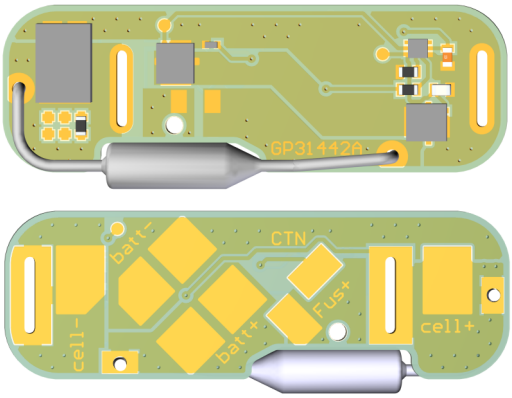
Battery safety
Single cell protection circuits

Electronic protection circuits for Li-ion 3.65 V MP xtd range of cells

The Saft 1s protection circuit is specifically designed to provide optimum protection for Li-ion batteries consisting of series assemblies from one to eight cells with a maximum number of one to six cells in parallel, depending on the maximum voltage. Other configurations are possible, please contact Saft for further information.



Benefits
- Safety management for battery assemblies
- Balancing during discharge depending on load
- Active mode and sleep mode
- Temperature performance from -40°C to +85°C
- Easy assembly into multi-cell batteries with the large solder pads
- High reliability

Key features
- Over voltage protection
- Under voltage protection
- Over current protection
- Short circuit protection
- Over temperature protection
- Fuse protection as an option
- NTC integrated in circuit
- Zero (0V) battery protection
- UL94-V0
- **Made in the EU**

Designed to meet all major quality, safety and environmental standards
- Quality: ISO 9001 Saft World Class program
- Environment: ISO 14001, RoHS and REACH as applicable.

Typical applications
- Backup for industrial equipment
- Medical devices
- Tracking applications
- Military applications
- Commercial applications
- General purpose industrial equipment.

Electrical characteristics—Voltage	Typical
Voltage upper limit (VUL) at +25°C	4.275 ±0.020 V
Voltage hysteresis upper limit (VHUL) at +25°C	4.075 ±0.050 V
Delay time for VUL (TUL) at +25°C	1.00 ± 0.30 s
Voltage lower limit (VLL) at +25°C	2.30 ± 0.050 V
Voltage hysteresis lower limit (VHLL)	0 ± 0.000 V
Delay time for VLL (TLL) at +25°C	0.128 ± 0.038 s

Electrical characteristics—Current	5 Amp 1s circuit		10 Amp 1s circuit	
	Min	Max	Min	Max
Current max		5A (85°C)		10A (60°C)
Over current 1 detection (Oc) at +25°C	7 A	13 A	16 A	20 A
Over current 1 detection (Oc) at +25°C	11 ± 2.0ms		11 ± 2.0ms	
Over current 2 detection (Oc) at +25°C	30 A	36 A	37 A	44 A
Over current 2 delay time (Ocd) at +25°C	4 ± 1.0ms		4 ± 1.0ms	
Reverse charge current limit		3 A		3 A
Charge inhibition voltage	⩽ 1.2 ± 0.3V		⩽ 1.2 ± 0.3V	

Operational characteristics	Value
Temperature sensor (NTC) @ +25°C	10kΩ
Ceramic fuse	(optional)
Maximum circuit consumption at +25°C	5 µA
Maximum sleep mode circuit consumption	0.1 µA
Operating temperature range	-40°C to +85°C
Maximum voltage	6.0 V
Dimension L x W x D (mm) (D=5.2mm with thermal fuse)	42.65 x 14.15 x 2.10
Weight (2.2g with thermal fuse)	1.4 g
Operational MTBF	2.23 M hours

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Functions and operations

0V Battery protection

For user safety, the battery cannot be recharged if the cell voltage falls below 1.2V (± 0.3V).

Over and under voltage

Battery voltage is monitored continuously and if the threshold is exceeded for a period longer than the Delay time, then the charge or discharge MOSFET is switched off interrupting the current.
When the battery voltage falls back to the recovery threshold , the circuit will automatically reset.

