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CalBatt™
premium charging technology

NomoStor

The indispensable decision support tool for best-in-class battery chargers

How to maximize charging efficiency

THE KEY POINT

A crucial question arises in dealing with batteries:

How to control the charging power to achieve maximum efficiency while meeting power availability and charging time constraints?

Being able to manage effectively this dilemma is the enabling factor to win competition in the development of a large series of devices in Energy Storage and E-mobility applications

Efficient battery charging is, in fact, not just a matter of hardware, since a poor control of the charging power can make the **real efficiency** achieved on the field remarkably lower than the peak efficiency attainable, jeopardizing in part the effort of introducing more efficient chargers and batteries. This is because charging efficiency actually depends on the mutual interaction between the efficiency performance of the battery and the charger, which show a complex dependence on:

- **charging parameters** (current and voltage);
- **specific characteristics** of the two devices, which vary during the life of the vehicle because of components aging and even every day during the charging process, because of the continuous variation of the battery state of charge.

WHERE "BLIND" TRADITIONAL CHARGING TECHNOLOGIES FAIL

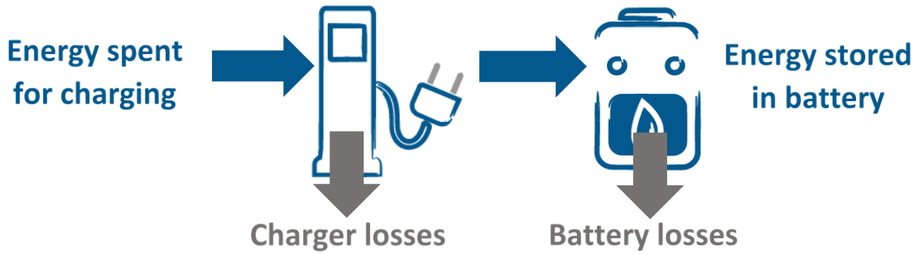
Traditional charging management technologies are based on constant-current/constant-voltage charging profiles using **pre-defined thresholds** which do not take into account actual efficiency characteristics of the specific battery/charger set. **This makes traditional charging resulting in energy waste.**

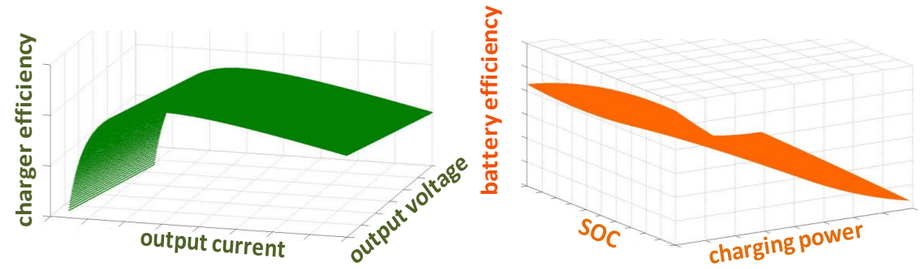
The solution: CalBatt premium charging technology

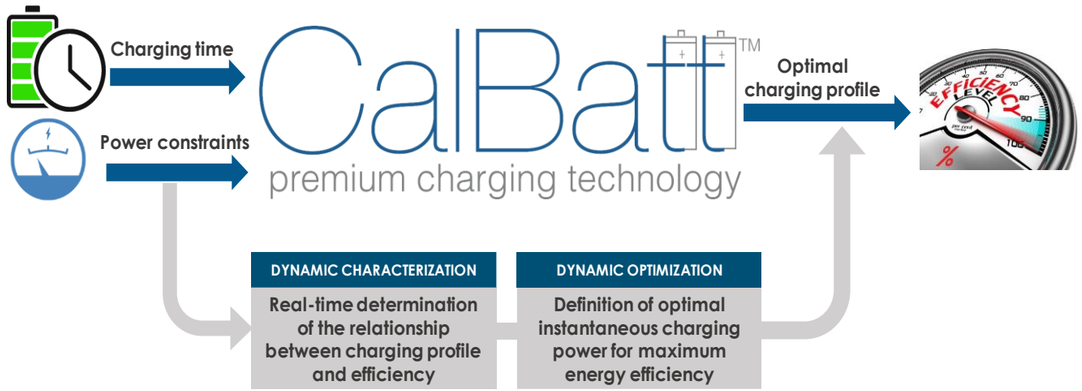
CalBatt patented innovative technology (patents EP2709202 and US2014081585) allows the **real-time characterization and forecast** of efficiency performance of both the charger and the battery during the charge. Thanks to this unique feature, CalBatt technology allows to perform a **"what-if"** analysis to know which would be the instantaneous charging efficiency related to each possible charging power, and perform accordingly an **optimized dynamic modulation** of the charging power.

