



**Battery Regenerator,  
Battery Charger, Discharger  
& Battery Monitoring System**



# ONLY ONE, NOT NO. ONE.

Dear Customers,

My name is Han Yeon-soo, CEO of MarooOn.

MarooOn specializes in development and global marketing of various products, including battery restoration systems, chargers, discharge machines, and battery monitoring systems, with the development principles of "how to use batteries for a long period" and "convenient management".

Even before the term IoT was used, battery monitoring systems were developed by implementing the internet of things. We have started to develop products that enrich human life from uncomfortable routines with a single idea.

Based on our power control and IoT technology, for which we boast the lion's share of the global market, we strive to develop power equipment, such as UPS and ESS, to advance our product quality from 'no one' to 'only one'.

With the skills and the value of human management, we strive to be a trusted and respected company that gives back to society.

Thank you.



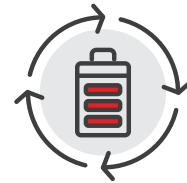
MarooOn provides comprehensive service related to secondary batteries with **the world's best electric power technology** and **ICT convergence**.



Strengthening global competitiveness with by Product Diversification



Accelerating business growth by expanding the market for secondary batteries



Providing batteries, using them efficiently, re-use of battery resource, **leading recycle market**



## MarooOn Technical Skills

MarooOn's world-renowned technology!  
**Proud Korean products.**



Equipment exports to 86 countries as of Dec. 2018



Manufacturer of electric logistics equipment, including Germany Linde, the US Liftech, the Hyster-Yale Group, Raymond, Crown, and Toyota

As of Nov. 2018, we have more than 20 battery regeneration plants  
& battery maintenance services in operation in five countries.



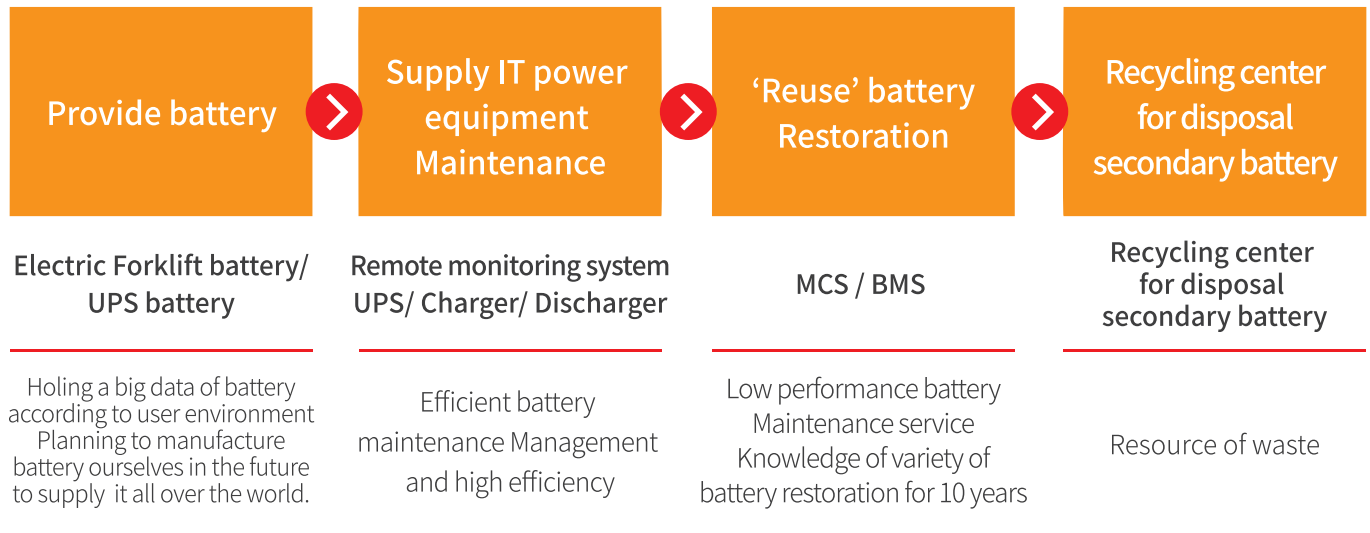
Battery maintenance services for large telecommunication providers in Southeast Asia and South America



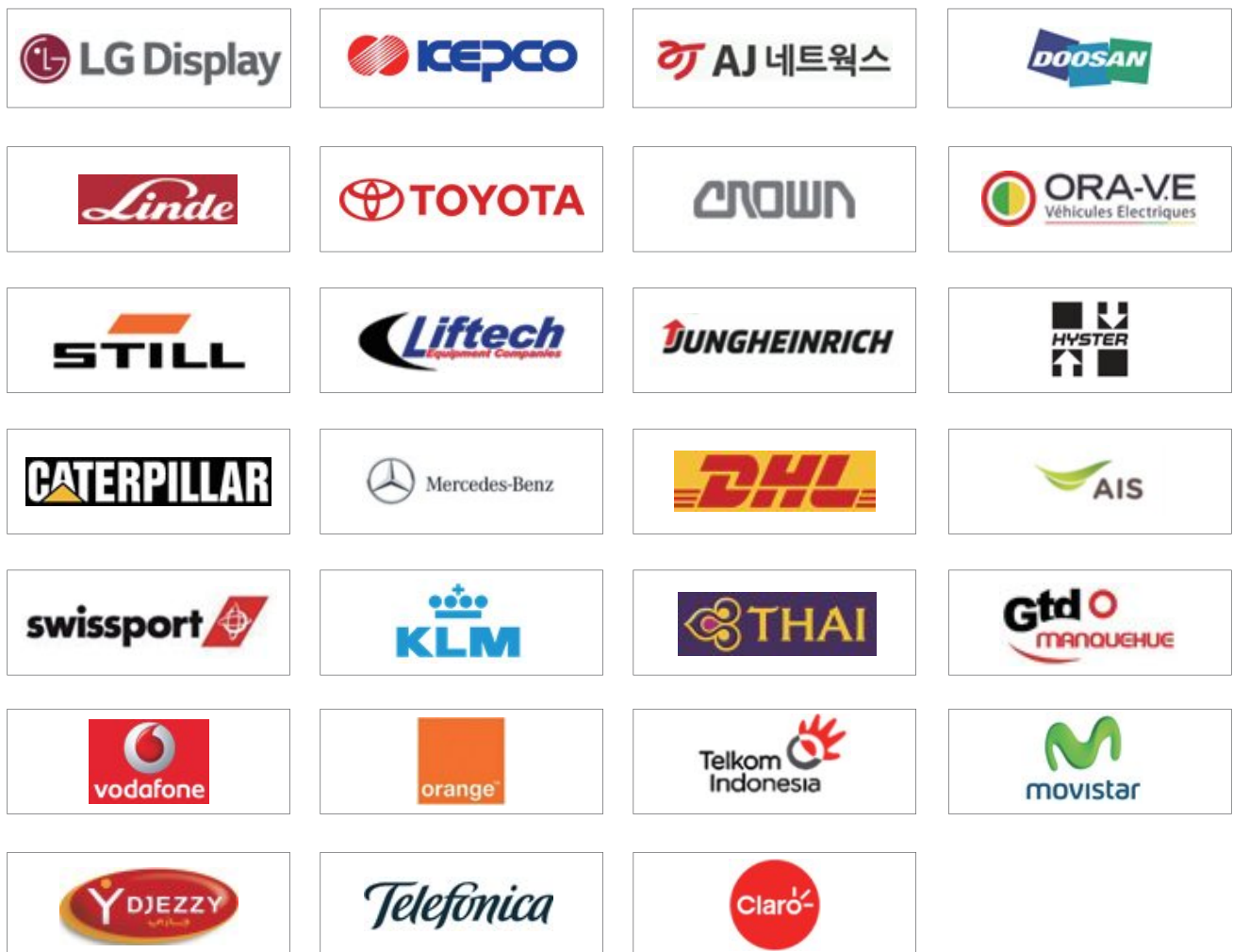
- Thailand Plant: AIS (Mobile carrier), ToT (state-run telephone company), Thai Airline, DHL/Throughout Thailand
- Indonesia: Telkomsel (Mobile carrier)/Throughout Indonesia
- South America (Chile): Telefonica, Claro, Movistar, Gtd manquehue



## MarooOn Vision



## Global Reference



## MarooOn Sales Partner



## Certification (Patent: Domestic 11, overseas 5, application 10)

### Pattern



### Design



### Trademark



### Certificate of business





## MarooOn Brands



## Equipment, monitoring devices & Accessories

### Battery Maintenance Equipment



### Battery Charger & Discharger



### FBMS & CBMS (Electric Equipment Monitoring System)

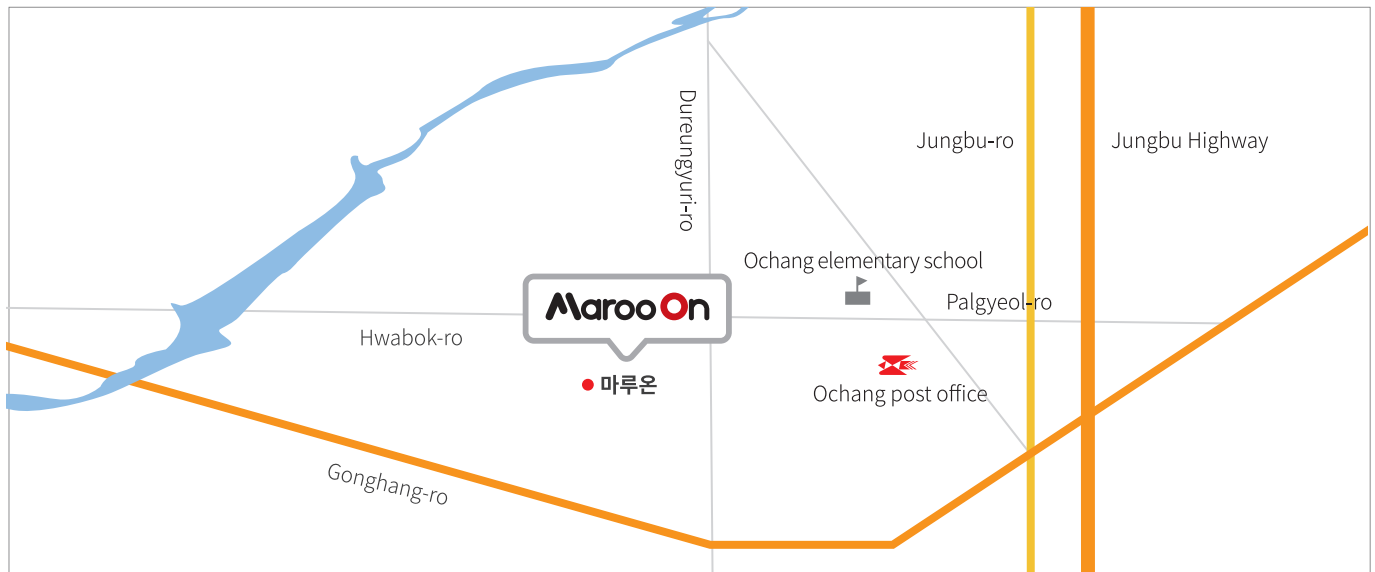


### Accessories





## Company Location



MarooOn Inc.

