LIM Series: Industrial use Lithium Ion Battery:

LIM30HL
LIM50EL
LIM50EL-13
Creating the Future of Energy

INDEX

Line Up

<table>
<thead>
<tr>
<th>LIM30HL Series</th>
<th>Nominal Voltage(V)</th>
<th>Nominal Capacity(Ah)</th>
<th>The Number of Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIM30HL-8</td>
<td>28.8</td>
<td>31.5</td>
<td>8</td>
</tr>
<tr>
<td>LIM30HL-12</td>
<td>43.2</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIM50EL Series</th>
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<tr>
<td>LIM50EL-8</td>
<td>30.4</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>LIM50EL-12</td>
<td>45.6</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

LIBMII (Battery Management System)

<table>
<thead>
<tr>
<th>LIM50EL Series</th>
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</table>

Installation Record

<table>
<thead>
<tr>
<th>Telecom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Machinery</td>
</tr>
<tr>
<td>Energy Storage Systems</td>
</tr>
</tbody>
</table>

Creating the Future of Energy

Features of the LIM Series

High Reliability

Excellent battery safety design. High safety and reliability is realized by using a Battery Management System (BMS) and each battery module has a module monitoring PCB. This explains the rich installation record that has been achieved over more than 15 years since the start of mass production in 2002.

Wide range applications

The LIM series is mainly divided into two types, the high energy type with large capacity and the high-power type which can do high current charge and discharge. The lineup has various module capacities thus making it possible to design suitable sizes for the various customer needs.

High charge and discharge current performance

High power type battery has an industry top class of 600A (20C) charge and discharge performance. The high energy type battery also shows an excellent performance with maximum discharge current at 300A (6C).

Long life

Designed to achieve long calendar life and high cycle life performance. LIM30HL series have a cycle life performance of more than 30,000 cycle at DOD 100%.

Creating the Future of Energy
GS Yuasa lithium ion batteries are manufactured with high technical knowhow, have high reliability thus also used in the international space station. The industrial use lithium ion batteries (LIM series) are designed based on technology and knowhow achieved from over 20 years of manufacturing lithium ion batteries for space, airplane and vehicle applications. LIM series have been used in various applications since the start of mass production in 2002 and have continued to provide reliable battery power to customers all around the world.

Features of the LIM Series

1. Wide range applications
   The LIM series is mainly divided into two types, the high energy type with large capacity and the high-power type which can do high current charge and discharge. The lineup has various module capacities thus making it possible to design suitable sizes for the various customer needs.

2. High Reliability
   Excellent battery safety design.
   High safety and reliability is realized by using a Battery Management System (BMS) and each battery module has a module monitoring PCB. This explains the rich installation record that has been achieved over more than 15 years since the start of mass production in 2002.

3. Long life
   Designed to achieve long calendar life and high cycle life performance.
   LIM30HL series have a cycle life performance of more than 30,000 cycle at DOD 100%.

4. High charge and discharge current performance
   High power type battery has an industry top class of 600A (20C) charge and discharge performance. The high energy type battery also shows an excellent performance with maximum discharge current at 300A (6C).

5. PSOC (PARTIAL STATE OF CHARGE)
   Not effected by partial state of charge (PSOC) operation. The formation of sulfate crystals that causes early failure in other battery chemistries is not a factor in this battery.
Product

High Power Modules

LIM30HL Series

Features

- Maximum charge and discharge rate of 20C
- High cycle life performance (More than 30,000 cycles*)
- Tolerance to cold temperatures of up to -20°C(-4°CF)

