The industrial battery of the future – today

Rethinking power

nilar

Flexible, powerful, long lasting battery solutions

Nilar provides safe and environmentally-friendly industrial batteries and energy storage solutions. These are based on a modular battery solution that provides a flexible and powerful platform for high and low voltage applications.

The 12V energy module is the key building block in Nilar's battery and energy storage solution. The module is a maintenance free, energy optimized battery for demanding industrial applications. The long service life, wide operational window and excellent safety and environmental characteristics of the nickel metal hydride technology, provide an ideal power supply for a large number of applications.

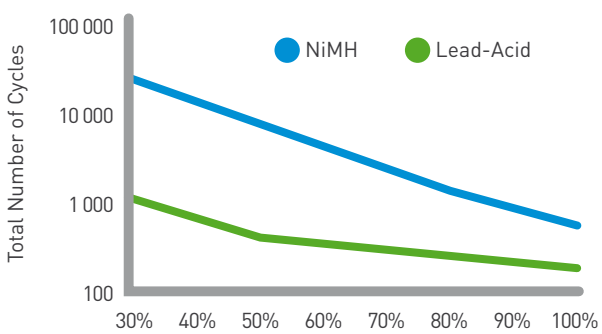
Features of Nilar Batteries

- The patented Nilar bipolar design enables Nilar to offer safe, reliable and cost efficient energy storage solutions
- High energy density with excellent discharge power capability over a wide temperature range
- The Nilar battery requires very low maintenance, in many cases no maintenance, and is a sealed design with no emissions of gases or electrolyte during its service life
- The Nilar battery is easy to transport and is not affected by any costly or complicated transport regulations
- The Nilar battery contains none of the regulated heavy metals mercury, cadmium and lead. The design has been developed to enable a cost efficient recycling process and a high degree of reused materials

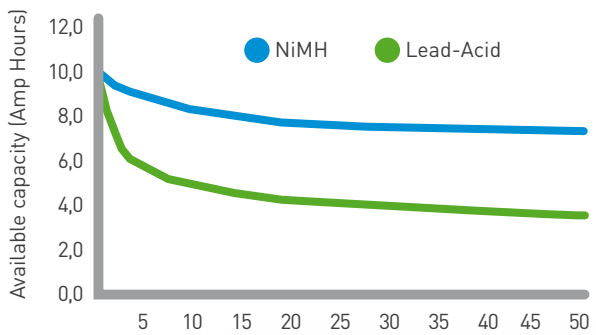
NiMH vs Lead-Acid

There are three main advantages that NiMH offers when compared to lead-acid: **reduced weight**, **longer cycle life**, and **capacity** at high rates. This makes NiMH an ideal solution if product replacement becomes a significant cost. In many cases, a NiMH battery will outlast the life of the product.

Cycle Life vs SOC



Rated 10Ah Capacity Battery



Next Gen technology for today's applications

Nilar bi-polar NiMH batteries deliver unrivalled industrial power solutions to a number of applications.

Smart Grid (Wind/PV)

The electrical grid is undergoing a transformation with the advent of alternative energy sources. Wind and solar power are becoming more prevalent.

"Peak Shaving", or the ability to handle surges in production or demand, is an important component in the grid of tomorrow and energy storage is key to providing this function, especially in business/ domestic settings.

Key requirements met by Nilar batteries in the smart grid back-up power application include:

- Size and flexibility
- Easy to use in high voltage applications
- Deep discharge, long cycle life and maintenance free

UPS / Telecom

Industrial telecom batteries are dominated by lead-acid based solutions. With the inherent difficulties of traditional solutions such as reduced cycle life due to deep discharges, the formation of gas when charging and the environmental aspects, Nilar's bi-polar NiMH battery can solve these problems by withstanding deep discharges and longer use per charge without reducing its cycle life.

Key requirements met by Nilar batteries in telecom back-up applications include:

- Size and flexibility
- Capability over a wide temperature range
- No transport restrictions
- Deep discharge, long cycle life and maintenance free

Electric Mobile Equipment

Nilar batteries have a very long calendar lifetime, often longer than the electric mobility equipment they power. This means Nilar batteries may not have to be replaced during the entire lifetime of the equipment. By using Nilar batteries, electric mobile equipment can achieve superior performance and a lower total cost of ownership.