**Address** 1247 Dureungyuri-ro, Ochang-eup, Cheongwon-gu, Cheongju-si, Chungcheongbuk-do, South Korea

**Main Number** +82-1599-9882 **FAX Number** +82-43-276-6334

## We are MarooOn



All employees of MarooOn are dedicated to achieving customer success through ceaseless endeavor.

## CHAPTER 1

---

# Battery Maintenance Equipment



## Battery Restoration System

It may be complicated for people to talk about battery maintenance, diagnosis and battery regeneration and restoration.

People think that proper analysis, maintenance, and restoration of battery capacity takes a lot of time.

MarooOn battery restoration technology of is the most professional and easy to use in today's marketplace.

The technology is precise and efficient and provides detailed reporting of before/after battery conditions.

The MarooOn Battery Restoration System is a proven technology used by more than **500 clients in 86 countries.**



### ○ Restore process

The system ensures rapid regeneration and significantly prolongs battery life.

Batteries can be used for 2-3 years if properly maintained.

The restoration process is fully automated and all processes are controlled by software programs.

When used with the BMS (Battery Monitoring System), even the cell level of batteries can be analyzed.

If you can reduce the fixed overhead, your business can enjoy a big profits with minimum maintenance cost.

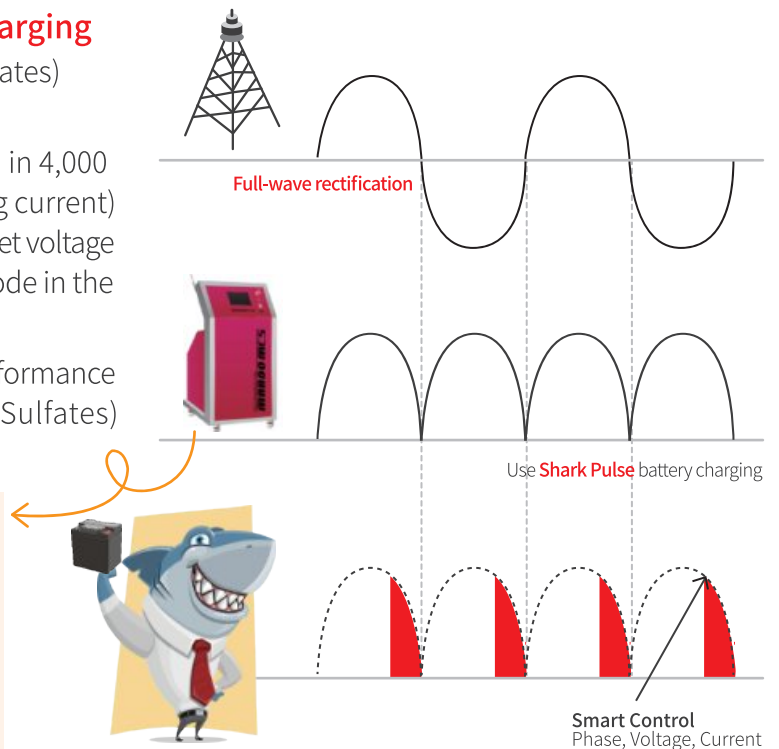
Please take full advantage of MarooOn's maintenance equipment to save your enterprise money and time.



## ○ The principle of battery restoration charging

- Effective removal of chemical depletion (Sulfates) of batteries
- The input electricity is digitally broken down in 4,000-time resolution per cycle, and AC (alternating current) electricity is phase controlled according to the set voltage and current, and applied to the battery electrode in the form of ripple current Shark Pulse.
- Shark Pulse's skin effect improves battery performance and extends lifespan by removing  $\text{PbSO}_4$  (Sulfates) stiffening by momentary heat and vibration.

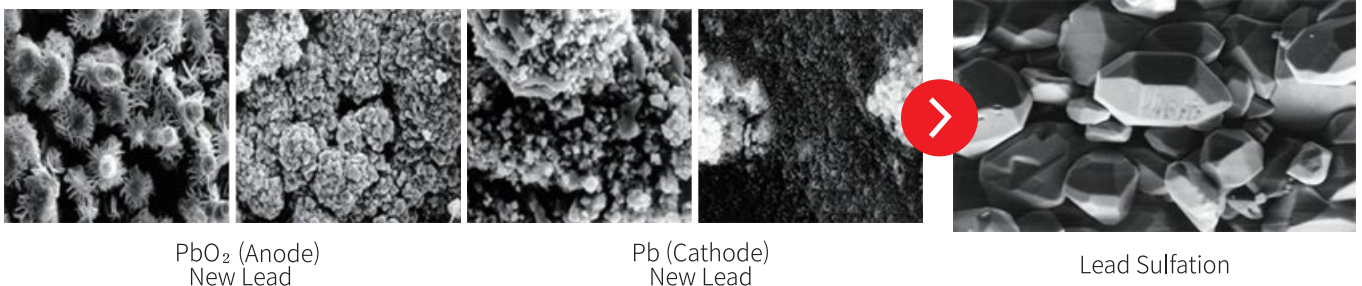
The input electricity is digitally broken down in 4,000-time resolution per cycle, and AC (alternating current) electricity is phase controlled according to the set voltage and current, and applied to the battery electrode in the form of ripple current Shark Pulse.



## ○ What is sulfation?

While using batteries, small lead sulfate crystals are formed. This is normal and not harmful.

In case of a prolonged lack of charge, however, lead sulfate is converted to a crystalline form deposited on a negative plate. This leads to a large crystal that reduces active substances of batteries that are responsible for high capacity and low resistance, which block the current passage on the surface of the electric current plate, which increases the resistance. When attached to more than 50% of the electric current plate, batteries are unable to charge and discharge and eventually will have to be discarded.



$\text{PbO}_2$  (Anode)  
New Lead

Pb (Cathode)  
New Lead

Lead Sulfation

## ○ The effect of sulfation

- Sulfation increases the internal resistance of batteries.
- It reduces the specific gravity of battery electrolyte.
- Sulfation cannot be avoided while using batteries.
- After 3-4 years of use, the sulfation process in batteries will accelerate significantly.
- Let us identify the cause of the sulfation in the battery.

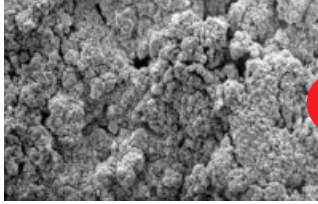
## ○ Identifying the cause of the sulfation in the battery

- Battery is not used for a long period
- If the battery is completely discharged
- If an incorrect charger is used
- If there is a problem with the cells inside the battery that are connected in series.
- If battery charging and operating temperature is too high or low
- If the battery is charged for a long period instead of charged frequently

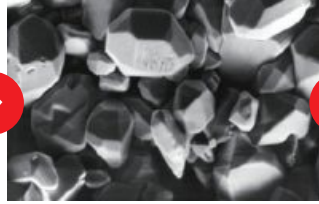


## Battery Restoration System

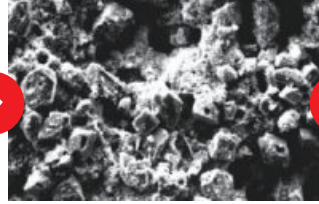
### Changes in the electrode plate due to battery restoration



new lead sponge battery plate.



battery plate that has been coated by dense, hardened, crystalline lead sulfate. Notice that no active lead sponge is visible.



The final recovery of the plate to active sponge lead.



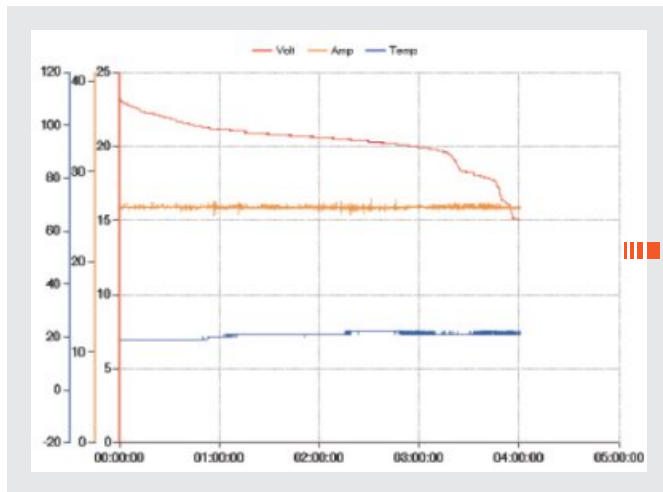
The size of the lead sulfate crystals is decreased, and the crystals are pitted as they are destroyed.

### Before Vs. after battery restoration

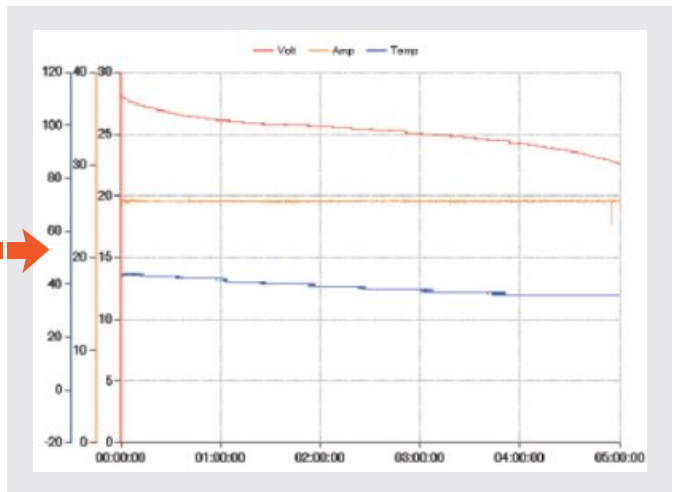
#### Target battery specification

Maker	Type	Terminal voltage	Total voltage	Cell quantity (pcs)	Capacity	HR
GS YUASA	NI - MH	1.2V	24V	20	130AH	5HR