*At DOD 100%, Temp 25°C

<table>
<thead>
<tr>
<th>Features</th>
<th>LIM30HL-8</th>
<th>LIM30HL-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of cells</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Nominal Capacity (Ah)</td>
<td>31.5</td>
<td>43.2</td>
</tr>
<tr>
<td>Nominal Voltage (V)</td>
<td>28.8</td>
<td>43.2</td>
</tr>
<tr>
<td>Maximum charge and discharge current (A)</td>
<td>600 (20C)</td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature (°C)</td>
<td>Charging: -10 Deg C ~ +45 Deg C Discharging: -20 Deg C to 45 Deg C</td>
<td></td>
</tr>
<tr>
<td>Weight (kg, lbs)</td>
<td>17.5kg</td>
<td>27.0kg</td>
</tr>
<tr>
<td>Dimension (L×W×H / mm, in)</td>
<td>440 × 219 × 128 mm</td>
<td>617 × 219 × 128 mm</td>
</tr>
<tr>
<td></td>
<td>17.32 × 8.62 × 5.05 in</td>
<td>24.29 × 8.62 × 5.04 in</td>
</tr>
</tbody>
</table>

Applications

- AGV
- *Automatic Guided Vehicle
- RTG
- *Rubber Tired Gantry Crane
- Diesel Hybrid Train
- UPS

Charging Characteristics

Discharging Characteristics

*The data is for reference purposes. Actual performance varies by condition.
High Energy Modules

**LIM50EL Series**

**Features**
- Maximum discharge rate of 6C,
  Maximum charge rate of 2.5C
- Tolerance to cold temperatures of up to -20°C(-4°CF)
- High cycle life performance (More than 11,000 cycles*)

*At DOD 100%, Temp 25°C

<table>
<thead>
<tr>
<th></th>
<th>LIM50EL-8</th>
<th>LIM50EL-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of cells</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Nominal Capacity (Ah)</td>
<td>30.4</td>
<td>45.6</td>
</tr>
<tr>
<td>Nominal Voltage (V)</td>
<td>10CA</td>
<td>125 (2.5C)</td>
</tr>
<tr>
<td>Maximum charge and discharge current (A)</td>
<td>Charge: 125 (2.5C), Discharge: 300 (6C)</td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature (C)</td>
<td>- 20 Deg C ~ + 45 Deg C</td>
<td></td>
</tr>
<tr>
<td>Weight (kg, lbs)</td>
<td>18.0kg</td>
<td>27.0kg</td>
</tr>
<tr>
<td>Dimension (L×W×H / mm, in)</td>
<td>440 × 219 × 128 mm</td>
<td>617 × 219 × 128 mm</td>
</tr>
</tbody>
</table>

**Applications**
- **UPS**
  - Uninterruptible Power System
- **ESS**
  - Energy Storage System
- **AGV**
  - Auto Guided Vehicle

**Charging Characteristics**

**Discharging Characteristics**

*The data is for reference purposes.
Actual performance varies by condition*
Product

Battery Management System (LIBM II)

The lithium ion battery requires appropriate battery management to protect the battery from over discharge, over charge, heat up etc. Each battery module is equipped with a battery monitoring PCB which measures and sends signals of cell voltage and module temperature to a battery management PCB (LIBM II) which protects the battery in case of overcharge, overdischarge, over heatup or over current.

Features

- **Balancing Function**
  Used to balance cell voltage of connected batteries.

- **State of Charge (SOC) Calculation**
  Automatically calculates SOC which can be monitored in real time via display.

- **Multiple Banks Batch Monitoring**
  Using a domain LIBM II which is master of LIBM II installed in each bank allows monitoring of large battery system.

