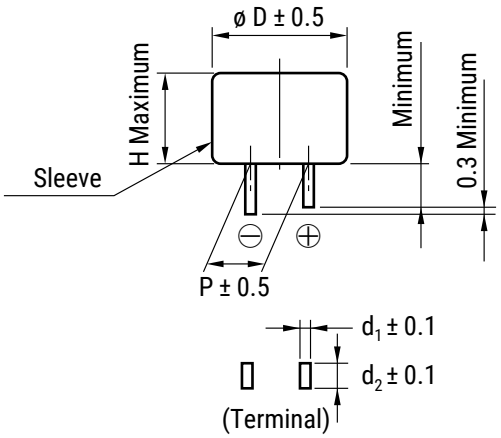
FR Series Supercapacitors, also known as Electric Double-Layer Capacitors (EDLCs), are intended for high energy storage applications.

Supercapacitors have characteristics ranging from traditional capacitors and batteries. As a result, supercapacitors can be used like a secondary battery when applied in a DC circuit. These devices are best suited for use in low voltage DC hold-up applications such as

- Maintenance free
- Maximum operating voltage: 5.5 VDC
- Highly reliable against liquid leakage
- Lead-free and RoHS Compliant

Series	Maximum Operating Voltage	Capacitance Code (F)	Capacitance Tolerance	Environmental
FR	0H = 5.5 VDC	First two digits represent		F = Lead-free



FR0H223ZF	11.5	14.0	5.08	2.7	0.4	1.2
FR0H473ZF	14.5	14.0	5.08	2.4	0.4	1.2
FR0H104ZF	14.5	15.5	5.08	2.4	0.4	1.2
FR0H224ZF	14.5	21.0	5.08	2.4	0.4	1.2
FR0H474ZF	16.5	21.5	5.08	2.7	0.4	1.2
FR0H105ZF	21.5	22.0	7.62	3.0	0.6	1.2

Supercapacitors should not be used for applications such as ripple absorption because of their high internal resistance

similar to that of secondary battery such as power back-up in DC circuit. The following list shows the characteristics of supercapacitors as compared to aluminum electrolytic capacitors for power back-up and secondary batteries.

	NiCd	Lithium Ion	Aluminum Electrolytic	Supercapacitor
Back-up ability	–	–	–	–
	Cd	–	–	–
Operating Temperature Range				
Charge Time	few hours	few hours	few seconds	few seconds
Charge/Discharge Life Time	approximately 500 times	approximately 500 to 1,000 times	limitless (*1)	limitless (*1)
Restrictions on Charge/Discharge	yes	yes	none	none
Flow Soldering	not applicable	not applicable	applicable	applicable
Automatic Mounting	not applicable	not applicable	applicable	applicable (FM and FC series)
Safety Risks	leakage, explosion	leakage, combustion, explosion, ignition	heat-up, explosion	gas emission (*2)

*(*1) Aluminum electrolytic capacitors and supercapacitors have limited lifetime. However, when used under proper conditions, both can operate within a predetermined lifetime.*
*(*2) There is no harm as it is a mere leak of water vapor which transitioned from water contained in the electrolyte (diluted sulfuric acid). However, application of abnormal voltage surge exceeding maximum operating voltage may result in leakage and explosion.*

All KEMET supercapacitors are RoHS Compliant.

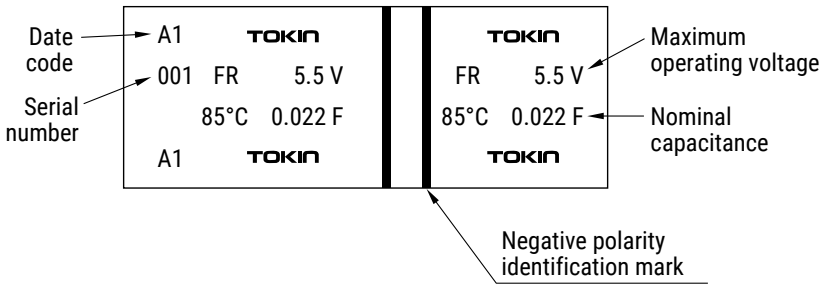
RoHS Compliant

	5.5	0.022	0.028	220	0.033	4.2	2.3
FR0H473ZF	5.5	0.047	0.060	110	0.071	4.2	3.9
FR0H104ZF	5.5	0.10	0.15	150	0.15	4.2	4.3
FR0H224ZF	5.5	0.22	0.33	180	0.33	4.2	5.3
FR0H474ZF	5.5	0.47	0.75	100	0.71	4.2	7.5
	5.5	1.0	1.6	60	1.5	4.2	13.3

Part numbers in bold type represent popularly purchased components.

