithium capacity	25.6 Ah/328 Wh
Usable lithium capacity	90 % (23 Ah/295 Wh)
Numbers of cycles at room temperature	>2000 complete cycles
Recommended lead acid capacity for each LE300 (not included)	70 - 125 Ah @ 12 VDC
Recommended lithium/lead acid capacity ratio (net)	1/3 in solar home applications. Values vary depending on needed autonomy and on application.
Continuous charging current	Max. 12.5 A between 5 and 40 °C, at higher and lower temperatures current is limited.
Continuous discharging current	Max. 12.5 A between 5 and 40 °C, at higher and lower temperatures current is limited.
Battery efficiency	> 90 %
Housing dimensions	175x229x67 mm
Weight	3.4 kg
Connection terminals	RAST 5/mini module 4 pin/communication interface/external display
Recommended wire size	1.5 - 4 mm ²
Ambient temp. (operation & warehousing)	-20 - 50 °C ambient temperature with maximum battery life at 15 - 25 °C. Warehousing temperature 10 - 30 °C.

Low and high temperature protection, heating, charging & discharging	Temp. sensor prevents lithium battery charge under -5 °C or above 55 °C cell temp. Charging starts once cell temp. is higher than -5 °C. Device has an integrated heating that is active between -20 °C and 10 °C cell temp. Discharge possible between -20 °C and 60 °C cell temp. At cell temp. below -20 °C and over 60 °C system is running in pure lead acid mode for higher battery lifetime.
Lithium cell balancing	Battery management inclusive balancer
Protection features	Overcurrent, overvoltage, short circuit, deep discharge, wrong polarity protection.
Operation mode/compatible external batteries	Works in combination with any 12 V lead acid battery & lead acid charge controller.
Connection possibilities	Packs can be connected in parallel with each other (see exemplary parallel combination in the table below).
Max. parallel LE300s	In standard version, a maximum of 24 LE300 can be connected only in parallel, higher quantities possible after consulting BOS partner.

Exemplary parallel combination	Parallel
Qt. in parallel	4
Total nominal voltage	12.8 VDC
Total lithium capacity	102.4 Ah/1.3 kWh
Continuous charging current to LEs	Max. 50 A
Continuous discharging current from LEs	Max. 50 A
Recommended lead acid capacity (not included)	4 - 12 kWh

LE300

3. OVERVIEW



- 1 State-of-charge-trend-display and torchlight
- 2 Push button
- 3 Mounting shape for standard lead acid mounting clamp
- 4 Holes for mechanical parallel mounting/mounting on mounting plate (optional)
- 5 Cable connector plugs
- 6 Cable strain relief connectors

4. SYSTEM FUNCTIONS

Charging

The lead acid battery is charged with higher priority. After the lead acid battery is charged 80% the LE300 starts being charged in parallel. However, it still leaves sufficient energy for the lead acid battery to be properly fully charged.

The charging current is limited to about 12.5 A per device, for instance 4x LE300 can be charged with up to 50 A.

Discharging

At the beginning of each discharge phase, the LE300 will be discharged first (given that the LE300 has not been empty). Depending on the load, the LE300 is doing all the work until the LE300 is almost completely discharged. Once the LE is discharged the lead acid battery will be discharged (if load continuous). Therefore, in charging & discharging phases the LE300 is supporting the lead acid battery.

The current is limited to about 12.5 A per device, for instance 4x LE300 can thus together support the lead acid battery with up to 50 A. Currents higher than the nominal rated currents of the LEs are supported by both, the LEs and the lead acid batteries, resulting in smaller C-rates for both batteries

Protection

Due to the intelligent battery management, the LE300 is fully protected against overload and deep discharge as well as overcurrent, short circuits, wrong polarity and too high or too low temperatures.