#### Before restoration



#### After restoration

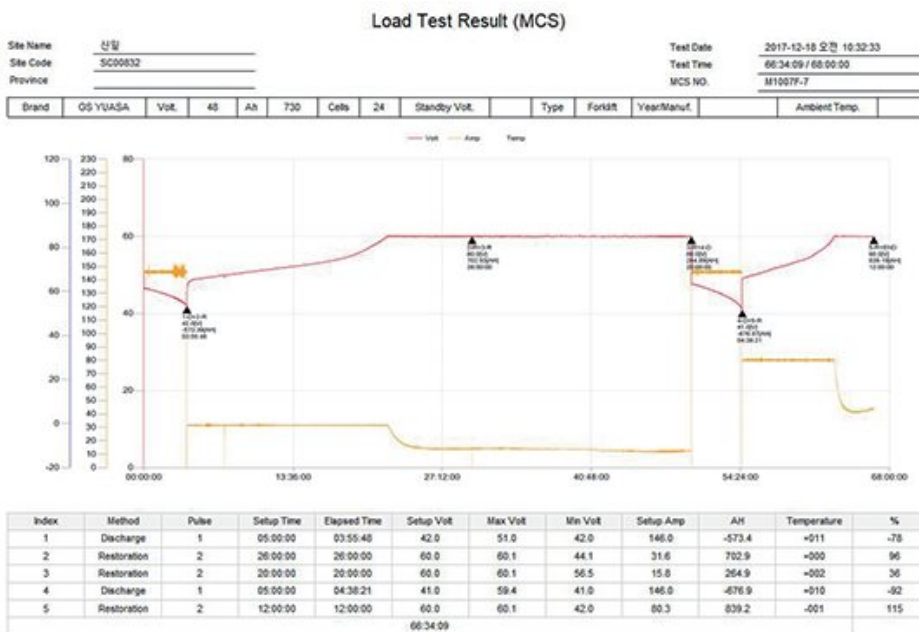


Before restoration	After restoration	Increase rate	Compare to new products
104AH	130AH	25%	100%

## ○ Advantage of MarooOn Battery Restoration System

- Battery charger and discharger in one
- BMS system, high-capacity discharge link function
- Minimal maintenance cost
- Extend battery life
- Rapid regeneration time and high generation efficiency
- Free analysis software support
- Automation program update support
- 18-month equipment warranty
- CE, MET Certifications
- Wireless connection support between equipment and computers

## ○ MarooOn Battery Restoration System - Report

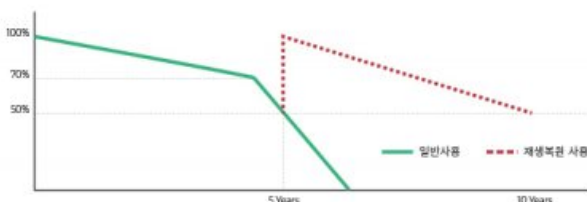


When 730AH electric forklift battery is discharged,

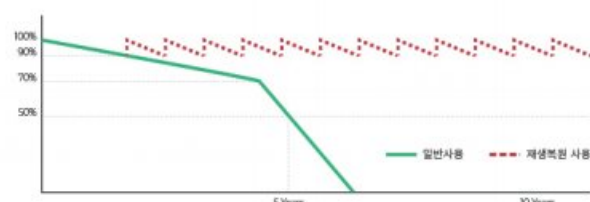


Our test result showed there has been **93% increase** in capacity after regeneration of 79% capacity.

## ○ Efficient use of battery restoration system



Extend life span through restoration at battery deterioration point(4 - 5 years)



Carry out battery maintenance periodically for a short period to continue usage without Sulfate.

## ○ Line-up of Models



Model	<b>M-1001I</b>
Power	AC 1PH, 110~220V, 50/60Hz
Output	1.2 ~ 100V, 0A ~ 30A
Battery Volume	300 AH
Transformer	7.5 kW



Model	<b>M-1005G</b>
Power	AC 3PH, 200V or 380-400V, 50/60Hz
Output	1.2 ~ 120V, 0A ~ 50A
Battery Volume	500 AH
Transformer	10 kW



Model	<b>M-1007F</b>
Power	AC 3PH, 200V or 380-400V, 50/60Hz
Output	1.2 ~ 150V, 0A ~ 100A
Battery Volume	1,000 AH
Transformer	20 kW



Model	<b>M-1009A</b>
Power	AC 3PH, 200V or 380-400V, 50/60Hz
Output	1.2 ~ 75V, 0A ~ 300A
Battery Volume	3,000 AH
Transformer	50 kW





# MCS M-101

## Portable Maintenance System

### ○ Features

- Constant current of High performance and high efficiency / High frequency pulse charge and discharge of the way of constant current-constant voltage
- Available to deal with large capacity battery up to 300AH
- Various battery restoration process to suit each situation
- Alarm function to use this equipment safely
- Including an 8-inch touch LCD, USB data storage, wire and wireless control support for user' convenience
- Synchronizing with BMS(Battery Monitoring System) to get the information of each battery cell

### ○ Product Overview

Portable Battery Maintenance System, MCS M-101, is that combines the know-how of MCS experienced in the field around the world for 10 years and the latest power control technology. Without any expertise in batteries, you can easily maintain and manage with a various features.

Throughout a function-specific optimized system that fits the battery status, it controls charge, discharge voltage and current to protect from over-voltage, over-current and maintain it in optimal condition.

By applying an 8-inch touch LCD, it is possible to see the operation of the equipment at a glance. It has an alarm function to use it safe, and supports USB data storage function.

PC program provided can control multiple devices with one PC throughout wired and wireless communication using a network adapter, and provide a complete report only a few click after completion of the restoration process. In addition, when updates it can be installed automatically.

With Battery Monitoring System, you can analyze battery performance in more detail on a cell basis.

### ○ Technical Specifications

#### Input specification

Input power	AC 200V ~ 240V
Input frequency	50Hz / 60Hz
Input phase	Single phase

#### Charging function

Charge voltage / Current range	DC 0.0 - 30.0V, 0.0 - 30.0A
Charging mode	Constant current, Constant current-constant voltage
Voltage/Current accuracy	Voltage: 0.2 - 0.5%, Current: 1.0%
Voltage/current Unit	Voltage: 0.1A, Current: 0.1V

#### Discharge specification

Discharge voltage/Current range	DC 0.0V - 30.0V, 1.0A - 30.0A
Discharge mode	Constant current, Constant current-constant voltage
Voltage/current accuracy	Voltage: 0.2 - 0.5%, Current: 1.0%
Voltage/current unit	Voltage: 0.1V, Current: 0.1A

#### Accessory

Output cable
--------------

#### Battery restoration process

Manual Mode	Charge and discharge that users set
Auto Mode	Auto charge and discharge battery for battery specification
Program Mode	Users can set maximum 6 step-setting for charge and discharge

#### User interface

Display	8-inch touch LCD
Alarm	Battery connection status (normal, reverse) Over current, over current, internal temperature, etc.
Date storage	USB
PC program	Supports for Network adapter - Remote control - Wire: RS-232 - Wireless: Bluetooth - BMS (optional)

#### Service information

Operating temperature	0 - 50°C (32°F~122°F)
Operating humidity	5 - 90% RH

#### Equipment instrument information

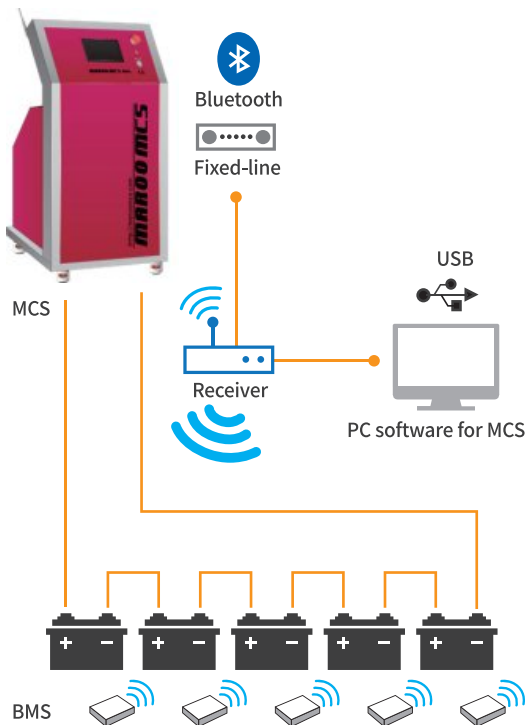
Dimension / Weight
--------------------

## Professional individual voltage measurement of all cells during battery discharge fully evaluates the battery.

A typical system displays only the full voltage and capacity of the battery, but does not display the results of individual cells. With BMS, accurate measurements of the performance of each cell can be obtained, allowing accurate evaluation of the battery.

### ○ BMS provides the following

- Precise voltage measurement for individual cell during the entire discharge process (BMS for 2V, 6V, 12V)
- Real-time battery monitoring
- Analysis function through the provided software
- Easy installation, wireless connection between equipment and computer
- MarooOn Battery Regeneration System interlocking (Easy Sync support)



### ○ BMS Composition

- Comprises in BMS sensors of the same number as the battery cell number
- The BMS sensor measures the voltage of each cell and transmits to the wireless receiver.
- When used with the MarooOn Battery Regeneration System and discharger, defect elements can be detected and battery capacity increased.



12V ~ 120V Battery	10 BMS Sensor (12V) + 1 Receiver
48V Battery	24 BMS Sensor (2V) + 1 Receiver
80V Battery	40 BMS Sensor (2V) + 1 Receiver

## ○ Introduction the BMS software

Table View

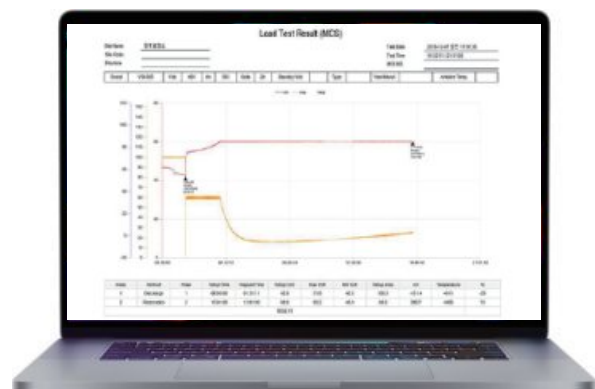


Line View



Column View

## ○ MCS Restoration System + BMS Sync Drive



Combine MCS regeneration system and BMS and control in one program. You can learn more about the status of individual cells in the battery in the charge-discharge test process.

Create report in just a few clicks.

○ Let us find out how easy it is to use the BMS.



**Step. 1**

Connect the MCS battery regeneration system and the BMS to the forklift battery.

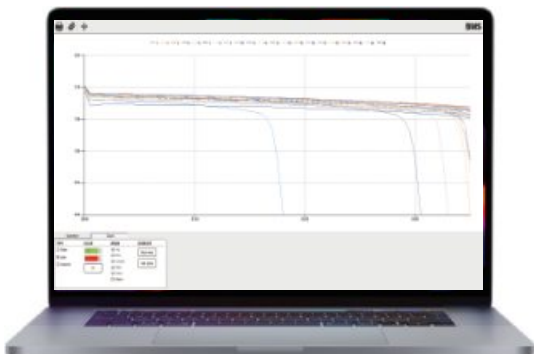
**Use the program and control the equipment and the BMS.**



**Step. 2**

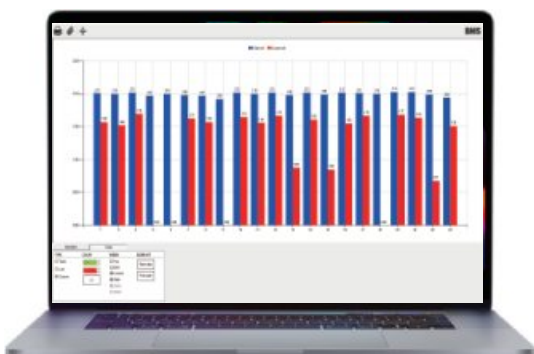
Discharging progress

During several hours of discharge, the operator cannot continue to measure 24 battery cells at a set time.



