

# Green Orca<sup>®</sup> High Energy

Technical Information



Green Orca<sup>®</sup>



EST-Floattech  
Intelligent Energy Storage Solutions

# From superior cell to one of the safest battery systems

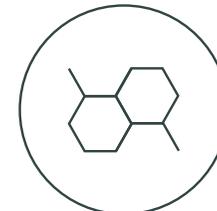


In the construction of our batteries, we collaborate closely with Kokam, which supplies us with the best Lithium Polymer Battery Cells on the market today. This, combined with our patented safety system and unique balancing BMS, results in an extremely reliable, modular, and passive safety system, with a very high energy density that has been approved by the strictest maritime classification societies.

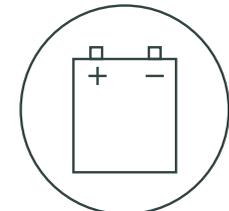


SAFETY

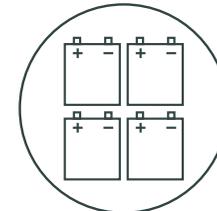
*The technical choices for the design of the Green Orca battery system starts with the cells. We then consider the module and battery management system, before examining the system as a whole and how it is integrated on board in order to guarantee the safety of the entire system.*



CELL



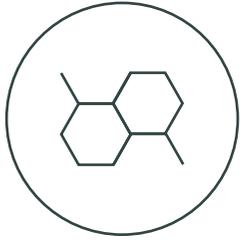
MODULE



BATTERY APPLICATION



SYSTEM ON BOARD



# Battery Cells

## Lithium Polymer NMC cells by Kokam

### Kokam's Leading Cell Technology

Kokam develops and manufactures different kinds of Lithium Polymer Cells. These Lithium Polymer Cells have been proven to deliver the best performance and quality to demanding customers in the aerospace industry. Due to their patented and certified cell design and the highest energy density available on the market, a strong partnership with Kokam is the best foundation for building the safest possible maritime system.



### Lithium Polymer NMC cells by Kokam

Our Green Orca Modules use Lithium Ion Polymer NMC (Lithium Nickel Manganese Cobalt Oxide). The combination of nickel, manganese and cobalt ensures the highest energy density, in combination with good overall performance compared to other lithium-based battery technologies, such as Lithium Ion Phosphate (lower energy density) or Lithium Titanate (extremely expensive).

### Pouch Cells & Z-Folding

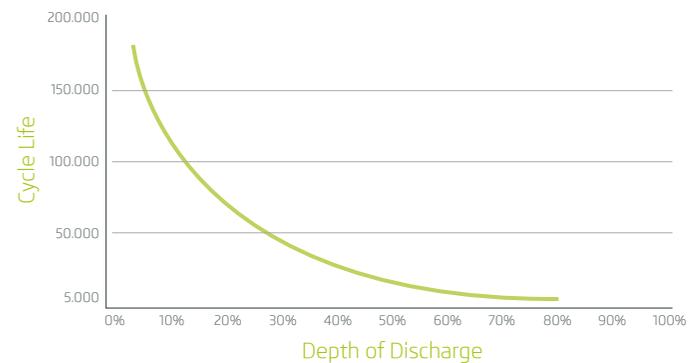
The pouch cells we use provide a flexible and lightweight solution for battery design, while delivering high load currents. Compared to prismatic cells and cylindrical cells, pouch cells make more efficient use of space and achieve 90% to 95% packaging efficiency. The cells



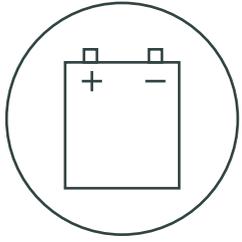
benefit from improved thermal behaviour, as there is no heat encapsulated in the cell core, as is the case with prismatic and cylindrical cells. The Z-fold stacking method significantly reduces internal resistance (which results in less energy lost as heat as the cell charges and discharges), and increases efficiency, power, and cycle life.

