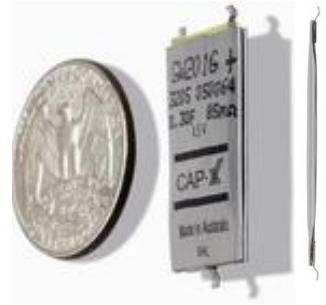


CAP-XX

Supercapacitors



Product Guide

2013



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Revision History

Release	Release Date	Author	Changes
Product Guide 2013 v1.0	February 18, 2013	Peter Buckle	New document. Replaces "G Series Product Bulletin v9.04" and "H Series Product Bulletin v9.05".

1. Key Features of CAP-XX Supercapacitors

- Thin, flat and small – ideal for space-constrained applications
- High power density (up to 90kW / litre) and high power output
- Ultra-low ESR (from 14mΩ), even at low temperatures (~2x nominal at -30°C)
- High energy density (up to 2.1Wh / litre) and cell voltage (up to 2.75V / cell)
- Wide operating temperature range (-40°C, up to +85°C)
- Very low leakage current (typically < 1μA after 120hrs)
- Long cycle life (exceeding 1 million cycles) and excellent frequency response
- Environmentally friendly: RoHS, WEEE and REACH compliant, Lead-free, Halogen-free and Conflict metal-free
- UL recognized and ISO 9001-2008 certified

2. Typical Applications of CAP-XX Supercapacitors

CAP-XX supercapacitors are ideally suited to provide:

- Peak power for pulsed loads - Extending battery run time and cycle life, especially when “old or cold”, and allowing the use of smaller and lower power batteries in high peak load applications such as RF transmissions, LED flash, GPS location, valve/lock actuation, screen refresh in OLED and ePPD displays, thermal printers, injection and inhalation systems, etc.
- Backup power for mission-critical applications - Providing maintenance-free continuous power, through outages and fluctuations, such as SSD cache protection and write speed optimization, last gasp transmissions from WSNs, drop-test protection, graceful shutdown and battery hot swap in industrial handheld devices, and safety valve/lock actuation to failsafe mode – even at low temperatures.
- Stored energy for low/variable power sources - Offering an environmentally friendly and maintenance-free alternative to batteries, for systems powered by ambient energy harvesters, as well as enabling quick charge at high energy via cable, cradle or induction, to shorten charge time and maximize operating time and process speed.

3. CAP-XX Product Range

CAP-XX supercapacitors are available as dual cell modules - ideal for use with Li-ion rechargeable batteries and USB power supplies - or in a single cell configuration, offering ultra-thin design options for space-constrained applications.

Four footprints are currently available:

- “A” (20.0mm x 18.0mm)
- “B” (20.5mm x 18.5mm)
- “W” (28.5mm x 17.0mm)
- “S” (39.0mm x 17.0mm)

Note that the “Z” footprint (20.0 x 15.0mm) is currently available only to order, and will be discontinued in 2013 (contact CAP-XX for more information).

“S”, “W”, “A” and “Z” series products have an external package made of aluminium. “B” series products are packaged in stainless steel.



G Series Product Specifications

4. G Series Product Specifications

Dual cell modules

Product Name ¹	CAP ² (± 20%) ³	ESR ² (± 20%) ³	Thickness (max)	Body Size (mm)	Voltage & Temperature
GA209F	80 mF	130 mΩ	2.20 mm	20.0 x 18.0	4.5V _{nominal} 5.0V _{peak} -40°C to +70°C T _{max} = 70°C
GB230F	350 mF	60 mΩ	3.10 mm	20.5 x 18.5	
GW209F	140 mF	70 mΩ	2.20 mm	28.5 x 17.0	
GW202F	220 mF	50 mΩ	3.00 mm		
GW201F	350 mF	70 mΩ	2.50 mm		
GW203F	550 mF	50 mΩ	3.50 mm		
GS203F	250 mF	45 mΩ	2.20 mm	39.0 x 17.0	
GS206F	600 mF	40 mΩ	2.50 mm		
GS208F	900 mF	28 mΩ	3.50 mm		
GS230F	1200 mF	28 mΩ	3.80 mm		
GZ215F	75 mF	150 mΩ	2.50 mm	20.0 x 15.0	
GW207F	450 mF	55 mΩ	3.00 mm	28.5 x 17.0	
GS211F	370 mF	28 mΩ	3.00 mm	39.0 x 17.0	

Single cell supercapacitors

Product Name ¹	CAP ² (± 20%) ³	ESR ² (± 20%) ³	Thickness (mm)	Body Size (mm)	Voltage & Temperature
GA109F	160 mF	65 mΩ	1.10 mm	20.0 x 18.0	2.3V _{nominal} 2.5V _{peak} -40°C to +70°C T _{max} = 70°C
GB130F	700 mF	30 mΩ	1.50 mm	20.5 x 18.5	
GW109F	280 mF	36 mΩ	1.10 mm	28.5 x 17.0	
GW102F	440 mF	26 mΩ	1.45 mm		
GW101F	700 mF	36 mΩ	1.20 mm		
GW103F	1100 mF	26 mΩ	1.70 mm		
GS103F	500 mF	22 mΩ	1.10 mm	39.0 x 17.0	
GS106F	1200 mF	22 mΩ	1.20 mm		
GS108F	1800 mF	14 mΩ	1.70 mm		
GS130F	2400 mF	14 mΩ	1.85 mm		

Parameter	Name	Condition	Minimum	Nominal	Maximum
Leakage Current ⁴	I _L	23°C		1μA	2μA
RMS Current	I _{RMS}	23°C			4A – 7A
Pulse Current ⁵	I _{peak}				30A
ESR change with Temperature		Min @ +70°C Max @ -40°C	75% of nominal		200% of nominal

Notes

1. Bold products are Standard. GZ215, GW207, GS211 and all single cell devices are available on a “build to order” basis. Special terms and conditions of sale apply (MOQ, L/T, NCNR, etc.). Contact CAP-XX for more information.
2. Capacitance will decline and ESR will rise over time, at a rate which depends on temperature and voltage. Operation at concurrent high temperature & voltage is not recommended for extended periods. See Section 6 for more information.
3. DC capacitance and ESR tolerance are measured at +23°C.
4. Leakage current is measured after 120hrs at nominal voltage and +23°C.
5. Single pulse, non-repetitive current (positive & negative terminal short-circuited)

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5. H Series Product Specifications

Dual cell modules					
Product Name ¹	CAP ² (± 20%) ³	ESR ² (± 20%) ³	Thickness (max)	Body Size (mm)	Voltage & Temperature
HA202F	120 mF	140 mΩ	3.00 mm	20.0 x 18.0	5.5V _{nominal} 5.8V _{peak} -40°C to +70°C T _{max} = 85°C
HA230F	400 mF	140 mΩ	3.80 mm		
HW209F	140 mF	120 mΩ	2.20 mm	28.5 x 17.0	
HW202F	220 mF	90 mΩ	3.00 mm		
HW201F	350 mF	120 mΩ	2.50 mm		
HW203F	550 mF	90 mΩ	3.50 mm		
HS203F	250 mF	75 mΩ	2.20 mm	39.0 x 17.0	
HS206F	600 mF	70 mΩ	2.50 mm		
HS208F	900 mF	50 mΩ	3.50 mm		
HS230F	1200 mF	50 mΩ	3.80 mm		
HZ202F	90 mF	200 mΩ	3.00 mm	20.0 x 15.0	
HW207F	450 mF	100 mΩ	3.00 mm	28.5 x 17.0	
HS211F	370 mF	50 mΩ	3.00 mm	39.0 x 17.0	
Single cell supercapacitors					
Product Name ¹	CAP ² (± 20%) ³	ESR ² (± 20%) ³	Thickness (mm)	Body Size (mm)	Voltage & Temperature
HA102F	240 mF	70 mΩ	1.45 mm	20.0 x 18.0	2.75V _{nominal} 2.9V _{peak} -40°C to +70°C T _{max} = 85°C
HA130F	800 mF	70 mΩ	1.85 mm		
HW109F	280 mF	60 mΩ	1.10 mm	28.5 x 17.0	
HW102F	440 mF	45 mΩ	1.45 mm		
HW101F	700 mF	60 mΩ	1.20 mm		
HW103F	1100 mF	45 mΩ	1.70 mm		
HS103F	500 mF	38 mΩ	1.10 mm	39.0 x 17.0	
HS106F	1200 mF	38 mΩ	1.20 mm		
HS108F	1800 mF	26 mΩ	1.70 mm		
HS130F	2400 mF	26 mΩ	1.85 mm		
Parameter	Name	Condition	Minimum	Nominal	Maximum
Leakage Current ⁴	I _L	23°C		1μA	2μA
RMS Current	I _{RMS}	23°C			5A – 10A
Pulse Current ⁵	I _{peak}				30A
ESR change with Temperature		Min @ +70°C Max @ -40°C	75% of nominal		350% of nominal

Notes

1. Bold products are Standard. HZ202, HW207, HS211 and all single cell devices are available on a "build to order" basis. Special terms and conditions of sale apply (MOQ, L/T, NCNR, etc.). Contact CAP-XX for more information.
2. Capacitance will decline and ESR will rise over time, at a rate which depends on temperature and voltage. Operation at concurrent high temperature & voltage is not recommended for extended periods. See Section 6 for more information.
3. DC capacitance and ESR tolerance are measured at +23°C.
4. Leakage current is measured after 120hrs at nominal voltage and +23°C.
5. Single pulse, non-repetitive current (positive & negative terminal short-circuited).