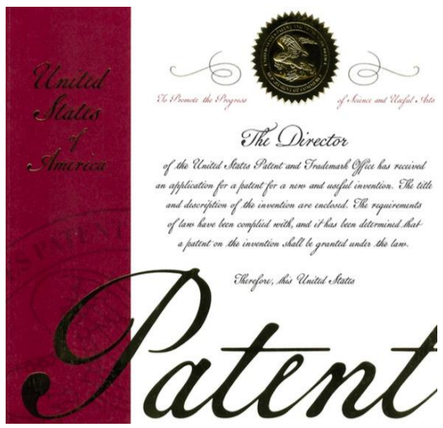
UNIQUE BENEFITS

- ✓ **Maximum energy saving,** increasing the real charging efficiency by **up to 15%**
- ✓ **Maximum money saving**, thanks to a **perfectly coordinated charging management** allowing to spread the charge intelligently also in the presence of variable tariffs and in a demand response scenario
- ✓ **Forecast**, allowing to predict the efficiency performance of both the charger and the battery for **predictive maintenance** and smart **Energy Management Systems**









(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) EP 2 709 202 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication: 19.03.2014 Bulletin 2014/12

(51) Int Cl.: H01M 10/44 (2006.01) H02J 7/00 (2006.01)

(21) Application number: 13425120.6

(22) Date of filing: 06.09.2013

(84) Designated Contracting States: AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States: BA ME

(30) Priority: 18.09.2012 IT RM20120446

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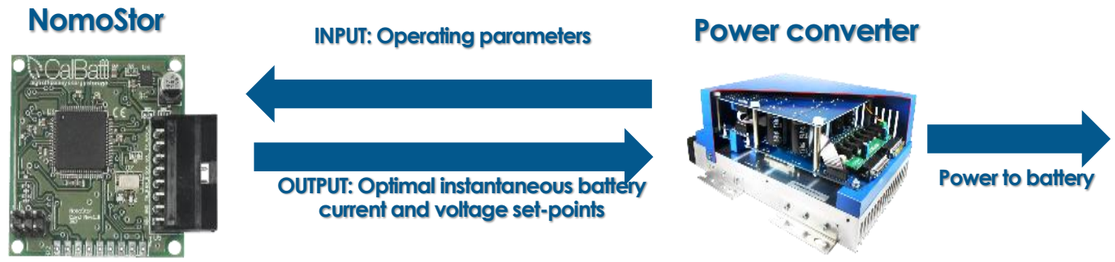
(54) System and method for the measurement and prediction of the charging efficiency of accumulators

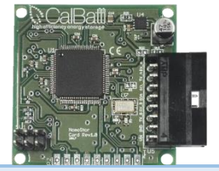
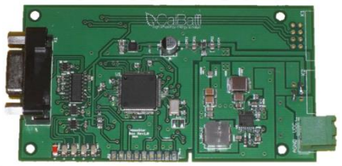
A complete portfolio of smart charger controllers

CalBatt technology is implemented by **NomoStor** charge controller, an **add-on card** which can be practically embedded with charging control logic units of power converters thanks to ad-hoc communication protocols (more details about communication available on requests).

Working as **decision support tool**, NomoStor synthetizes inputs data from the charging control unit about operating parameters of battery and power converter (battery voltage, current and SOC, input power of the charger, maximum charging time and power available) into a **simple answer** indispensable for smart battery charging: the **optimal** instantaneous battery current and voltage set-points for **maximum efficiency**.

NomoStor is available in two versions (Core and Card) for maximum flexibility in implementing a broad range of applications in Energy Storage and E-mobility fields.



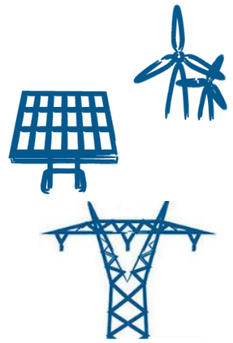
NomoStor Core	NomoStor Card
	
Supply Voltage: 3,3 V; 5V (Two options)	**Supply Voltage:** 7-36 V (Wide range)
Communication protocols: I2C, UART	**Communication protocols:** RS232

HOW TO USE NOMOSTOR FOR ENERGY STORAGE APPLICATIONS

- ✓ **Renewables: smart battery inverters** capable of guaranteeing really **maximum self-consumption** of renewable sources
- ✓ **Smart grid**: **advanced power converters** capable of **maximizing profitability** of grid flexibility services (frequency and voltage regulation, load shifting etc.)
- ✓ **Microgrids**: **intelligent hybrid gensets** capable of **minimizing diesel consumption** in remote off-grid areas

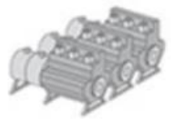
HOW TO USE NOMOSTOR FOR E-MOBILITY APPLICATIONS

