

KOKAM BATTERY SOLUTION

TRANSPORTATION APPLICATION



Kokam
Great Power for Everyone

Electrifying Transport

Kokam Battery System is designed for use in commercial truck, bus, tram, and heavy duty transportation. The system can be integrated in parallel and in series to create very high energy and high voltage systems. Furthermore, the "Variable Bulkhead" allows Kokam to customize the packs' electrical and cooling interfaces without having to retool the entire systems.

Superior Lithium Ion Battery

- Exceptionally high power performance
- Extremely safe and wide range of operating temperature

Compact and High Reliability Battery Packs

- Exceptionally efficient direct liquid cooling
- Ease of installation
- Customizable solution
- IP67 Compliant

State-of-the-Art Battery Management Systems

- ISO-26262 compatible RTOS
- Highly configurable for any chemistry
- 12V and 24V compatible
- Designed for system voltages up to 1250V

Complete System Design and Component Selection

- Battery disconnect unit, System controller, Master controller
- Controls up to 300 cells in series; 24 strings in parallel

Extensive R&D, Engineering, and Test & Validation Resources

KOKAM MODULAR PACK

For High Performance E-Mobility

Customizable Design



Single Unit



Scalable Modular Design

Features

- Variable bulkhead design
- Advanced liquid cooling system
- New Kokam BMS, BDU and MCU
- A function to prevent spreading a fire out of the pack in case of internal fire
- Advanced ultrasonic welding of cell tabs to busbars
- Extremely durable and safe under the toughest conditions
- Available with high energy or high power cells
- All external connections at front panel
- Low and stable impedance



| | 71P 7.1 kWh | 105E 10.5 kWh |
|-----------------------------|-----------------------|---------------|
| Cell Configuration | 40NMC-2P24S | 60NMC-2P24S |
| Specific Energy (Wh/kg) | ≥92 | ≥140 |
| Energy Density (Wh/L) | ≥116 | ≥172 |
| Capacity (Ah; Rated at C/2) | 80 | 120 |
| Voltage (Nominal; V) | 88.8 | 87.8 |
| Mass (kg) | 77 | 75 |
| Dimensions (L x W x H) | 753mm x 303mm x 282mm | |

Available 1Q 2017

Available 3Q 2017

KOKAM EV BATTERY SYSTEM

Certified & Guaranteed

Advantages

- Easy to customize high voltage, low voltage and cooling interfaces to each application
- All connections at front panel; rear access not needed for installation
- New Kokam BMS permits very large strings and pack combinations (Up to 750V per string, and up to 24 strings in parallel)
- Allows upgrades to connector styles, fuses, VTBs without tooling entire pack
- Robust, highly serviceable BDU with integrated SCU; standalone MCU
- Available with or without internal fuse
- Highly robust tab-to-busbar joint survives the harshest vibration & shock environments while maintaining ultra-low DCIR
- Direct cooling to cell face; 50-75% less mass than competing technology; maximizes volumetric efficiency
- Enhanced cell separator eliminates the need for thermal barriers

EV Battery Pack Validation

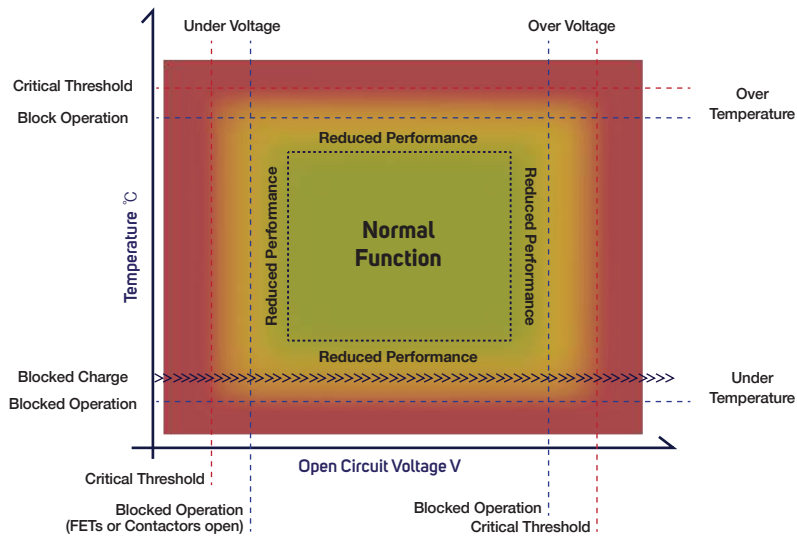
| Test | Conditions | Reference |
|---------------------------------|---|---------------|
| Vibration | Random, 3axis, 21hr.axis | ISO 12405 |
| Mechanical Shock | 50G, 6ms, 3axis, 10ea | ISO 12405 |
| Thermal Shock | 85°C to -40°C within 30min | ISO 12405 |
| Ingress Protection | Mated: IP67; Unmated: IP2xB | ISO 20653 |
| Composite Heat & Humidity | RH93%, 25° - 65°C 28day | ISO 16750 |
| Housing Load | Knee 150kN/m ² ; Foot 356kN/m ² | GMW 16390 |
| UNDOT | UN T-1, 2, 3, 4, 5 | UNDOT 38.3 |
| External Fuel Fire | 130 sec over fuel fire | ECE R100 8E |
| Drop Test | 1.3m onto cement on corner | IEC 62281 |
| Unbalanced Overcharge | 1cell @ 200% forced overcharge | |
| Forced Internal Coolant Leak | Intentional internal coolant leak | |
| External Short Circuit, Fused | 5mΩ, 100mΩ | J2929,UN 38.3 |
| External Short Circuit, Unfused | 5mΩ | J2929 |



Fully Automated Production Line
From Manufacturing Cells to Pack Assembly



KOKAM EV BATTERY SYSTEM-BASED SAFETY



Kokam Cell 40Ah HP Certified & Guaranteed



Kokam cell incorporates ceramic coated separator and builds upon proven NMC chemistry. Kokam tests cells, modules and systems in its own test labs or in certified regional test agency labs. Development and test of battery systems are done according to the following standards :

Integrated, multiple layers of protection : Passive and active safety

Passive safety per many industry standards :

- ECE R100, R17; FMVSS; ISO 6469; UNDOT 38.3 Ellicert / INERIS Safety Tests
- French Automotive Consortium, ISO 12405-2 / EN 60068-2 / ISO 20653 / ISO 11452-2

Active safety follows methods defined in ISO 26262 and IEC 61508 :

- Develop, execute, and maintain, safety plan through the entire product lifecycle
- Strategies, activities, and procedures for achieving product safety
- Utilize tools, methods, and procedures from relevant industry standards, regulations, and best known practices of industry

Obtained Additional Test & Certifications

| | |
|--|--|
| UN transport test | ST/SG/AC.10/11/Rev.6 |
| Crush | UN 38.3 T6, QC/T 743, GBT**, SAE J2464** |
| Nail penetration | SAE J2464, QC/T 743, GBT** |
| Thermal stability | SAE J2464 |
| Analysis of hazardous substances during cell opening without thermal runaway | USABC (SAND2005-3123)** |
| Analysis of hazardous substances during cell opening with thermal runaway | USABC (SAND2005-3123)** |
| FTIR analysis of escaping gases in free space | USABC (SAND2005-3123)** |

** testing performed on similar chemistry cells having non ceramic coated separator

www.kokam.com
battery@kokam.com

Kokam
Great Power for Everyone