6. Storage & Operation Metrics

Parameter	Condition	Metric	G Series	H Series	Notes
Operating temperature	Maximum operating temperature	$T_{\max}$ (°C)	+70°C	+85°C	Brief excursions to $T_{\max}$ will not damage the device.
	Continuous operating temperature range	T_{cont} (°C)	-40°C to +70°C	-40°C to +70°C	Continuous operation at $T_{\max}$ is not recommended. See data on load life for more.
Shelf life	Recommended maximum storage temperature & humidity	T_{shelf} (°C)	-40°C to +35°C	-40°C to +35°C	Store in original packaging in an air conditioned room.
		RH_{shelf} (%)	< 60%	< 60%	Storage at high temperature is not recommended.
	2 years @ T_{shelfmax}	C loss (% of initial C)	< 10%	< 20%	Storage at high humidity is not recommended.
		ESR rise (% of initial ESR)	< 20%	< 40%	
	10 years @ 23°C	C loss (% of initial C)	< 20%	< 20%	
		ESR rise (% of initial ESR)	< 50%	< 100%	
Cycle life	500,000 cycles @ 23°C ($V_n \rightarrow \frac{1}{2}V_n$, $I = 0.5A$)	C loss (% of initial C)	< 1%	< 5%	Voltage cycling at low RMS current will not affect life.
		ESR rise (% of initial ESR)	< 1%	< 5%	Cycling at high RMS current will cause self-heating, which will in turn affect life. See Technical Guide.
Load life	@ V_n & 23°C G series = 4.5V, 23°C H Series = 5.5V, 23°C	C loss rate (% / 1000h)	< 1%	< 3%	C loss rates & ESR rise rates are drawn from long term life tests, conducted over periods at least 12 months.
		ESR rise rate (% of initial / 1000h)	< 1%	< 3%	
	@ 80% V_n & 80% T_{cont} G series = 3.6V, 50°C H Series = 4.5V, 50°C	C loss rate (% / 1000h)	< 2%	< 6%	ESR rise rate is linear.
		ESR rise rate (% of initial / 1000h)	< 4%	< 9%	C loss follows an exponential decay.
	@ V_n & T_{cont} G series = 4.5V, 70°C H Series = 5.5V, 70°C	C loss rate (% / 1000h)	< 10%	< 15%	
		ESR rise rate (% of initial / 1000h)	< 15%	< 45%	
MTTF	@ V_n & 23°C G series = 4.5V, 23°C H Series = 5.5V, 23°C	MTTF (years)	> 10	> 10	MTTF is calculated with a regression equation (Arrhenius form) from observed failures during long term life testing.
	@ 80% V_n & 80% T_{cont} G series = 3.6V, 50°C H Series = 4.5V, 50°C	MTTF (years)	3	2	
	@ V_n & T_{cont} G series = 4.5V, 70°C H Series = 5.5V, 70°C	MTTF (years)	< 1	< 1	Note that such calculations are inaccurate at low temperatures due to low/no observed failures.

7. Energy & Power Density

Parameter	Description	Metric	G Series	H Series	Notes
Energy	Full discharge from V_n	Capacity (mAh)	0.09 - 1.53	0.14 - 1.83	$\text{Capacity} = (C \times V_n) / 3.6$
	Gravimetric Energy Density	E_{grav} (Joules/kg)	1,013 - 4,883	1,552 - 6,981	$E_{\text{grav}} = (\frac{1}{2}C \times V^2) / \text{Weight}$
		E_{grav} (Wh/kg)	0.28 - 1.36	0.43 - 1.94	$E_{\text{grav}} = (\frac{1}{2}C \times V^2) / (3600 \times \text{Weight})$
	Volumetric Energy Density	E_{vol} (Wh/L)	0.27 - 1.44	0.42 - 2.06	$E_{\text{vol}} = (\frac{1}{2}C \times V^2) / (3600 \times \text{Volume})$
Power	Gravimetric Power Density	P_{grav} (kW/kg)	45.0 - 84.1	43.1 - 70.3	$P_{\text{grav}} = V_n^2 / (4 \times \text{ESR}) / \text{Weight}$
	Volumetric Power Density	P_{vol} (kW/L)	43.3 - 90.9	39.5 - 76.0	$P_{\text{vol}} = V_n^2 / (4 \times \text{ESR}) / \text{Volume}$

8. Product Names

CAP-XX products have a 6 character alpha-numeric product name in the form "GS230F", in which the characters convey the following information:

Position	Code	Meaning	Description
1	G H	Series code	G series are "General purpose" supercapacitors: - Operating temperature range: -40°C to +70°C - Continuous load voltage: 2.3V / 4.5V H series are "High temperature/High voltage" supercapacitors: - Operating temperature range: -40°C to +85°C - Continuous load voltage: 2.75V / 5.5V
2	S W A B Z	Body size code	"S" products are 39mm x 17mm, excluding the terminals. "W" products are 28.5mm x 17mm, excluding the terminals. "A" products are 20mm x 18mm, including the terminals. "B" products are 20.5mm x 18.5mm, including the terminals. "Z" products are 20mm x 15mm, including the terminals. Refer to the Mechanical Drawings section for detailed information on body sizes and terminal projections.
3	1 2	Number of cells	1 denotes a single cell supercapacitor (2.3V or 2.75V). 2 denotes a dual cell supercapacitor module (4.5V or 5.5V).
4, 5	nn	Product code	These codes are an internal CAP-XX reference to a particular supercapacitor configuration. Refer to the Product Specifications in Sections 4 & 5 for more information.
6	F G	Mounting code	An "F" suffix (e.g. GS230F) indicates no adhesive tape on the underside of the device (standard configuration). A "G" suffix (e.g. GS230G) indicates the presence of a double-sided, insulating adhesive tape on the underside of the device, to assist with mounting, electrical isolation and extreme shock and vibration. This option is available to order on all CAP-XX parts.

Note that only the first 5 characters of the product name are printed on the device.

9. Product Markings

All CAP-XX products are marked with the Product Name (first 5 characters only), the Batch Code, nominal Capacitance and Voltage, and the Positive and Balance (mid-point) terminal locations. Some products also show the nominal ESR, Country of Manufacture, and Device Number.

"S" & "W" Products

Dual cell module	Front: (positive terminal)	+	Back: Device Number
	(mid-point terminal)	Product Name Batch Code CAP & ESR Voltage CAP-XX Country of Mfr BAL	

Single cell	Front: (positive terminal)	+	Back: Device Number
		Product Name Batch Code CAP & ESR Voltage CAP-XX Country of Mfr	

"A" & "Z" Products

Dual cell module	Front: (positive terminal)	+	Back: Device Number
	(mid-point terminal)	Product Name Batch Code CAP & ESR Voltage CAP-XX BAL	

Single cell	Front: (positive terminal)	+	Back: Device Number
		Product Name Batch Code CAP & ESR Voltage CAP-XX	

"B" Products

Dual cell module	Front: (positive terminal)	Batch Code +	Back:
	(mid-point terminal)	Product Name CAP & V CAP-XX BAL	
Single cell	Front: (positive terminal)	Batch Code +	Back:
		Product Name CAP & V CAP-XX	

10. Batch Codes

“S”, “W”, “A” & “Z” products have a 6 character alpha-numeric Batch Code of the form "P2CAJ2", where:

- Position 1: Manufacturing site code
- Position 2: Manufacturing line number
- Position 3: Year of manufacture
- Position 4: Month of manufacture
- Position 5: Day of manufacture
- Position 6: Batch number that day on the specified line

The characters at Positions 3 - 6 indicate a number according to the following sequence:

Character	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G
Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Character	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
Number	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

“B” series products have a 5 character alpha-numeric Batch Code of the form "2Q-354", where:

- Position 1: Year of manufacture
- Position 2: Month of manufacture
- Position 3: A 3 digit, sequential batch number

The year code indicates the final digit in the year, as in 2 = 2012, 3 = 2013, etc.

The month code indicates the month according to the following sequence:

Character	F	G	H	J	K	L	M	N	P	Q	R	S
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

11. Transportation & Storage

IATA Dangerous Goods Regulations

Supercapacitors with an energy storage capacity of $< 0.3\text{Wh}$ are not subject to any transportation restrictions as of January 1, 2013 under the IATA Dangerous Goods Regulations, 54th Edition (see UN3499 in Class 9, Electrical Double-Layer Capacitors, ELDC).

All CAP-XX supercapacitors have an energy storage capacity $\ll 0.3\text{Wh}$ (1080J) and are not subject to any transportation restrictions.

Storage Conditions

CAP-XX recommends storing supercapacitors in their original packaging in a controlled environment until ready for use, ideally in an air conditioned room, with temperatures between 18°C and 28°C , and relative humidity between 40% and 60%.

Storage temperature should not exceed the maximum recommended range of -40°C to $+35^{\circ}\text{C}$, and relative humidity should not exceed 70%, with no condensation. Under no circumstances should storage conditions exceed the operating temperature range specified for the device.

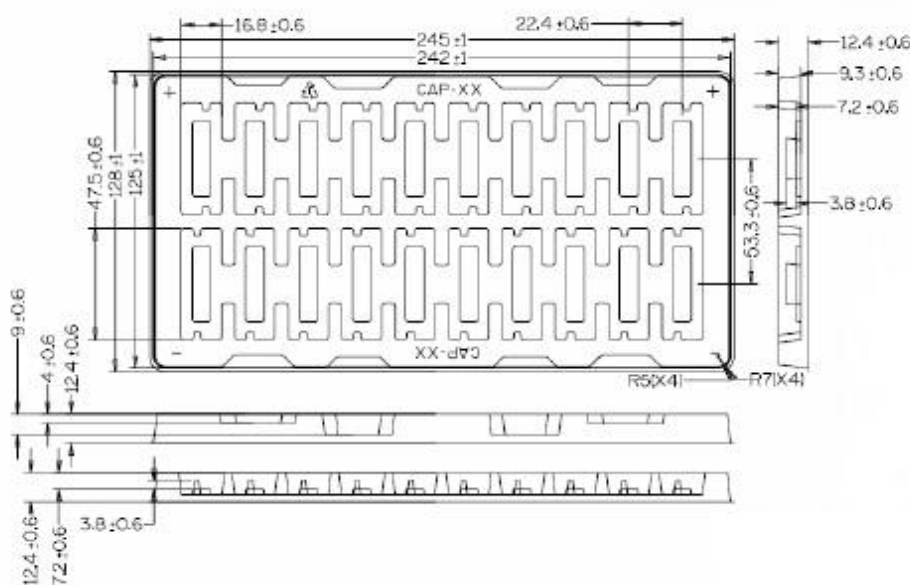
Avoid acidic or alkaline storage environments and any excessive external forces.

12. Packaging & Package Quantities

CAP-XX supercapacitors are shipped in stackable, anti-static trays. Each tray holds 20 to 50 devices (depending on the body size), in cavities moulded into the tray. The trays are designed to protect the devices during transportation, and to facilitate their removal by hand or vacuum pen prior to assembly.

