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HS130 / HS230 SUPERCAPACITOR

Datasheet Rev3.1, May 2013

This Datasheet should be read in conjunction with the CAP-XX Supercapacitors Product Guide which contains information common to our product lines.

Electrical Specifications

The HS130 is a single cell supercapacitor. The HS230 is a dual cell supercapacitor with two HS130 cells in series, so HS230 capacitance = Capacitance of HS130/2 and HS230 ESR = 2 x HS130 ESR.

Table 1: Absolute Maximum Ratings

Parameter	Name		Conditions	Min	Typical	Max	Units
Terminal Voltage	Vpeak	HS130		0		2.9	V
		HS230				5.8	
Temperature	Tmax			-40		+85	°C

Table 2: Electrical Characteristics

Parameter	Name		Conditions	Min	Typical	Max	Units
Terminal Voltage	Vn	HS130		0		2.75	V
		HS230		0		5.5	
Capacitance	C	HS130	DC, 23°C	1920	2400	2880	mF
		HS230		960	1200	1440	
ESR	ESR	HS130	DC, 23°C	21	26	31	m :
		HS230		40	50	60	
Leakage Current	I_L		2.75V, 23°C 120hrs		3	5	µA
RMS Current	I_{RMS}		23°C			6	A
Peak Current[1]	I_P		23°C			30	A

[1]Non-repetitive current, single pulse to discharge fully charged supercapacitor.

Table 3: Thickness

HS130F	1.85mm	No adhesive tape on underside of the supercapacitor	HS130G	1.95mm	Adhesive tape on underside, release tape removed
HS230F	3.80mm		HS230G	3.90mm	

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Effective Capacitance

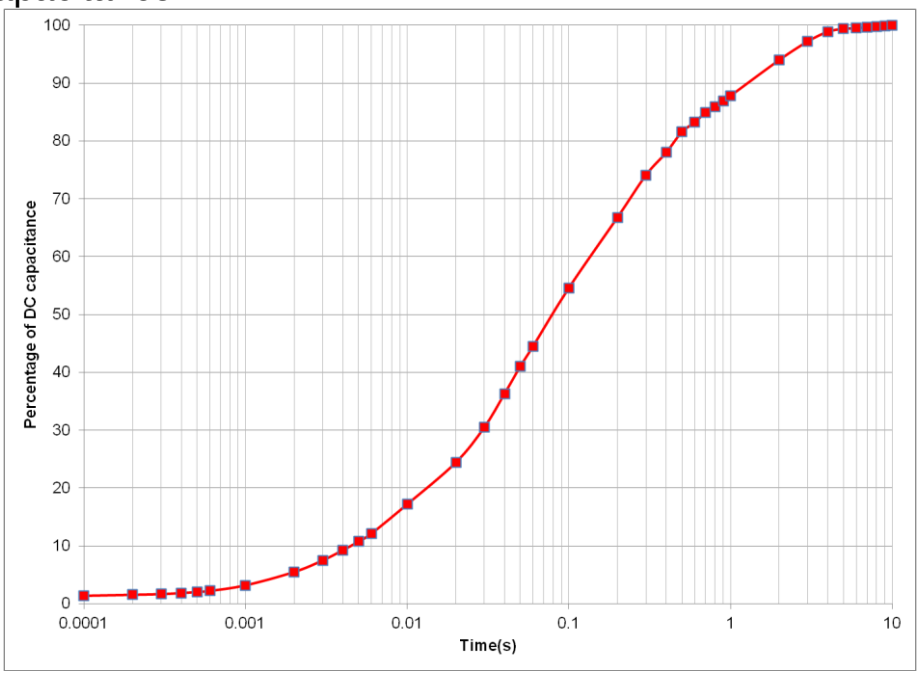

Figure 4: Effective Capacitance

Fig 4 shows the effective capacitance for the HS130, HS230 @ 23°C. This shows that for a 1msec PW, you will measure 4% of DC capacitance or 96mF for an HS130 or 48mF for an HS230. At 10msecs you will measure 18% of the DC capacitance, and at 100msecs you will measure 55% of DC capacitance. Ceffective is a time domain representation of the supercapacitor's frequency response. If, for example, you were calculating the voltage drop if the supercapacitor was supporting 1A for 10msecs, then you would use the Ceff(10msecs) = 18% of DC capacitance = 216mF for an HS230, so Vdrop = 1A x ESR + 1A x duration/C = $ [P Ÿ $ [216mF = 96.3mV. The next section on pulse response shows how the effective capacitance is sufficient for even short pulse widths.