Key requirements met by Nilar batteries in the electric mobile equipment application include:

- Deep discharge and long cycle life
- Fast charge
- Energy per weight and volume

Power Applications (Hybrid)

Vehicle manufacturers are currently developing hybrid functionality in many of their models, in particular micro-hybrids, which are expected to account for two thirds of all new car sales in the near- term. For Nilar, this application is particularly interesting for vehicles built for inner city use where, due to frequent stop/ starts, the ability to capture and store a considerable amount of breaking energy enables a micro-hybrid to significantly improve fuel economy. NiMH is an advantageous solution for this application, due to Li-Ion's safety issues and lead-acid's weight and lifetime issues.

Hybrid vehicle producers often view the purchasing process from a total cost of ownership perspective. Long battery life and low maintenance are key determinants.

Key requirements met by Nilar batteries in the hybrid vehicle application include:

- High Power
- Low cost of ownership
- Proven and safe NiMH technology

Smart power by design

Product overview

Nilar has established a new paradigm in battery design and production through combining proven NiMH chemistry with unprecedented modularity.

This provides industrial, safe and environmentally friendly energy storages. These are based on a bi-polar modular battery solution that provides a flexible and powerful platform for high and low voltage applications.

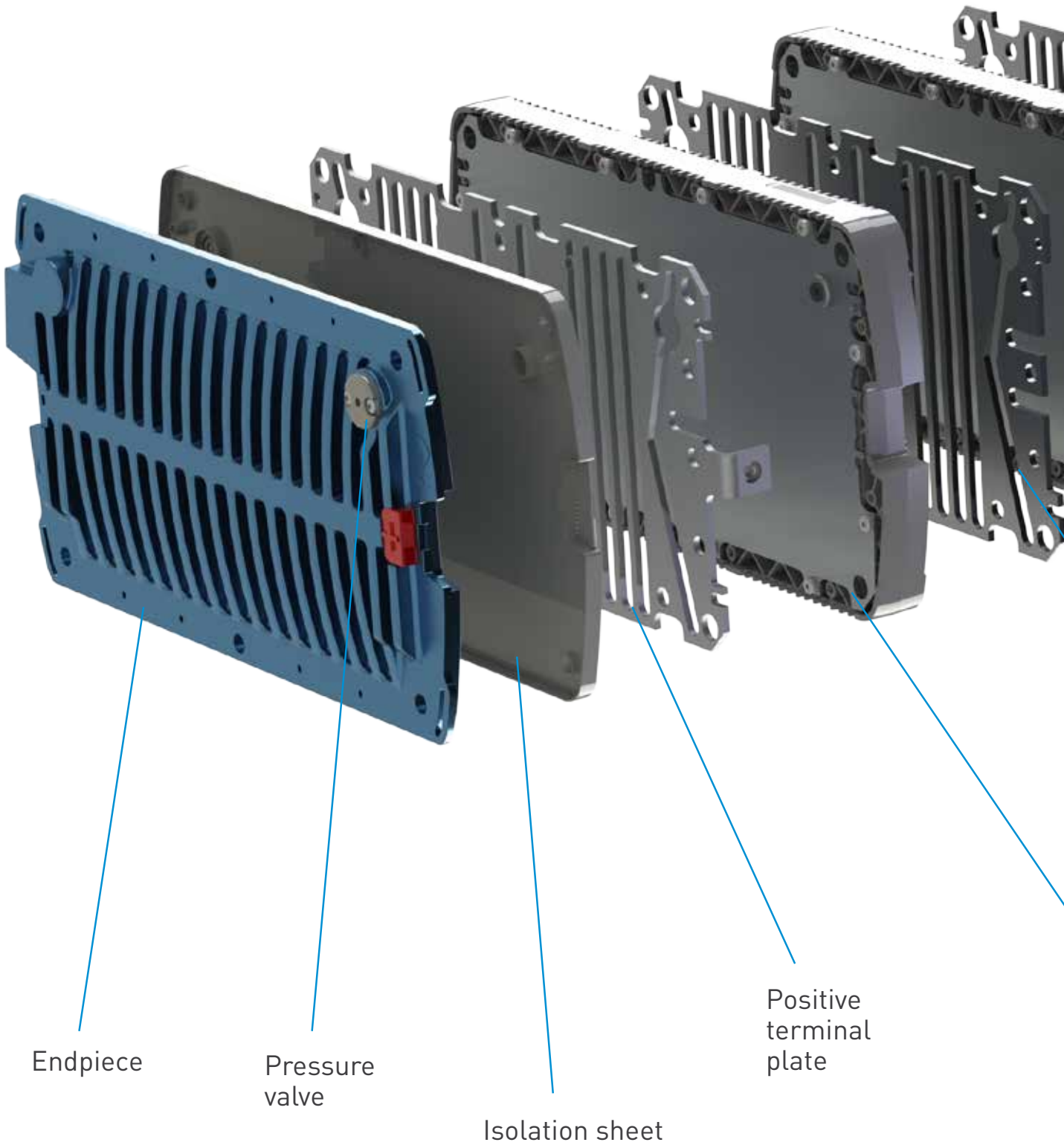
The patented Nilar technology enables the cell and subsequent module manufacturing steps to be combined into one process.

