

Saft. Rechargeable Battery Systems Handbook



SaFT

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Saft, the specialist in Rechargeable Battery Systems

Saft advantages and performances

Saft, a worldwide leader in the design, development and manufacturing of Rechargeable Battery Systems, has developed a broad range of high performance nickel-cadmium and nickel-metal hydride cells to meet the requirements of a wide range of applications. Saft's full range of cells and battery pack solutions use both proven and innovative technologies for exceptional performance tailored to your specific needs. For the best and latest rechargeable cylindrical cells in a wide range of capacities, look no further than Saft.

Saft batteries offer exceptional performances:

- Constant voltage during discharge
- High power
- A broad temperature range (-40°C to +65°C)
- A lifetime often outlasting the equipment they serve
- Zero maintenance
- Extremely high reliability
- Long cycle life (over 500 charge/discharge cycles)
- Excellent long term storage

Saft factories are certified ISO 9001.



Saft, total quality and respect for the environment

Of course, the use of rechargeable is an environment-friendly act since the batteries can be used over and over again. In addition, Saft is extremely sensitive to protecting nature through the battery's entire life cycle. Saft factories strictly adhere to environmental regulations concerning air, water, ground and solid-waste standards. When batteries have given their best through existing national collection and recycling organisms (i.e. RBRC in US, S.C.R.A. in France, and others in European countries), Saft offers a collection and treatment service to recycle Ni-Cd and Ni-MH batteries safely and efficiently. Saft also operates a recycling plant in Oskarshamn (Sweden).



Safety instructions for handling and use

- Never cause a short circuit between battery's positive and negative poles.
- Do not disassemble cells and batteries.
- Do not incinerate or overheat.
- Do not clean cells and batteries with water or corrosive agents.
- Never use a leaking or externally damaged battery.
- Keep cells and batteries away from children to avoid them being accidentally swallowed
- Collect used cells and batteries for recycling to protect environment.

The right battery for every application

Saft meets all your needs

Saft's solutions are customer-driven. Our standard batteries and special power assemblies are engineered to meet the growing power needs for high-power and high-energy battery solutions.

Saft batteries can be found in:

Mobility

Includes e-bikes, e-scooters and other personal electric vehicles.

Professional appliances

Includes handheld terminals, medical electronics, lighting equipment, portable instruments and professional notebook computers.

Security devices

Includes emergency lighting units, back-up systems, UPS and alarms.

Power tools

Includes professional cordless drills, sanders, screw-drivers, agricultural and gardening equipment.

Communication

Includes cellular and cordless phones, Personal Communication systems, private mobile radios and military equipment.

Audio/video









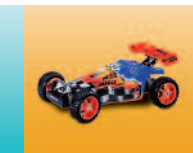
Includes, professional video equipment, camcorders, portable TVs, CD players and personal stereos and digital cameras.

Home appliances

Includes cordless vacuum cleaners, shavers, tooth-brushes, and more.

Battery powered hobbies

Includes radio-controlled cars, boats, planes, electronic games and walkmans.

								
VH/VHT Ni-MH	✓	✓		✓	✓	✓	✓	✓
VT/VNT Ni-Cd			✓					
VE/VSE Ni-Cd		✓					✓	✓
VR/VRE Ni-Cd	✓	✓		✓	✓		✓	

Saft, the expert in battery pack assembly

A world class worldwide battery manufacturer

Saft's sole business is the design and manufacturing of high end battery and energy systems. Saft is an international company with nearly 80 years of experience in cell and battery design and production. Saft offers a partnership between your product design team and our battery development teams. By combining our strengths, we can provide concept, design and delivery that shorten your time to market, with a portable power system custom-designed for your product's unique demands.

Generate efficient solutions

Through Saft's teams of experts, your product and its energy system are developed simultaneously, so you avoid expensive design problems and delays that could hold your product back in today's fast-moving marketplace. Quick sample turnaround and rigorous testing enable you to assess the performance of both your product and its energy system. Saft's up-to-date service network efficiently coordinates every step of production and delivery. At every step throughout the product development process, the Saft team helps you streamline your product design and accelerate its time to market.

Design and other considerations

The basic building block of any nickel-cadmium or nickel-metal hydride battery configuration is the 1.2V sealed cell, which can be any of the cylindrical shapes described below. A typical 12 volt battery, for example, will consist of 10 cells connected in a series to give $1.2 \times 10 = 12$ volts.

In the simplest application, therefore, a knowledge of the voltage and current required and the duration of the discharge will provide the initial selection.

Configuration

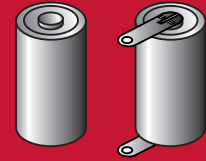
After electrical considerations, you must plan the battery pack itself in terms of space, protection and electrical connection. When planning the battery pack, you should consider the following:

- The number of cells needed.
- Physical arrangement in available space.
- The outer case or wrap, which provides both "packaging" for the battery and protection for the cells.
- Arrangement and type of materials needed for electrical connection to the device.

