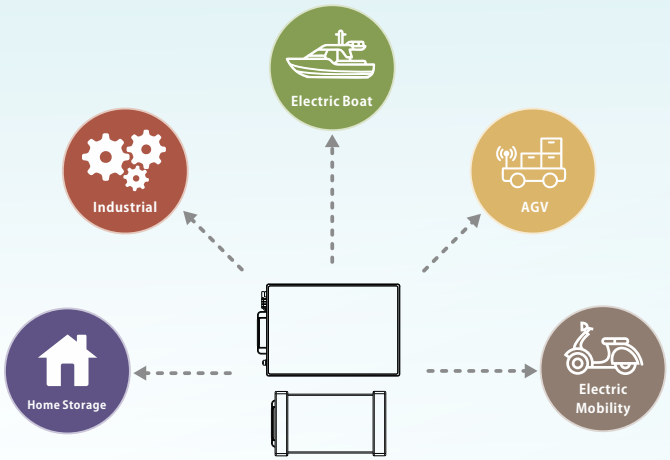
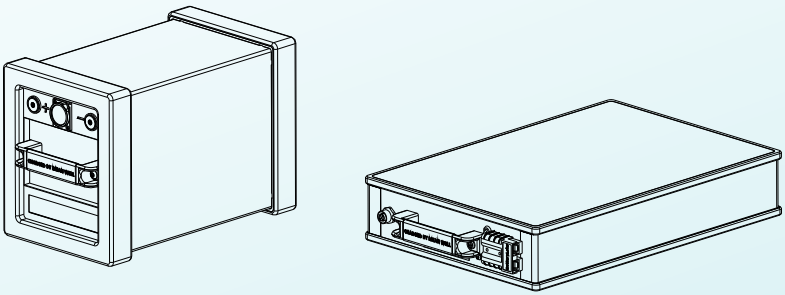
A Technical Approach to Selecting Mean Well Chargers and Lithium Batteries

Charged by MEAN WELL



APPLICATION NOTE

• Lithium Battery Pack - FMB/QHB Series



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Part 1: Batteries

1.1 How does a battery work?

A battery has 2 poles, a positive and a negative pole, depending on whether you charge or discharge the battery, a reaction takes place in which electrons move from the positive to the negative side.

This effect is called a redox reaction (reduction-oxidation), in which the electrons are released from the cathode (reduction) and bind to the anode via an electrochemical reaction (oxidation). This creates a potential difference and electrode current, which can be used to drive a user, such as an electric motor.

These anode and cathode have the largest possible surface area and therefore consist of layers or are rolled up in a cell. The cell contains electrolyte in which the electrons can move freely from the anode to cathode.

1.2 Types of batteries

Basically, there are 3 types of battery, these types are divided into subcategories.

1: Lead batteries - divided into AGM and GEL
2: Lithium batteries - divided into NMC, LiFePO4 and the rest.
3: The rest - divided into NiCd and NiMH, among others.

1.3 Lead-acid batteries

For years, these were the most common batteries worldwide. Most are of the AGM (Absorbed Glass Mat) or GEL type.

With the latter, the electrolyte is incorporated in a kind of gel. The advantages of AGM batteries are the higher discharge currents than what is possible with gel. Because the electrolyte in gel batteries is processed in a gel, the electrons can move less freely. An advantage about GEL batteries is that you can usually mount them in multiple positions (such as upside down), which is usually not possible with AGM batteries.

These batteries can usually be discharged much deeper on a regular basis without high levels of chemical wear. A term you will also encounter is SLA, which means sealed lead acid and does not mean anything other than that these batteries are completely closed and cannot be refilled with electrolyte, which also applies to MF (maintenance free).

1.4 Lithium batteries

Here we only discuss about NMC and LiFePO4 batteries. There are many other types of batteries that are based on lithium. NMC, or Nickel Manganese, Cobalt Oxide is a very popular chemical compound, commercially strong due to the favourable cost of ownership.

The NMC cells can be supplied as Polymer (LiPo) in the form of a rectangular so-called "pouch cell" and in a cylindrical shape such as the very popular 18650 cell shape, they are then called lithium ion (li-ion) cells. The disadvantage of LiPo cells is the higher initial costs and the lack of a CID (Current Interrupt Device), interrupts the circuit if the cell temperature is too high. This could, for example, occur during charging if the cell is broken. The CID is incorporated in the positive pole of the cell.

LiFePO4 basically has a longer lifespan than NMC due to the lower wear rate, but because the energy density and nominal voltage are lower, you need more cells to achieve the same power as NMC cells. This results in a higher cost price and a larger and heavier battery than what is possible with NMC. The positive point of LiFePO4 beyond its lifespan is the safety attributed to the cells.