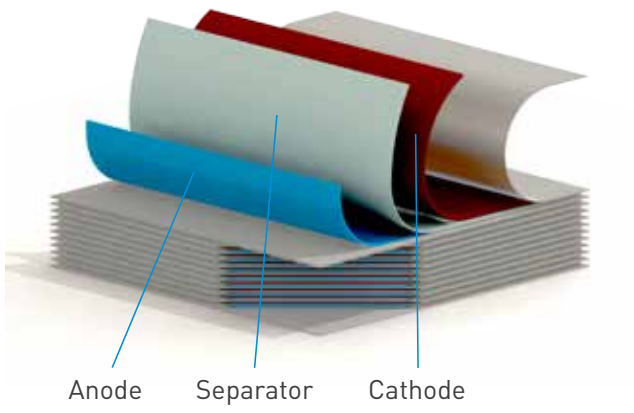
The modules, in turn, can be assembled into battery packs of different capacity (Ah) and/or voltages (V) in a very simple stacking operation. The Nilar manufacturing process involves no welding operations, typically a weak point in battery construction.

As a final step, Nilar has developed proprietary, modular, electronic battery management systems.

Together, these features provide unique flexibility to tailor application specific energy storage solutions.

The 12V energy modules are the key building blocks in Nilar's energy storage solution. The modular system is maintenance free, energy optimized for demanding industrial applications, fully recyclable, and has no hazardous materials incorporated.





The Nilar Battery Pack

Endpiece
There is one endpiece on each side of the pack connected to assure the required compression. Besides providing uniform cell compression over the electrode surfaces it also provides impact protection to the cell stack as well as electrical insulation from the pack potential.

Pressure valve
The Nilar battery pack is fitted with one self resealing pressure valve per pack with an opening pressure of 689 kPa corresponding to 100 psi. The pressure valve is located on the end piece with the negative terminal connector. The pressure valve is only activated at abusive conditions. At normal operation the internal pressure of the Nilar battery pack is lower than the opening pressure of the safety valve.

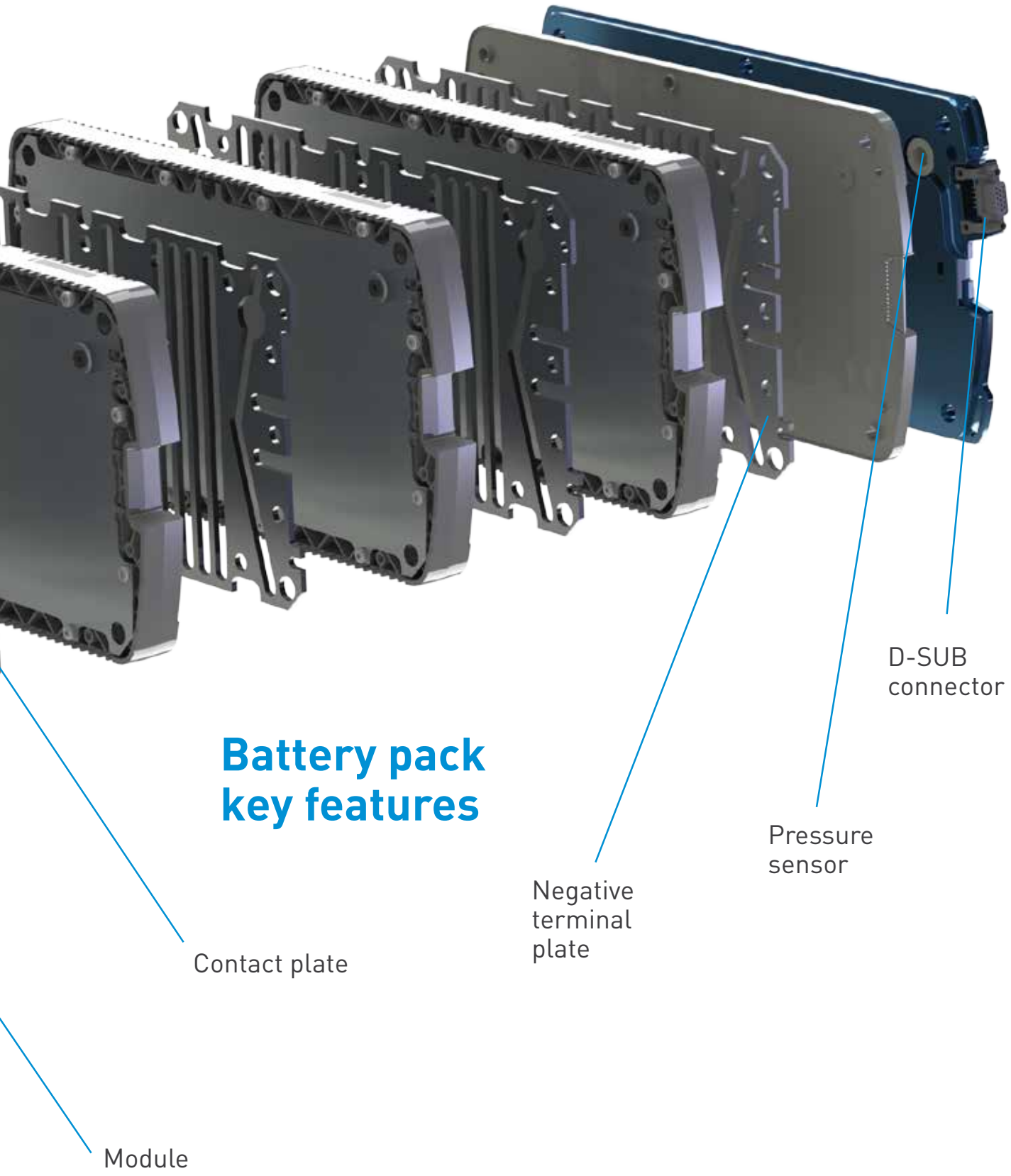
Isolation sheet
The isolation sheet isolates the endpieces from the pack voltage potential.