Category Temperature Range				
Maximum Operating Voltage		5.5 VDC		
Capacitance		Refer to Table 1		Refer to “Measurement Conditions”
Capacitance Allowance				Refer to “Measurement Conditions”
ESR		Refer to Table 1		“Measurement Conditions”
Current (30 minutes value)		Refer to Table 1		Refer to “Measurement Conditions”
Surge	Capacitance			Surge voltage: 6.3 V Charge: 30 seconds Discharge: 9 minutes 30 seconds Number of cycles: 1,000 Series resistance: Discharge resistance: Temperature:
	ESR			
	Current (30 minutes value)			
	Appearance	No obvious abnormality		
Characteristics in Different Temperature	Capacitance	Phase 2		Conforms to 4.17 Phase 1: Phase 2: Phase 3: Phase 4: Phase 5: Phase 6:
	ESR			
	Capacitance	Phase 3		
	ESR			
	Capacitance	Phase 5		
	ESR		Satisfy initial ratings	
	Current (30 minutes value)			
	Capacitance	Phase 6		
	ESR		Satisfy initial ratings	
	Current (30 minutes value)		Satisfy initial ratings	
Lead Strength (tensile)		No terminal damage		Conforms to 4.9
Vibration Resistance	Capacitance	Satisfy initial ratings		Conforms to 4.13 Frequency: Testing Time: 6 hours
	ESR			

Temperature Cycle	Capacitance	Satisfy initial ratings	Conforms to 4.12 Temperature Condition: » Room » Room temperature Number of cycles: 5 cycles
	ESR		
	Current (30 minutes value)		
	Appearance	No obvious abnormality	
High Temperature and High Humidity Resistance	Capacitance		Conforms to 4.14 Temperature: Relative humidity: Testing time: 240±8 hours
	ESR		
	Current (30 minutes value)		
	Appearance	No obvious abnormality	
High Temperature Load	Capacitance		Conforms to 4.15 Temperature: Voltage applied: Maximum operating voltage Series protection resistance: Testing time: hours
	ESR		
	Current (30 minutes value)		
	Appearance	No obvious abnormality	
Self Discharge Characteristics (Voltage Holding Characteristics)		Voltage between terminal leads > 4.2 V	Charging condition Voltage applied: 5.0 VDC (Terminal at the case side must be negative) Series resistance: Charging time: 24 hours
			Storage Let stand for 24 hours in condition described below with terminals opened. Ambient temperature: Relative humidity:



FR0H223ZF	800 pieces
FR0H473ZF	400 pieces
FR0H104ZF	400 pieces
FR0H224ZF	300 pieces
FR0H474ZF	240 pieces
FR0H105ZF	90 pieces

By changing the solder plating from leaded solder to lead-free solder and the outer tube material of can-cased conventional supercapacitor from polyvinyl chloride to polyethylene terephthalate (PET), our supercapacitor is now even friendlier to the environment.

FR	All FR Types	a	PET (Blue)

Recommended Pb-free solder : *Sn/3.5Ag/0.75Cu*
Sn/3.0Ag/0.5Cu
Sn/0.7Cu
Sn/2.5Ag/1.0Bi/0.5Cu

measurement, the capacitor is discharged by shorting both pins of the device for at least 30 minutes. In addition, use the polarity indicator on the device to determine correct orientation of capacitor for charging.

Eo: 3.0 (V) Product with maximum operating voltage of 3.5 V
5.0 (V) Product with maximum operating voltage of 5.5 V
6.0 (V) Product with maximum operating voltage of 6.5 V
10.0 (V) Product with maximum operating voltage of 11 V
12.0 (V) Product with maximum operating voltage of 12 V

(seconds)

0.010 F	–	–	–	–	–		–		–		–	–	–	–
0.022 F		–							–		–	–	Discharge	–
0.033 F	–	–	–											

As shown in the diagram below, charging is performed for a duration of 30 minutes once the voltage of the capacitor terminal reaches 5.5 V. Then, use a constant current load device and measure the time for the terminal voltage to drop from 3.0 to 2.5 V upon discharge at 0.22 mA per 0.22 F, for example, and calculate the static capacitance according to the equation shown below.