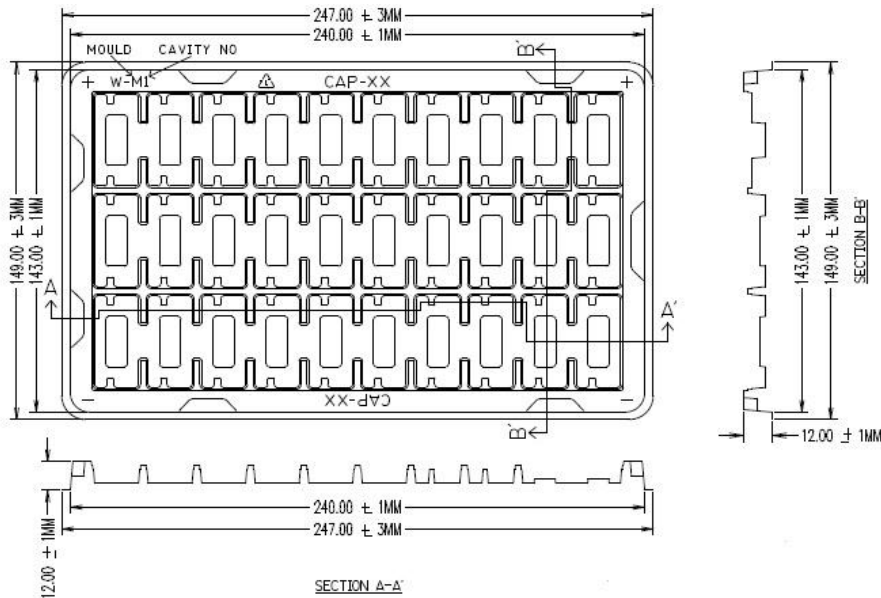
"S" Products Packing Tray

20pcs / Tray, Package quantity = 200pcs



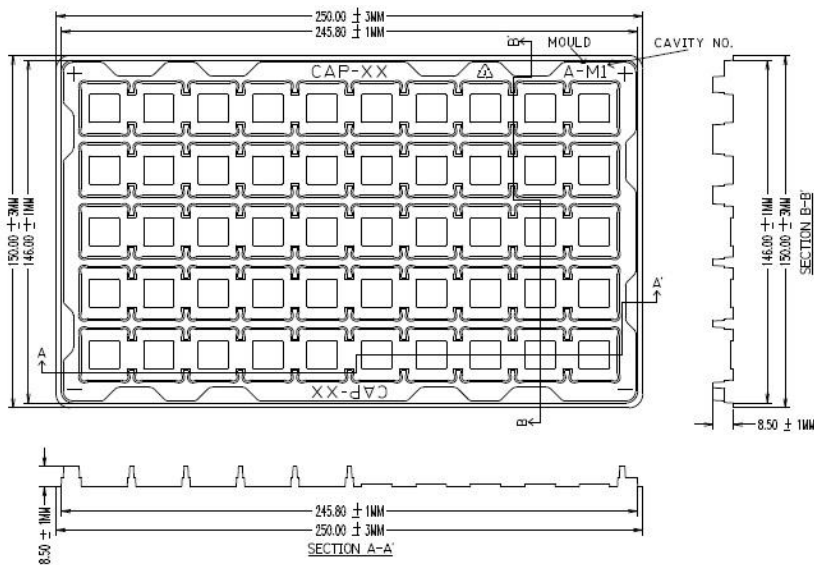
"W" Products Packing Tray

30pcs / Tray, Package quantity = 300pcs



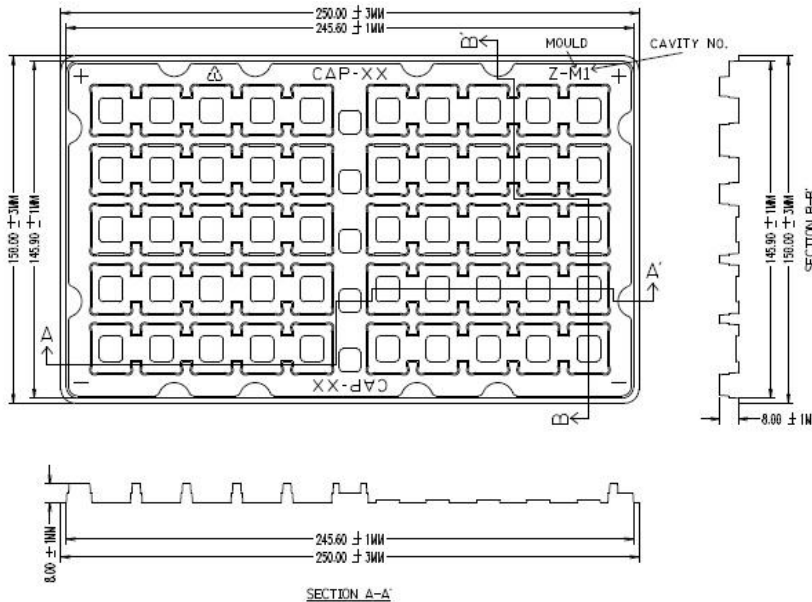
"A" Products Packing Tray

50pcs / Tray, Package quantity = 500pcs



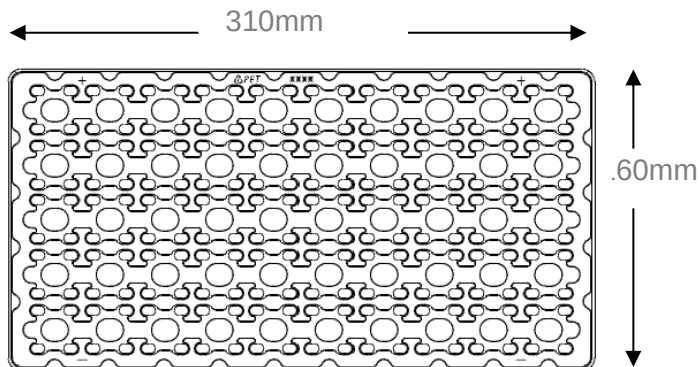
"Z" Products Packing Tray

50pcs / Tray, Package quantity = 500pcs



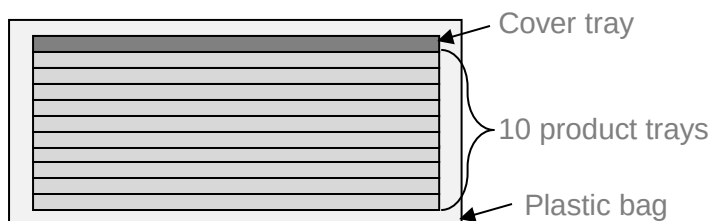
"B" Products Packing Tray

50pcs / Tray, Package quantity = 500pcs



Packaging for Shipment

A shipping package contains a stack of 10 product trays with a cover tray on top, wrapped in plastic bubble wrap. Each package contains 200 to 500 devices, which generally represents the Minimum Shipment Quantity for all products, and the Minimum Order Quantity for standard products.



13. Cautions Before Use

CAP-XX supercapacitors are “burned in” during production and have a defined polarity, as shown by the positive terminal marked on the face of the product. Reversing the polarity of the device may cause a rise in the ESR, and will void the warranty. Please verify the orientation of the supercapacitor in accordance with the product markings before assembly.

CAP-XX supercapacitors are heat sensitive. Over-heating of the supercapacitor may result in a degradation of performance and useful life.

CAP-XX supercapacitors must only be used within their rated voltage range. Over-voltage may cause swelling and eventually, product failure.

Dual cell supercapacitor modules contain two cells connected in series. Please ensure that the voltage in both cells remains below the rated peak and constant operating voltages. CAP-XX recommends the use of an active balancing circuit or passive balancing resistors to prevent an over-voltage situation developing in one cell. Contact CAP-XX for more information on cell balancing.

CAP-XX supercapacitors are fully discharged when shipped. Devices should be handled and soldered in a discharged state.

14. Soldering & Assembly

Placement

Avoid contact between conductive areas on the underside of the supercapacitor and any vias or tracks on the PCB. Refer to the Product Drawings for detailed information on the location and size of these conductive areas, and the recommended positioning and size of PCB landing pads.

Do not apply excessive force to the supercapacitor during placement. CAP-XX supercapacitors should not be exposed to more than 400kPa pressure across the flat surface of the device (equivalent to a weight of 10kg). Bending or applying too much pressure to the device may damage the seals, resulting in device failure.

CAP-XX supercapacitor terminals are manufactured from tinned (pure bright tin), annealed (low temper) copper that is pliable. Care should be taken to avoid bending the terminals.

To mount the supercapacitor on the PCB, remove the device from the tray by hand, with a vacuum pen, or by an automated pick and place robotic arm with a vacuum pen, and locate onto the PCB.

CAP-XX offers an adhesive insulating tape on the underside of the device as an option to assist in mounting. Remove the release tape from this adhesive prior to positioning on the PCB. The PCB surface must be clean and free from oil, grease or flux residue. With the adhesive exposed, the device should be positioned and pressed firmly into place. An extended hold time is not required.

Soldering

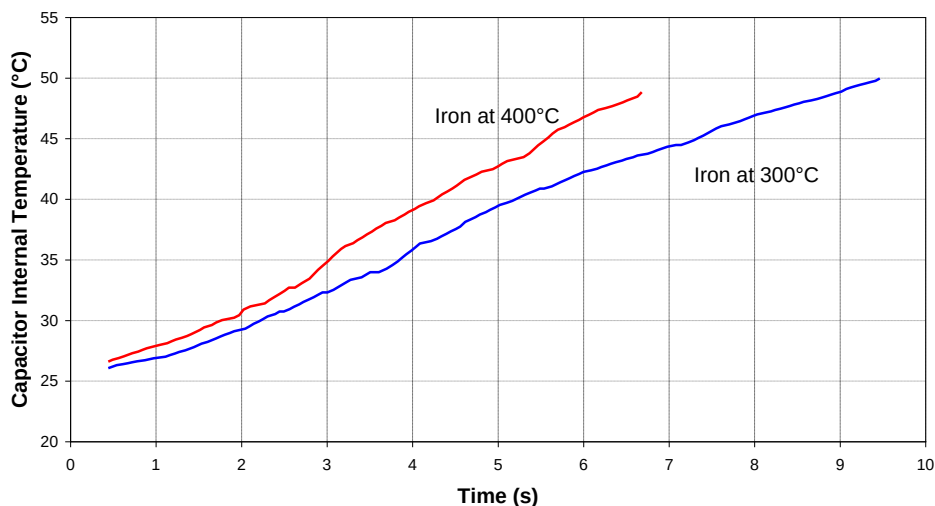
CAP-XX supercapacitors are designed for direct soldering onto the PCB. Soldering the terminals to the PCB will ensure the highest contact reliability and lowest contact resistance. Do NOT solder directly to the device casing. This will cause permanent internal damage to the supercapacitor.