Under cold conditions (<10 °C cell temperature) the integrated heater heats up the LE300 to operating temperature to avoid damage to the cells during the charging phase. At cell temperatures below -20 °C no discharge of the device is possible. At cell temperatures below -5 °C no charge is possible. Once the integrated heater has warmed up the LE300 and the thresholds of -5 °C for charging and -20 °C for discharging are passed, the LE300 starts charging/discharging. Full charging and discharging power is available between 5 °C and 40 °C. At cell temperatures lower than 5 °C and higher than 40 °C the charging and discharging currents are limited.

LE300

The device is short circuit protected, in case of short circuit the device will show an error code (see details under chapter 7 Display & operation).

The device is wrong polarity protected, in case of connection with wrong polarity the device will show an error code (see details under chapter 7 Display & operation).

Sleep mode

An internal sleep mode protects against a complete discharge of the Li-cells. When idle, under normal conditions the LE300 goes into a standby/sleep mode. Every 128 seconds the device will be automatically waked up to check, if LE300 is needed for charging/discharging.

If one of the Li-cells falls under deep discharge, caused by self-discharge, the LE300 goes into a deep sleep mode. In this mode, the LE300 can only be woken up by pressing the push button or by recharging the device (this is checked every four mins automatically). After wake-up, a charging phase is possible.

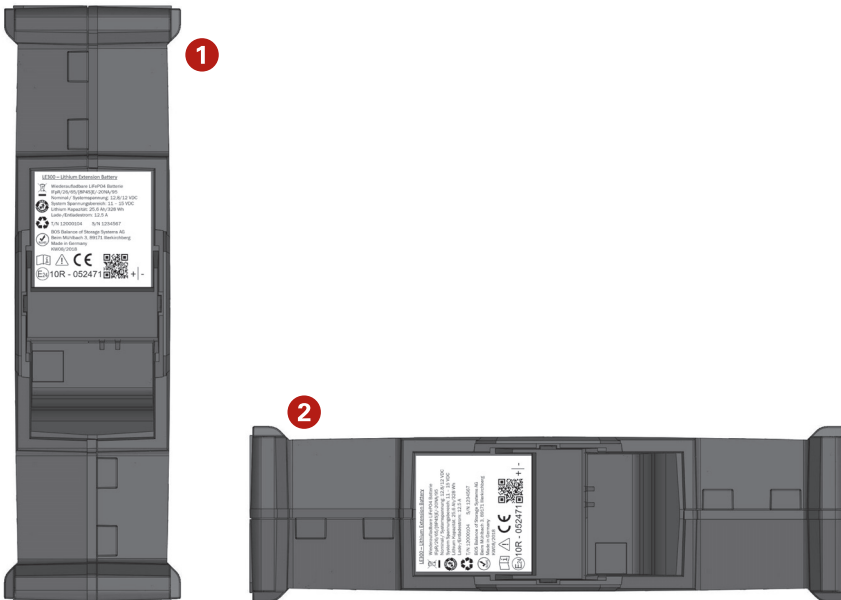
If one of the Li-cells is critically deep discharged, the LE300 system shuts down completely into a safety mode to protect from potential dangers that could occur when recharging depleted lithium cells. The LE300 cannot be woken up anymore. Neither charging nor discharging is possible anymore. In this case, please contact your local BOS dealer for support.

5. INSTALLATION

Please read and understand our general information before starting the installation.

Technical installation

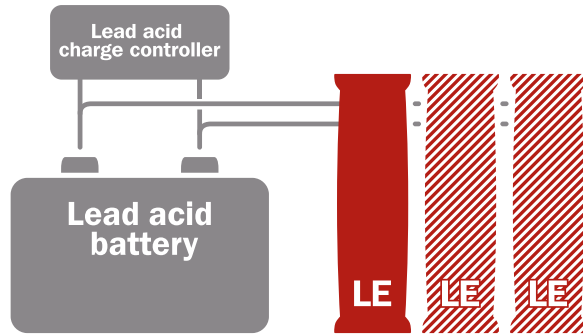
In general, the LE300 can be installed in any mounting direction. Recommended mounting directions are **1** mounting in upright position using the standard lead acid battery clamps and **2** mounting flat on biggest area using direct mounting to a mounting plate with screws/bolts. See graphics below for details.