Note: The current value is 1 mA discharged per 1 F.

As shown in the diagram below, charging is performed for a duration of 30 minutes once the voltage of the capacitor terminal reaches 3.5 V. Then, use a constant current load device and measure the time for the terminal voltage to drop from 1.8 to 1.5 V upon discharge at 1.0 mA per 1.0 F, for example, and calculate the static capacitance according to the equation shown below.

As shown in the diagram below, charging is performed for a duration of 30 minutes once the voltage of the capacitor terminal reaches maximum operating voltage. Then, use a constant current load device and measure the time for the terminal voltage to drop from 2.0 to 1.5 V upon discharge at 1.0 mA per 1.0 F, and calculate the static capacitance according to the equation shown below.

ESR shall be calculated from the equation below.

Current shall be calculated from the equation below. Prior to measurement, both lead terminals must be short-circuited for a minimum of 30 minutes. The lead terminal connected to the metal can case is connected to the negative side of the power supply.

Eo: 2.5 VDC (HV Series 50 F)
2.7 VDC (HV Series except 50 F)
3.0 VDC (3.5 V type)
5.0 VDC (5.5 V type)

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1.1 Useful life
The FC Series Supercapacitor (EDLC) uses an electrolyte in a sealed container. Water in the electrolyte can evaporate while in use over long periods of time at high temperatures, thus reducing electrostatic capacity which in turn will create greater internal resistance. The characteristics of the supercapacitor can vary greatly depending on the environment in which it is used. Basic breakdown mode is an open mode due to increased internal resistance.

times this amount. Therefore, we assume that the fail rate is below 0.06 Fit.

1.3 Exceeding maximum usable voltage
Performance may be compromised and in some cases leakage or damage may occur if applied voltage exceeds maximum working voltage.

1.4 Use of capacitor as a smoothing capacitor (ripple absorption)
As supercapacitors contain a high level of internal resistance, they are not recommended for use as smoothing capacitors in electrical circuits. Performance may be compromised and, in some cases, leakage or damage may occur if a supercapacitor is used in ripple absorption.

1.5 Series connections
As applied voltage balance to each supercapacitor is lost when used in series connection, excess voltage may be applied to some supercapacitors, which will not only negatively affect its performance but may also cause leakage and/or damage. Allow ample margin for maximum voltage or attach a circuit for applying equal voltage to each supercapacitor (partial pressure resistor/voltage divider) when using supercapacitors in series connection. Also, arrange supercapacitors so that the temperature between each capacitor will not vary.

1.6 Case Polarity
The supercapacitor is manufactured so that the terminal on the outer case is negative (-). Align the (-) symbol during use. Even though discharging has been carried out prior to shipping, any residual electrical charge may negatively affect other parts.

1.7 Use next to heat emitters

and posistors, etc.) where the supercapacitor itself may become heated.

1.8 Usage environment
This device cannot be used in any acidic, alkaline or similar type of environment.

capacitor into a soldering dip tank.

2.2 Flow soldering conditions

2.3 Installation using a soldering iron
Care must be taken to prevent the soldering iron from touching other parts when soldering. Keep the tip of the soldering

Internal capacitor resistance is likely to increase if the terminals are overheated.

2.4 Lead terminal processing
Do not attempt to bend or polish the capacitor terminals with sand paper, etc. Soldering may not be possible if the metallic plating is removed from the top of the terminals.

2.5 Cleaning, Coating, and Potting
Except for the FM series, cleaning, coating and potting must not be carried out. Consult KEMET if this type of procedure is necessary. Terminals should be dried at less than the maximum operating temperature after cleaning.

3.1 Temperature and humidity

change.

3.2 Environment conditions
Make sure there are no corrosive gasses such as sulfur dioxide, as penetration of the lead terminals is possible. Always store this item in an area with low dust and dirt levels. Make sure that the packaging will not be deformed through heavy

checking and verifying the extent to which the Information contained in this publication is applicable to an order at the time the order is placed.

All Information given herein is believed to be accurate and reliable, but it is presented without guarantee, warranty, or responsibility of any kind, expressed or implied.

Statements of suitability for certain applications are based on KEMET Electronics Corporation's ("KEMET") knowledge of typical operating conditions for such

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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product–related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicted or that other measures may not be required.