- ✓ **Automotive: smart battery chargers** implementing the **Eco-Charging** mode for **minimizing energy costs** of each recharge according to user charging time needs
- ✓ **Industrial**: **advanced battery chargers** capable of **minimizing the Total Cost of Ownership** of forklift fleets used in intralogistics
- ✓ **Railway**: **intelligent battery chargers** capable of **maximizing the effectiveness** of battery used for railway services



Renewables

Smart grids



Microgrids

Automotive

Industrial

Railway

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Best-in-class Energy Storage systems

Smart battery inverters for renewable plants

Standard inverters generally start battery charging as soon as the renewable production begins, and they use only the battery to satisfy entirely loads until the battery is not completely discharged, without caring about the impact of the charging/discharging profiles on the roundtrip storage efficiency. But what if battery could be used not just as a simple "tank" to store the excess energy produced by the PV plant, but as **another smart appliance which offers a further degree of freedom in the energy management**, by optimally "shaping" battery charging and discharging power?

This is what can be achieved by embedding NomoStor into the inverter control logic: an optimal scheduling of the charging during renewable production and a perfect "mix" of power coming from the battery and the grid to satisfy loads, leading to **maximize really the storage roundtrip efficiency and then the renewable self-consumption**.

Intelligent power converters for smart grid

Smart grid requires effective energy storage systems as flexibility resources to perform frequency/voltage regulation, load shifting etc. Standard power converters perform grid services without taking into account the importance of efficient storage management to maximize revenues from grid services.

The integration of NomoStor into the power converter control logic allows implementing intelligent storage management to set perfectly the battery charging/discharging power taking into account energy efficiency other than constraints on grid load, voltage and frequency and on battery degradation, for a **real economic optimization of electrical systems into the smart grid**.

Advanced hybrid gensets for microgrids

Batteries can be effectively used together with diesel gensets to optimize the generator efficiency and then to reduce oil consumption. However, traditional genset controllers implement energy management strategies which neglect the importance of making also the batteries to work at its maximum efficiency.

Embedding NomoStor into genset controllers allows maximizing really the overall genset efficiency and battery care, **minimizing really operating costs of microgrids**.

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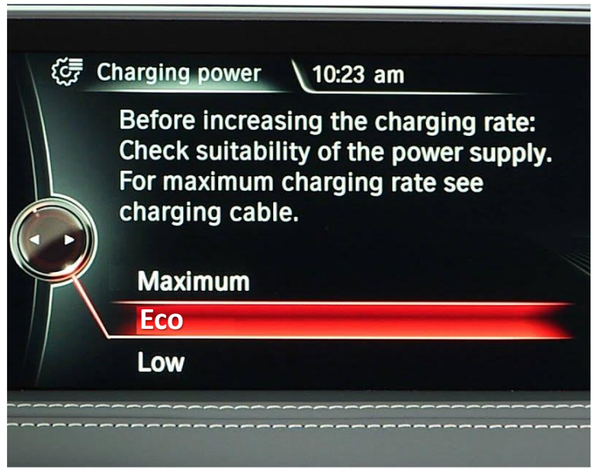
Best-in-class chargers for e-mobility

Smart battery chargers for automotive

How to set the best charging profile for electric vehicles according to charging time needs of the vehicle owner? The answer is the innovative **Eco-Charging** mode guaranteed by NomoStor, which allows identifying every day the best charging profile for the specific battery/charger set.

The integration of NomoStor into the control logic enables the implementation of smart EV battery chargers capable of **minimizing re-charging costs** and guaranteeing a **unique user experience**.



Advanced battery chargers for industrial forklifts

Standard battery chargers for electric forklifts use pre-defined charging profiles which do not take into account the particular characteristics of the specific battery, resulting in energy waste and poor battery care.

Embedding NomoStor can allow to realize advanced industrial chargers which allow to **minimize energy and battery maintenance costs** of forklift fleets used for material handling.

Intelligent battery chargers for railways

Batteries are very critical devices to achieve maximum service levels in railway transportation.

NomoStor allows developing intelligent chargers capable of maximizing energy efficiency and useful life of railway batteries, for **minimum Total Cost of Ownership and maximum quality of service**.

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About CalBatt

CalBatt develops solutions for smart charging of Energy Storage Systems and Electric Vehicles, based on its proprietary technology born in internationally recognized labs of University of Calabria. Since its beginning, the Company has always been fully committed to R&D, receiving several **awards** for its innovation.

Awarded by Enel for its disruptive technology validated on-field

In the **top 10 most innovative** European companies at Munich Cleantech Conference

Recognized as one of the Italian excellence in green technology at **COP 21 Paris Conference**

Awarded by EU Commission with "**Seal of Excellence**" for Companies with most innovative technologies in the world

Making batteries smarter

CalBatt™
premium charging technology

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