**Step. 3**

Viewing with the Line View, you can see the trend of decreasing voltage in the battery cell during discharge.



**Step. 4**

For this battery, four cells must be replaced.

## CHAPTER 2

---

# Battery Charger & Discharger





# MPC-1007K

Constant Current - Constant Voltage Charger

## Features

- Charge mode support of constant current/constant current-constant voltage methods of maximum performance and efficiency
- A wide range of battery charge and low-current charging (0V ~ 100V, 0A ~ 40A)
- Automatic adjustment of charge current according to battery temperature
- Overcharge protection through battery capacity settings
- Equipped with AC 220V input 50A breaker
- Overheat protection, battery polarity connection check alarm (equipment protection)
- Computer wireless control program (optional)

## Product Overview

The longer the battery is used, the smaller the capacity of the battery and longer the charging cycle and charging time. Battery capacity is reduced with repeated charge and discharge cycles.

This is due to the formation of crystallized sulfate and deactivation during the discharge cycle.

This causes an increase in internal resistance and a decrease in the specific gravity of sulfuric acid, resulting in deterioration of battery life. These batteries cannot use regular battery chargers.

MPC-1007K is capable of constant current or constant current-constant voltage charging in high battery voltage ranges. The system controls voltage and current precisely through CPU control, checks battery temperature during charging through a temperature sensor, and controls the current automatically to protect the battery. Further, the charge capacity setting protects the battery from overcharging.

The charging system contains a transformer to ensure high charging efficiency and reliability

You can achieve efficient battery management using MPC-1007K for battery charge management.

MPC-1007K can freely set charging current, so it can be used as a low current charger.

It can charge and manage all electric forklift batteries, regardless of battery capacity.

## Technical Specifications

### Input Specification

Input power	AC 200V ~ 240V
Input frequency	50Hz/ 60Hz
Input phase	Single-phase
Input breaker specification	Mounted with 50A breaker equipment

### Charging function

Charge voltage range	DC 0.0 - 100.0V
Charge current range	1.0A ~ 40.0A (Constant current)
Charging mode	Mode1 : Constant current charge mode Mode2 : Constant - Constant voltage charge mode
Voltage/current precision	Current: 1.0% / Voltage: 0.2~0.5%
Voltage/current display unit	Current: 0.1A / Voltage: 0.01V
Charge data storage method	USB, Zigbee wireless (2.4GHz/option)
Charge current limit	More than 45 degrees, according to temperature 50% of the set current
Charge capacity limit	Termination when set capacity AH is reached

### User interface

Display	128 x 64 Mono-LCD
Input interface	Rotary & Push switch
Protocol interface	RS-232 D-sub
LED Display	2-LED Indicators -Power, -Discharging
Alarms	- Battery connection (Notices on display screen) - Reverse battery electrode

### Accessories

Output cable	50SQmm <sup>2</sup> x 2.0m, SB-175
--------------	------------------------------------

### Service information

Operating temperature	0°C ~ 50°C (32°F ~ 122°F)
Operation humidity	5% ~ 90% RH

### Equipment instrument information

Dimensions / Weight	360 x 400 x 691.9mm / 69kg
---------------------	----------------------------





# MPC-S6060K

High Frequency Charger for Electric Forklifts

## Features

- Constant current of High performance and high efficiency / High Frequency Charger with the way of constant current – constant voltage
- Charge for various type of 48V forklift battery (200AH ~ 600AH)
- Protection from overcharging throughout battery capacity setting
- Including a function to protect from overheating, a alarm to check battery polarity connection (Protect to equipment)
- Available to check charge status with LED display
- Stand type for Charging (Optional)

## Product Overview

High Frequency Charger, MPC-S6060K, is only for electric logistics equipment and electric forklifts. It is able to charge with various capacity of electric logistics equipment using high efficient IGBT, CPU voltage, current control. It is available to operating equaled charge and managing batteries efficiently.

It can protect batteries by detailed control of voltage and current, and charge voltage and current automatically.

It is easy to check charge status and equal charge through LED directly.

And it proceeds charging automatically with the way of Plug & Play.

It protects overheating of equipment with an internal temperature sensors, and protects from use environment and human mistakes with the function such as battery disconnection and polarity check alarm.

Try this High Frequency Charger to charge and manage your batteries.

## Technical Specifications

### Input specification

Input power	AC 200V ~ 240V
Input frequency	50Hz / 60Hz
Input phase	Single phase

### Charging function

Forklift battery voltage/capacity	48V / 200AH ~ 600AH only for lead battery
Charge current range	1.0A ~ 60.0A
Auto charge operating mode	Mode1 ..... Constant current charge mode Mode2 ..... Constant current-constant voltage charge mode Mode3 ..... Constant power charge mode
Charge hour	5Hr ~ 10Hr
Equal charge	Support for Equal charge Choice of On/Off switch

### User interface

LED display	4-LED display - Power - 50%, 75%, 100% - Equal charge
Alarm	- Battery connection status - Battery polarity opposite connection

### Accessory

Output cable

### Service information

Operating temperature	0 °C ~ 50°C (32°F~122°F)
Operating humidity	5% ~ 90% RH

### Equipment instrument information

Dimension / Weight	T.B.D
--------------------	-------

### Remark

- When above 48V 500AH batteries charges, you have to use distribution box power or breaker (above 30), and prohibited using an outlet.
- It might be different charge hour according to battery condition.





# MPC-S10060K

High Frequency Charger with constant current-constant voltage

## Features

- Constant current of high performance and high efficiency / support for high frequency charging mode with the way of constant current-constant voltage
- Wide range of battery charge and available to charge with low current (0V ~ 100V, 0A ~ 60A)
- Preventing from overcharging through battery capacity setting
- AC220V input 50A breaker included
- Overheating prevention function, Battery polarity connection check alarm (In order to protecting Equipment)
- PC wireless control program (Optional)

## Product Overview

High-Frequency Charger, MPC-S10060K, has a wide range of charging from 2V to 110V and 0.1A to 60A large capacity charging current that can charge and manage all batteries regardless of battery capacity. Simple settings allow you to use low-current charging, high-current fast charging, equal charging, and it is available to use for user's batteries situation.

It is hard to charge old, neglected or high internal resistance batteries with a general chargers due to deactivation during crystallized sulfate and discharge cycles.

MPC-S10060K is able to charge constant current or constant current-constant voltage in range of high battery voltage, and also charge batteries with high internal resistance caused by performance degradation.

It is possible to charge with high-efficiency throughout high-frequency switching and CPU control. Voltage, current sensor and 16bit ADC are applied to automatically control voltage and current to protect the battery from overvoltage and overcharging.

Try freely charge and manage the battery regardless of voltage or capacity.

## Technical Specifications

### Input specification

Input power	AC 200V ~ 240V
Input frequency	50Hz / 60Hz
Input phase	Single phase
Input breakerspecification	50A breaker included

### Charging function

Charge voltage range	DC 2.0 - 100.0V
Charge current range	1.0A ~ 60.0A
Charging mode	Mode1 Constant current charge mode Mode2 Constant - Constant voltage charge mode
Voltage/current accuracy	Current: 1.0% / Volitage: 0.2~0.5%
Voltage/current unit	Current: 0.1A / Volitage: 0.01V
The way of charge data storage and control	USB Wireless communication and control PC (Optional) It finishes when reaching at set capacity
Charge capacity limit	It finishes when reaching at set capacity

### User interface

Display	128x64 Mono-LCD
Input interface	Rotary & Push switch
Protocol interface	RS-232
ED display	2-LED display - Power, Charge
Alarm (Display on LCD screen)	- Battery connection status - Battery polarity reverse connection

### Accessory

Output cable

### Service information

Operation temperature	0 °C ~ 50°C (32°F~122°F)
Operation humidity	5% ~ 90% RH

### Equipment instrument information

Dimension / Weight



# MPC-2000K

300kW Large capacity Charger

## Features

- 300kW large capacity charger (2,000V, 150A)
- Wide range of battery voltage charge (400V ~ 2,000V, 0A ~ 150A)
- 1.0V/1.0A unit control and setting function
- Charging channel automatic control function according to battery voltage
- Overcharge protection through battery capacity settings

## Product Overview

MPC-2000K 300kW large-capacity charger is constant voltage - constant current charger capable of charging max. 150A within the range of 400V ~ 2,000V charge voltage.

MPC-2000K can be used in high battery charging voltage range of 2,000V. It uses circuits and components that require high reliability and high-quality appropriate for high pressure.

The CPU control allows the charging channel to automatically operate over a wide range of charging voltage. Furthermore, the charge capacity setting protects the battery from overcharging.

The charging system consists of a transformer ensures high charging efficiency and reliability.

## Technical Specifications

### Input Specification

Input power	AC 380V
Input frequency	50Hz / 60Hz
Input phase	3-phase
Input breaker specification	Mounted with 200A breaker equipment

### Charging function

Charge voltage range	DC 400.0V ~ 2000.0V
Charge current range	1.0A ~ 150.0A
Charging mode	Mode 1 : Constant current charge mode Mode 2 : Constant - Constant voltage charge mode
Voltage/current precision	Current: 1.0% / Voltage: 0.2~0.5%
Voltage/current display unit	Current: 0.1A / Voltage: 0.01V
Charge data storage method	USB, Zigbee wireless (2.4GHz/Option)

### User interface

Display	4.3 inch TFT-LCD
Input interface	Touch
Protocol interface	RS-232 D-Sub
LED Display	2-LED display - Power, Charge
Alarms (Notices on display screen)	- Battery connection - Reverse battery electrode

### Service information

Operating temperature	0 °C ~ 50°C (32°F~122°F)
Operation humidity	5% ~ 90% RH

### Equipment Instrument information

Dimensions / Weight	T.B.D
---------------------	-------

※ The specification is subject to change as the product is made-to-order for customers.

# MPC-101K

Battery charger for generator starting

## Product Overview

MPC-101K is battery charger for generator starting, which is designed specifically for starter batteries.

General chargers cause many defects due to over current when the engine starts. In addition, constant voltage and constant current charging cannot be performed, significantly deteriorating battery life due to overcharging and insufficient charging.

MPC-101K charger is specialized for starting batteries with floating charge function to enable extended battery service time.