CAP-XX supercapacitors are NOT SUITABLE for infrared reflow soldering, hot-air reflow soldering, or wave soldering. They should be mounted as a secondary operation, using a manual soldering iron, a hot bar soldering jig, conductive adhesive, ultrasonic welding or laser welding.

CAP-XX recommends the use of a water-soluble flux, or a no-clean (low residue) flux, and low temperature solder compounds.

Soldering should be undertaken with a low wattage soldering iron (70W), applying heat just long enough to achieve a good connection. The maximum recommended soldering time is 5 seconds, when using an iron at 400°C in an ambient temperature of 25°C.

Capacitor Internal Temperature when Soldering



If a hot-air gun is used to reflow the solder during a re-mount or de-mount, care must be taken to prevent excessive heating of the package adjacent to the solder terminals. Allow at least 15 sec between successive soldering attempts for the device to cool down.

Washing

CAP-XX supercapacitors are NOT SUITABLE for solvent-based washing. Do not use any solvent cleaners such as acetone, benzene, isopropyl alcohol or halogenated solvents.

CAP-XX recommends that the assembly be washed with an aqueous cleaning solution based on de-ionized water to remove any flux residue. Do not wash at temperatures exceeding 70°C, or at spray pressures exceeding 50psi. The supercapacitor may be fully submerged briefly during the washing process, but exposure times to water should generally be minimized.

Drying

Rapid airflow around the device during drying will assist in the removal of any residual moisture trapped in the package. Keep drying times to the minimum necessary, at temperatures not exceeding 70°C.

Conformal Coatings

Some applications require the use of “potting” compounds or conformal coatings on the assembled PCB in order to meet specific performance requirements, such as enhanced shock and vibration resistance, waterproofing, protection from corrosive environments, and ATEX / Intrinsic Safety certifications. Potting may involve the use of thermo-setting plastics, silicone rubber gels, or polyurethane, whilst conformal coatings generally involve acrylics, epoxies, polyurethane, silicones, Parylene, or amorphous fluoro polymers.

In all cases, consideration must be given to the potential for the solvents used in the process to damage the external packaging of the supercapacitor, and the temperatures to which the device will be subjected during setting and curing. Contact CAP-XX for more information.

15. Safety

CAP-XX supercapacitors are very safe and reliable.

Failure modes

The failure mode for a supercapacitor is usually open circuit, with ESR rising to infinity.

This can occur if the device is exposed to high temperature or voltage or as a result of electrolyte loss over time. These situations can occur as a result of assembly errors (e.g. over-heating the device during soldering), circuit design errors (e.g. failure to balance the cell voltages in a dual cell device correctly), environmental extremes (e.g. temperature excursions beyond the specified range or duration), or natural ageing (e.g. permeation of the electrolyte solvent through the package seal).

Occasionally, supercapacitors will fail as a short circuit. This can be due to physical damage sustained during handling or assembly (e.g. if the package is pierced by a sharp, conductive object), assembly errors (e.g. by shorting a terminal to the package during soldering), circuit design errors (e.g. by running vias on the PCB under conductive areas on the package), industrial design errors (e.g. by exerting excessive pressure on the device, damaging the internal separator membrane), or by manufacturing errors (e.g. by misalignment of the separator between electrodes).

Resistance to Shock

CAP-XX has undertaken tests in accordance with IEC68-2-27 to determine the effects of repeated shocks on both the mechanical integrity and electrical performance of its supercapacitors:

- Pulse Shape Half-Sine
- Amplitude 30g $\pm$ 20%
- Duration 18ms $\pm$ 5%
- No. of Shocks 3 in each direction (18 in total)
- No. of Axes 3, orthogonal

Results: No electrical or mechanical degradation observed.

Note that this test was undertaken on the standard product, with no adhesive mounting tape. To achieve the highest levels of resistance to shock, CAP-XX recommends the use of its “G” suffix parts, with adhesive mounting tape on the underside of the device.

Resistance to Vibration

CAP-XX has undertaken tests in accordance with IEC68-2-6 to determine the effects of sustained vibration on both the mechanical integrity and electrical performance of its supercapacitors:

- Type Sinusoidal
- Frequency 55Hz - 500Hz
- Amplitude 0.35mm $\pm$ 3dB (55Hz to 59.55Hz)
5g $\pm$ 3dB (59.55Hz to 500Hz)
- Sweep Rate 1 Oct/min
- No. of Cycles 10 (55Hz - 500Hz - 55Hz)
- No. of Axes 3, orthogonal

Results: No electrical or mechanical degradation observed.

Note that this test was undertaken on the standard product, with no adhesive mounting tape. To achieve the highest levels of resistance to vibration, CAP-XX recommends the use of its “G” suffix parts, with adhesive mounting tape on the underside of the device.

Drop-Test

CAP-XX has undertaken tests to determine the effects of repeated drops on both the mechanical integrity and electrical performance of its supercapacitors:

- Mounting Mount the supercapacitor in a test jig as set out below
- Method Drop the test jig onto a concrete floor from a height of 2m
- No. of Cycles 3 drops, one on each axis

Results: No electrical or mechanical degradation observed when following the mounting rules.

Mounting during drop test:

- Constrained by the device housing, with a maximum clearance of 1mm – The supercapacitor was connected to the PCB only by the solder connections on the terminals.
- Unconstrained by the device housing - The supercapacitor was connected to the PCB with double-sided adhesive tape and by solder connections on all terminals.

For maximum product performance in harsh environments, CAP-XX recommends the use of the “G” mounting tape option, some other form of adhesive bonding, or a conformal coating.

Exposure to an Open Flame

A fully charged supercapacitor was burned with an alcohol lamp.

Results: The supercapacitor expands due to the heat, and the seal weakens, but does not burst. There is no ignition, no fire, and no scattering of pieces and/or sparks.



Exposure to Heat

A fully charged supercapacitor was placed in an oven for 1hr at 130°C.

Results: The supercapacitor expands due to the heat, and the seal weakens, but does not burst. There is no smoke, no fire, and no gas emission.



Pressure

A fully charged supercapacitor was pressed with a 10mm diameter pole, to 2/3 of its initial thickness.

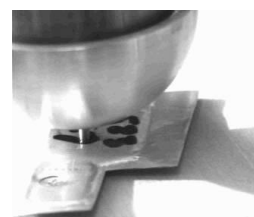
Results: The supercapacitor loses its charge. There is no ignition, no smoke, no fire, no gas emission, and no scattering of pieces and/or sparks.



Puncture

A fully charged supercapacitor was punctured with a 2mm diameter steel needle.

Results: The supercapacitor loses its charge. There is no ignition, no smoke, no fire, no gas emission, and no scattering of pieces and/or sparks.





Dimensional Stability & Over-Temperature

16. Dimensional Stability & Low Pressure Environments

CAP-XX supercapacitors are hermetically sealed, and contain a very small amount of a liquid electrolyte. At high altitudes (with low external pressure), the device may swell and ESR may increase. Please contact CAP-XX for more information on use in low pressure environments.

The aluminium soft pack devices will swell at high temperature, and may exert force on adjacent components. If unconstrained, "S", "W", "A" and "Z" devices may swell by up to 50% of their nominal thickness at 70°C. The steel packaged "B" series devices will swell by <10% at 70°C.

If constrained by the device housing or adjacent components, the supercapacitor may exert up to 7N of force on its surroundings at 70°C. As an example, with a contact surface area of 1.7cm², a dual cell W device will exert a pressure of ~42kPa (6psi) on a fixed surface at 70°C.

17. Response to Over-Temperature Events

CAP-XX supercapacitors are heat sensitive. Over-heating of the supercapacitor may result in a degradation of performance and useful life. Note that the thermal mass of CAP-XX supercapacitors is very small, so the temperature of the device will equalize to its environment very quickly.

G series devices are rated to a maximum temperature of 70°C, whilst the H series is rated to 85°C. CAP-XX does not recommend operating supercapacitors at or near their maximum temperature rating constantly, as they will age rapidly (i.e. ESR will rise and capacitance will fall).

Exceeding the rated maximum temperature will cause even more accelerated ageing, and may cause immediate failure depending on the temperature reached and the time exposed.

At temperatures between 85°C and 100°C, there will be a progressive change in the dimensions of the package (puffing). Usually, this is completely reversible, and electrical performance is retained. As the temperature approaches 100°C, the probability of non-reversible change increases. This will occasionally cause immediate failure, and degraded electrical performance due to physical damage to the internal structure of the device.

At temperatures greater than 100°C, electrical performance will degrade rapidly, and permanent electrical failure becomes increasingly likely. At 150°C or higher, the seals will melt and the device will fail both physically and electrically.

Contact CAP-XX for more information on ageing, life, and performance at high temperature.

18. Certifications & Compliances

ISO9001-2008

CAP-XX is certified as following the ISO 9001 Quality Management System.

The current certification can be found by typing "CAP-XX" in the Organisation field of the Certified Organisations Search page of the JAS-ANZ Register at cab.jas-anz.org.

Underwriter's Laboratory (UL)

All CAP-XX standard products have been tested by Underwriter's Laboratory and are certified as UL-Recognized Components.

The CAP-XX certified products can be found under UL category code BBBG2, and UL file number MH47599 in the Online Certifications Directory at database.ul.com.



Dimensional Stability & Over-Temperature

RoHS

All CAP-XX products are RoHS2 compliant. Substances specified in the European Union directive 2011/65/EU and Chinese Government directive (to standard SJ/T 11363 – 2006) are either not present at all, or are present at levels below those specified in the directive.

The current RoHS Certificate of Compliance is available on the CAP-XX website.

REACH

All CAP-XX products are REACH compliant.

Pre-registration and registration of substances in articles: CAP-XX does not supply any products that would be considered an article with a substance intended to be released during normal and reasonably foreseeable conditions of use, and therefore has no plans for pre-registration.

Substances of Very High Concern (SVHC): CAP-XX products do not contain any chemicals listed as SVHC in Annex XIV or the Candidate List under Article 57 of European Directive EC 1907/2006 and as amended by subsequent regulations.

Restricted use substances: CAP-XX products either do not contain any of the restricted-use substances given in Annex XVII of European Directive EC 1907/2006 and as amended by subsequent regulations, or meet any of the restrictions placed on them.

The current REACH Certificate of Compliance is available on the CAP-XX website.