Terminal plate
The terminal plate is a contact plate with an integrated terminal pillar for connecting a battery cable to the pack. There is one positive and one negative terminal per pack. The terminal connector design of the Nilar battery pack does not require any means for sealing between terminal and container to maintain the integrity of the electrochemical system within the cells. The design eliminates the risk of electrolyte or gas leakage thru any terminal sealing.

Contact plate
The contact plate electrically connects the adjacent modules in the pack and thus eliminates the need for external connectors between modules.

Module
The 12 V module is the building block for all Nilar batteries. 10 cells are connected in series in a module to create modules with a rated capacity of 10 Ah and nominal voltages of 12 V.

D-SUB Connector
The D-sub socket, located on the endpiece at the negative terminal pillar, is the communication interface for the modulevoltage, pressure and temperature sensors in the Nilar battery pack.



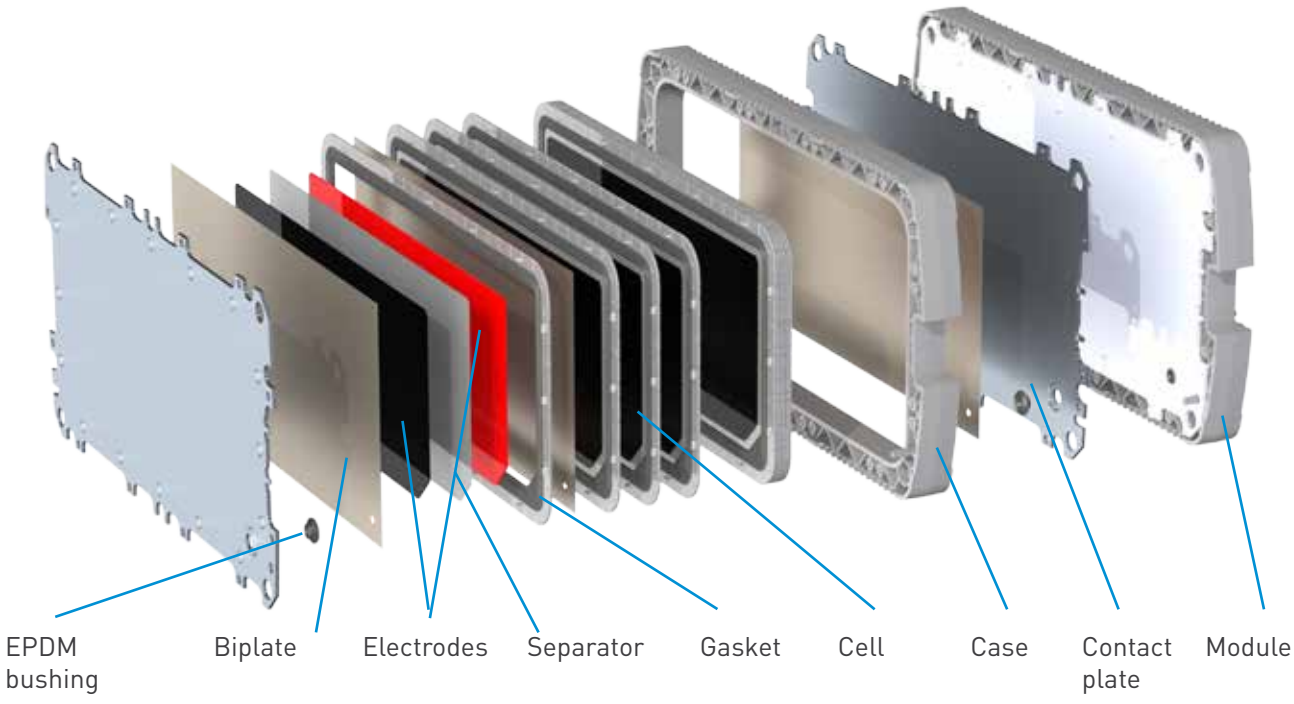
Battery pack key features

NiMH bi-polar module design

Nilar fundamentally innovated battery design through developing a completely new way of building a modular, bi-polar battery. Bi-polar design has always been the holy grail of battery technology, but has up until now been difficult to realize. Nilar's design has managed to overcome previous issues through innovative thinking and modern technology, resulting in total modularity at the production, battery pack and at the cell level. Furthermore, the bi-polar design has advantages in performance derived from inherently low internal resistance, which enables high input/output currents.

The design also increases the utilisation rate of the active materials such as cobalt coated nickel hydroxide and metal hydride: above 95 per cent of the theoretical capacity. The solution optimizes space and dramatically reduces part count, which results in lower manufacturing cost, coupled with considerable performance advantages compared to cylindrical and prismatic NiMH batteries.

A main advantage of the bi-polar design utilized by Nilar is the large area current collector. This important feature inherently results in uniform current flow across the cell, thus minimizing harmful gradients across the cell. Uniform current and resistance paths promote uniform heat generation over the electrode surface, i.e. low temperature gradient within each cell in the battery. A uniform battery temperature promotes a uniform electro-chemical aging of the electrodes in the modules, which translates to a longer cell life. The design eliminates the need for inter-cell connectors and the need for safety valves is reduced to one valve per module instead of one valve per cell as with traditional cell designs.



Superior bi-polar solution with modular design

- "Lasagne" stacked bi-polar design allows the whole area between each cell to be used for current transfer
- Uniform transfer with less resistance and heat results in a longer battery life
- Resilient for high speed charging trough seamless transfer of current

The battery pack construction is based on the module. The module 12 V is the building block for all battery packs, and the number of modules in a pack determines the voltage and the capacity. Bi-polar modules are easily stacked into packs; this provides the flexibility to adapt to specific customer requirements at attractive cost and performance ratios.

Operating features

Discharge voltage

The discharge voltage of the Nilar battery pack is typical for NiMH batteries with a moderate initial voltage drop followed by a stable plateau voltage for the middle 80% of the discharge and a distinct knee at end of the useful capacity. Discharge voltage is dependent on discharge rate, temperature and the state of charge. The discharge voltage decreases with increased discharge rates and decreases with decreasing temperature.

