Advanced & Versatile lithium ion battery solution

Kokam Battery for Marine Industry





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Deployment of more than 50MWh with Kokam lithium ion battery technology in marine & submarine industry

Electric Vessels Require Reliable Power Supplies

Kokam's batteries optimize the performance of electric vessels. With high energy density, Kokam provides battery solutions which are significantly smaller in size and weigh less than competing products. These features are suitable for long distance navigation, such as submarine applications, where they can provide a reliable source of energy for long term missions. In addition, Kokam batteries outstanding power output serves as an optimal power source for the engine starter.

SMALL FOOTPRINT Compact and powerful

EXTENSIVE AVAILABILITY Wide operating temperature range

DEPENDABLE Consistent and reliable power supply





APPLICATIONS

- > Hybrid vessels and boats > Electric boats and yachts
- > Solar powered boats
- > Civil submarines
- > Container ships

Safe and Reliable Liquid Cooled Battery System

KOL Module

Kokam has developed liquid cooled lithium ion batteries suitable for marine applications which require safety and reliability in harsh ocean environments. They provide peak shaving capabilities along with momentary high energy bursts to enable both commercial vessels or offshore supporting vessels to save fuel and extend the life of main engines or generators. Kokam's offshore liquid cooled modules (KOL) can be configured to make a system of 12.5kWh to MWh scale. With their flexible and modular design, the KOL module can be customized to meet various technical needs of customers.



KEY STRENGTHS

- > Direct water cooling systems for cells
- > IP54 and salinity resistive housing
- > Easily customizable module length
- > Tested for thermal runaway
- > Ship roll and pitch tested by submarine / ship motion
- > Tested by submarine / ship motion requirement
- > Tested for shock, vibration, temperature, EMI/EMC, salinity
- > Fully compliant with maritime safety standards and rule (DNV-GL available by 1Q, 2021)

MODULE CONFIGURATION













MODULE SPECIFICATION 12.5kWh / 15.1kWh

Item	Specification		Remark
Module Configuration	2	P20S	
Туре	High Power	High Energy	HP Cell: SLPB125255255G1H (85Ah)
Capacity	170Ah	206Ah	HE Cell: SLPB130255255G1 (103Ah)
Installed Energy	12.5kWh	15.1kWh	
Nominal Voltage	73	3.6Vdc	
Operating Voltage Range	64~	·82.6Vdc	
Max. Charge Power	25.0kW (2P)	15.1kW (1P)	1 Cycle
Rated Charge Power	12.5kW (1P)	7.5kW (0.5P)	
Max. Discharge Power	36.2kW (2.9P)	30.3kW (2P)	1 Cycle
Rated Discharge Power	12.5kW (1P)	7.5kW (0.5P)	
Cycle Life @ DoD 80%	2	8,000	@ 25±3℃, 1C/1C, SOH 70%
Weight (Approx.)	124kg 127kg		±5%
Dimension (W x D x H)	335 x 7	16 x 433 mm	±2mm
IP Grade	54		

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* DNV-GL Certification for Kokam module accommodating 85Ah and 103Ah cells will be available by 1Q, 2021. Kokam makes no warranty explicit or implied with these specifications. The contents are subjected to change without prior notice. * HP : High Power / HE : High Energy

Cartridge Stacking

Conductor Assembling

BMS Housing Assembling

KOL Module



LIQUID COOLING CAPABILITY

Cells are packaged in cartridges and water jackets are placed in between each cell for thermal control, which help maintain optimal performance of the cells throughout their life cycles. The water jackets are made of thin aluminum sheets that enhance the heat dissipation capability of the module.



A COMPLETE BATTERY SYSTEM

The KOL Module is enclosed in an IP54 grade enclosure and is supplied with a Battery Protection Unit (BPU) and a fusebox. Kokam's BPU manages and protects the battery system through control, monitoring and safety devices. The BPU controls pre-charging to prevent the failure of the battery system, monitors the battery system in real time to detect potential hazards and protects the system by activating protection mechanisms.





KOL Liquid Cooled Battery Solution

KOL Rack



GENUINE SCALABILITY

The KOL battery solution is composed of multiple KOL battery modules configured in various ways in order to accommodate the voltage and capacity requirements. Due to its flexibility and compact size, the KOL battery solution can be installed in places with limited space.