Pulse Response

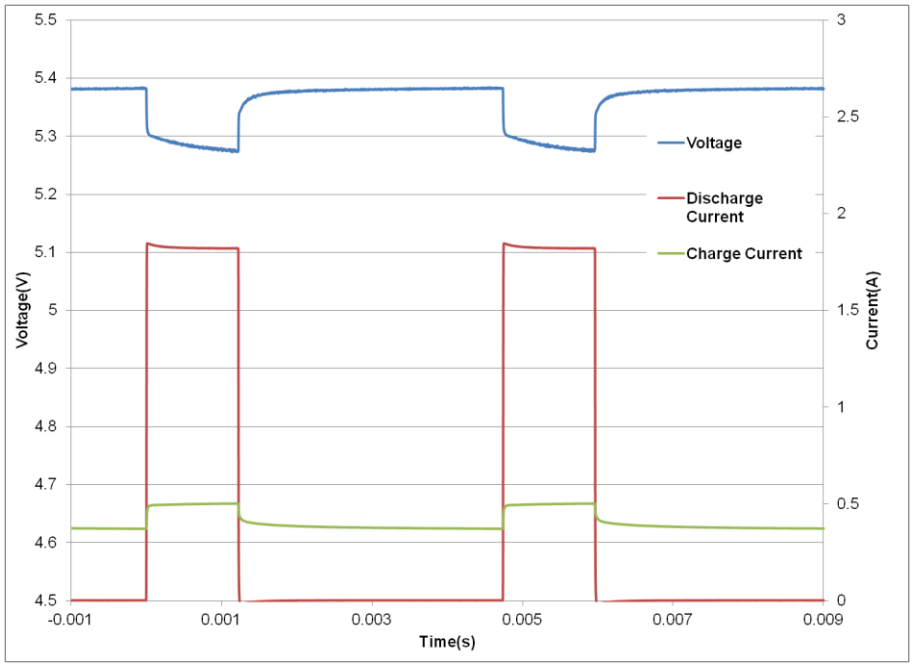

Fig 5 shows that the HS230 supercapacitor does an excellent job supporting a GPRS class 10 pulse train, drawing 1.8A for 1.1ms at 25% duty cycle. The source is current limited to 0.6A and the supercapacitor provides the 1.2A difference to achieve the peak current. At first glance the freq response of Fig 8 indicates the supercapacacitor would not support a 1ms pulse, but the Ceff of 48mF coupled with the low ESR supports this pulse train with only ~110mV droop in the supply rail.

Fig 5: HS230Pulse Response with GPRS Class 10 Pulse Train

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DC Capacitancevariation with temperature