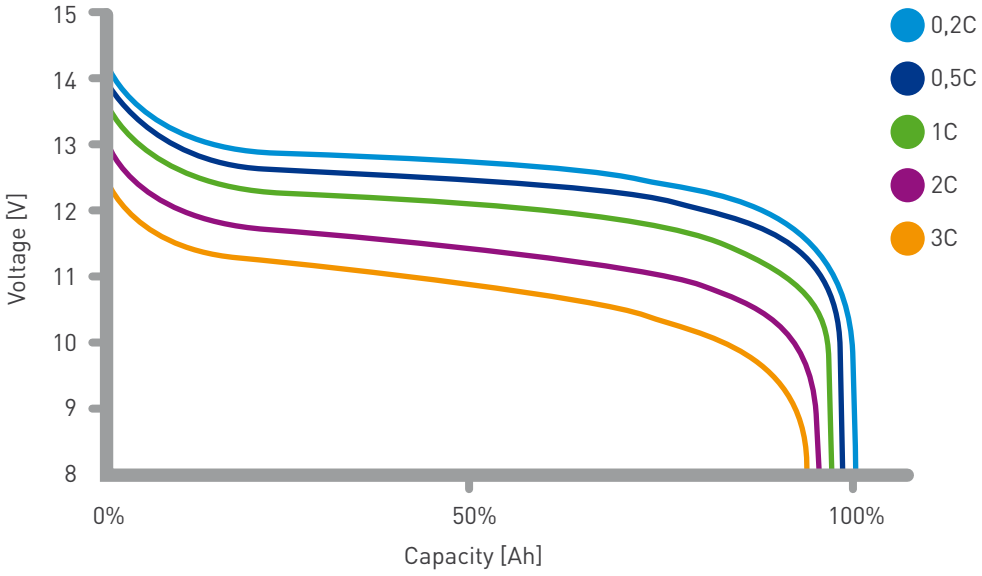


Figure 1.
Constant current discharge at +20 °C.

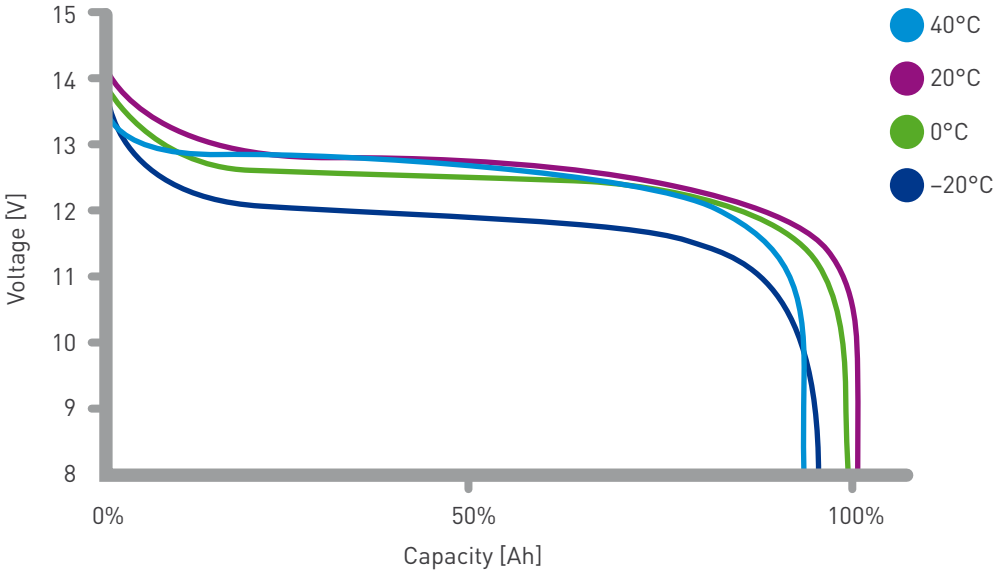


Figure 2.
Constant current discharge with 0.2C at various temperatures.

Charging

Nilar charging systems

Nilar battery packs require optimized charge procedures and charge settings to ensure performance and service life. Constant current chargers modified to enable control from the Nilar charging system are required. Packs with modules connected in series, with a rated pack capacity of 10 Ah, can be charged with constant current chargers with specific charge termination settings that are based on pack temperature, pressure and terminal voltage. In parallel configurations, packs have to be charged with electronic charge control systems controlling individual modules in the pack. The electronic charge systems offered by Nilar can be used with both serial and parallel pack configurations. For specific applications, where the customer wants to integrate their own battery management systems, Nilar will provide algorithms and settings in cooperation with the customer.

Low voltage BMS

- Packs with modules in series and parallel configurations
- Low voltage systems 12 – 48 V
- Controls charging on module level
- Communicates with Nilar approved chargers to regulate charge power

High voltage BMS

- High voltage system 60 – 720 V
- Communication interface with charge settings, alarm signals and pack status indicators for large format energy storage systems
- Communicates with main control system through Programmable Logic Controller (PLC)