### Life time & Cycle Life

Our cells have Cycle Life<sup>1)</sup> of approx. 5,000 cycles by and DoD<sup>2)</sup> of 80% at an EoL<sup>3)</sup> of 80%. This means that the cell's energy content and life expectancy have been decreased by 20%. There are more cycles possible in the 2nd life phase.



- 1) Cycle Life #: the number of complete charge-discharge cycles a battery can perform by a certain DoD (see table);
- 2) Depth of Discharge % (DoD): the percentage of total capacity that is discharged (see table)
- 3) End-of-Life % (EoL) indicates the time elapsed before a battery becomes unusable, as the capacity decreases with use and over time;

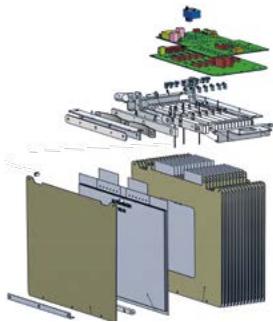


# Green Orca® high energy module

Built as one of the industry's safest modules

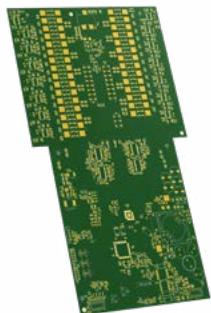
## Green Orca® Modules

The Green Orca® High Energy module is a modular, patented system designed in accordance with the strictest safety norms required by the DNV-GL and the Norwegian Maritime Authority. The system is DNV-GL type approved and offers in combination with the Gas Exhaust System a passive protection system against thermal runaway. The Gas Exhaust System routes gasses out of the ship and reducing requirements on the battery room.



## Mechanical structure

The system's simple, but effective modular structure makes it easy to install it in accordance with the client's wishes. The direct cell-to-cell connection makes optimal use of the system's volume-to-energy density, low impedance and limited heat generation. Its spring-loaded system keeps the cells in position under even the most demanding circumstances. Thanks to the IP 67 watertight aluminium casing, the system is extremely robust and safe.



## BMS, Redundant & Active balancing

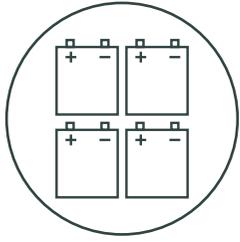
The Battery Management System (BMS) was developed by EST-Floattech to meet the highest requirements for naval purposes. The cells are monitored and logged for voltage and current, and the redundant safety circuit constantly monitors the temperature and communicates with the BCU. It is unique in the market in that it features active cell-to-cell and battery-to-battery balancing, for optimal energy storage and battery life.

## Energy Modules (C-Ratings, Capacity)

The Green Orca® High Energy has a gross power rating of 10.5kWh, in which 14 200Ah cells are connected in series to provide a nominal 52 volts. The Green Orca has a nominal C-rating of 2C discharge, and a Nominal charge rating of 1C. The 2 C rating means that the discharge current will discharge the entire battery in 30 minutes (0,5 hours) with 21kW, where 1C means that the entire battery can be charged in 1 hour with 10,5kW.



Dimensions (WxHxD)  
335 mm x 541 mm x 542 mm



# Battery Application

## Building the system and integration

### Green Orca® Energy Storage System

The EST-Floatech Energy Storage System is ideal for use in maritime applications, such as fully electric or hybrid propulsion, coupled with diesel, hydrogen or LNG power systems. It can be used for propulsion, hotel load, auxiliary equipment and during harbour stays, and for optimal engine efficiency during peak saving and peak power applications. The system is DNV-GL type approved and offers in combination with the Gas Exhaust System a passive protection system against thermal runaway. The Gas Exhaust System routes gasses out of the ship and reducing requirements on the battery room.



### Battery Control Unit (BCU)

The Battery Control Unit (BCU) is responsible for communication between the battery modules and the application's power management. The BCU transforms the separate battery modules into an Energy Storage System (ESS), and is integrated with the complete on-board power management system.



### Communication

Like the BMS, the BCU features a redundant safety circuit and checks, validates and collects all of the data from BMSs, and is the data gateway to the on-board Power Management System. The maximum module power rating is 1000 volts, with 18 modules per string. One Master BCU can be connected to 3 slave BCUs.