1.5 Batteries offered by MEAN WELL Europe

Nowadays the dynamics of the energy sector are rapidly changing, and the electrification process is accelerating. MEAN WELL Europe has expanded its product offering by including IoT connected lithium batteries, and it is made in Europe.

Here is the Lithium Battery offering from MEAN WELL Europe.

A.FMB Series - Flat type & Modular Lithium Battery Pack

MWEU PN	Product Description	Voltage Nominal	Max Charge Current	Discharge current Continuous/pk	Battery Weight	Dimensions (L x W x H)	Chemical Composition
FMB-24N70.2	BAT NMC24V70.2Ah,SB50.BLK-flat	25,2V	25A	50A/100A-3sec	10,2kg	265 x 74 x 410 mm	Li-ion NMC
FMB-24N70.2C**	BAT NMC24V70.2Ah, SB50.BLK-flat/ M12F	25,2V	25A*	20A/100A-3sec			
FMB-48N33.8	BAT NMC48V33.8Ah,SB50.BLK-flat	50,4V	10A	40A/80A-3sec			
FMB-48N33.8C**	BAT NMC48V33.8Ah,SB50.BLK-flat/ M12F	50,4V	10A *	40A/80A-3sec			
FMB-48N43.5	BAT NMC48V43.5Ah,SB50.BLK-flat	50,4V	10A	40A/80A-3sec			
FMB-48N43.5C**	BAT NMC48V43.5Ah,SB50.BLK-flat/ M12F	50,4V	10A*	40A/80A-3sec			

*Specified max charge current can be higher with CAN controlled charge algorithms
**Optional model, 0008: Weipu 7P F, Example: `FMB-48N43.5C-0008"
Please contact the specialists of MEAN WELL EUROPE if you need special connectors

B.QHB Series - Cube type & Harsh environment Lithium Battery Pack

MWEU PN	Product Description	Voltage Nominal	Max Charge Current	Discharge current Continuous/pk	Battery Weight	Dimensions (L x W x H)	Chemical Composition
QHB-12F70.0	BAT LFP12V70Ah, M5 + XLR-3P	12,8V	20A	50A/100A-3sec	9,8kg	197 x 167 x 296,5 mm	LiFePO4
QHB-12F70.0C	BAT LFP12V70Ah, M5 + M12-F	12,8V	20A	50A/100A-3sec			
QHB-24N62.4	BAT NMC24V62.4Ah, M5 + XLR-3P	25,6V	20A	50A/100A-3sec	10,8kg		Li-ion NMC
QHB-24N62.4C	BAT NMC24V62.4Ah, M5 + M12-F	25,6V	20A	50A/100A-3sec			
QHB-48N33.8	BAT NMC48V33.8Ah, M5 + XLR-3P	46,8V	15A	50A/100A-3sec			
QHB-48N33.8C	BAT NMC48V33.8Ah, M5 + M12-F	46,8V	15A	50A/100A-3sec			

*Via battery terminals
Please contact the specialists of MEAN WELL EUROPE if you need special connectors

FMB series
Flat type & Modular Battery

QHB series
Cube type & Harsh environment Battery

1.6 Voltage (V)

Lead-acid batteries have a nicer linear decrease in voltage during use than lithium, lithium has a flatter curve roughly between 10% and 90% of the discharge time.

How do we arrive at the voltages indicated on a battery? To do this, it must first be explained what exactly "nominal voltage" means. This nominal voltage is the average voltage of the battery (the voltage of a battery therefore slowly decreases during consumption). This average voltage is used as the calculation voltage and is called nominal voltage.

You can calculate this nominal voltage by multiplying the number of cells in series by the nominal cell voltage below.

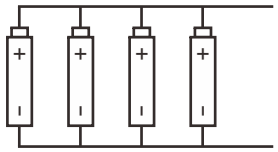
- NMC (Li-ion/LiPo) 3.6/3.7V
- LiFePO4 3.2V
- Lead acid AGM/GEL 2.0V

Now we come to the voltage indicated on a battery or charger, which is usually an approximation of the nominal battery voltage. So for which type of battery the charger is suitable. This is usually correct with lead/batteries. There are more differences and creative approaches with lithium batteries because the older lead-acid batteries are taken as a reference. For example, 12V can be made very nicely with 2V nominal cells, but with 3.6V Li-ion cells this is of course not possible and 3S or 4S is often used, both of which are called a 12V battery, which is of course not entirely correct.

When a very high power is required from a battery, the voltage of the battery drops at that moment, this is a phenomenon called voltage drop. This effect is caused by the resistance in the battery, so much energy is required from the battery that the redox reaction does not go fast enough. This occurs, for example, when a starter motor in a combustion engine is activated, the required current is so high that the voltage (temporarily) drops.