Standard to custom-designed arrangements

Standard Saft battery packs include shrink wrapped configurations from 1.2 to 36 volts, or more. Packaging with adhesives, special insulation materials, or the inclusion of battery management devices (charge control, discharge control, fuel gauge...) are also available.

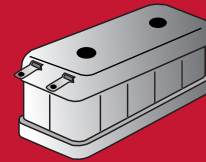
EXAMPLES OF STANDARD ASSEMBLIES:



CELLS Saft can offer several types of terminals for its "standard assembly" packs. The most common models are automatically welded on the same side.



SIDE-BY-SIDE For cylindrical cells, Saft uses single cells separated by sleeves or plastic labels. For some applications, Saft can offer cardboard tube insulation.



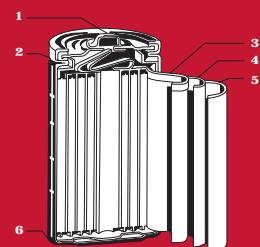
FLANGE

Side-by-side or stick batteries can be assembled into flanges, PVC shrink-wrapping, or plastic casings.



STICK Saft also manufactures stick assemblies arranged in series connected by cups. Insulation is guaranteed either by sleeve or cardboard tube.

CYLINDRICAL CELLS



Cutaway of a cylindrical cell

1. Safety vent
2. Seal
3. Positive plate
4. Separator
5. Negative plate
6. Nickel-plated steel case

Ni-MH

SUPER HIGH ENERGY VH/VHT series

Saft's range of Ni-MH cylindrical cells is being extended. Manufactured for use in high capacity, these cells are designed for portable applications which

demand fast charge and discharge over an extended lifetime. The VH Cs, VH D and VH F specially target cordless power tools applications, e-bikes and personal electric vehicles and professional appliances.

The latest VHT range has been designed to accept high temperature requirements such as in emergency back-up applications.

Saft type	IEC Capacity at 0.2C rate		Standard charge (**)	Quick or fast charge		Internal impedance m Ω	Max. Dimensions for bare cells		Approx weight (g)	
	Nominal voltage: 1.2 volts/cell	Typical (mAh)	Minimum (mAh)	Current (mA)	Max current (mA)		Time (h)	Diameter (mm)		Height (mm)
VH										
VH AA*		1300	1200	120	1200	~1	21	14.0	49.2	25
VH AA 1500*		1500	1400	140	1400	~1	20	14.0	49.2	26
VH AA 1700		1700	1600	160	1600	~1	25	14.0	49.2	25
VH Cs 3200		3200	3000	300	1500	~2-3	5	22.0	42.3	59
VH D		8500	8000	800	4000	~2-3	4	32.3	58.6	160
VH D 9500		9500	9000	900	4000	~2-3	4	32.3	58.6	168
VH F 15000		15000	14000	1400	4000	~3-4	4	32.3	89.1	250
VHT AA		1150	1100	110	-	-	18	14.0	49.2	26
VHT Cs		2200	2000	200	-	-	5.3	22.0	42.4	50
UNDER DEVELOPMENT										
VH Cs 3500		3500	3200	320	1500	~2-3	4	22.0	42.3	59
VH D 10000		10000	9500	950	5000	~2-3	4	32.3	58.6	170
VH F 16000		16000	15000	1500	4000	~3-4	4	32.3	89.1	250
VHT 7/5 Cs		4200	3900	390	-	-	21	22.2	60.0	76
VHT F		11000	10000	1000	-	-	4	32.3	89.1	230

* Those cells, VH AA and VH AA 1500, are also available with a high top. Diameter is identical. The projection of the top is 1.7 ±0.2 mm, the flat area diameter is 4.0 mm, and the total height of the cell is 49.9 ±0.3 mm.

(**) Standard charge is 16 hours.



Ni-Cd

STANDARD VR and VRE series

Engineered for cycling applications, Saft's standard series can be used for a wide range of applications. In addition, the VRE series is well-

adapted for applications requiring a permanent charge (C/20 to C/15) at temperatures of up to +35°C. These two standard series have been produced in hundreds of

millions of units for many years, with a high level of reliability. They offer an excellent cost/performance ratio.