RACK SPECIFICATION 150kWh / 181kWh

Item	Specification		Remark
Rack Configuration	12 module	es in series	
Module Configuration	2P2	20S	
Туре	High Power	High Energy	
Installed Energy	150kWh	181kWh	
Nominal Voltage	883	Vdc	
Operating Voltage Range	768 ~ 9	991Vdc	
Max. Charge Power	300kW (2P)	181kW (1P)	1 Cycle
Rated Charge Power	150kW (1P) 90kW (0.5P)		
Max. Discharge Power	435kW (2.9P)	363kW (2P)	1 Cycle
Rated Discharge Power	150kW (1P)	90kW (0.5P)	
Cycle Life @DoD 80%	≥8,000		@ 25±3°C, 1C/1C, SOH 70%
Weight (Approx.)	1,820kg 1,850kg		±5%
Dimension (W x D x H)	1,260 x 743 x 2,311 mm		±2mm, excl. gas duct, BPU, fuse box
IP Grade	54		@ Module level

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BPU (Battery Protection Unit)

The BPU manages the battery system and it is composed of a pre-charge circuit, main relay, a switch disconnector and a string BMS.

Fusebox

Fuse is designed to protect the battery strings during a short-circuit or overcurrent event.



Transcend The Limitations with **The Fusion of Superior Cell Chemistry**

Kokam sets about to solve the limitations associated with conventional lithium ion battery technology, including cycle and calendar life, safety, recharge time, power delivery, and ability to operate in extreme temperatures. The performance and features of this technology surpass other existing battery capabilities in the market today.

FEATURES

- > High power and energy density
- > High gravimetric and volumetric power density
- > Longer cycle and calendar life
- > Low impedance and heat generation

- > Low self-discharge rate
- > Light weight
- > High discharge energy efficiency
- > Excellent power-to-energy balance

HIGH ENERGY NMC

- > High energy density and improved space efficiency
- > Specially designed for Marine industry
- Competitive price : The NMC cells have a comparative advantage in terms of price, considering their superior performance, reliability and safety features

SPECIFICATION SLPB130255255G1

Nominal Capacity (Ah)	Energy Density (Wh/L)	Current Disc Continuous	charge Peak	Internal Resistance (mΩ) / Max.	Dimension (WxLxT, mm)
103	503	2	3	0.55	268 x 265 x 1

*Please refer to the cell datasheet

HIGH POWER NMC

- > Optimized performance with 8C-rate continuous discharge
- > Optimized performance with 3C-rate continuous charge
- > Improved high power cycle life

SPECIFICATION SLPB125255255G1H

Nominal Capacity (Ah)	Energy Density (Wh/L)	Current D Continuou	ischarge ıs Peak	Internal Resistance (mΩ) / Max.	Dimension (WxLxT, mm)
85	439	8	12	0.40	268 x 265 x 12.

*Please refer to the cell datasheet



PERFORMANCE





Since 1989

Over 30 Years Experience in Battery Industry

As a globally acknowledged battery manufacturer and battery solution provider, Kokam has developed customer-centered, reliable, safe, high performing, and eco-friendly solution for the past 31 years.

With 31 years of field experience, Kokam has installed over 600MWh of batteries around the world. Kokam manufactures over 30 different types of lithium ion batteries for variety of military applications such as fighter jets, armed fighting & support vehicles, mobile energy storage systems(ESS), and portable devices. Kokam battery has pioneered applications in unmanned aviation and ground vehicles(UAV & UGV), and unmanned underwater vehicles(UUV). Kokam's technology has been proven to be high performing, reliable, durable, and safe.

Material(Chemistry) > Manufacturing Equipment > Battery cell > Pack / System > BMS (Battery Management System) > Battery container



Great Power for Everyone

Kokam has overcome numerous technical challenges to successfully develop innovative and customer-centered battery solutions

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(KOL + BPU + Fuse Box) Preliminary

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EUT



EUT Construction ; Summary

- Components of KOL String for DNV GL Certification
 - EUT : KOL Module-85/103 , KOL BPU-2, KOL Fuse Box
 - KOL Module-85/103 with water cooling system
 - For water cooling system used to EUT with Chillier

KOL String

- The rack string can be configured in accordance with the required operation voltage considering the available installation space KOL BPU-2
- A maximum of 12 KOL modules can be connected in series to form a system with a maximum nominal voltage of 883.2Vdc



EUT Construction ; KOL Module

KOL Module Specification

ltem		Specification		Unit	Remark
Type Designation		KOL <u>Module-85</u>	KOL Module-103		
Coll		85Ah	103Ah	-	NMC, Pouch type cells
Cell		High Power	High Energy	-	
Module Config	uration	2P20S	-		Module Configuration
Installed End		12.5	15.1	kWh	25±1℃, 0.5P-rate
installed Ene	ergy	170	206	Ah	25±1℃, 0.5C-rate
Poted Ener		11.2	13.6	kWh	25±1℃, 0.5P-rate
Rateu Eller	9y	153	185.4	Ah	25±1℃, 0.5C-rate
Nominal Vol	tage		73.6	Vdc	
Operation Voltage	Upper		82.6	Vdc	
Operation voltage	Lower		64.0	Vdc	
Charge Dewer	Cont.	12.5	7.5	kW	
	Мах	25	15.1	kW	
	Cont.	12.5	7.5	kW	
Discharge Power	Мах	36.8	30.3	kW	
	Peak	100	45.4	kW	<10sec, >SOC 50%
	Charge	0 ~ 45		C	
Temperature	Discharge	-	-10 ~ 55	C	
	Storage		$0 \sim 25$	C	
IP grade			IP 56		
Weight		124.6±5%		127±5%	kg
Cooling		Liquid cooling		-	<u>1.5</u> ~2 <u>bar</u> <u>3</u> ~ <u>5L/min</u>