1.7 Capacity (Ah or Wh)

The capacity of a battery, also known as ampere hours (Ah), is determined by the total surface area of the anode and cathode per cell and how many of these cells are in parallel.



Suppose the cells in the above diagram have a capacity of 10Ah each, then the total capacity is 10*4= 40Ah. If the cells in this example have a voltage of 2V, the voltage of the entire system remains 2V.

Although capacity is often expressed in Ah, it is more accurate to express the capacity of a battery in Wh (Watt hours), or Voltage (V) * Ampere hours (Ah). This applies in particular to all batteries that are not based on lead acid or 1.5V penlites. For all other forms, including lithium, the voltage is often rounded to an equivalent lead-acid battery variant.

As an example; take a 12V 10Ah lead battery and a 12V 10Ah li-ion battery. You would initially say that the capacity of both batteries is the same. The capacity of the lead acid battery in Watt hours is 12*10 = 120Wh. For the lithium battery you must first know whether this is a 3S or 4S version to approach 12V, after all 3*3.6V = 10.8V and 4*3.6V = 14.4V. In other words, 12V cannot actually be simulated well with li-ion cells, yet it is offered. Let's assume it's 4S. Then the sum becomes 14.4V*10Ah is 144Wh. Basically more effective than the lead battery, and then we leave the Peukert effect aside.

Part 2: Chargers

2.1 How does a charger work?

A charger works by applying a certain voltage (V) and current (A) to a battery. That is why there is always a voltage and current indicated on the label of a charger. Please note, the current of a charger is indicated in A of amperes, so this is slightly different from the capacity of a battery which is indicated in Ah (ampere hours).

You can calculate how quickly you can charge your battery with a particular charger based on the charging current A of the charger and the capacity in Ah of the battery. You can charge a 20Ah battery in about 4 hours with a 5A charger (20/5). - It is an approximation, depends on the charging phases that the charger has.

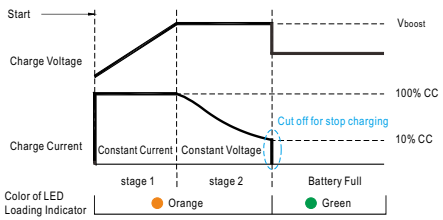
2.2 Which charger do I need?

Which charger you can use depends on which type of battery is used, so you all need different chargers for the batteries below:

- NMC (li-ion/LiPo)
- LiFePO4
- Lead/acid AGM
- Lead/acid GEL

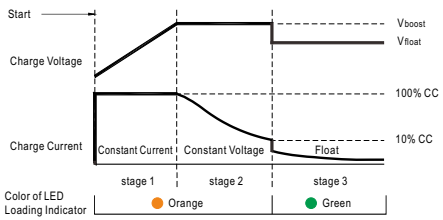
The charging characteristic for all the above batteries is CC/CV, which means constant current/constant voltage. In other words, first it is charged with a constant current (the current indicated on the charger), then with a constant voltage. While this voltage is maintained, the current drops to the charger's cut-off point. For different types of battery, there are different specified charging currents at that point.
Please see below, this is a typical CC/CV charging curves for 2/3 stage charging curves. It depends on the characteristics of the battery that you are using. This is MEAN WELL spec of NPB-750 for your reference.

◎ 2 stage charging curve



State	NPB-750-12	NPB-750-24	NPB-750-48
Constant Current	43A	22.5A	11.3A
Vboost	14.4V	28.8V	57.6V

◎ Default 3 stage charging curve



State	NPB-750-12	NPB-750-24	NPB-750-48
Constant Current	43A	22.5A	11.3A
Vboost	14.4V	28.8V	57.6V
Vfloat	13.8V	27.6V	55.2V

In addition to this 1st phase (CC) and 2nd phase (CV), MEAN WELL smart chargers have additional phases depending on whether it is a lead or lithium charger (2 or 3-stage selectable via DIP S.W on panel or set via SBP-001-Intelligent Battery Charging Programmer). For example, lead-acid chargers have a float mode as the 3rd phase, in which the batteries are kept at a fixed voltage with a small current. The lithium chargers have a "rest phase" as a 3rd phase in which the voltage of the battery drops. If the voltage falls below a preset level, the charger switches to another phase, which is known as a topping charge.

The correct charging voltage and current are essential for safely charging a battery. You have to calculate the correct charging voltage yourself if you know how many cells in the battery are in series. Each chemical composition has its own charging voltage per cell. Here are the (maximum) charging voltages per composition:

- NMC (Li-ion/LiPo) 4.2V (sometimes 4.1V)
- LiFePO4 3.65V
- Lead/acid AGM 2.37V-2.45V
- Lead/acid GEL 2.41V-2.45V

A Li-ion battery with a nominal voltage (the average battery voltage) of 48V with 13 cells in series (13S) therefore requires a charging voltage of 54.6V.