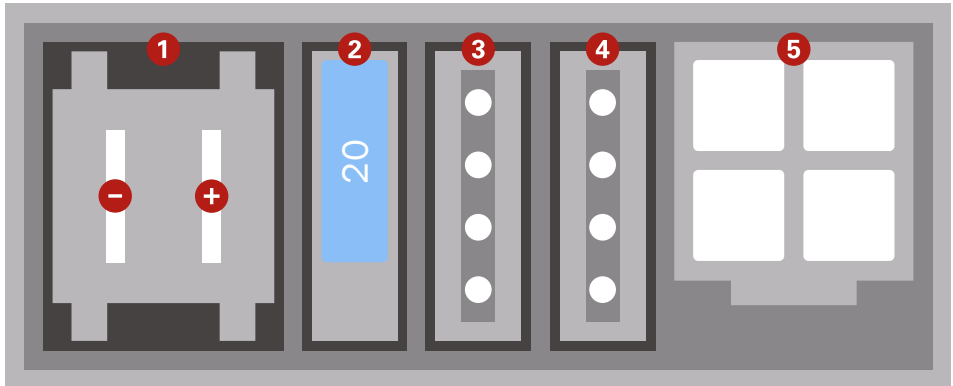
Electronical installation

The LE300 Lithium Extension Battery is connected in parallel to the lead acid battery. Please note that a standard lead acid battery charge controller is needed. No special additional charge controller is needed for the LE300. It is important to choose the right size of connection cable, depending on the maximum currents. Several sets of connecting cables might be required. Make sure that wiring is done according to DIN VDE 0298-4.

LE300



The picture above is a basic visualization of the system connection, details on the electrical connection are explained in the following:



1		2	3	4	5
RAST 5 LEAD ACID IN/OUT		Fuse	Communication interface	Communication interface	DISPLAY OUT
-	+				
to lead acid -	to lead acid +	20 A mini-KFZ fuse	<i>Optional to next LE</i>	<i>Optional to next LE</i>	<i>Optional to display</i>

Simply connect the LE300 system directly in parallel to the lead acid battery at the RAST 5 (code 00E) power connector **1**. Therefore, use the supplied plug connector, fix cables to it, plug it to the back of the LE300 at the power connector **1** and mount the other side of the cables to your lead acid battery. Pay attention to right polarity and proper cable connection!

Check if the 20 A fuse is inserted at **2**. If fuse is missing, insert the supplied spare part 20 A fuse.

In case of parallel connection of several LEs, make sure that LE enclosures are mounted firmly together. It is recommended to use a threaded bolt and nuts to tighten LEs with each other (optional mechanical parallel mounting kit). It is recommended to connect all LE300 with each other through RS485 communication **3** and **4**. LE300s would also work in parallel mode without the RS485 communication, however one common state-of-charge-trend-signal couldn't be generated anymore for the whole system. Maximum number of LEs in parallel configuration is 24 LEs as standard version, please get in touch with your BOS dealer if more LEs in parallel are needed.

5 Optional signal outlet for display connection. 0 - 10 V state-of-charge-trend-signal to be connected to displays with 0 - 10 V signal input. It is recommended to use the following plug with cables at the signal outlet: Mini-Fit Jr.™ TPA Cable Assembly 45135 (plug not included). Optionally a LCD state-of-charge-trend-display is available.

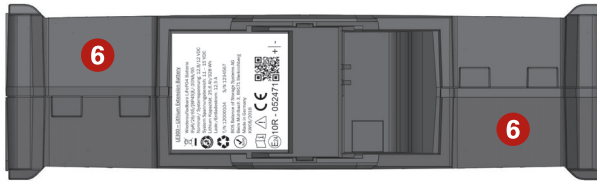
Display out graphic **5**



Pin	Name	Description
1	Anout	Analog OUT 0 - 10 V SOC (0 V = 0% 10 V = 100%)
2	DIN1	Digital IN 1 (Wake up)
3	DIN2	Digital IN 2
4	GND	Ground

LE300

6 Tighten the installed cables with a cable tie to the strain relief connectors to avoid damages to the electronics from moving cables.