## Features



### Problems of conventional chargers for starters

- There is no charger considering the characteristics of the generator starting battery start
- Charger malfunction due to over current during engine starting
- Non-constant voltage and constant current charging as the output voltage changes according to input voltage
- Battery life is reduced due to overcharge and under-charge occurrence

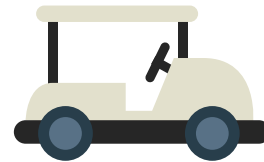
## Technical Specifications

### Input Specification

Input power ····· AC 200V ~ 240V  
Input frequency ····· 50Hz / 60Hz  
Input phase ····· Single-phase

### Charging function

Charge voltage range ····· DC 1.0V ~ 30.0V  
Charge current range ····· 1.0A ~ 15.0A (Constant current)  
Charging mode Mode 1 ····· Constant current charge mode  
Mode 2 ····· Constant - Constant voltage charge mode  
Voltage/current precision ····· Current: 1.0% / Voltage: 0.2~0.5%  
Voltage/current display unit ··· Current: 0.1A / Voltage: 0.01V



### MPC-101K battery advantage

- Over-current protection circuit embedded for generator engine start
- Ensures durability and reliability with embedded overheat protection circuit
- Constant voltage - constant current charge function and floating charge function
- Charges all batteries below 30V (competitive with 8V, 12V, 24V batteries)
- Quick charge function
- Three years of warranty service, the first in the industry

### User interface

Display ····· Segment LED Display  
Input interface ····· Rotary & Push switch  
Protocol interface ····· RS-232 D-Sub  
LED Display ····· 4-LED Indicators  
- Charging - Full charging  
- Quick charging - Setting  
Alarms ····· - Battery connection  
(Notices on display screen) - Reverse battery electrode

### Service information

Operating temperature ····· 0 °C ~ 50°C (32°F~122°F)  
Operation humidity ····· 5% ~ 90% RH

### Equipment Instrument information

Dimensions / Weight ····· 150 x 334 x 180mm / 11.2kg



# MPD-1007K

Constant current 200A discharger

## Features

- MCS battery regeneration system interlocking function (MCS equipment is operated for charging, MPD-1007K operation/automatic control for discharging)
- Automatic switch control through discharge current monitoring (200A constant current discharge from 110V to 10V)
- Large capacity discharge (1.0A ~ 200A), 1,000AH Forklift battery compatible
- Overheat protection, battery polarity connection check alarm (equipment protection)
- Computer wireless control program (optional)

## Product Overview

Discharge testing is the only way to verify battery capacity. MPD-1007K is available for battery performance test, battery capacity test, battery maintenance, engineering test and DC power test with load.

By precise sensing of electric current utilizing digital control, instead of manual correction of electric current, it can discharge constant current automatically and continuously, no matter the voltage range, during the discharge test.

The MPD-1007K can be used with the MCS Restoration System. It can check the performance of the battery accurately by linking with equipment control and BMS (Battery Monitoring system) through wireless communication.

## Technical Specifications

### Input Specification

AC input voltage	AC 100V ~ 120V or AC 200V ~ 240V
Frequency	50Hz/ 60Hz
Phase	Single-phase

### Discharge function

Discharge voltage range	DC 10.0V ~ 110.0V
Discharge current range	1.0A ~ 200.0A (Constant current)
Voltage/current precision	Current: 1.0% / Voltage: 0.2~0.5%
Voltage/current display unit	Current: 0.1A / Voltage: 0.01V
Discharge data storage method	USB, Zigbee wireless (2.4GHz)

### User interface

Display	128 x 64 Mono-LCD
Input interface	Rotary & Push switch
LED Display	2-LED Indicators -Power -Discharging
Alarms (Notices on display screen)	- Battery connection - Reverse battery electrode

### MCS regeneration system interlocking

MCS equipment	MCS M-1001I, 1005G, 1007F interlocking model
Discharge current range	1.0A ~ 200.0A
Protocol interface	S-232 cable
Discharge function support	Manual mode discharge Program mode discharge & Restoration mode Pulse 3,4
PC Software support	YES, Wireless communication support.
BMS support (Battery monitoring system)	(Use existing MCS operation method)

### Accessories

Output cable	70SQmm <sup>2</sup> x 2.5m, SB-350
USB	Provide sub(optional)

### Service information

Operating temperature	0 °C ~ 50°C (32°F~122°F)
Operation humidity	5% ~ 90% RH

### Equipment Instrument information

Dimensions / Weight	360 x 400 x 899mm / 68kg
---------------------	--------------------------



# MPD-2000K

2,000V High Voltage Discharger

## Features

- High Voltage discharge voltage range (250V ~ 2,000V)
- Automatic switch control through discharge current monitoring (10A constant current discharge from 2,000V to 250V)
- Voltage adjustment range 0.1V, current adjustment unit 1A/precision within 5%
- Overheat protection, battery polarity connection check alarm (equipment protection)

## Product Overview

The discharge test is the only way to verify the capacity of the battery.

MPD-2000K is available for battery performance test, battery capacity test, battery maintenance, engineering test and DC power test with load.

By precise sensing of electric current utilizing digital control, instead of manual correction of electric current, it can discharge constant current automatically and continuously, no matter the voltage range, during the discharge test.

The MPD-2000K High Voltage discharger can precisely check the performance of batteries in a wide operating range of 250V to 2000V battery voltage.

## Technical Specifications

### Input specification

AC input voltage	AC 200V ~ 240V
Frequency	50Hz / 60Hz
Phase	Single-phase

### Discharging function

Discharge voltage range	DC 250.0V ~ 2000.0V
Discharge current range	1.0A ~ 10.0A (Constant current)
Voltage/current precision	Current: 5.0% / Voltage: 0.2~0.5%
Voltage/current display unit	Current: 0.1A / Voltage: 0.01V
Discharge element	Transistor
Discharge data storage method	USB, SD Card (Memory)

### User interface

Display	4.3 inch TFT-LCD
Input interface	Touch
Protocol interface	RS-232 D-Sub
LED Display	2-LED Indicators -Power -Discharging
Alarms (Notices on display screen)	- Battery connection - Reverse battery electrode

### Service information

Operating temperature	0 °C ~ 50°C (32°F~122°F)
Operation humidity	5% ~ 90% RH

### Equipment Instrument information

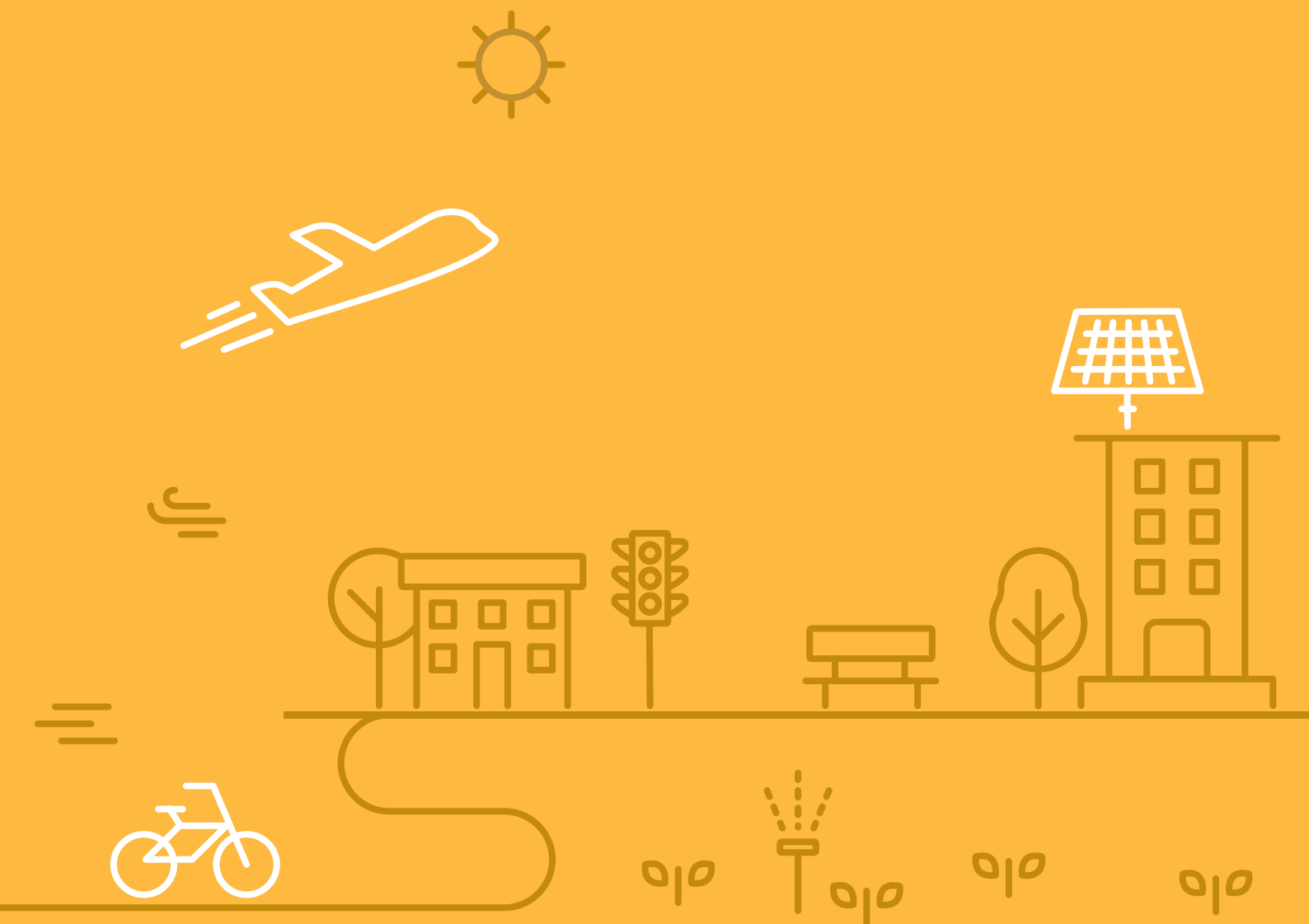
Dimensions / Weight	T.B.D
---------------------	-------

※ The specification is subject to change as the product is made-to-order for customers.

## CHAPTER 3

---

# Electric Monitoring System (FBMS, CBMS, BBMS)



## MarooOn Electric Equipment Monitoring System

The Electric Equipment Monitoring System of MarooOn is applicable to logistics equipment, e.g. battery-operated golf carts and electric forklifts.

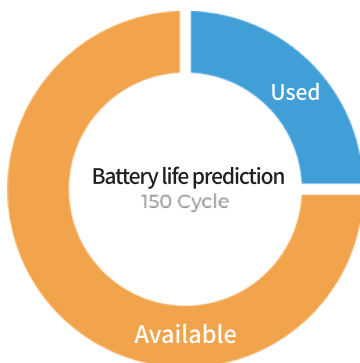
By utilizing IoT (Internet of Things) technology, users can monitor usage and battery of their equipment with computer or smart devices. Manage your logistics equipment with Data Mining, AI (Artificial Intelligence) and status diagnosis using Big Data Technology.