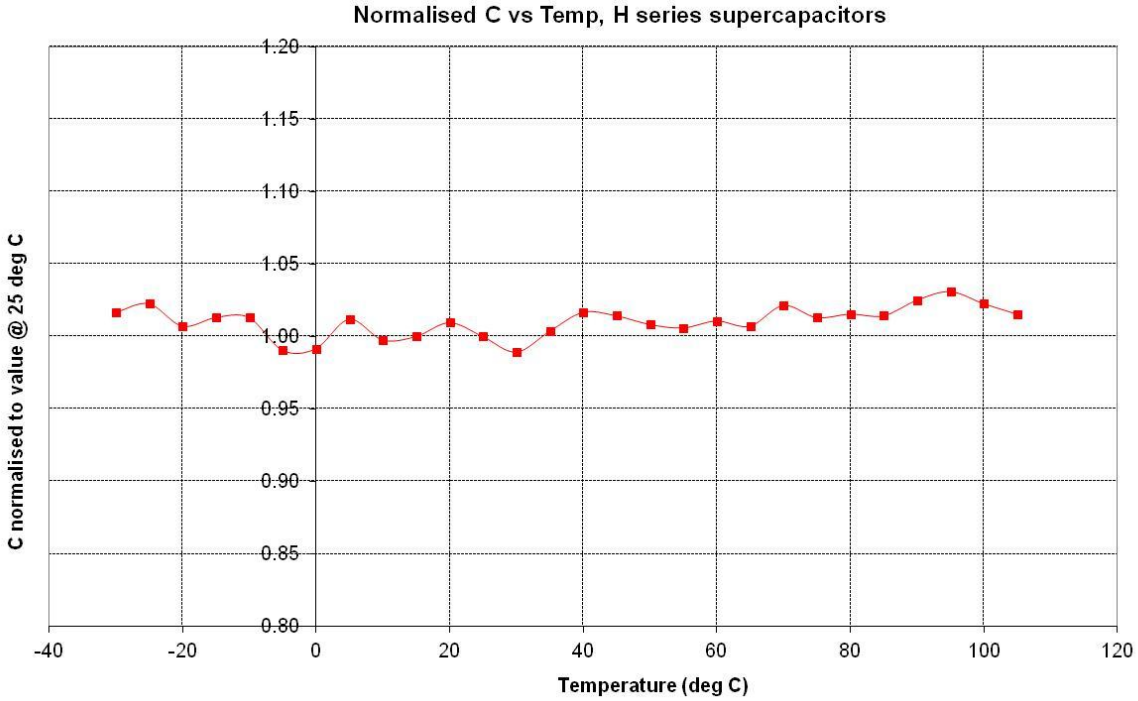

Figure 6: Capacitance change with temperature

Fig 6 shows that DC capacitance is approximately constant with temperature.

ESR variation with temperature

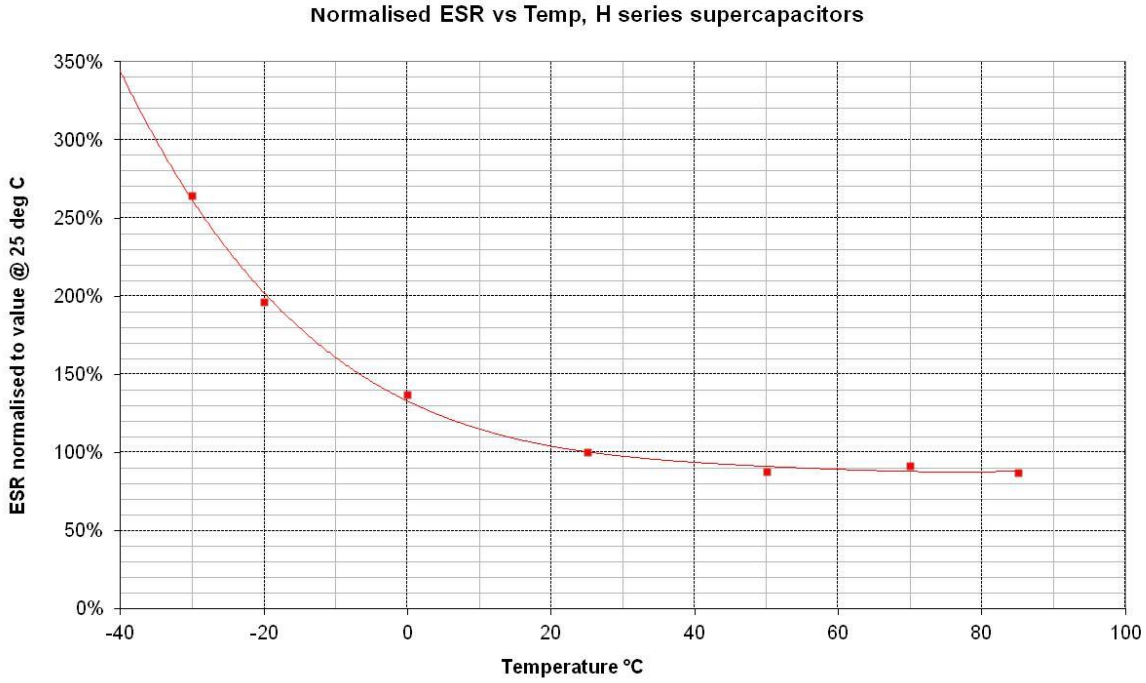

Figure 7: ESR change with temperature

Fig 7 shows that ESR at -40°C is ~3.5 x ESR at room temp, and that ESR at 70ºC is ~0.9 x ESR at room temperature.