Saft type	IEC Capacity at 0.2C rate		Standard charge (**)	Quick or fast charge		Internal impedance mΩ	Max. Dimensions for bare cells		Approx. weight (g)	
	Nominal voltage: 1.2 volt/cell	Typical (mAh)	Minimum (mAh)	Current (mA)	Current (mA)		Time (h)	Diameter (mm)		Height (mm)
VR	VR 2/3 D	2850	2500	250	2500	~1	3.3	32.4	43.3	103
	VR 4 D	4500	4000	400	4000	~1	3.1	32.4	60.3	145
	VR 7 FL	7700	7000	700	3500	~2.5	2.7	32.4	89.1	228
	VR 10 SF	11600	10000	1000	-	-	2.0	41.2	89.0	390
VRE	VRE AA 600⁽¹⁾	700	600	60	600	~1	16	14.0	49.2	20
	VRE AA 700⁽¹⁾	780	700	70	700	~1	14	14.0	49.2	21
	VRE Cs	1450	1300	130	1300	~1	6	22.2	42.2	46
	VRE Cs 1600	1600	1500	140	1400	~1	6	22.2	42.2	46
	VRE Cs 1800	1800	1700	170	1700	~1	5	22.2	42.2	50
	VRE C	2550	2300	230	2300	~1	8	25.3	49.5	77
	VRE 1/2 D	2550	2400	240	2400	~1	18	32.3	36.8	82
	VRE D	5100	4500	450	4500	~1	4	32.3	58.6	140
	VRE D 5500	5500	5000	500	5000	~1	4	32.3	58.6	151
	VRE F	8800	8000	800	8000	~1	4	32.2	88.8	220



(1) Those cells, VRE AA 600 and VRE AA 700 are also available with a high top. Diameter is similar. The projection of the top is 1.7 ±0.2 mm, the flat area diameter is 4.0 mm, and the total height of the cell 49.9 ±0.3 mm.

(2) This cell, VTD 70, is also available with a low top. The projection of the top is 1.4mm +/-0.4 and the total height is 58.0 +/- 0.4.

(3) VTD, VTF: up to 40°C temperature environment. VTD 70, VTF 70, VTD U: up to 55°C temperature environment.

(4) Standard charge is 16 hours.

(5) This cell, VSE AA, is also available with a high top. Diameter is similar. The projection of the top is 1.7 ±0.2mm, the flat area diameter is 4.0mm, and the total height of the cell 49.9 ±0.3mm



HIGH TEMPERATURE VT/VNT series

These cells accept a permanent charge (C/20 to C/15) for a minimum of 4 years in high-temperature environment (up to +40°C) such as security

emergency equipment. Improved versions of the cells, such as the VTCs 1500 U and VTD 70, can withstand a constant temperature of up to +55°C with a similar lifetime when permanently charged.

Saft type	IEC Capacity at 0.2C rate		Standard charge (**)	Permanent charge		Internal impedance m Ω	Max. Dimensions for bare cells		Approx. weight (g)	
	Nominal voltage: 1.2 volts/cell	Typical (mAh)	Minimum (mAh)	Current (mA)	Current (mA)		Time (h)	Diameter (mm)		Height (mm)
VT AA		700	600	60	30	-	28	14.0	50.2	20
VT Cs		1350	1200	120	60	-	12	22.2	42.2	45
VT Cs 1500		1650	1500	150	75	-	8	22.2	42.2	48
VT Cs 1500 U		1650	1500	150	75	-	8	22.2	42.2	48
VT Cs 1600		1750	1600	160	80	-	7	22.2	42.2	49
VNT Cs 1600		1670	1600	160	80	-	11	22.2	42.2	45
VT C		2500	2200	220	110	-	14	25.3	49.5	75
VT C 2500		2700	2500	250	125	-	14	25.3	49.5	75
VT 1/2 D		2500	2200	220	110	-	10	32.3	36.8	80
VT D ⁽³⁾		4300	4000	400	200	-	7	32.3	60.3	120
VT D 70 ⁽²⁾⁽³⁾		4500	4000	400	200	-	6	32.4	60.3	128
VT D U ⁽³⁾		4700	4100	400	200	-	6	32.3	58.4	136
VT F ⁽³⁾		7500	7000	700	350	-	5	32.4	91.1	196
VT F 70 ⁽³⁾		7700	7000	700	350	-	5	32.4	89.5	210

UNDER DEVELOPMENT

VNT C		3100	3000	300	150	-	-	25.3	49.5	75
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HIGH ENERGY VE and VSE series

With the VE series, Saft upgrades its standard technology: it boosts capacity by 10 to 15% without increasing volume, while at the same

time maintaining performance levels. The VSE series uses advanced nickel foam electrode technology providing both fast charge and higher capacity meeting the needs of today's light and compact portable equipment.

Saft type	IEC Capacity at 0.2C rate		Standard charge (**)	Quick or fast charge		Internal impedance m Ω	Max. Dimensions for bare cells		Approx. weight (g)	
	Nominal voltage: 1.2 volts/cell	Typical (mAh)	Minimum (mAh)	Current (mA)	Current (mA)		Time (h)	Diameter (mm)		Height (mm)
VE VE 2/3 A		670	600	60	600	~1	25	16.7	28.0	18
VE VE 4/5 A		1050	1000	100	1200	~1	21	16.7	42.3	27
VE Cs		1560	1400	140	1680	~1	5	22.2	42.2	51
VE C		2400	2200	220	2200	~1	5	25.3	49.5	75
VE D		5100	4500	450	4500	~1	2.6	32.4	58.8	150
VSE VSE AA ⁽⁵⁾		980	940	94	940	~1	16	14.0	49.2	22
VSE VSE 4/5 A		1300	1200	120	1200	~1	17	16.7	42.3	28

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