The MarooOn's monitoring system is manufactured with international patent technology. Furthermore, by embedding a life-predicting algorithm according to user environment, active maintenance operation is feasible through prior maintenance.

Industrial batteries are expensive consumables and **one of the major fixed costs that require periodic replacement.**

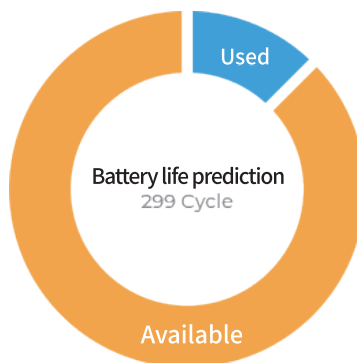
Our innovative system reduce costs through efficient resource management and utilization.

### ○ Battery life prediction algorithm based on user environment and big data analysis



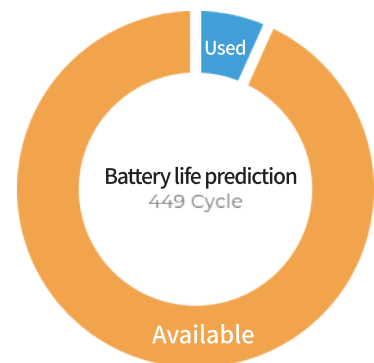
Grade B (100%) → 80%

Used : 37 Cycle  
Available : 113 Cycle



Grade C (100%) → 60%

Used : 37 Cycle  
Available : 262 Cycle



Grade D (100%) → 40%

Used : 37 Cycle  
Available : 412 Cycle



[Patent]  
Power monitoring systems  
and power monitoring method  
of electric devices



[Patent]  
Battery power monitoring  
systems for electric devices





## ○ How did the industry manage equipment and batteries?

Small business size, non-professional manpower, and simple battery voltage measurement all make it very difficult perform battery evaluation, particularly for large volumes of batteries.

The high-priced battery replacement cycle is short due to inability to recognize performance degradation, e.g. inadequate charge and low electrolyte caused by lack of professional management manpower.

Batteries are the main cause of electric logistics equipment malfunction.

That is, 80% of cases more are due to charger and batteries.



As the batteries used in logistics equipment are connected and used in series, degraded batteries can dramatically reduce usage time.

## ○ What can we learn from equipment and battery monitoring systems?



### 1. All information on the use of power equipment

Accumulative management and operation through big data, e.g. information for use by operating hours, charging time, and time zone.



### 2. All information about batteries

Early diagnosis of problems, e.g. voltage, current, usage and charging voltage, and number of charging times during operation.



### 3. Low voltage, low electrolyte automatic alarm

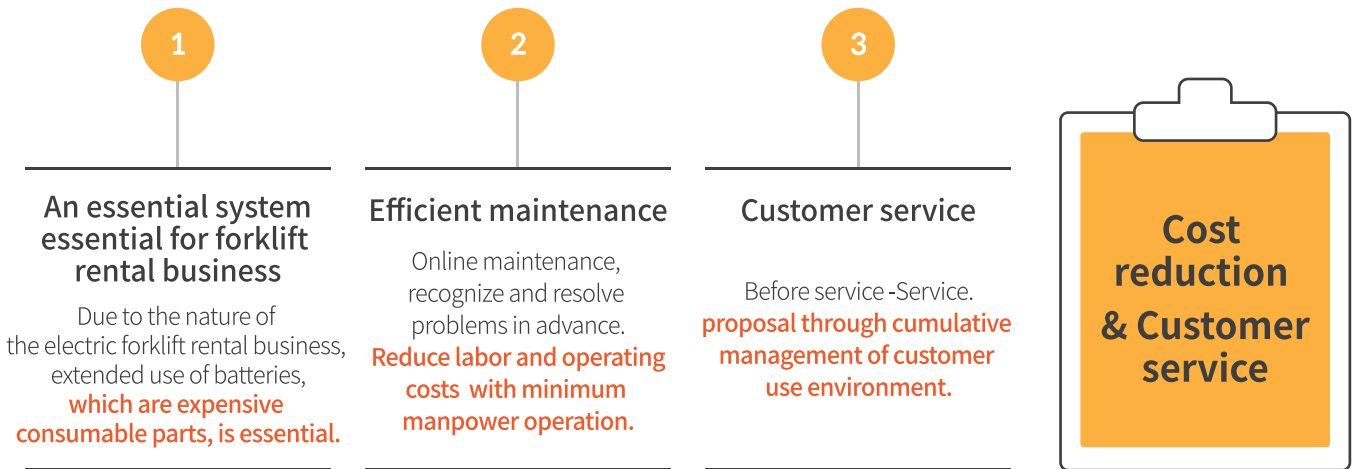
Precautions against problems caused by low voltage and not replenishing distilled water. Reduces operating costs by enabling management with small manpower.



### 4. Equipment and battery management online

Monitoring with computer and smart devices anywhere in the world. No extra modem and mobile communication fees because it uses an Internet network.

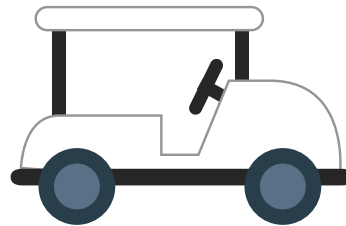
## ○ MarooOn Electric Equipment Monitoring System



## ○ Cost reduction analysis after introducing monitoring systems



1. 50 electric forklift operation site
2. Average battery price: 3,000,000 won
3. Three-year cycle replacement cost: 150,000,000 (4,166,000/Month)
4. 6-month extension use: 25,000,000 won
5. 12-month extension use: 50,000,000 won



1. Golf course with 100-golf carts operation
2. Average battery price: 230,000 won (installed 6 units, 380,000 won)
3. Three-year cycle replacement cost: 138,000,000 (5,750,000/Month)
4. 6-month extension use: 34,500,000 won
5. 12-month extension use: 69,000,000 won

## ○ Extended usage period and cost reduction details

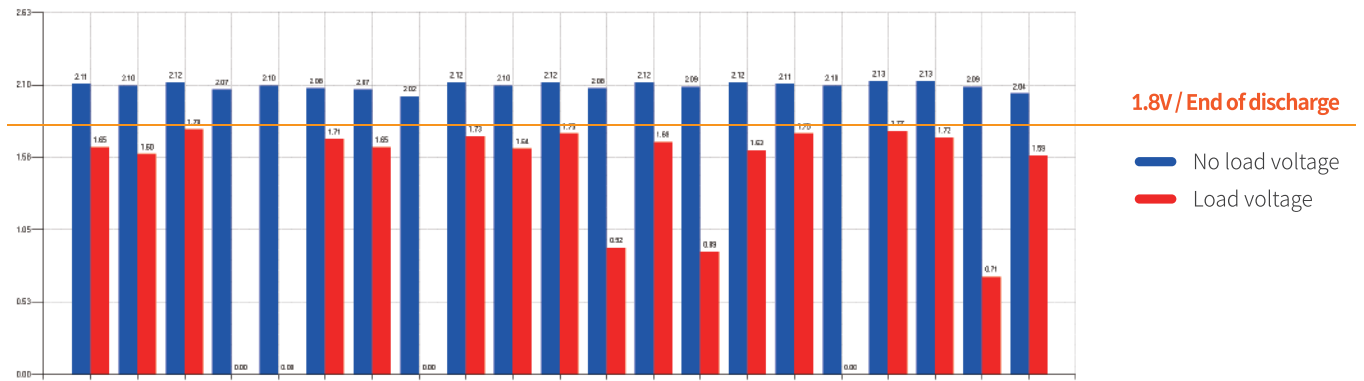
- Charge state of battery, over-discharge use, usage check, low-voltage and battery distilled-water alarm
- Maintains performance by restoring degraded batteries
- Circular placement through electric equipment usage (efficient use of resources)
- Reduces labor costs for battery and power equipment management
- Accident prevention through pre-inspection

**ROI (Return on Investment)  
= Within 6 months**

## ○ FBMS : Electric forklift battery monitoring system

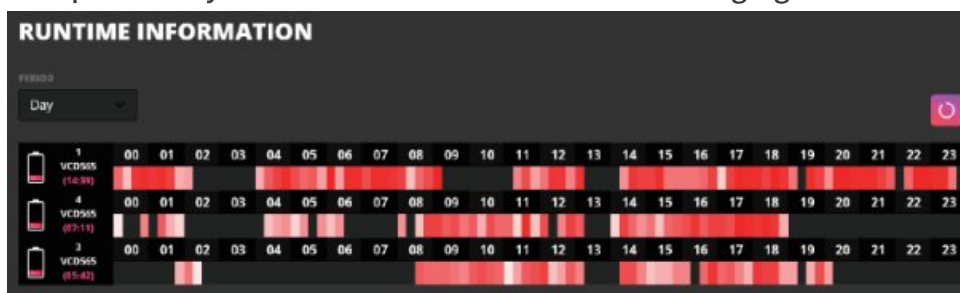
### Problems of electric forklift and battery management

#### 1. Battery life is reduced due to deviation between battery cells used in series



[BMS data after 1 hour discharging of 48V 400AH electric vehicle batteries 80A used for 2 years]

#### 2. Rapid battery life reduction due to insufficient charging time and absence of charging recognition



Charge Info		Discharge Info	
Statistics Monitoring Period: 2019-01-01 ~ 2019-12-31			
Start Charge	Start Discharge	Start Charge	Start Discharge
00:00:00	00:00:00	00:00:00	00:00:00
End Charge	End Discharge	End Charge	End Discharge
00:00:00	00:00:00	00:00:00	00:00:00
Charge Count	Discharge Count	Charge Count	Discharge Count
54	54	54	54
Charge Time	Discharge Time	Charge Time	Discharge Time
00:00:00	00:00:00	00:00:00	00:00:00
Discharge Time	Charge Time	Discharge Time	Charge Time
00:00:00	00:00:00	00:00:00	00:00:00

[Total number of charges in one year (54 times), Average 0.1 time/A company FBMS Data]

Electric forklift in operation under low charge

[\* Hourly usage information of electric forklift for one day at a logistics center – FBMS Data]

#### 3. In case of business locations that use many power forklifts, the distribution of forklifts is not easy due to lack of accumulation management for the number of operation and usage.