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Frequency Response

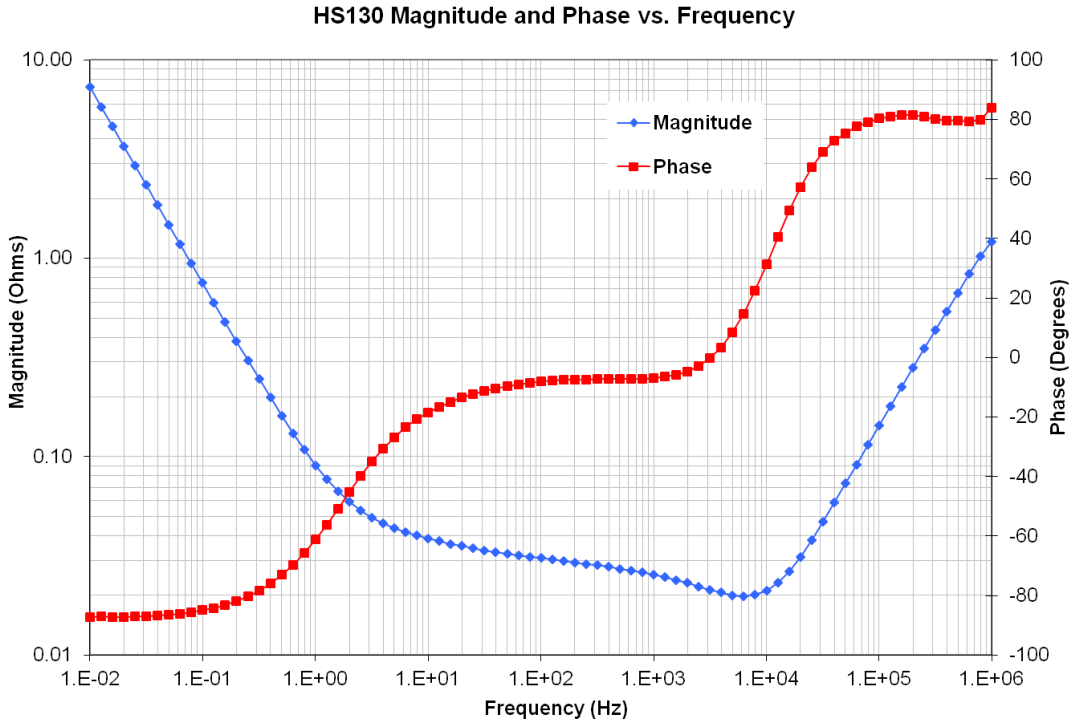

Fig 8: Frequency Response of Impedance (biased at 2.5V with a 50mV test signal)

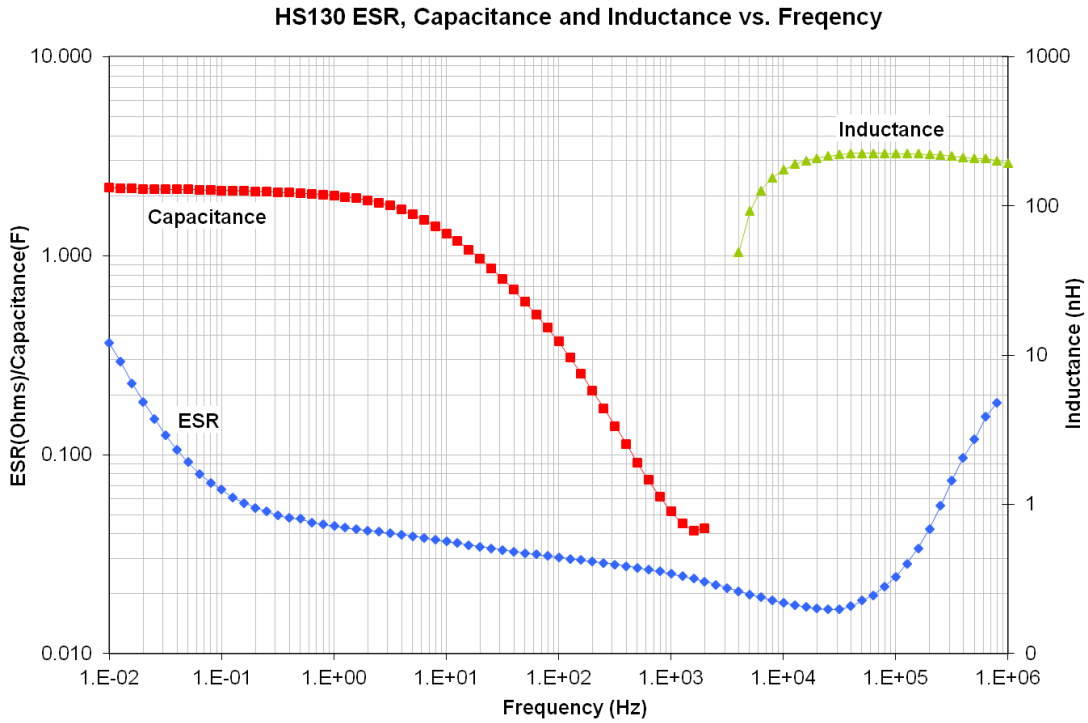

Fig 9: Frequency Response of ESR, Capacitance & Inductance

Fig 8 shows the supercapacitor behaves as an ideal capacitor until approx 2 Hz when the magnitude no longer rolls off proportionally to 1/freq and the phase crosses -45°. Performance of supercapacitors with frequency is complex and the best predictor of performance is Fig 4 showing effective capacitance as a function of pulsewidth.