6. COMMISSIONING

Once mechanical and electrical connection is done according to chapter 5, the LE300 will automatically start working and supporting the lead acid battery system. Please push the pushbutton of LEs to check the status of the products (see details in chapter 7).

It is recommended to fully charge the system once LEs were connected. A full system charge is needed in order to give accurate information on the state of charge of the system.

For devices which are stored over a longer period of time, several charging cycles might be necessary. This is done to balance each lithium-cells and to show an accurate state-of-charge-trend-display.

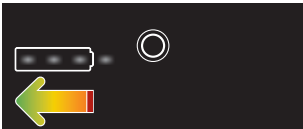
7. DISPLAY & OPERATION

The display is off by default, to save power. To activate the device, just press the push button. It consists of four status LEDs and one push button. Once the push button is no longer pressed, the display turns off after ten seconds.

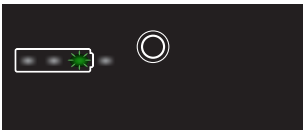
Once the push button is pressed and hold, the device shows whether it is charging or discharging (in case of errors in the LE or the set-up, error codes are shown as described in chapter 8):



Chaser light from red to green indicate that the LE300 is being charged.



Chaser light from green to red indicate that the LE300 is being discharged.

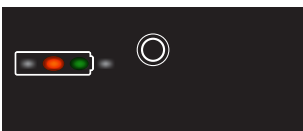


If green LED flashes whilst the push button is pressed, the LE300 is neither charged nor discharged but in idle mode.

Once the push button is released, the device shows the state of charge:



Green LED indicates, that the LE300 is fully charged, SOC > 80 % (SOC = State of charge).



Green and yellow LED indicates, that the LE300 is between 61 – 80 % SOC.

LE300



Yellow LED indicates, that the LE300 is half-full, SOC between 41 – 60 %.

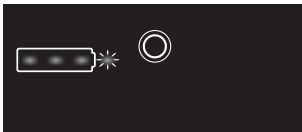


Yellow and red LED indicates, that the LE300 is at low SOC between 21 – 40 %.



Red LED indicates, that SOC is between 0 – 20 %.

If the push button is pressed for five seconds, an emergency light turns on:



The emergency light can be activated by pressing the push button for five seconds. It turns off automatically after ten seconds and automatically starts a reboot.

8. TROUBLESHOOTING AND FAQ



If yellow LED flashes once the push button is pressed and hold, the LE itself is fine. However, there is some problem in the operation of the LE, which is linked to either of the following events: the connection to the lead acid battery is not working (tripped fuse or bad/no connection to lead acid battery or wrong polarity); short circuit.

Please check if the LE is properly connected to the lead acid battery with the right polarity and if the lead acid battery voltage is higher than 10.5 V. Also, please check if the 20 A fuse at the LE and any other fuse in the line between the LE and the lead acid battery is tripped. Exchange tripped fuses and recheck status once it is assured that connection to lead acid battery is done properly (no short circuit, right polarity, properly connection at lead acid and LE). Once the issue is resolved, restart the LE by pushing the push button.

In case of too low temperature, the LE heats up, once the system gets charged. In case of too high temperature, the LE will reactivate, once temperature is lower. The LE300 itself is fine, but either the short circuit or the wrong polarity protection was triggered. Please check the wiring for short circuits or wrong polarity connection.



Red LED flashes, if temperature is too high or too low ($<-40\text{ }^{\circ}\text{C}$ or $>60\text{ }^{\circ}\text{C}$). If no LED turns on once the push button was pushed, please contact your BOS dealer.

Why is there no voltage at the power connector of the LE?

As long as the LE300 is not connected to a lead acid battery, the power connector of the LE300 is deactivated. In order to use the LE300, connect it to a 12 V lead acid battery.