- **High Voltage System Specification**
  Max DC1800V

### LIBM II Specifications

<table>
<thead>
<tr>
<th></th>
<th>Standard Type</th>
<th>High Voltage Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage (V)</td>
<td>DC21~27</td>
<td></td>
</tr>
<tr>
<td>Max Series Connection (Module)</td>
<td>26</td>
<td>53</td>
</tr>
<tr>
<td>Max Parallel Connection (Bank)</td>
<td>72</td>
<td>36</td>
</tr>
<tr>
<td>Ambient Temperature (°C)</td>
<td>-20 Dec D ~ + 65 Deg C</td>
<td></td>
</tr>
<tr>
<td>Mass (g)</td>
<td>230 (Circuit Board), 800 (Touch Panel)</td>
<td></td>
</tr>
<tr>
<td>Dimension (L×W×H/ठ, in)</td>
<td>130×185×30(Circuit Board) mm, 5.12×7.28×1.18(Circuit Board) in</td>
<td>59.5×169.5×137(Touch Panel) mm, 2.34×6.67×5.39(Touch Panel) in</td>
</tr>
</tbody>
</table>

- **Optional**
  Network card for monitoring Lithium ion battery (Acroware-iGYNetworkAgent)

- **Web interface**
  Lithium ion battery charge and discharge status, battery voltage etc can be monitored via network.

- **Logging Function**
  Can record charging current, cell voltage, SOC and battery temperature. Recorded data can be downloaded by web interface or collected by using USB memory.

- **Modbus/TCP, SNMP Communication**
  Having multiple types of communication makes it possible to interface with various types of customer’s device including remote monitoring systems.
Battery Management System Overview

LIBM collects data from the module monitoring PCB and outputs status of the battery to an external device. In case of an abnormality, LIBM will independently send signal to bank MCCB to disconnect battery bank. For a single battery bank application, only one LIBM is required. In case of multiple battery banks, one LIBM for each bank and a domain LIBM is required to monitor all banks.

LIBM has two CAN Channels. Channel 1(ch1) is for monitoring battery status and Channel 2(ch2) is for communication with external device.
Product

High Energy type (DC 48V Applications)

**LIM50EL-13**

**Features**
- Maximum charge and discharge rate of 1C
- Tolerance to cold temperatures of up to -20°C (-4°F)
- High cycle life performance (More than 11,000 cycles*)
- Can be installed on 19-inch rack (3U)

*At DOD 100%, Temp 25°C

<table>
<thead>
<tr>
<th>Features</th>
<th>LIM50EL-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of cells</td>
<td>13</td>
</tr>
<tr>
<td>Nominal Capacity (Ah)</td>
<td>50</td>
</tr>
<tr>
<td>Nominal Voltage (V)</td>
<td>49.4</td>
</tr>
<tr>
<td>Maximum charge and discharge current (A)</td>
<td>50 (1C)</td>
</tr>
<tr>
<td>Ambient Temperature (°C)</td>
<td>-20 Deg C ~ + 50 Deg C</td>
</tr>
<tr>
<td>Weight (kg, lbs)</td>
<td>32.5kg or under</td>
</tr>
<tr>
<td>Dimension (L×W×H / mm, in)</td>
<td>480×437×130 18.9×17.2×5.11 in *3U (Length: not including 32mm handles)</td>
</tr>
<tr>
<td>Multiple Connection</td>
<td>MAX 32 units</td>
</tr>
<tr>
<td>User Interface</td>
<td>CAN 2.0B 1ch</td>
</tr>
<tr>
<td>- dry contact</td>
<td>MAX 32 units</td>
</tr>
<tr>
<td>- communication 1</td>
<td>RS-485 1ch</td>
</tr>
<tr>
<td>- communication 2</td>
<td>CAN 2.0B 1ch</td>
</tr>
</tbody>
</table>

**Charging Characteristics**

- Charging: CCCV at each current rate, charge voltage=53.3V, 6 hours, 25°C

**Discharging Characteristics**

- Discharging: Each discharge rate up to 42.9V, 25°C

Applications
- Telecom
- CATV
  *Community Antenna Television
- BTS
  *Base Transceiver Station

*Actual performance varies by condition

The data is for reference purposes.