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Leakage Current

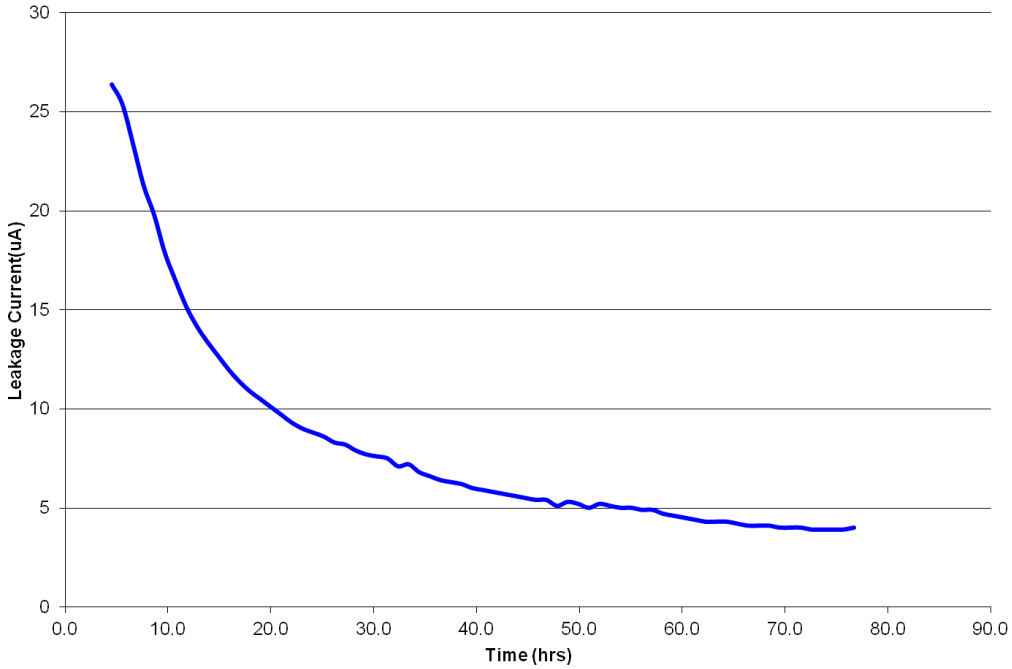

Fig 10: Leakage Current

Fig 10 shows the leakage current for HS130 at room temperature. The leakage current decays over time and the equilibrium value leakage current will be reached after ~80hrs at room temperature. The typical equilibrium leakage current is 4µA at room temperature. At 70°C leakage current will be ~10µA.