Communication is provided by ModBus or CanBus, in accordance with NMEA 2000 standards for plug-and-play communications.

### Installation and Commissioning

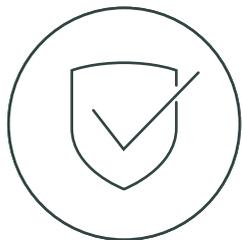
EST-Floatech differentiates itself from the competition by supporting the client from start to finish, from the conceptual design and detailed engineering phases, to the final installation of the system on board.

### System Sizes

The batteries are delivered together with their storage racks, with makes the modules easy to assemble. These racks can be configured to customers requirements and to fit the battery compartment. The visual shows a example of a 284kWh system with Gas Exhaust System and Fire Retardant.



Dimensions (WxHxD)  
3.638 mm x 1.646 mm x 611 mm



# Safety & Certification

Safe under all circumstances

## Safety and Certification

Energy Storage Systems on board are only an option when they are proven to be both reliable and safe. To that end, everything in the module is geared towards preventing a thermal runaway or thermal event from ever occurring in the first place, by means of electronic safety measures. However, in a worst-case scenario, the battery design needs to be so robust that it is capable of dealing with a thermal runaway without the need for any active systems.

## Safe by design

EST-Floattech's 'Safe by Design' principle served as the foundation the design of our energy storage system & modules. This principle is based on the understanding that in order to offer the maximum level of safety, thermal runaway protection should not be dependent on a system such as a Battery Management System, cooling system or external fire extinguisher, but should rather be an intrinsic element of the design itself. That way, the last line of defence in safety does not rely on an active safety system.

## Unique features of the Green Orca® Safety System

The Green Orca Energy Storage System is built to withstand a full Thermal Runaway, beyond a Thermal Event such as cell venting. The unique gas exhaust system eliminates hazardous inflammable gases from the compartment via the integrated exhaust channel. And if a thermal runaway does occur, the temperature of the adjacent modules will stay well within safe limits.

## DNV-GL type approval & NMA Propagation

Norway is currently at the forefront of the use of maritime battery systems. The Norwegian Maritime Authority (NMA) and the DNV-GL classification society both build on the Norwegian maritime industry's advantage in this area in order to further develop the technology in a safe manner and to set the standard for maritime battery systems.



# Technical specifications

## Green Orca® High Energy

Capacity	10,5 kWh
Cycle Life at 80% D.O.D and 80% E.O.L.	>5.000 cycles
Cycle Life at 50% D.O.D and 80% E.O.L.	>20.000 cycles
Cycle Life at 20% D.O.D and 80% E.O.L.	>75.000 cycles
Nominal Charge	200A/1C
Nominal Discharge	400A/2C
Maximum Discharge <10 sec.> S.O.C. 50%	600A/3C
Nominal Charge	10,5kW
Nominal Discharge	21kW
Maximum Discharge	32kW
Volt Minimum	44,8V
Volt Nominal	52V
Volt Maximum	58V
BMS	Active Balancing
Certification	DNV-GL Type Approval NMA Level 1 Propagation Approval
Dimensions (W x H x D)	335 x 542 x 541 mm
CanBus Communication	NMEA 2000
Weight	82 kg.
Cooling	Air Cooled
Gas Exhaust System	Included
Racking	Included
Dedicated Battery Room	Required by Class

## Battery Cell Tests

UN38.3 T-2 Thermal abuse  
UN38.3 T-5 External Short Circuit  
UN38.3 T-6 Impact  
UN38.3 T-8 Forced Discharge  
Overcharge (by the redundant safety system)

## Battery System Tests

Propagation Test  
Safety function test - Emergency stop function  
Capacity Validation  
Sensor Failures  
State of Charge Validation  
IEC 62619 Overcharge with Voltage  
IEC 62619 Overcharge with Current  
IEC 62619 Overheating Control

## Environmental Tests

DNV-GL CG0339 Vibration  
DNV-GL CG0339 Dry Heat  
DNV-GL CG0339 Damp Heat  
DNV-GL CG0339 EMC



Green Orca®



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