Over current protection

There are two levels of protection against overcurrent in discharge, the first is from the charge and discharge MOSFET's and optionally a thermal fuse or micro fuse directly on the circuit board. The temperature may also be externally monitored via the NTC thermistor.

Cell balancing

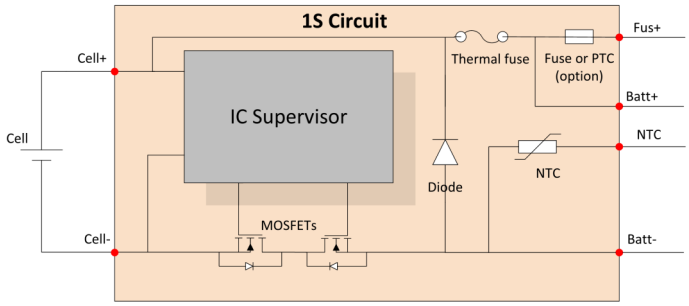
Reduce cells' charge differences during the end of discharge when the current drops to ≤1 Amp. Batteries assembled from the 1s circuit may also be rebalanced after long periods of storage or use by discharging until 0V at ≤1 Amp. A well balanced multicell battery will have a longer runtime, and retain more capacity from cycle to cycle.

Storage

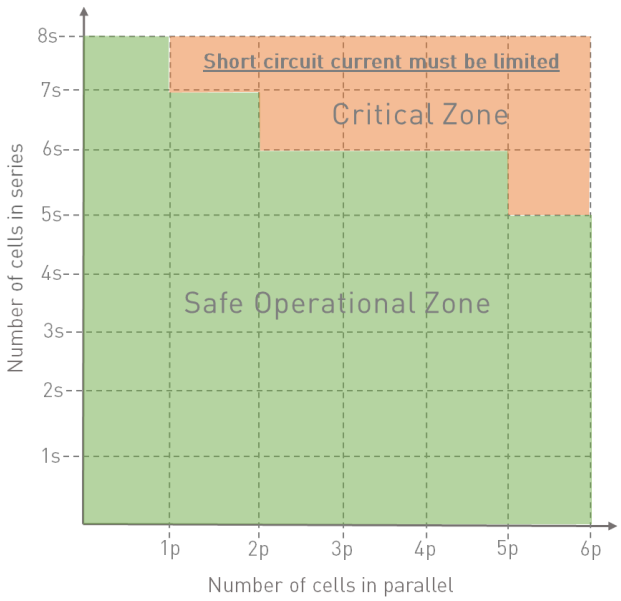
In the case of long duration storage, it is strongly recommend recharging the battery every 6 months to a level of 50% State of Charge.
The storage area should be clean, cool (preferably not exceeding +30°C), dry and ventilated.

Circuit board reference Max (I) 5A	NTC[1]	Fuse[4]	Thermal fuse[3]
GP31444	Yes	(Optional)	Yes
GP31447	Yes	(Optional)	No
Circuit board reference Max (I) 10A	**NTC[1]**	**Fuse[4]**	**Thermal fuse[3]**
GP31469	Yes	(Optional)	Yes
GP31471	Yes	(Optional)	No
Circuit board interconnection[2]	**NTC**	**Fuse**	**Thermal fuse**
GP16391	No	No	No

[1] The NTC thermistor is fitted to all variants of the circuit board as a standard component. Its connection to and use by the end application is optional. [2] The interconnection board contains no components and is used solely for the interconnection of cells in parallel when building a multicell battery. [3] Where "yes" is noted, the circuit board has a 117°C thermal fuse fitted as a standard component. [4] An SMD Fuse (non-resettable) *or* SMD PPTC (Polymer Positive Temperature Coefficient—resettable) are readily available options.



Above is a representative diagram of the main circuit components of the 1s protection circuit. The Thermal fuse, SMD Fuse and PPTC are available options.



The above diagram depicts the maximum number of MP xtd/ise cells in series and in parallel that can be constructed using the Saft 1s circuit. The diagram is representative for an ambient temperature of 25°C and a maximum external short circuit of 100mΩ.

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