Rare Earth Metals & Conflict Metals

CAP-XX products do not contain any rare earth metals or conflict metals as defined in Section 1502 of the United States Financial Reform Bill (HR 4173), 2010. Specifically, CAP-XX supercapacitors do not contain any Tantalum (Ta), Tungsten (W) or Gold (Au). CAP-XX products contain Tin (Sn) sourced only from non-conflict sources.

The current Certificate of Compliance is available on the CAP-XX website.

Halogens

CAP-XX products are halogen-free as defined under the draft IPC/JEDEC J-STD-709 standard for electronic components and assemblies. Specifically, CAP-XX products do not contain any brominated or chlorinated flame retardants (BFRs/CFRs) or PVC plastics.

The current Certificate of Compliance is available on the CAP-XX website.

19. Notes & Disclaimers

Product specifications in this document are current as of January 2013. Specifications are subject to change, and products may be discontinued without advance notice.

This document contains limited specification detail. Please review the relevant Data Sheet or contact CAP-XX for more information about specific products.

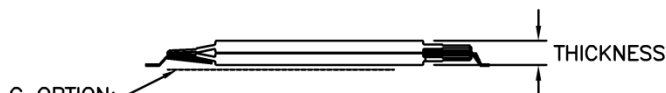
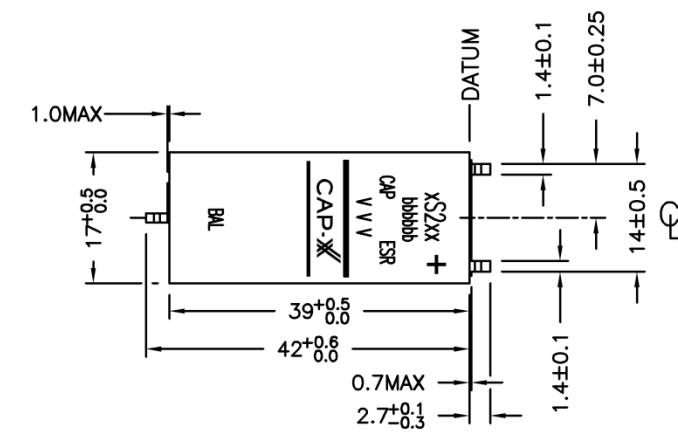
CAP-XX products are not authorized for use in medical devices classified as Class III under the European Union Directive 93/42/EC, 2010, or Class D of the Global Harmonization Task Force Guidelines, 2012. Please contact CAP-XX for more information on the use of our products in any applications which may be considered to carry any risk of harm to people or property.

CAP-XX and trade names associated with CAP-XX are protected by Trademark.

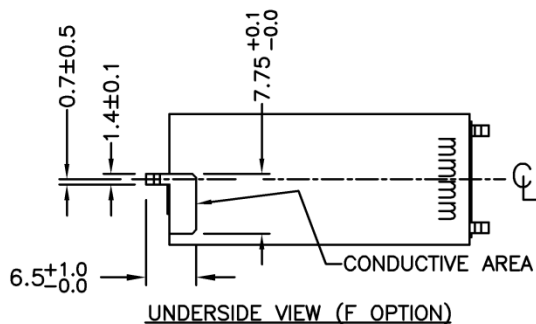
Technology referred to in this document is protected by US patent 06631072 and other patents and pending patents.

20. Product Drawings: Dual Cell Modules

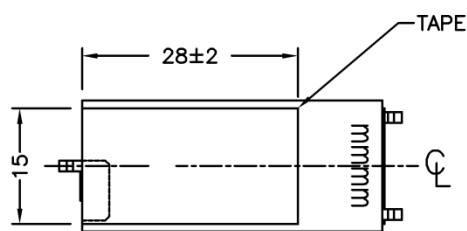
GS2 & HS2 Mechanical & Electrical Drawing



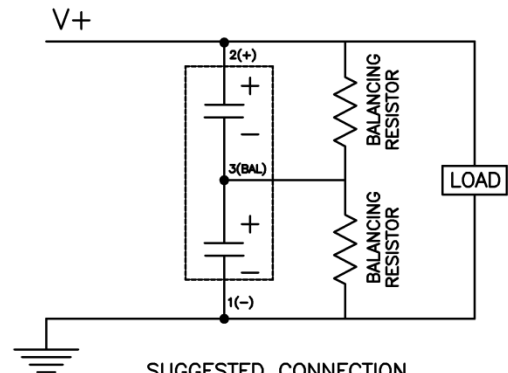
G OPTION:
TAPE ON UNDERSIDE ADDS 0.1mm
TO DEVICE THICKNESS WITHOUT RELEASE TAPE



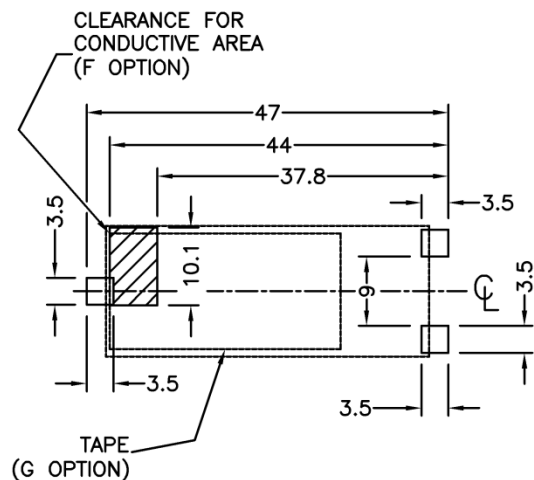
UNDERSIDE VIEW (F OPTION)



UNDERSIDE VIEW (G OPTION)



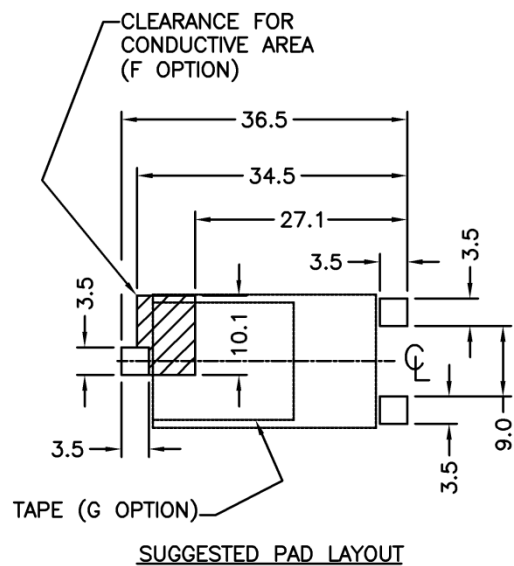
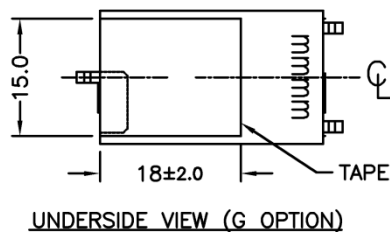
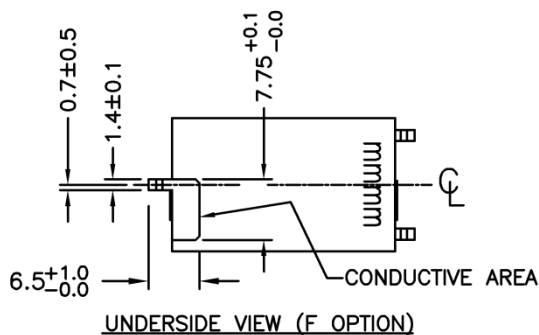
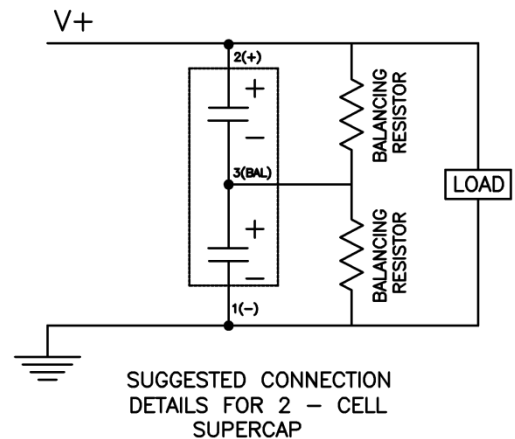
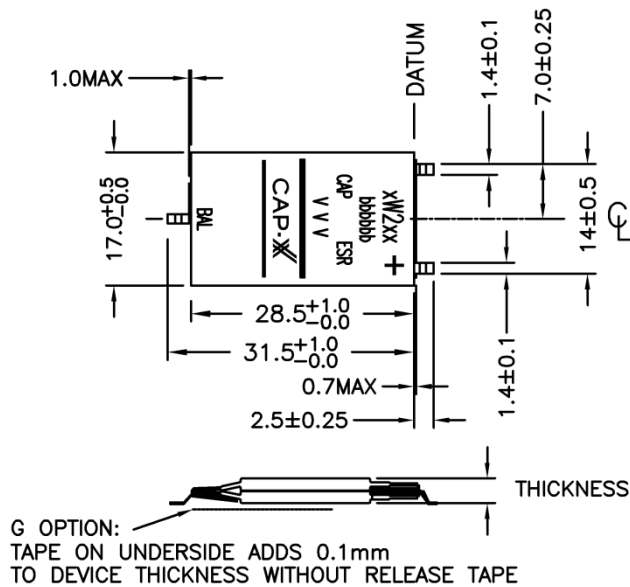
SUGGESTED CONNECTION
DETAILS FOR 2 - CELL
SUPERCAP