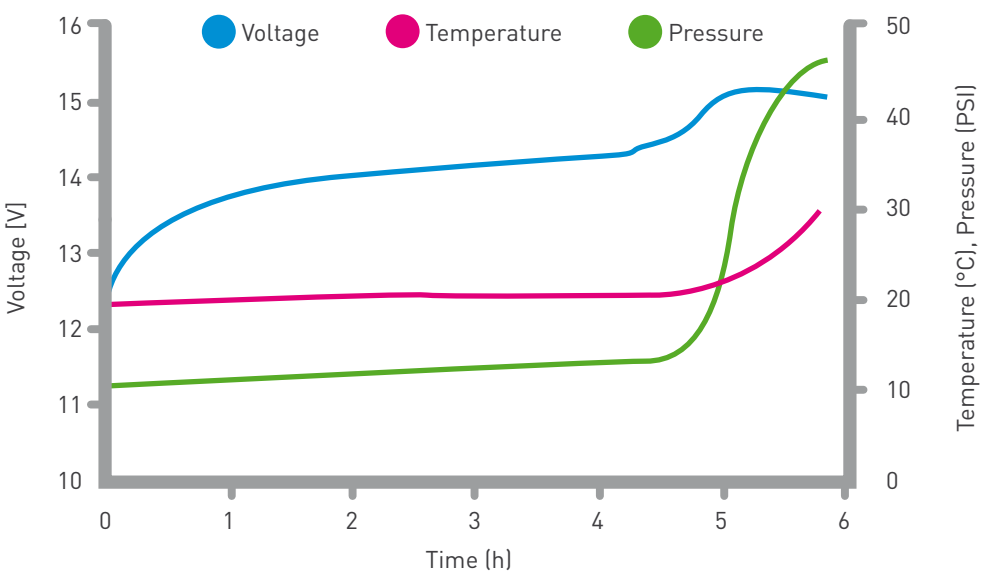


Figure 3.
Typical charge characteristics at +20 °C when charging a 12 V / 10 Ah Nilar battery pack with 0.2C A to a charge termination based on rate of temperature increase (dT/dt).

Green battery technology

Nilar's bi-polar NiMH batteries are fully recyclable and contain no hazardous chemicals. Furthermore, the Nilar manufacturing process uses no volatile organic compounds and does not create any waste streams that could potentially impact air or water. When the Nilar battery has reached end of life, recyclers will turn the active materials into raw ingredients.