3-month usage time statistics of a business location using 5 power forklifts - FBMS Data

#### 4. Difficult to know the appropriate timing for replenishing distilled water

## ○ FBMS : Electric forklift battery monitoring system

### MarooOn FBMS characteristics

#### 1. Equipped with battery life prediction algorithm

- Provides battery life prediction graphics through statistical analysis of battery usage
- Displays used cycle, displays usable cycle by battery status rating

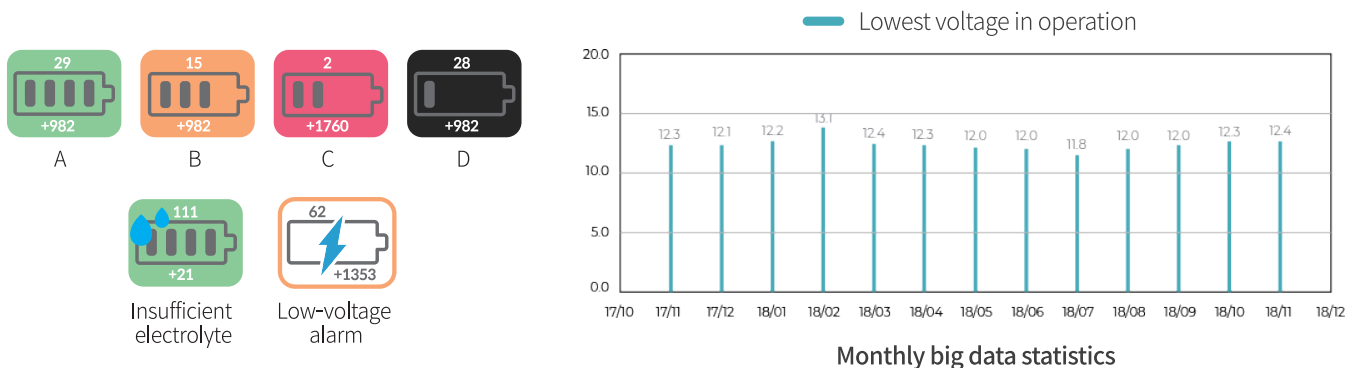
Windows OS program screen



Mobile, android application screen

#### 2. Battery status information big data process and alarm function (low-voltage, electrolyte level)

- Battery rating according to data statistics, charging state, low-voltage cell (performance degradation), detailed information graph of batteries by electric forklift
- Insufficient battery electrolyte, low-voltage alarm function



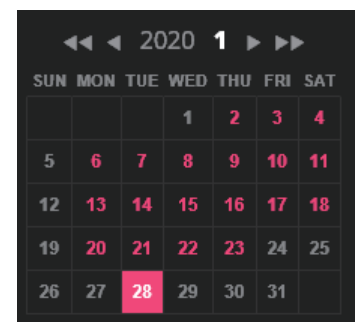
#### 3. Electric forklift usage time information (by 24-hour and 15-minute)

- Displays various driving information, e.g. battery charging time and operation time, also checks insufficient charging time versus usage

Information by electric forklift time zone (daily/weekly/monthly/yearly), dispatch management



Displays electric forklift usage time by 15 minutes  
The darker the red, the more usage is displayed



Checks equipment usage date, work details through calendar

## FBMS : Electric forklift battery monitoring system

#### 4. Maintenance by electric forklift planning and inspection cycle

- Periodic maintenance by electric forklift usage time
- Efficient management through accident prevention



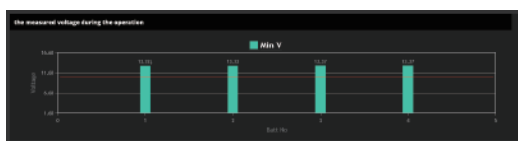
## Usage information by big data statistics

## Plan maintenance and inspection cycle

Drive axle housing (wet disk) _ Oil change	500 hours or every 3 months
Discharge and change of drive shaft oil	1000 hours or every 6 months
Hydraulic oil filter change	1000 hours or every 6 months
rive axle housing (show break) _ Oil change	1500 hours or every 9 months
Hydraulic breather change	2000 hours or every 1 years
Tire_front _ change	Every 4 years
Hydraulic oil and strainer change	2500 hours or every 1.5 years
Drive handle motor _ DC motor brush and commutator replacement	Every 1.5 - 2 years
Tire _rear change	2500 hours or -every 2 years
Battery	2.5- 3 years

## 5. Distinguished before & after service

- Customer satisfaction with "Before Service"
- Familiarize with usage information and visit customers, special memo function sharing



Information					
Batt. Pack No.	24	Brand	ROKET	Model	VCI 820
Forklift Type	TEC25E	AH / Discharge Rate	820 AH / 5 Hour	MPG No.	20180109
BMS CH / Voltage	4 / 12 V	Purchase date	2018-01-09	Period after using	02 Y 00 M 19 D
Remark	<div></div>				<div>SAVE</div>

## 6. Grant master admin. account by user

- Sales office and agency management by granting the master admin. account
- Prevents accidents through joint monitoring at 3-5 locations, e.g. the headquarters, exclusive sales, local retails, sales agencies

AVAILABLE USER ACCOUNT LIST							
User ID	Service	Category	Country	NextDUES	LastCharge	Registration Code	Account
super	ADMIN	최고권 (000)	Korea, Republic of	-	-	AAAAAAA	
† prestor	CBMS	수출권 (402)	Korea, Republic of	70	2017-11-01	VLESDP9	Bar
† marcelino	CBMS	중대권 (400)	Korea, Republic of	1	-	WPGDNEE	Bar
† marcelino	CBMS	중대권 (400)	Korea, Republic of	1	2016-05-24	SDZCJG0	Bar
† wether	CBMS	중대권 (400)	Korea, Republic of	1	2016-12-23	NICKRLL	Bar
† gwetwark	ADMIN	최고권 (000)	Korea, Republic of	-	-	EDWTCMA	
† qibungu	CBMS	중대권 (400)	Korea, Republic of	7	2017-07-12	WGLPOMN	Bar
† qibungu	CBMS	중대권 (400)	Korea, Republic of	3	2017-01-24	UJLUMTLA	Bar
† aggepo	CBMS	중대권 (400)	Korea, Republic of	2	-	AFBQMGK	Bar
† aggepoan	CBMS	중대권 (400)	Korea, Republic of	1	2017-01-24	9JWJNZ	Bar
† namchoso	CBMS	수출권 (402)	Korea, Republic of	59	2016-01-11	SDRQJG2	Bar
† dengchoso	CBMS	수출권 (402)	Korea, Republic of	64	2017-11-01	UJF9H4E	Bar
† Regner	ADMIN	BSG	Indonesia	-	-	Q75HJG2	Bar
† dengjark	CBMS	Indonesia BSG	Indonesia	2	2016-09-16	DWZGJG2	Bar
† albinolano	CBMS	PT. BSG	Indonesia	1	-	WQBDKOH	Bar

Master Admin. Account and Slave Account in operation (Windows OS)

○ FBMS : Electric forklift battery monitoring system

FBMS Model – Advance(System composition)





## ○ FBMS : Electric forklift battery monitoring system

### FBMS Model – Advance(System composition)



Model	<b>A-DCS</b>
Power Supply	24.0V
Current Measurement	$\pm 400.0$ A
Current Consumption	40mA
Interface	Zigbee 2.4GHz
Dimension	93×52×23 mm



Model	<b>VMS</b>
Power Supply	8.0V
Current Measurement	2.0V / Cell / 4CH
Current Consumption	30mA
Interface	Zigbee 2.4GHz
Dimension	50×70×20 mm



Model	<b>NA</b>
Power Supply	5.0V
CPU	ARM7 Core
Interface	Zigbee 2.4GHz, Ethernet
Dimension	97×72×38 mm

○ FBMS : Electric forklift battery monitoring system

FBMS Model – Standard(System composition)



## ○ FBMS : Electric forklift battery monitoring system

### FBMS Model – Standard(System composition)



Model	<b>S-DCS</b>
Power Supply	24.0V
Current Measurement	$\pm 400.0 \text{ A}$
Voltage Measurement	8V, 12V, 16V
Battery / Channel	48V Battery = $8\text{V} \times 6\text{CH}$ 80V Battery = $16\text{V} \times 5\text{CH}$
Current Consumption	60mA
Interface	Zigbee 2.4GHz
Dimension	$93 \times 52 \times 23 \text{ mm}$

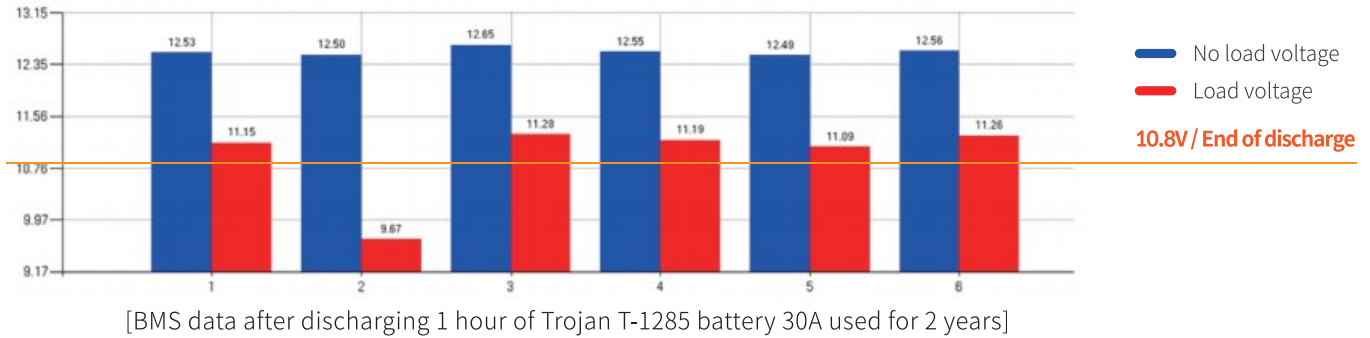


Model	<b>NA</b>
Power Supply	5.0V
CPU	ARM7 Core
Interface	Zigbee 2.4GHz, Ethernet
Dimension	$97 \times 72 \times 38 \text{ mm}$

## ○ CBMS : Golf cart battery monitoring system

### Problems of electric golf cart and battery management

#### 1. Shortens battery life due to deviation between batteries used in series



The cart uses 4 to 6 batteries in series, and due to the nature of the battery, depletion is caused by the use of 1 or 2 batteries.  
If the problem is left untreated, all batteries will rapidly become depleted and will require early disposal.