LIM50EL-13 is a high-performance lithium ion battery module designed for telecom and other DC48V applications. It has an increased capacity compared to lead acid batteries. Battery capacity can be flexibly increased to match customer needs by connecting multiple modules in parallel. LIM50EL-13 can be mounted onto a 19 inch rack making installation and maintenance easy. In addition, using the built-in BMS (Battery Management System) thus does not require an external BMS (LIBM). The LIM50EL-13 has excellent cycle life performance and can charge at 1C thus reducing the Total Cost of Ownership (TCO) in regions with unstable or unavailable grid power. It can be used for Base Transceiver Station (BTS), Community Antenna Television (CATV), and Telecom applications.
System Design

The LIM50EL-13 is a high-performance lithium ion battery module designed for telecom and other DC48V applications. It has an in-built BMS (Battery Management System) thus does not require an external BMS (LIBM). An optional Remote Monitoring Unit (IMUBM) can also be installed to allow remote monitoring of the lithium ion battery status. LIM50EL-13 has excellent cycle life performance and can charge at 1C thus reducing the Total Cost of Ownership (TCO) in regions with unstable or unavailable grid conditions.

![Diagram of System Design]

Installation image

LIM50EL-13 can be mounted onto a 19 inch rack making installation and maintenance easy. In addition, using LIM50EL-13 will save space and have less weight compared to lead acid batteries. Battery capacity can be flexibly increased to match customer needs by connecting multiple modules in parallel.

![Diagram of Installation image]

Remote Monitoring Unit IMUBM (Optional)

IMUBM is a battery monitoring unit which can combine output signals and information from multiple modules connected in parallel. The size is only 1U, therefore this unit can be installed in same rack/cabinet as modules.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Battery Monitoring Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>DC38 ~ 60V</td>
</tr>
<tr>
<td>Dimensions (WxDxH)</td>
<td>W439 x D282 x H42mm (not including protruding part)</td>
</tr>
<tr>
<td>Weight</td>
<td>4kg</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>-20 ~ 50°C</td>
</tr>
<tr>
<td>External Signal output Interface</td>
<td>Input signals : 2ch Output signals : 7ch CAN, RS485, Ethernet (SNMP, Modbus TCP, Web Monitoring), USB1.1X(TypeA)</td>
</tr>
<tr>
<td>Connections</td>
<td>Max. 32 units</td>
</tr>
</tbody>
</table>
Installation Record

Telecom

True Corporation Group
Application : Backup for Cable TV
Capacity : 2kWh
Operation Start Date : October, 2015

Axiata Group
Application : Backup for Base Station
Capacity : 12kWh
Operation Start Date : September, 2016

Industrial Equipment

ZPMC
Application : Automatic Guided Vehicle
Capacity : 316kWh/vehicle
Operation Start Date : Jan, 2017

Japan Freight Railway Company
Application : Train
Capacity : 67kWh
Operation Start Date : February, 2012

Sumitomo Heavy Industries Material Handling Systems. Co.,Ltd.
Application : Transfer Crane
Capacity : 14kWh/crane
Operation Start Date : July, 2008
Energy Storage

Tokyo Tama Intercity Monorail Co., Ltd.
Application: Regenerative Power Absorption/Emergency Running
Capacity: 75kWh (Power Absorption), 203kWh (Emergency Running)
Operation Start Date: July, 2016

Parker Hannifin Corp.
Application: Energy Storage
Capacity: 5MWh
Operation Start Date: Oct, 2016

Chugoku Electric Power Co., Inc.
Application: Output Fluctuation Regulation for Renewable Energy
Capacity: 1,350kWh
Operation Start Date: September, 2015

TOBU Railway Co., Ltd.
Application: Regenerative Power Absorption
Capacity: 104kWh
Operation Start Date: October, 2012

True Corporation Group
Application: Backup for Cable TV
Capacity: 2kWh
Operation Start Date: October, 2015

Japan Freight Railway Company
Application: Train
Capacity: 67kWh
Operation Start Date: February, 2012

Axiata Group
Application: Backup for Base Station
Capacity: 12kWh
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