A report from Sweden's Environmental Protection Agency states NiMH's lower weight, in combination with higher capacity and longer operational periods, are reasons why NiMH is well placed to substitute toxic metals.

The Nilar production process

1. The production process starts with pressing specially treated metal powder onto thin sheets of substrate that will form the positive and negative parts of the battery cell. The sheets are cut to the correct size and optically inspected by a robot to ensure quality.

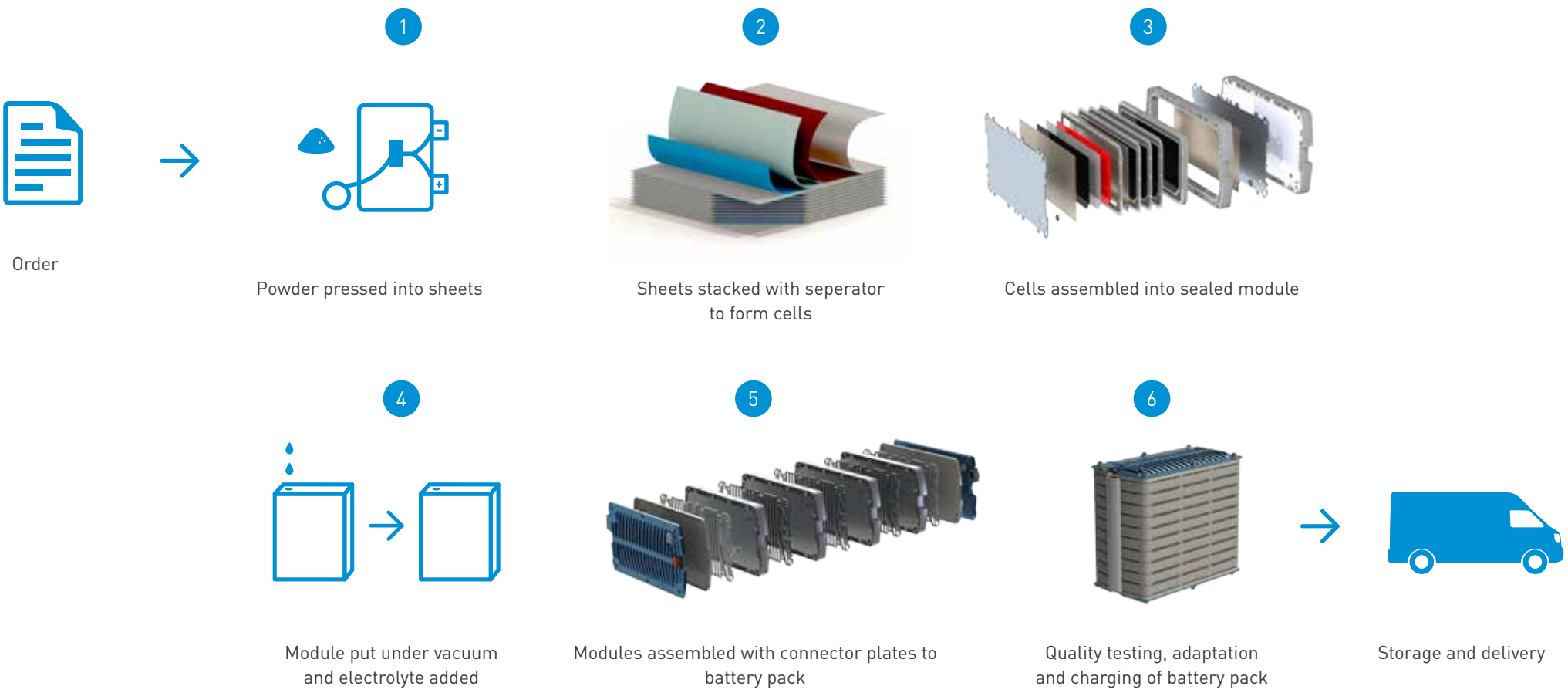
2. Once quality tested, the sheets are sent to the assembly robot, which stacks the sheets like a lasagne, with a separator between each sheet to form the battery cell.