#### 2. Golf courses with many golf carts cannot implement cumulative management for number of operations and usage, which makes it difficult to assign and operate carts

OPERATIONAL INFORMATION								
Batt No.	Charge-Out	Charge-In ▼	Operation Time	Move	Used Ah	Min. Volt.	Dev. Wh	Water
49	09:46	10:16	24:30	00:33	21	10.34	2	OK
35	04:14	10:16	06:02	00:31	24	10.36	5	OK
8	04:21	10:16	05:55	00:30	23	10.46	3	OK
16	04:40	10:16	05:36	00:35	22	10.62	3	OK
29	04:27	10:16	05:49	00:31	23	10.38	4	OK
27	05:26	10:16	04:50	00:31	22	10.51	4	OK
33	04:35	10:16	05:41	00:30	24	9.69	8	OK
14	05:01	10:16	05:15	00:33	24	10.4	4	OK
37	05:04	10:15	05:11	00:29	24	10.51	4	OK
59	04:50	10:15	05:25	00:31	23	10.42	3	OK
11	05:08	10:15	05:07	00:28	25	10.45	6	OK
9	04:27	10:15	05:48	00:30	24	10.45	4	OK

#### 3. Difficult to know the appropriate timing for replenishing distilled water

## ○ CBMS : Golf cart battery monitoring system

### CBMS Model – Standard(System composition)



## PRODUCT

BATTERY MONITORING SYSTEM (FBMS, CBMS, BBMS)

### ○ CBMS : Golf cart battery monitoring system

#### CBMS Model – Standard(System composition)



Model	<b>S-DCS</b>
Power Supply	24.0V
Current Measurement	$\pm 400.0$ A
Voltage Measurement	8V, 12V, 16V
Battery / Channel	48V Battery = 8V $\times$ 6CH 80V Battery = 16V $\times$ 5CH
Current Consumption	60mA
Interface	Zigbee 2.4GHz
Dimension	93 $\times$ 52 $\times$ 23 mm



Model	<b>NA</b>
Power Supply	5.0V
CPU	ARM7 Core
Interface	Zigbee 2.4GHz, Ethernet
Dimension	97 $\times$ 72 $\times$ 38 mm



## CHAPTER 4

---

# Accessories





# FLUKE Thermal Imagers

## Fluke TI90 & TI100 THERMAL IMAGERS

The thermal imaging camera of Fluke TI90 & TI100 makes it easy to find abnormal and performance-defective battery cells of the battery connector.

### Features

- Wireless with superior image quality
- Easy-to-use and rugged
- Size (H x W x D): 284 x 86 x 135 mm
- Weight: 0.726 kg
- Warranty: 2 years

### Technical Specifications

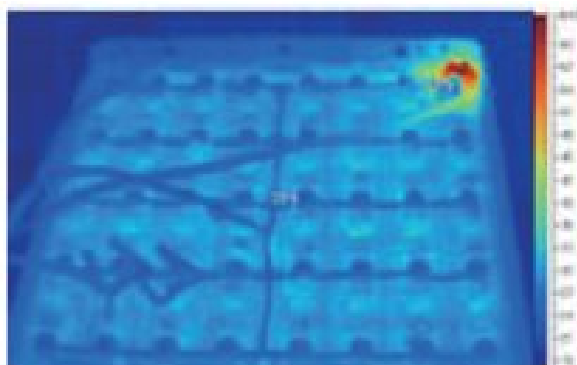


TI90



TI100

Resolution	80 × 60 (4800 pixels)	160 × 120 (19200 pixels)
Field of view	19.5 ° H × 26 ° V	22.5 ° H × 31 ° V
Thermal sensitivity	≤ 0.15 °C at 30°C target temp. (150 mK)	≤ 0.10 °C at 30°C target temp. (100 mK)
Type of images	Thermal and visible images	Thermal images only
Built-in digital camera	2 megapixel industrial performance	R only
Ruggedized display	3.5 inch diagonal (portrait format)	3.5 inch diagonal (portrait format)
Laser pointer	No	Yes
Emissivity correction	Yes	Yes
Field replaceable battery	1 × Lithium-Ion	1 × Lithium-Ion
Ingress protection (IP) rating	IP54 dust-/splash-proof housing	IP54 dust-/splash-proof housing
Focus system	Fixed focus 46cm and beyond	Fixed focus 122cm and beyond



The left is thermal image of an 80V electric forklift battery. After thermal analysis, an abnormal battery connector has been identified .

The average temperature of the battery is 22 ° C, but the temperature of the connector has increased to 62 ° C.

Problems that are difficult to find with the naked eye can be easily found using a thermal imaging camera.



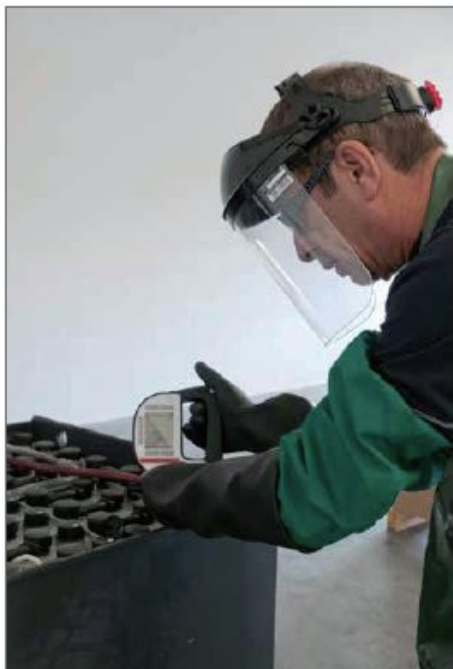
# Digital hydrometer

The digital hydrometer demonstrates accuracy of 99.9% and is 50% faster compared to normal hydrometers.

## Features

- Easy operation, handy and light design capable of measurement with one hand
- Large LCD with backlight

## Technical S



### Measuring range:

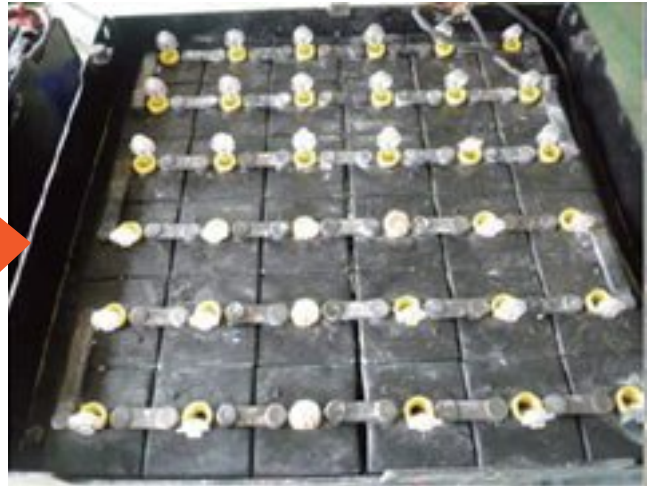
Density	0 g/cm <sup>3</sup> to 3 g/cm <sup>3</sup>
Temperature	0 °C to 40 °C
Viscosity	0 mPa · s to 1000 mPa · s
Sample volume	2a ml
Dimensions	140 x 138 x 27 mm (L x W x H)
Data memory	1024 measured results
Power supply	two 1.5 V alkaline batteries
Immediately compensates to 25 °C	
Measure the density of all your cells and then export them wirelessly to your PC in Excel	

### ○ MarooOn battery cleaner

- Extends the battery life by suppressing natural discharge of battery due to exposure to battery electrolyte
- Prevent corrosion of battery case, terminals, and power equipment due to battery electrolyte
- Protects operators' skin and clothing from battery electrolyte
- Indicator function to check leakage of electrolyte
- Neutralization of sulfuric acid which is battery electrolyte
- Actively prevent accidents caused by electrolyte



Before cleaning

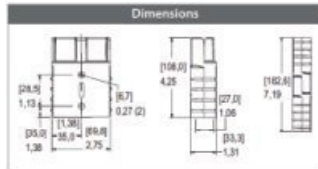


After cleaning



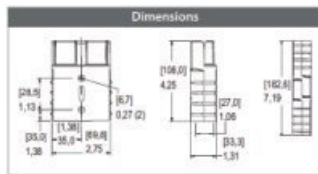
## Industrial battery connector

### SB350



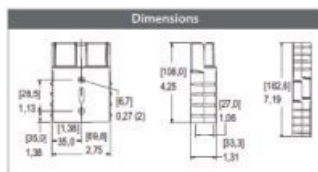
UL Current rating	350 A*
UL Voltage ratings	600 V*
Contact barrel wire size	2/0 to 300 AWG 67,4 to 152.0 mm <sup>2</sup>
Maximum wire insulation diameter	1,10 inches 27,9 mm <sup>2</sup>
AVG contact resistance	50 mΩ
Insulation withstanding test voltage	2200 VAC/DC
Contact retention force	500 lbf
Life	
a. No load (contact/disconnect cycles)	To 10 000 A
b. Under load (Hot Plug 250 cycles @120V)	100 A
Avg. connection.disconnect	30 lbf
Operating temperature range	-20°C to 150 °C ** -4 °F to 221 °F
Flammability rating of housing material	UL94 V-0

### SB175










UL Current rating	175 A*
UL Voltage ratings	600 V*
Contact barrel wire size	#4 to 1/0 AWG 21,1 to 53,5 mm <sup>2</sup>
Maximum wire insulation diameter	0,75 inches 19,01 mm <sup>2</sup>
AVG contact resistance	100 mΩ
Insulation withstanding test voltage	2200 VAC/DC
Contact retention force	300 lbf
Life	
a. No load (contact/disconnect cycles)	To 10 000 A
b. Under load (Hot Plug 250 cycles @120V)	75 A
Avg. connection.disconnect	25 lbf (SB 2 Pole) 35 lbf (SB 2 Pole)
Operating temperature range	-20°C to 150 °C ** -4 °F to 221 °F
Flammability rating of housing material	UL94 V-0

### SB50



UL Current rating	50 A*
UL Voltage ratings	600 V*
Contact barrel wire size	#6 to #16 AWG 13,3 to 1,3 mm <sup>2</sup>
Maximum wire insulation diameter	0,44 inches 11,2 mm <sup>2</sup>
AVG contact resistance	200 mΩ
Insulation withstanding test voltage	2200 VAC/DC
Contact retention force	50 lbf
Life	
a. No load (contact/disconnect cycles)	To 10 000 A
b. Under load (Hot Plug 250 cycles @120V)	50 A
Avg. connection.disconnect	10 lbf - low detent 15 lbf - high detent
Operating temperature range	-20°C to 150 °C ** -4 °F to 221 °F
Flammability rating of housing material	UL94 V-0

○ Cable assembly for battery connection

Cable assembly	Part Number	Specification
	<b>AC-CAS-0001-10A</b>	SB350 - SB175, 360mm
	<b>AC-CAS-0002-10A</b>	SB175 - SB50, 360mm
	<b>AC-CAS-0003-10A</b>	SB350 - Ring terminal (50-8) / 3.5m
	<b>AC-CAS-0004-10A</b>	SB175 - Clamp, 1.5m
	<b>AC-CAS-0005-10A</b>	Clamp - Ring terminal (25-8) / 3.5m
	<b>AC-CAS-0006-10A</b>	SB175 - Ring terminal (50-10) / 1.0m
	<b>AC-CAS-0013-10A</b>	SB350 - SB350, 2.5m

**MarooOn's  
world-renowned technology!**



**Maroo On**









Production  
information QR code



**MarooOn**

1247 Dureungyuri-ro, Ochang-eup, Cheongwon-gu, Cheongju-si, Chungchungbuk-do, South Korea  
TEL +82-1599-9888 FAX +82-43-276-6334

[www.maroo-on.com](http://www.maroo-on.com)