SUGGESTED PAD LAYOUT

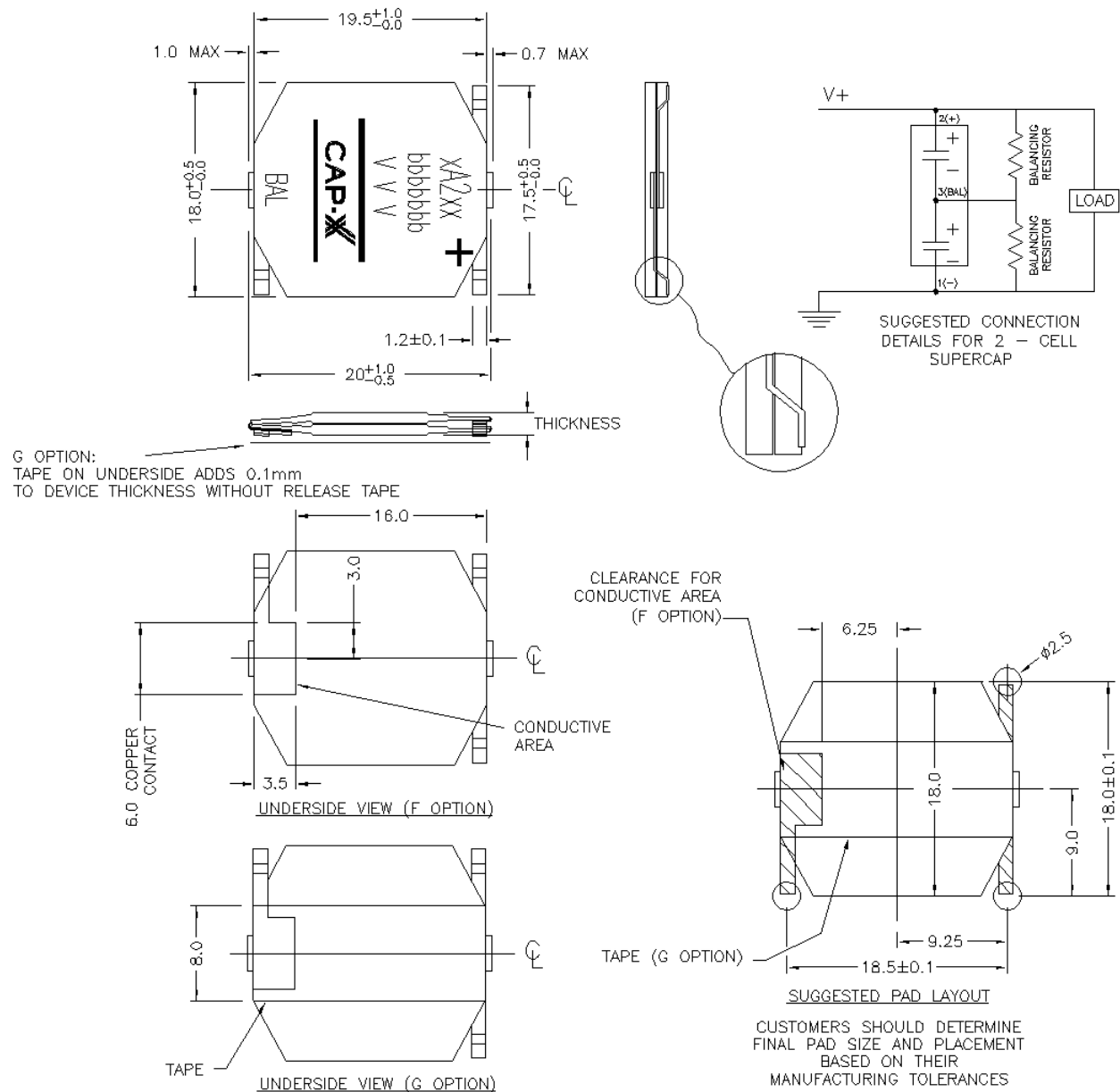
CUSTOMERS SHOULD DETERMINE
FINAL PAD SIZE AND PLACEMENT
BASED ON THEIR
MANUFACTURING TOLERANCES

GW2 & HW2 Mechanical & Electrical Drawing

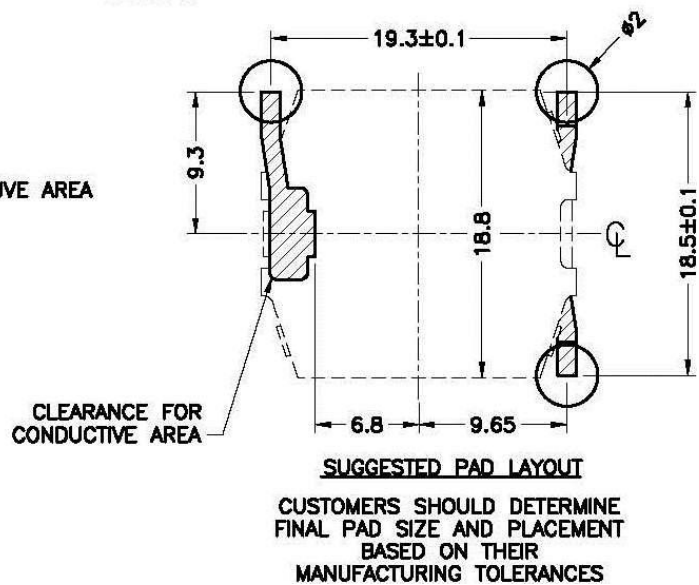
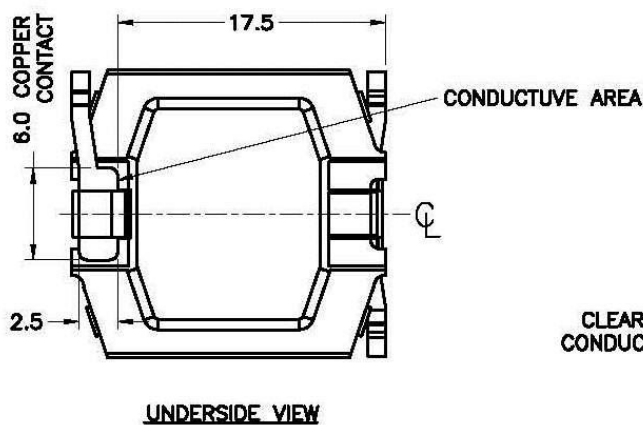
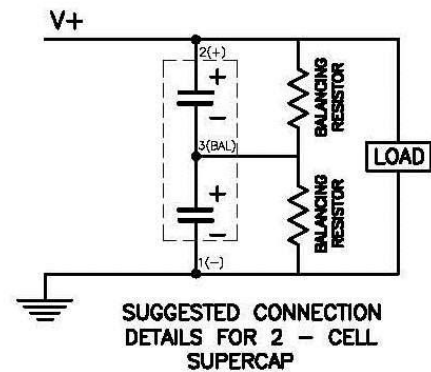
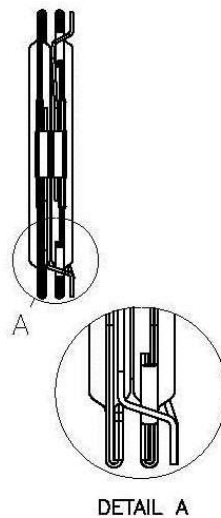
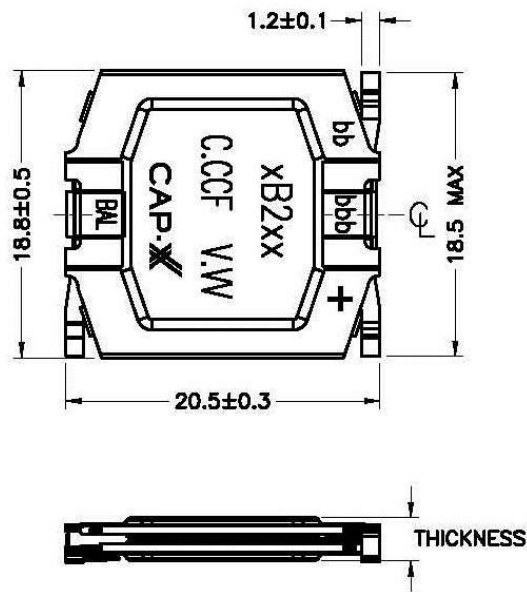


CUSTOMERS SHOULD DETERMINE
FINAL PAD SIZE AND PLACEMENT
BASED ON THEIR
MANUFACTURING TOLERANCES

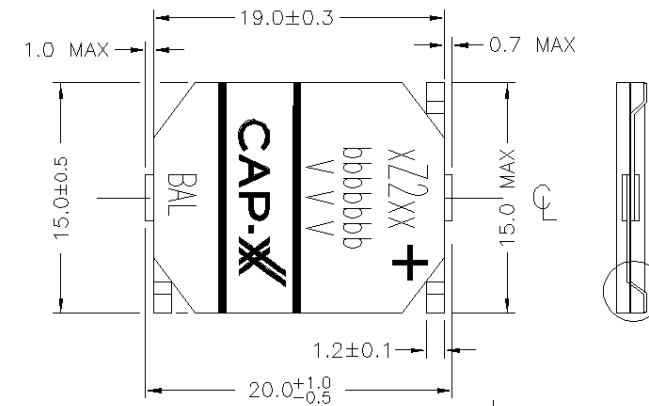
HA2 Mechanical & Electrical Drawing



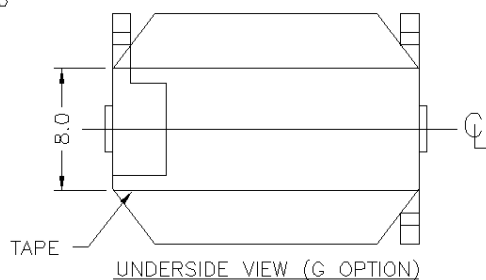
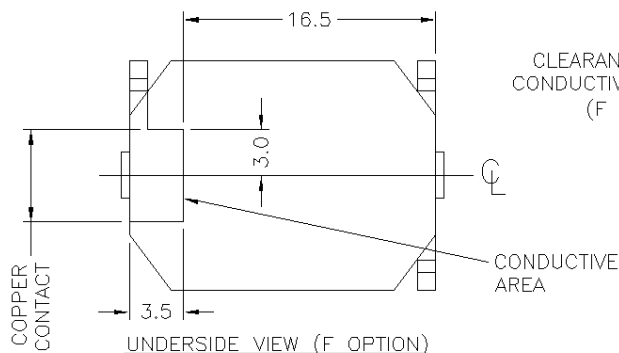
GB2 Mechanical & Electrical Drawing



GZ2 & HZ2 Mechanical & Electrical Drawing

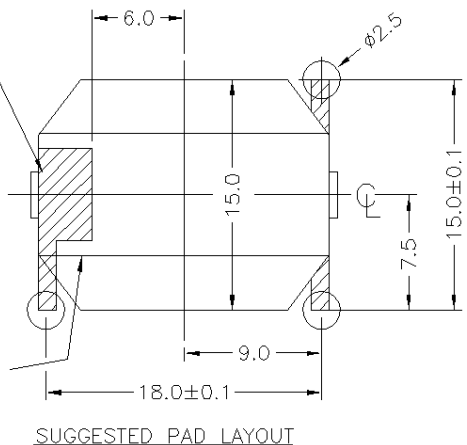
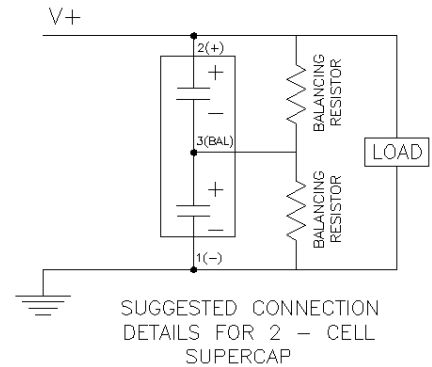