3. In the next stage, cells are assembled by robots, together with gaskets and fittings, to form a sealed module.

4. After the module is finished, it is placed under vacuum and electrolyte is distributed evenly throughout the cells in the module.

5. After adding the electrolyte, the module is ready to be stacked and assembled, together with connectors, endplates and electronics, into a battery pack.

6. For each module added, the battery pack increases with 12V, enabling a large range of variants to satisfy different voltage requirements, by simply adding more or fewer modules into the pack. Once assembled with control electronics, the pack undergoes rigorous quality testing, formatting and charging. The battery pack is cycled (formatting) – repeatedly charged & discharged – to activate the battery. When this process is completed, the battery is ready for delivery.



Nilar battery pack features

Nominal Voltage
For the nickel metal hydride system used in Nilar's battery pack, the nominal cell voltage is 1.2 V. The smallest unit in a Nilar battery pack is the 12 V module with 10 cells assembled in series. Modules in a pack are connected in series to achieve a nominal battery voltage in multiples of 12 V.

Rated Capacity
The battery capacity is rated in ampere-hours (Ah) and denotes the quantity of electricity a fully charged battery can deliver at a 5 h discharge to 1 V per cell at +20 °C. A Nilar battery pack module has a capacity rating of 10 Ah. Modules in a pack and packs are connected in parallel to achieve the rated battery capacity in multiples of 10 Ah.

Operating voltage
Operational battery voltage is dependent on the number of cells connected in series in the battery, state of charge, discharge rate, temperature and on how the battery is being charged. Typical operational voltage for the Nilar battery pack is 1.6 to 1 V per cell corresponding to 16 to 10 V for a 12 V Nilar battery pack module.

Operating temperature
The Nilar battery pack can, in general, be operated in temperatures from -20 °C to +50 °C.

Intermediate state of charge
The Nilar battery pack can be stored or operated at intermediate state of charge for a long period of time without any permanent loss of performance.

Installation
The Nilar battery pack design is a sealed design. At normal operating conditions the Nilar battery pack does not produce any emissions and requires no forced ventilation to handle any explosive gases generated at operation of the battery.

Reliability
The Nickel metal hydride system is a stable electro-chemical system regarding structural integrity of the components in the battery. There is no corrosion of components that can result in premature and unpredictable critical damage to the battery or any type of sudden death. The design is shock and vibration resistant with critical welds and other critical parts eliminated in the design. The end of life characteristics of the Nilar battery pack is a graceful decline in performance over the life.

Storage
Nilar battery packs can be stored several years without loss of performance.

Maintenance
The Nilar battery pack is a sealed design with no need, or possibility, to fill up electrolyte. The Nilar battery pack requires a minimum of maintenance and in many applications no maintenance at all.

Transport
One of the advantages with the Nilar battery pack, as compared with many other battery types and especially Li ion batteries, is that the Nilar battery pack does not require UN approved packaging and marking when transported by sea, road, rail and air.

Disposal
Environmental protection is highly prioritized by Nilar, starting at the design and development of new products, during production and process development, to end-of-life collection, disposal, and recycling. Nilar continuously works to improve all stages of the battery's life cycle with the aim to minimize environmental impact. Nilar stays in the front line of recycling technology by participating in different research programs for recycling.

Design: Lupodesign.se. for Nilar International AB

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