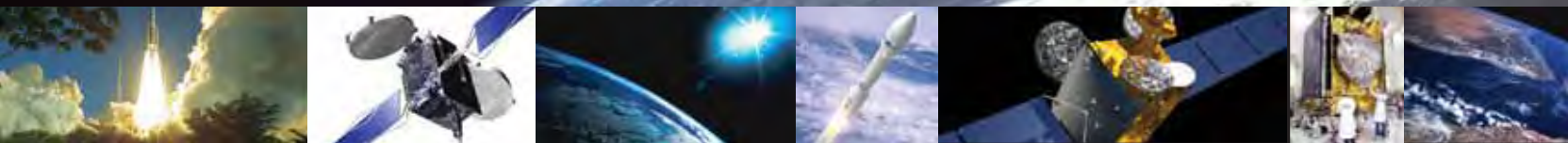


Rechargeable Li-ion battery systems

Light energy storage for space applications



Saft. A hi-tech capability

Moving forward with lithium-ion



Saft is trusted, universally

Saft is a recognised leader in bringing cutting-edge battery systems to the market. More than 40 years in space. Professional experience from over 100 years' close association with international industry enable Saft continually to push back frontiers through innovative thinking and development of advanced technology.

How do our customers view Saft?

Major industries acknowledge Saft's expertise and have installed new battery technology in their applications. The benefits that flow from installing Li-ion bring significant advantages over traditional solutions.

Why lithium-ion in space?

Batteries for high-tech space applications face a particularly tough life. They must deliver additional guarantees of reliability, performance and durability.

How do you improve upon conventional energy storage capability? Saft has the answer: lithium-ion batteries.

The first, with Li-ion

Saft shares a pioneering spirit with many of its customers who lead in their own fields of high technology. Our customised solutions contributed to the success of

- the first military GEO satellite (Syracuse IIIA with Li-ion)
- the first permanent constellation of MEO satellites (Galileo)
- W3A, the first civil GEO, communications satellite, launched in 2004 with lithium-ion batteries
- the first mini-LEO satellite powered by rechargeable Li-ion batteries (Calipso)
- SMART 1, the first moon probe to use Li-ion VES batteries



Li-ion: staying ahead in space

A new dimension in energy storage

Saft is already present ...

Saft has built a long-term relationship with the industry, providing technical excellence and expert support continuously from conception to implementation, and beyond.

Fully integrated energy storage systems are already deployed in key space applications such as launchers, satellites, ATVs, probes, power tools and planetary rovers.

Saft is involved with cutting-edge, high profile companies, including

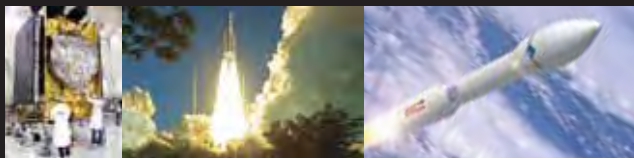
- Alcatel Alenia Space
- Arianespace
- Boeing
- EADS Astrium
- ELV (Vega)
- Galileo Industries
- Orbital Sciences

... and is part of the future

The next generation Li-ion VES 180S high energy cells have been commissioned for the Galileo IOV satellites, confirming Saft's position as European leader.

Saft is deeply committed to research innovative solutions for new applications. For example, through detailed research into lithium-ion, our focus on developing VES180 has resulted in achieving 165 Wh/kg.

Saft's offer will evolve to provide both standardised battery designs and customised products suiting most requirements in a diversifying market.



Saft Li-ion cells – specially designed for space applications

	VES 100	VES 140	VES 180	MPS	VL8P
GEO		●	●		
MEO		●	●		
LEO-minisat	●	●	●	●	
LEO-microsat	●	●	●	●	
Launchers				●	●
Space vehicles	●	●	●	●	



The Li-ion advantage – smaller, lighter, more durable

Built to meet objectives

Saft's Li-ion cells are specially adapted for space applications from field-proven designs. Cells are manufactured on two sites – Bordeaux (France) and Cockeysville (USA) – which together meet the demanding quality, schedule and cost objectives of space programs.

A high cycle life is guaranteed by design: spiral-wound cylindrical cells are mechanically sealed into aluminium containers enabling high specific energy in a compact format.

Smaller and lighter

High voltage lithium-ion cells averaging 3.6 V/cell equal the energy storage of 3 serial-connected Ni-Cd or Ni-H₂ cells, but in a smaller package. Around 50% weight reduction leaves room for a larger payload.

Radiator size reduction

Li-ion's low thermal power with high energy efficiency enables installation of smaller solar panels and battery radiators, further reducing critical weight.