G OPTION:
TAPE ON UNDERSIDE ADDS 0.1mm
TO DEVICE THICKNESS WITHOUT RELEASE TAPE



CLEARANCE FOR
CONDUCTIVE AREA
(F OPTION)

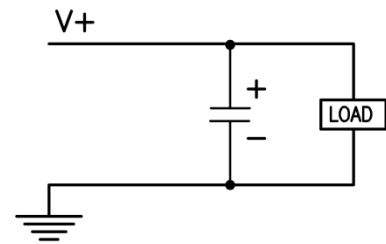
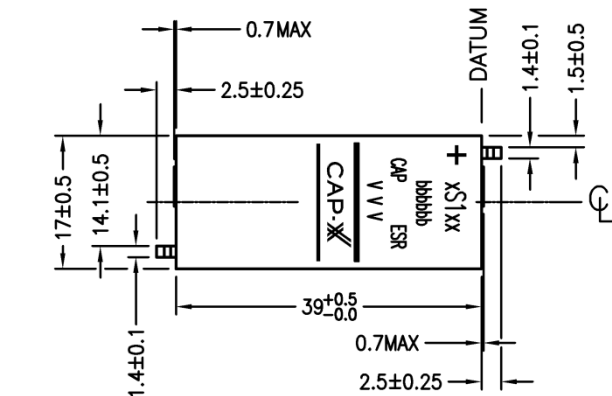
TAPE (G OPTION)



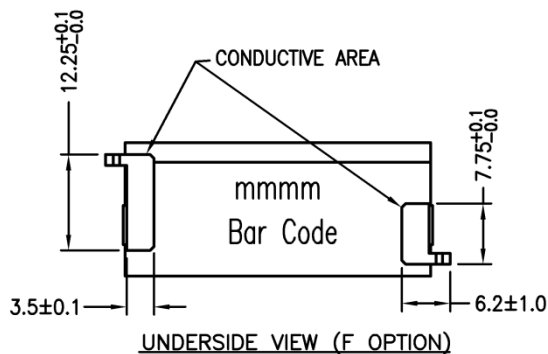
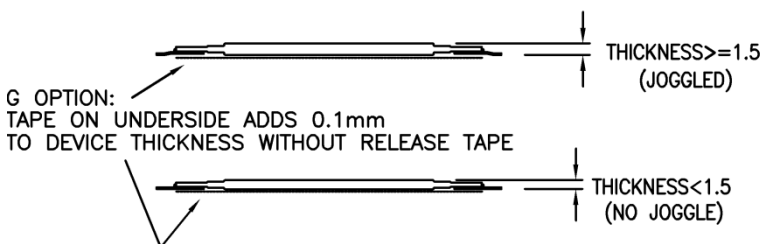
CUSTOMERS SHOULD DETERMINE
FINAL PAD SIZE AND PLACEMENT
BASED ON THEIR
MANUFACTURING TOLERANCES

21. Product Drawings: Single Cell Supercapacitors

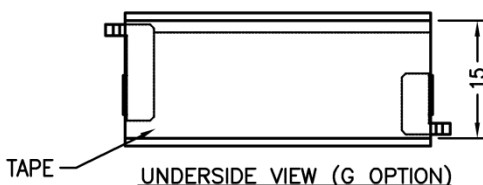
GS1 & HS1 Mechanical & Electrical Drawing



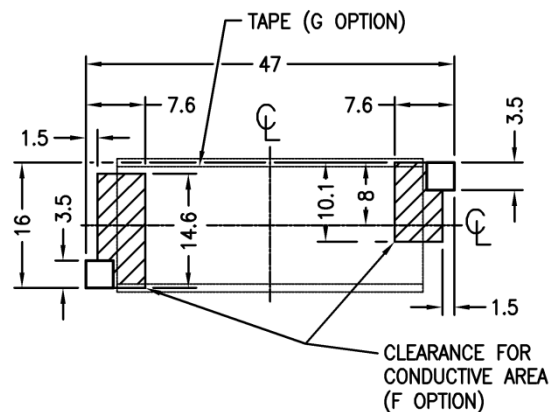
SUGGESTED CONNECTION
DETAILS FOR SINGLE CELL
SUPERCAP



UNDERSIDE VIEW (F OPTION)



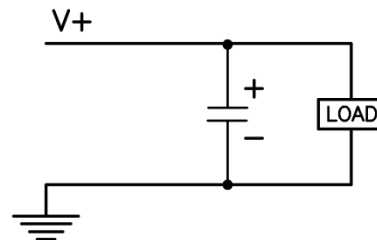
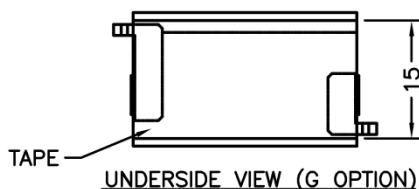
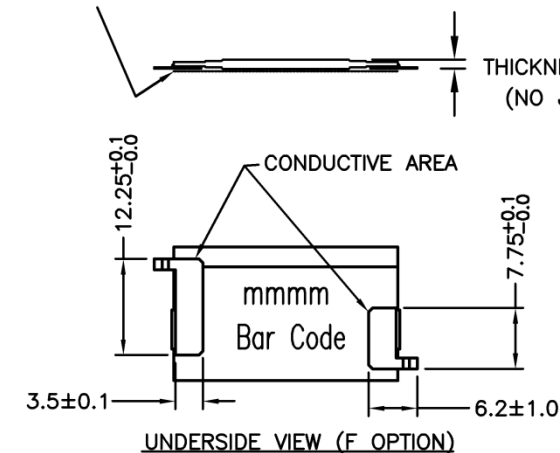
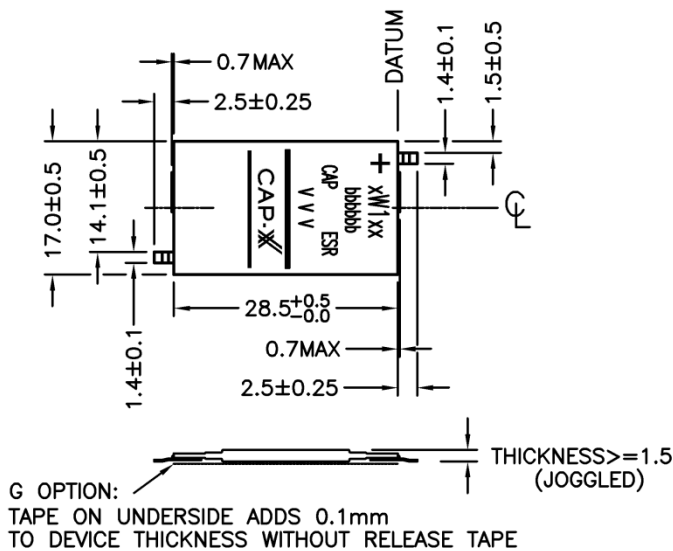
UNDERSIDE VIEW (G OPTION)



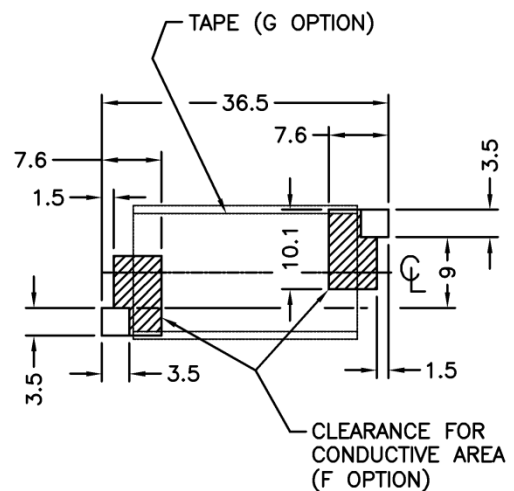
SUGGESTED PAD LAYOUT

CUSTOMERS SHOULD DETERMINE
FINAL PAD SIZE AND PLACEMENT
BASED ON THEIR
MANUFACTURING TOLERANCES

GW1 & HW1 Mechanical & Electrical Drawing



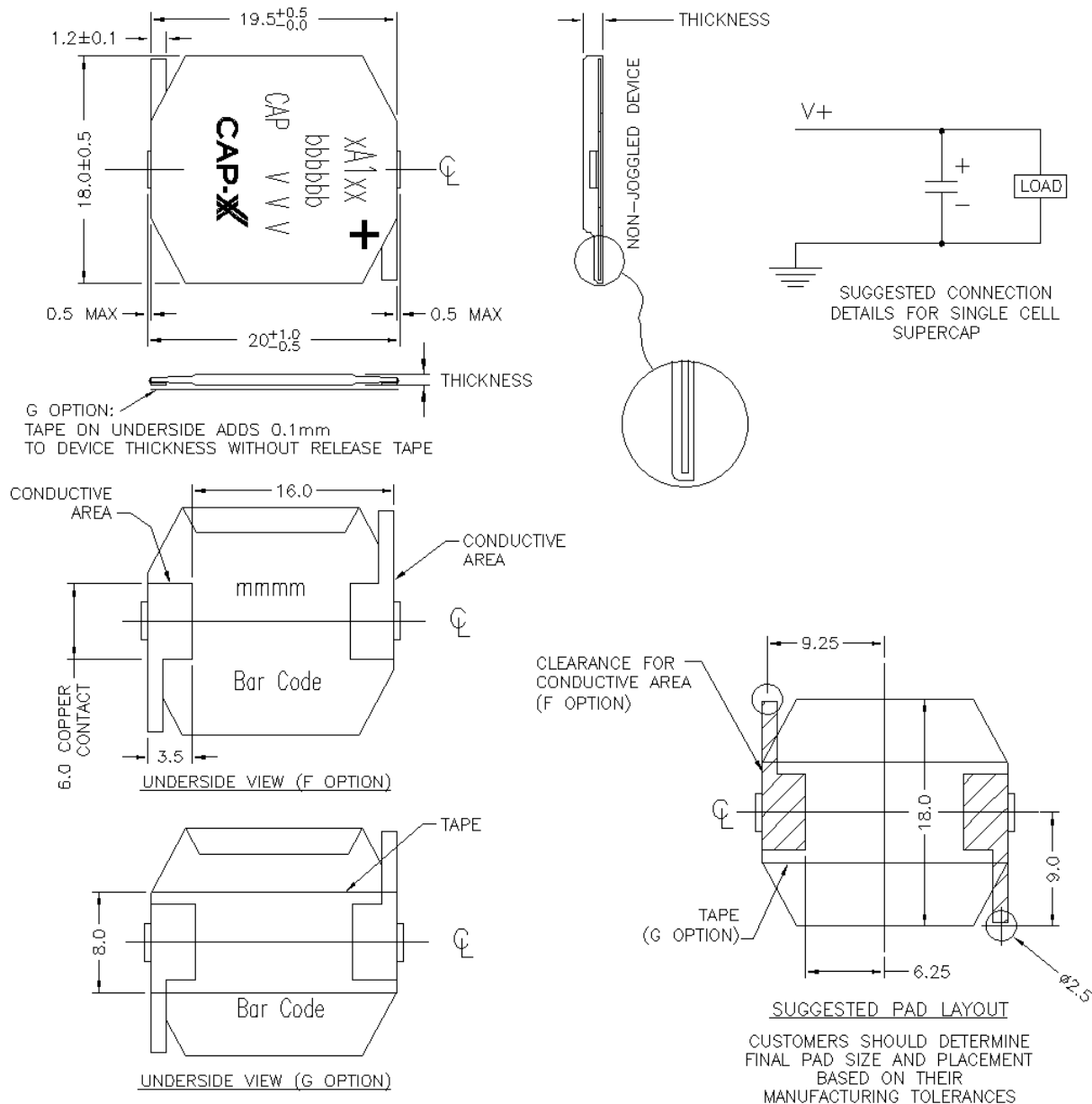
SUGGESTED CONNECTION
DETAILS FOR SINGLE CELL
SUPERCAP