9. MAINTENANCE

The device is basically maintenance-free. Cable connections should be checked frequently. Clean the device from dust when necessary with a dry cloth. Avoid any contact with water or other liquids.

The lifespan of the LE300 can be prolonged when being properly maintained and especially when being operated and stored at the right temperatures.

With increasing age however, the LE300 capacity will diminish even when properly maintained.

If the operating period significantly reduces after charging, the LE300 is probably worn out and must be replaced.

10. STORAGE

The LE300 has been designed to last at least ten years of normal use. If the product is stored for a long period of time, please recharge the device every six months. Therefore, connect the system to either a photovoltaic (PV) module or to a direct current (DC) power source (in each case the usage of a lead acid charge controller is mandatory). Please be aware that batteries will get damaged by deep discharge, if not recharged regularly.

Note: When the LE300 is stored empty for longer periods, it can become damaged despite the low self-discharge and the LE300 capacity may be strongly reduced.

Store the LE300 in a dry and well-ventilated location. Protect the product against moisture and water. The LE300 can be stored at temperatures between 10 °C and 30 °C. Take care that the maximal storage temperature is not exceeded. Avoid relative humidity over 85 % as well as condensation.

11. TRANSPORTATION

The LE300 is UN38.3 certified, nonetheless it is subject to the Dangerous Goods Legislation requirements. Private users can transport undamaged LE300 by road without further requirements.

When being transported by commercial users or third parties (e.g. air transport or forwarding agency), special requirements on packaging and labelling must be observed (e.g. ADR regulations). If necessary, an expert for hazardous materials can be consulted when preparing the item for shipping.

Dispatch LE300 only when the housing is undamaged. Tape or mask off open contacts and pack up the LE300 in such a manner that it cannot move around in the packaging.

Inform your parcel service that the package contains dangerous goods. Please also observe the possibility of more detailed national regulations.

In case of questions concerning transport of the LE300, please refer to an authorized BOS dealer. The BOS dealers can also provide suitable transport packaging.

12. WARRANTY & LEGAL NOTES

Warranty

The LE300 Lithium Extension Battery come with a two-year warranty on the product including the integrated lithium battery starting from the date of purchase. There is no warranty granted on other system components from other manufacturers that are used together with the LE300 Lithium Extension Battery. In case of problems, comments or a warranty claim or the need for spare parts please contact the local dealer or BOS AG for support.

Exclusion of liability

The manufacturer can neither monitor the compliance with this manual nor the conditions and methods during the installation, operation, usage and maintenance of the device. Improper installation of the device may result in damage to property and, as a result, to bodily injury.

Therefore, the manufacturer assumes no responsibility and liability for loss, damage or costs which result from or are in any way related to incorrect installation, improper operation, incorrect execution of installation work and incorrect usage and maintenance.

Similarly, we assume no responsibility for patent right or other right infringements of third parties caused by usage of this device.

The manufacturer reserves the right to make changes to the product, technical data or installation and operating instructions without prior notice.

Declaration of conformity

The LE300 Lithium Extension Battery comply with all applicable provisions of relevant directives and regulations and are in conformity with the relevant standards. The full declaration of conformity is found for download at www.bos-ag.com.

13. RECYCLING INFORMATION



Recycling of the integrated lithium battery is handled in Germany by GRS Service GmbH.

Do not dispose in waste bin, but recycle electronics, batteries and packaging materials according to local regulations. Tape or mask off the contact surfaces of the LE300 terminals with adhesive tape before disposing of the device.

For more information, please contact your BOS dealer or BOS Balance of Storage Systems AG.

Only for EC countries:

According to the European Guideline 2012/19/EU, electrical devices/tools that are no longer usable, and according to the European Guideline 2006/66/EC, defective or used battery packs/batteries, must be collected separately and disposed of in an environmentally correct manner.

Contact BOS AG

BOS Balance of Storage Systems AG
Beim Mühlbach 3
89171 Illerkirchberg
Tel.: +49 (0) 731 72544107
service@bos-ag.com
www.bos-ag.com

Contact local BOS-dealer
