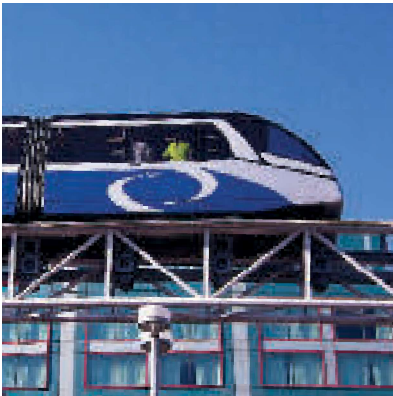
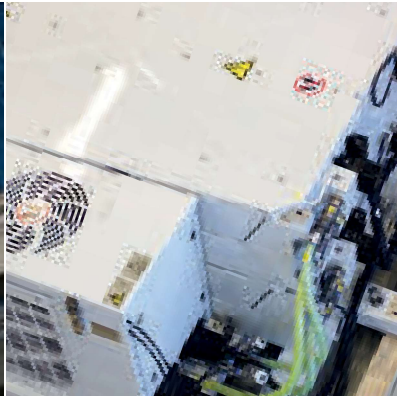


Saft's Ion-OnBoard[®] Regen Li-ion battery system

For regenerative traction



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Capture, store and reuse regenerative braking energy



For today new urban challenges, Saft's onboard Li-ion battery systems provide both high power and reserve energy to deliver increased energy efficiency for a variety of rail vehicles for eco-cities.

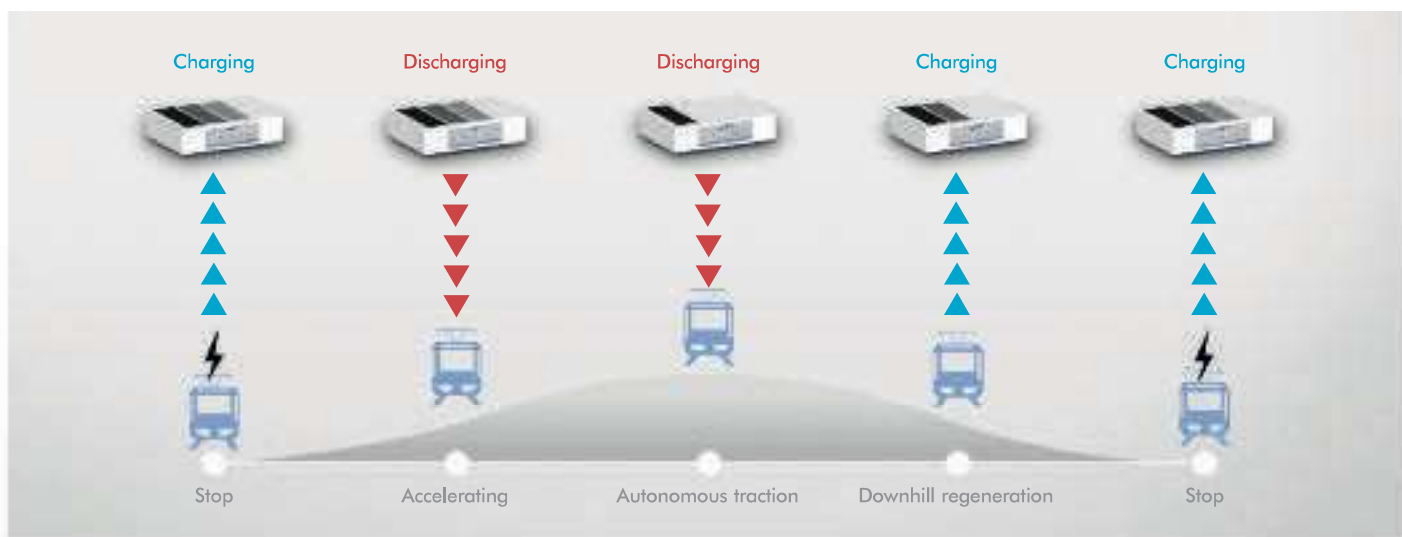
Saft Ion-OnBoard® Regen Li-ion battery system:
Engineered for autonomous traction and regenerative braking