The other factor besides charging voltage is the charging current. This depends on what the battery can handle. The higher this current, the faster you can charge. It is recommended not to charge a battery or product faster than originally indicated. The data sheet of a battery often states the maximum current allowed. We strongly recommend always staying well below these maximum values.

2.3 What does the voltage indicated on the charger mean?

This is the nominal voltage, or in the case of lithium batteries often the rounded nominal voltage but it will lead to different results of different Wh. See this in Part 1: Batteries, 1.6 Voltage. Different devices require different voltages to charge properly, so it's important to use a charger with the correct voltage to avoid damaging the device.

2.4 Power of a charger

You can calculate the power of a charger by multiplying the charging voltage by the charging current. In the case of 42V charging voltage and 5A charging current, you are at 210 Watts. So you will have to use a MEAN WELL smart charger of the 240Watt type.

The MEAN WELL chargers are available for different capacities, use different charger series for different application requirements. Please see below for MEAN WELL charger offering.

NPB Series

2.5 Benefits of using a lithium battery with BMS

1. Safety: BMS helps prevent overcharging, over-discharging, and overheating, which can improve the overall safety of the battery system.
2. Extended Battery Life: The BMS can help optimize the charging and discharging cycles, which can extend the lifespan of the lithium battery.
3. Efficiency: BMS helps monitor and regulate the flow of energy, ensuring that the battery operates at its most efficient levels.
4. Performance Optimization: BMS can enhance the performance of the battery by maintaining consistent power output and protecting it from damage due to misuse or environmental factors.
5. Monitoring and Diagnostics: BMS provides real-time monitoring of the battery's health, allowing users to identify any issues promptly and take corrective actions.
6. Balancing cell voltages: ensure that all cells are charged equally. This helps to extend the battery life and improve its performance.
7. Analysing battery data: collect from the sensors to determine the battery's state and condition and provide real-time information about the battery's performance.

2.6 MEAN WELL "Smart Charger + Lithium Battery"

➢ **Screw mount type of smart charger**

	MW Charger	Number of Lithium Battery
a	1pc of NPB-450-48 or NPB-750-48	✓ 1pc of FMB-48N33.8(C)/FMB-48N43.5(C)
b	1pc of NPB-1200-48	✓ 2pcs of FMB-48N33.8C or FMB-48N43.5C
c	1pc of NPB-1700-48	✓ 3pcs of FMB-48N33.8C or FMB-48N43.5C

* The charging time depends on the amount of charge current with selected charger
* "C" version battery incorporates a connector of M12 (A-coded/5pins), for CANBus communication
* Please contact your local MEAN WELL representative for accessories
* The recommended number of battery is only for reference. Please perform the overall evaluation with the final system.

Power line - SB50/BLK

Battery-pack has built-in BMS, you can connect it to a power supply (constant voltage) if only use one battery.

Power line + CANBus - M12/A-coded/5pins

It is highly recommended to use CANBus version to optimize the current if multi batteries connected in parallel.

➢ **IP6X solution**

	MW Charger	Number of Battery
a	1pc of HEP-600C-12	✓ 1pc of QHB-12F70.0(C)
b	1pc of HEP-600C-24	✓ 1pc of QHB-24N62.4(C)
c	1pc of HEP-600C-48	✓ 1pc of QHB-48N33.8(C)
d	1pc of HEP-1000-24W(CCAN)	✓ 1pc of QHB-24N62.4(C)

* The charging time depends on the amount of charge current with selected charger
* "C" version battery incorporates a connector of M12 (A-coded/5pins), for CANBus communication
* Please contact your local MEAN WELL representative for battery accessories
* The recommended number of battery is only for reference. Please perform the overall evaluation with the final system.

IP6x rating of battery QHB-24N62.4C • CANBus connector - M12/A-coded/ 5 pin • If system needs to read battery information	

CONCLUSION

MEAN WELL EUROPE created the platform of one-stop solution for lithium battery and smart charger to help you to shorten the development time & give the added value on your system design. This platform provides many advantages, you will benefit from quick response and the local technical support in Europe for both lithium battery and charger/power-supply. It's an approach that seeks to optimize the balance between cost and quality from your perspective, to make better decisions about what are the best investments for success.

MEAN WELL has various types of smart chargers and power supplies, from 30W up to 3200W. The lithium battery-pack can be able to communicate with the smart charger via the optimized interface to achieve the excellent performance in the entire solution that customer needs.

Contact us (contact@meanwell.eu) if you have questions on selecting our batteries or chargers.

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