EUT Construction ; Water cooling system

Water cooling System

- KOL Module ; KOL Module-85, KOL Module-103
- Controlling the temperature of the cell and prevents fire propagation between the cells
- It can be customized depending on the user request and site condition like figure 1.



Figure 1. Water Cooling System Configuration(Example)



EUT Construction ; KOL BPU-2

KOL BPU-2

- The KOL BPU-2 is a battery protection unit which controls and protects the batteries from over charge/discharge, over current, low current, and etc.
- The BPU houses a string BMS that detects the abnormality of the module based on the voltage & temperature status of the cells transmitted by the module BMS via ISO-SPI communication, and the status of the main circuit's voltage & current measured within the BPU.



ltem		Specification	Unit	Remark
Type Designation		KOL BPU-2		
Maximum voltage		1000	VDC	
Maximum cu	rrent	500	A	
	Width	335±2	mm	
Dimension	Depth	716±2	mm	Without connector
	Height	433±2	mm	Without terminal
Weight		50±5%	kg	
Operating ter	mperature	-20℃ ~ 65℃	Ĵ	
IP grade		IP 56		
Sting BMS		KOBIS-A1		Ver 1.XX
	Protection	Switch disconnector trip		
	Power control	Main relay and Switch disc		
Function	Current measurement	Hall sensor		
	Inrush protection	Pre-charge circuit		
Internal communication		ISO-SPI		
Interface	External communication	Ethernet, RS-232, RS485#1		
	Other interface	Control power, alarm and Fuse, Gas detector, Water o		



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EUT Construction ; KOL BPU-2





	ltem	Description		Item	Description
Α	Ethernet Communication Port	Used for Ethernet cable connection	К	8pin Connector	Spare
В	RS-485 Communication Port	Used for monitoring purposes. RS-485 communication cable should be connected to this port.	L	5Pin Connector	Fuse signal from fuse box & Water Leakage Detect Signal
С	Switch Disconnector handle	Manually connect or disconnect	М	Main Relay	Control the main DC power line
D	RS-232 communication port	RS-232 Communication cable should be connected to this port	N	String BMS	Monitor and control battery system
E	AC220V Input	Supply AC220V from outside system	0	Pre-Charge Relay	Mitigate the inrush current
F	Control power switch	Switch for the control power. The blue lamp is ON when power is alive.	Р	SMPS	Convert 220VAC to 24VDC for control power
G	Fuse	Protect the battery module from over current in control power line	Q	Relay	Generate the contacts on fuse status from fuse box
н	Module connector	Communication for module #1	R	Pre-Charge Resistor	Suppresses initial over current flow at start-up
I	Module connector	Communication for module #N	S	Current sensor	Measure current in string (Rack)
J	8Pin Connector	Ready signal, Alarm and Emergency stop	Т	Switch Disconnector	Connect and Disconnect the battery system



EUT Construction ; KOL FUSE BOX

KOL FUSE BOX

- The KOL FUSE BOX is a case that encloses a protection enclosure installed with a protection fuse.
- The protection fuse is designed to protect the battery strings during an internal shortcircuit event



ltem		Specification	Unit	Remark
Type Design	ation	KOL FUSE BOX-2		
Rated volta	age	1500	VDC	
Rated curr	ent	500	А	
Rated Breaking	capacity	100	kA	
	Width	324±2	mm	
Dimension	sion Depth	154±2	mm	
	Height	244±2	mm	
Weight		50±6%	kg	
Operating temperature		-20℃ ~ 65℃	C	Ambient temperature
IP grade		IP 56		
Function Protection		Fuse Blown		Short circuit Overload
Interface Alarm		Fuse		



Overview (String System)

String Overview



Thank You!

Cautionary Note Regarding Market Data & Industry Forecasts

This power point presentation contains market data and industry forecasts from certain thirdparty sources. This information is based on industry surveys and the preparer's expertise in the industry and there can be no assurance that any such market data is accurate or that any such industry forecasts will be achieved. Although we have not independently verified the accuracy of such market data and industry forecasts, we believe that the market data is reliable and that the industry forecasts are reasonable.



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