- Provides autonomous traction power for catenary free or emission free operations
- Stores kinetic braking energy (regenerative braking) and reuses it for autonomous traction and to boost train acceleration

Saft Ion-OnBoard® Regen Li-ion battery system:
A flexible concept that suits a multitude of trains

- Light rail systems including trams, streetcars and tram-trains
- Electric-powered trains including electric multiple units (EMUs)
- Diesel hybrid / diesel shunting and freight locomotives / DMUs
- Automated People Movers (APMs)

From start to finish, Saft Ion-OnBoard® Regen Li-ion battery system delivers an energy efficient journey



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Saft Ion-OnBoard® Regen Li-ion battery system

Designed for modularity and optimized energy

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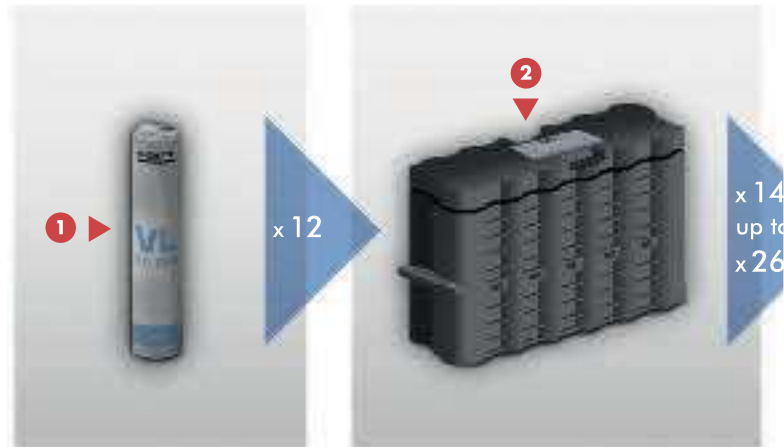


Saft Ion-OnBoard® Regen battery system - built on years of experience

- 20 years of expertise in taking Li-ion technology from R&D to mass production
- Proven capability in delivering Li-ion systems for hybrid automotive applications
- Broad portfolio of Li-ion technologies, industrially produced, enables Saft to provide the ideal electrochemistry for any application
- Key focus on safety & reliability
 - Protection devices are embedded in every cell, module and battery
 - Integrated real-time battery management system ensures optimized functionality and long life

Saft Ion-OnBoard® Regen battery system : designed to meet the following rail standards

- Shock and vibration: IEC 61 373
- Fire and smoke: EN 45 545-3/NFPA 130/BSS 7239
- Electrical insulation: NF EN 50 124-1
- IP protection: NF EN 60 529
- Electrical safety: NF EN 50 155
- Industrial Li-ion: IEC 62620
- EMC: NF EN 50 121-3-2
- Welding: EN 15 085 / EN ISO 13 918
- Transportation: UN 3480 – Class 9



1 Saft Li-ion cells: VL 30 PFe

Delivering high power and energy from a single source

- VL 30 Power cells based on PFe Super-Phosphate™ (SLFP) Li-ion chemistry
- Maintenance-free to reduce operating costs
- High power and energy efficiency to suit regenerative applications

2 Saft Li-ion modules: Modul'ion® 12 Power

Versatile modules for flexibility

- Each module comprises 12 VL 30 PFe cells
- Modules are available in 2 configurations:
 - Modul'ion® 12 Power - 20 V - 56 Ah
 - Modul'ion® 12 Power - 40 V - 28 Ah
- Modules are connected in series
- Modules are liquid cooled
- Light weight and compact design reduces the installation footprint



Saft Ion-OnBoard®
Regen Li-ion battery
systems are stackable.
Each battery system is
electrically independent.