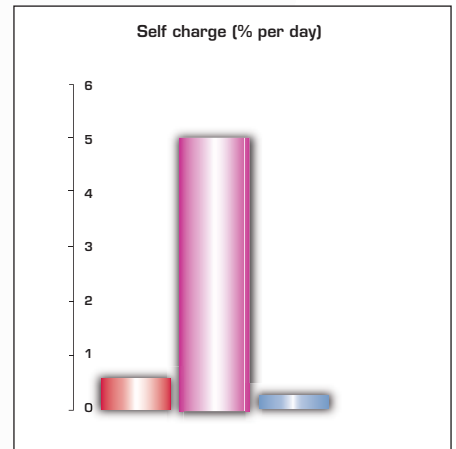
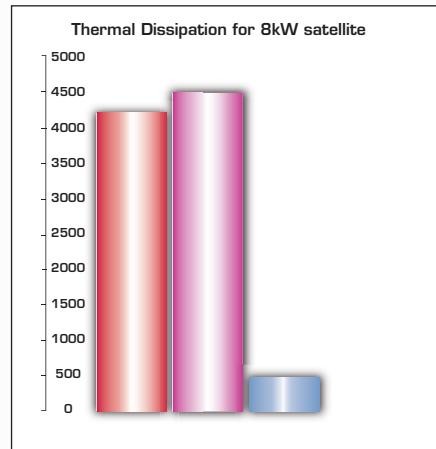
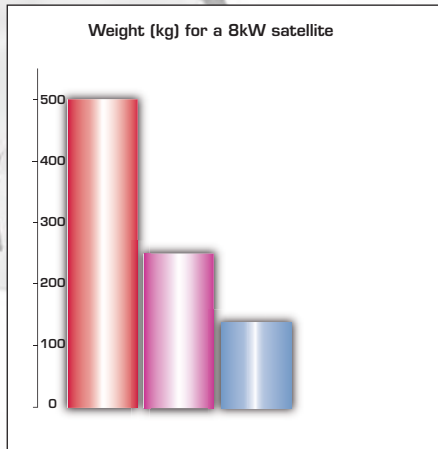
Zero maintenance, maximum performance

Li-ion batteries do not require reconditioning since the exchange of lithium ions does not create a memory effect.

Easier launch pad operations

Lithium-ion batteries retain around 99% charge after one month and do not require charging while awaiting launch. With low dissipation too, conventional safety and thermal management procedures are unnecessary, simplifying pre-launch operations and further contributing to cost reduction.

■ = Ni-Cd ■ = Ni-H₂ ■ = Li-ion



Saft Li-ion cells – technical excellence for performance in Space

VES 100	VES 140	VES 180	MPS*	VL8P	
28	39	50	5.8	7.5	Guaranteed capacity Ah
3.6	3.6	3.6	3.6	3.6	Mean voltage at C/1.5
4.1	4.1	4.1	4.1	4.1	End of charge voltage V at
100	140	180	20	100	Energy Wh
118	126	165	133	118	Specific energy Wh/kg
185	250	250	65	104	Height mm
54	54	53	18x65**	47	Diameter mm
0.81	1.13	1.11	0.15	0.38	Weight kg
Qualified	Qualified	Qualified	Qualified	Qualified	Status
LEO	GEO, MEO	GEO, MEO	LEO	Launcher	Main application

* generation 4

** depth x width

Modular flexibility –

Saft's lithium-ion modular systems are built from the proven types of VES cylindrical and MP prismatic cells. Batteries are based on parallel and series assemblies.

Li-ion is the only technology allowing parallel connection without protection devices.

The benefit? Voltages and states of charge are inherently balanced, even across varying cell capacities.

– for optimised configuration

A multitude of cell arrangements is possible, giving up to 12 cells in parallel (480 Ah) and up to 24 cells in series (100 V). The Li-ion battery design is available for GEO and MEO plate forms, ranging from 3 kW to 30 kW.

– from our range of products

- VES 100
- VES 140
- VES 180 "high energy cell"
- MPS
- VL 8P

	Ni-Cd	Ni-H ₂	Li-ion	System impact
Specific energy (Wh/kg)	30	60	165	Weight saving
Energy efficiency (%)	72	70	96	Reduction of charge power: solar panel
Thermal power (scale 1-10)	8	10	3	Reduction of radiator, heat pipe sizes
Self discharge (%/day)	0.5	5	0.3	No trickle and simple management at launch pad
Temperature range (°C)	0 to 40	-20 to 30	10 to 30	Management at ambient
Memory effect	Yes	Yes	No	No reconditioning
Energy gauge/monitor	No	Pressure	Voltage	Better observability of states of charge
Charge management	CC	CC	CC CV + Balancing	Weight saving
Modularity	No	No	Yes	One cell design, ability to put cells in parallel



VL48E	VL10E
48	10
3.6	3.6
4.1	4.1
170	36
150	139
250	129
54	33.8
1.13	0.25
Qualified	Qualified
GEO, LEO	GEO, LEO

For the special requirements of the US market, Saft has developed cell types VL10E and VL48E.



About Saft

Saft is a world specialist in the design and manufacture of high-tech batteries for industry. Saft batteries are used in high performance applications such as industrial infrastructure and processes, transportation, space and defence. Saft is the world's leading manufacturer of nickel-cadmium batteries for industrial applications and of primary lithium batteries for a wide range of end markets. The group is also the European leader for specialised advanced technologies for the defence and space industries. With approximately 3,800 employees worldwide, Saft is present in 18 countries. Its 18 manufacturing sites and extensive sales network enable the group to serve its customers worldwide.

Saft

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