Charge Current

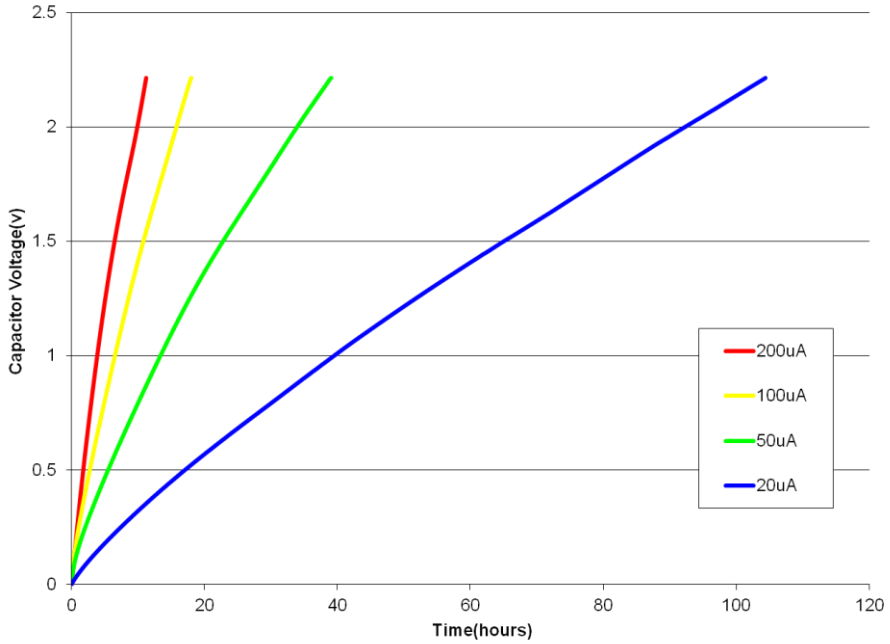

Fig 11: Charging an HS130with low current

The corollary to the slow decay in leakage currents shown in Fig 10 is that charging a supercapacitor at very low currents takes longer than theory predicts. At higher charge currents, the charge rate is as theory predicts. For example, it should take 2.4F x 2.3V / 0.00002A = 77hrs to charge a 2.4F supercapacitor to 2.3V at 20µA, but Fig 11 shows it took 109hrs. At 100µA charging occurs at a rate close to the theoretical rate.

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RMS Current

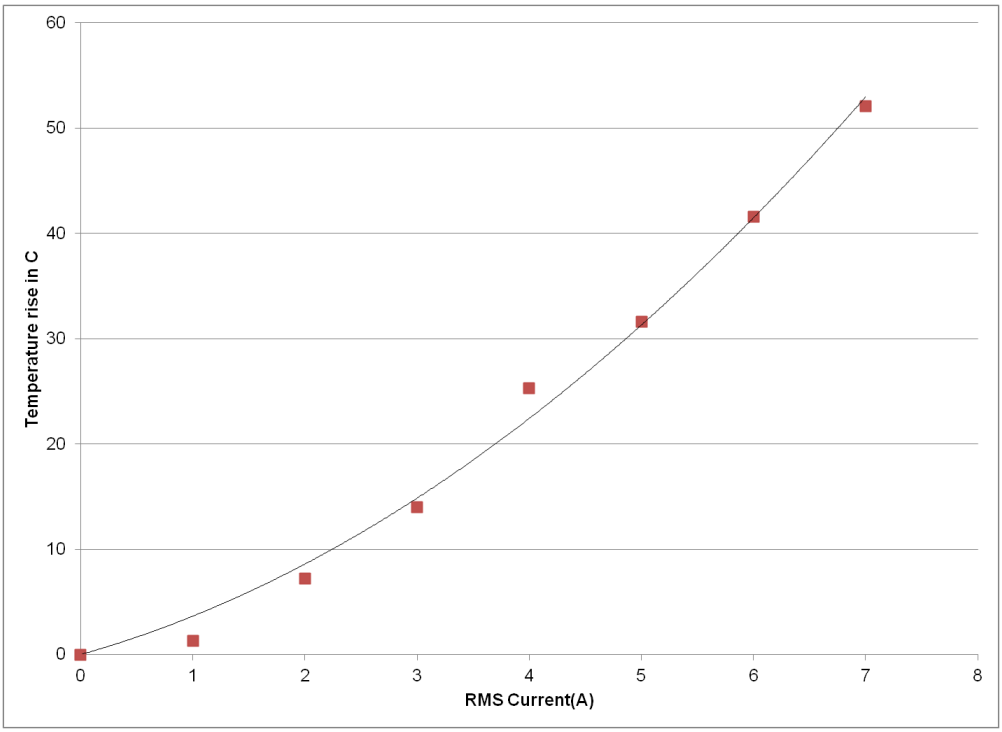

Fig 12: Temperature rise in HS230with RMS current

Continuous current flow into/out of the supercap will cause self heating, which limits the maximum continuous current the supercapacitor can handle. This is measured by a current square wave with 50% duty cycle, charging the supercapacitor to rated voltage at a constant current, and then discharging the supercapacitor to half rated voltage at the same constant current value. For a square wave with 50% duty cycle, the RMS current is the same as the current amplitude. Fig 12 shows the increase in temperature as a function of RMS current. From this, the maximum RMS current in an application can be calculated, for example, if the ambient temperature is 40 ¢J, and the maximum desired temperature for the supercapacitor is 70 ¢J, then the maximum RMS current should be limited to 5A, which causes a 30 ¢J temperature increase.

CAP-XX Supercapacitors Product Guide

Refer to the package drawings in the CAP-XX Supercapacitors Product Guide for detailed information of the S U R G X F W ¶ V G L P H Q V L R Q V 3 & % O D Q G L Q J S O D F H P H Q W V D F W L Y H

Refer to the CAP-XX Supercapacitors Product Guide for information on endurance and shelf life, transportation and storage, assembly and soldering, safety and RoHS/EREACH certification.

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