3 Saft Battery Box

Modular and adaptable building blocks

- 3 customisable Battery Box lengths:
 - Short - up to 2 rows of 7 modules
 - Medium - up to 2 rows of 10 modules
 - Long - up to 2 rows of 13 modules
- 2 different widths due to the position of the Power Box
- Ensures easy installation and direct integration into the rail equipment

4 Saft Power Box

Real time management for optimum performance

- Enables self-testing to verify internal functions
- Ensure safe operation of the Battery System
- Allows operators to manage the energy efficiency of their power usage in real time
- Can be located "in line" or "on side" (see below illustration)



5 Saft Battery System

Wide range of modular configurations

- Saft Ion-OnBoard® Regen Li-ion system is composed of a set of modules, a Battery Box and a Power Box
- Each of Saft Ion-OnBoard® Regen Li-ion system is electrically independent and is to be charged by its own charging system.

Battery Box type	SHORT	MEDIUM	LONG
Number of modules up to	2 X 7	2 X 10	2 X 13
Modul-ion® 12 Power 20 V - 56 Ah	Nominal Voltage (V) 198 to 277 Rated energy at C5 (kWh) 11.2 to 15.7 Max. Pulse Discharge (kW)* 83 to 116	317 to 396 18 to 22.1 133 to 166	436 to 515 24.4 to 28.8 183 to 218
Modul-ion® 12 Power 40 V - 28 Ah	Nominal Voltage (V) 396 to 554 Nominal Energy (kWh) 11.2 to 15.7 Max. Pulse Discharge (kW)* 117 to 164	634 to 792 17.7 to 22.1 188 to 238	871 24.4 to 28.8 257 to 304

All above data are typical values.

* in 30 s - Please contact Saft for battery sizing

6 Saft BTMS (Battery Thermal Management System)

Optimal and effective thermal management

- Ensures performance and long battery life by maintaining the operating temperature in a range from + 15°C to + 45°C
- Maximizes the useful energy available
- Option to use Saft's standard BTMS (6 kW) or customer's own BTMS

Saft Ion-OnBoard® Regen Li-ion battery system: driving energy efficiency



Next generation traction for a brighter, cleaner and more affordable future

Today, new urban cities and passengers require quieter vehicles that minimize the carbon footprint and the aesthetic appeal of city centres. Recent years, the rail industry has seen great progress in making rail transport more affordable and won a well-earned reputation as a sustainable mode of transport.

New energy efficient technology in areas such as regenerative hybrid traction is now helping to make the industry even more environmentally friendly and economically competitive.

Saft Ion-OnBoard® Regen Li-ion Battery system – the benefit of cutting-edge Li-ion technology

Lithium-ion (Li-ion) battery technology helps rail operators to achieve significant reductions in both emissions and operating costs. It provides the efficient high performance onboard power needed for regenerative hybrid traction, autonomous catenary free electric trains and hybrid diesel locomotives.

Delivering high power and energy from a single source

- High power and energy density compared with other commercially available technologies
- High cycling performance
- Modular, lightweight and compact systems for easy installation

Effective energy storage for regenerative braking efficiency

- Regenerative braking improves energy efficiency – with the potential for transport operators to save up to 30% of their energy costs
- Elimination of overhead catenaries reduces both infrastructure construction and maintenance costs
- Energy storage provides a reserve for use during periods of increased demand that facilitates peak shaving and/or demand management functions

Innovation reduces environmental impact

- Reliable battery power reduces diesel engine noise and particulate emissions during idling
- Hybrid traction using an onboard battery cuts diesel fuel consumption or electricity usage on electrical trains
- Autonomous battery-based traction without overhead catenaries makes mass transit systems more acceptable and aesthetically appealing, especially in historic city centres

Saft is committed to the highest standards of environmental stewardship

As part of its environmental commitment, Saft gives priority to recycled raw materials over virgin raw materials, reduces its plants' air and water releases year after year, minimizes water usage, reduces fossil energy consumption and associated CO₂ emissions, and ensures that its customers have recycling solutions for their spent batteries.

Regarding industrial batteries, Saft maintains long standing partnerships with collection companies in most EU countries, in North America and in other countries. This collection network receives and dispatches our customers' batteries at the end of their lives to fully approved recycling facilities, in compliance with the laws governing trans-boundary waste shipments.

Saft has selected a recycling process for industrial lithium-ion cells with very high recycling efficiency. A list of our current collection points is available on our web site. In other countries, Saft assists users of its batteries in finding environmentally sound recycling solutions. Please contact your sales representative for further information.



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