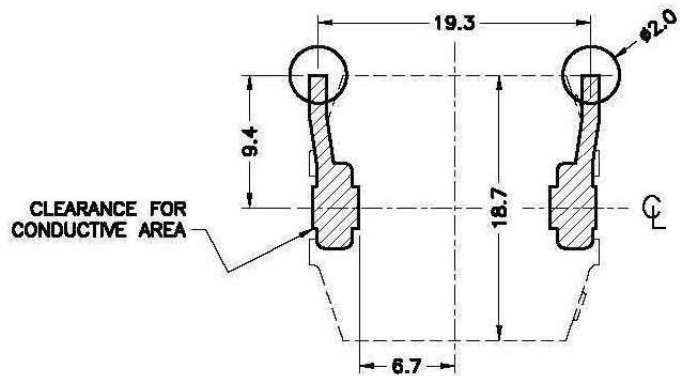
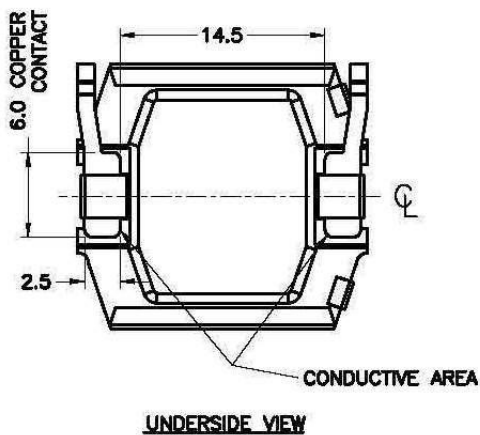
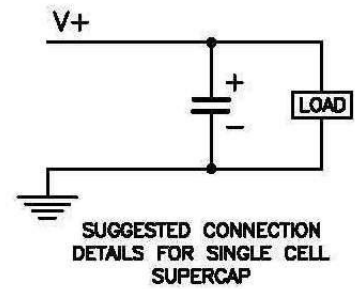
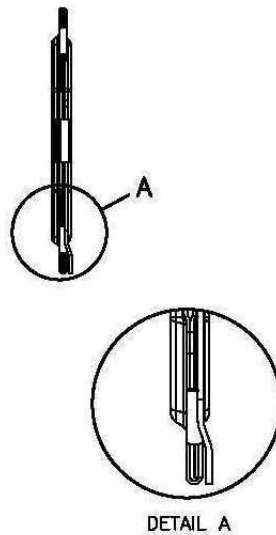
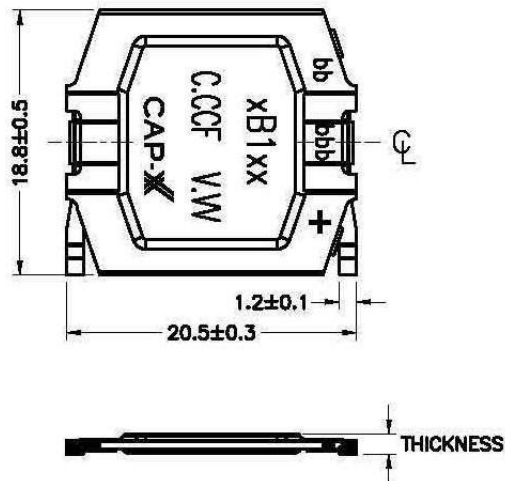
SUGGESTED PAD LAYOUT

CUSTOMERS SHOULD DETERMINE
FINAL PAD SIZE AND PLACEMENT
BASED ON THEIR
MANUFACTURING TOLERANCES

HA1 Mechanical & Electrical Drawing

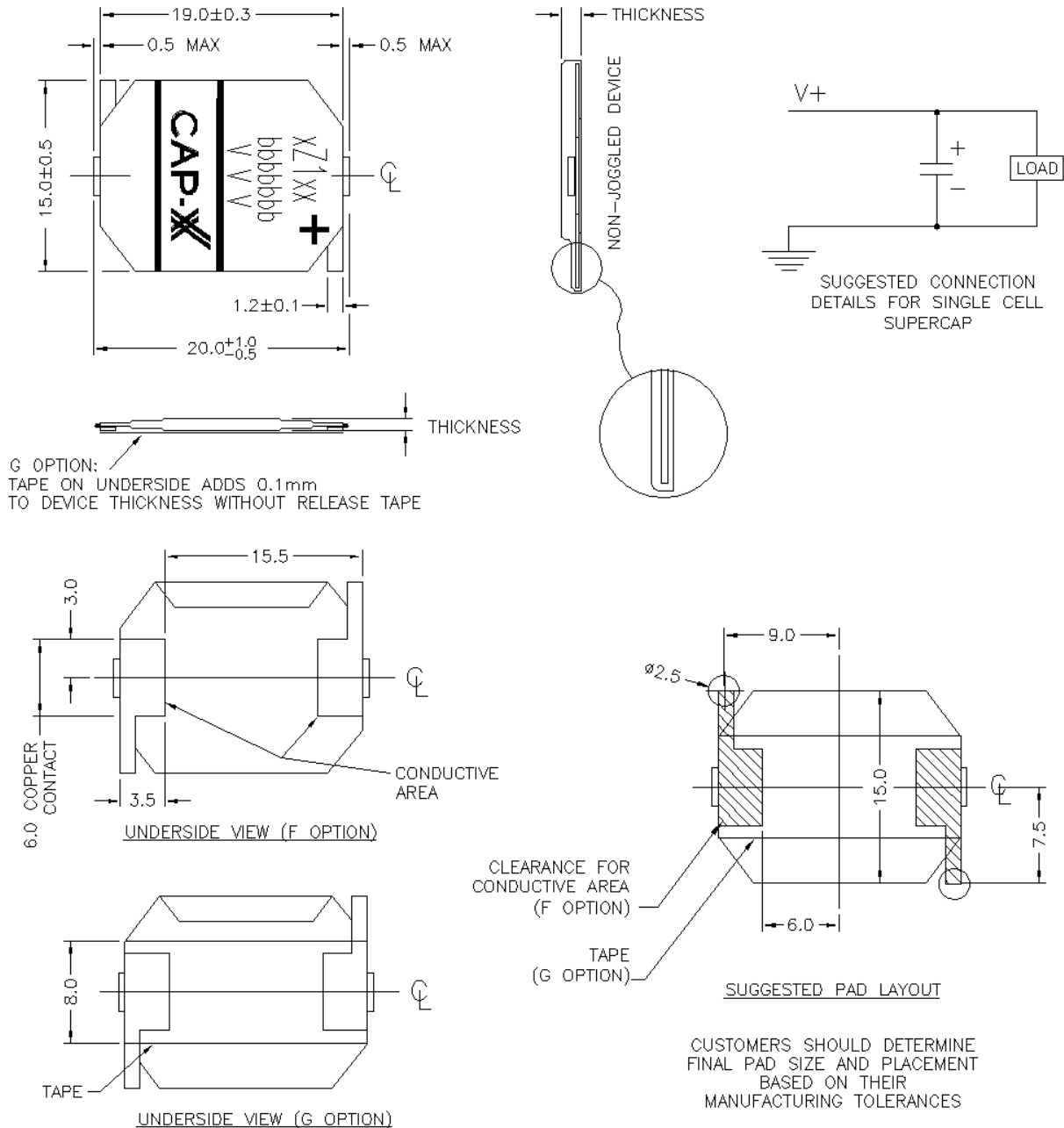


GB1 Mechanical & Electrical Drawing



CUSTOMERS SHOULD DETERMINE
FINAL PAD SIZE AND PLACEMENT
BASED ON THEIR
MANUFACTURING TOLERANCES

GZ1 & HZ1 Mechanical & Electrical Drawing





Contact Information

22. Contact Information

Principal Office

CAP-XX (Australia) Pty Ltd
Unit 9, 12 Mars Road
Lane Cove, NSW 2066
Australia

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Telephone:

+61 2 9420 0690

Investor Enquiries

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investor.relations@cap-xx.com

Press Enquiries

Moody & Associates

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michellemoody@moodypr.com

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www.uniquet.co.kr/products/magnatek

Singapore & China

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www.mccoycomponents.com

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Unitronic

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ACTE Norway

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Poland & Russia

ACTE Poland

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Spain & Portugal

ELCO Componentes

www.elcocomponentes.com

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ACTE Sweden

www.acte.se

Switzerland & Austria

Secos

www.secos.ch

UK & Ireland

ACTE UK

www.acte-uk.com

MIDDLE EAST & AFRICA

Israel

B. Roman (2001)

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South Africa

Seven Labs Technology

www.sevenlabs.co.za