Supercapacitors

FM Series

Overview

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

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 embedded microprocessor systems with flash memory.

Benefits

- Rectangular case
- Wide range of temperature from −25°C to +70°C (all types except FMR) and −40°C to +85°C (FMR type)
- Maintenance free
- 3.5 VDC, 5.5 VDC, and 6.5 VDC
- Highly reliable against liquid leakage
- Lead-free and RoHS Compliant
- Leads can be transverse mounted

Part Number System

FM	0H	223	Z	F	TP	16
Series	Maximum Operating Voltage	Capacitance Code (F)	Capacitance Tolerance	Environmental	Tape Type	Height (excluding lead)
FM FME FML FMR FMC	0V = 3.5 VDC 0H = 5.5 VDC 0J = 6.5 VDC	First two digits represent significant figures. Third digit specifies number of zeros.	Z = −20/+80%	F = Lead-free	TP = AMMO L1 = Transverse mounting Blank = Bulk	16 = 16 mm 18 = 18 mm Blank = Bulk

Performance Characteristics

Supercapacitors should not be used for applications such as ripple absorption because of their high internal resistance (several hundred mΩ to a hundred Ω) compared to aluminum electrolytic capacitors. Thus, its main use would be 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.

	Secondary Battery		Capacitor	
	NiCd	Lithium Ion	Aluminum Electrolytic	Supercapacitor
Back-up ability	–	–	–	–
Eco-hazard	Cd	–	–	–
Operating Temperature Range	−20 to +60°C	−20 to +50°C	−55 to +105°C	−40 to +85°C (FR, FT)
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.*

Typical Applications

Intended Use (Guideline)	Power Supply (Guideline)	Application	Examples of Equipment	Series
Long time back-up	500 µA and below	CMOS microcomputer, IC for clocks	CMOS microcomputer, static RAM/DTS (digital tuning system)	FM series

Environmental Compliance

All KEMET supercapacitors are RoHS Compliant.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

Part Number	Maximum Operating Voltage (VDC)	Nominal Capacitance		Maximum ESR at 1 kHz (Ω)	Maximum Current at 30 Minutes (mA)	Voltage Holding Characteristic Minimum (V)	Weight (g)
		Charge System (F)	Discharge System (F)				
FM0V473ZF	3.5	0.047	0.06	200	0.042	–	1.3
FMR0V104ZF	3.5	0.10	–	50	0.090	–	1.6
FM0V104ZF	3.5	0.10	0.13	100	0.090	–	1.3
FM0V224ZF	3.5	0.22	0.30	100	0.20	–	1.6
FM0H103ZF	5.5	0.01	0.014	300	0.015	4.2	1.3
FME0H223ZF	5.5	0.022	0.028	40	0.033	–	1.3
FM0H223ZF	5.5	0.022	0.028	200	0.033	4.2	1.3
FML0H333ZF	5.5	–	0.033	6.5	0.050	–	1.3
FME0H473ZF	5.5	0.047	0.06	20	0.071	–	1.3
FMC0H473ZF	5.5	0.047	0.06	100	0.071	4.2	1.3
FM0H473ZF	5.5	0.047	0.06	200	0.071	4.2	1.3
FMR0H473ZF	5.5	0.047	0.062	200	0.071	4.2	1.6
FMR0H104ZF	5.5	0.10	–	50	0.15	4.2	1.6
FMC0H104ZF	5.5	0.10	0.13	50	0.15	4.2	1.6
FM0H104ZF	5.5	0.10	0.13	100	0.15	4.2	1.6
FM0H224ZF	5.5	–	0.22	100	0.33	4.2	1.6
FMC0H334ZF	5.5	–	0.33	25	0.50	4.2	3.5
FM0J473ZF	6.5	0.047	0.062	200	0.071	–	1.6

Specifications – All Types Except FMR

Item		FM 5.5 V Type, 3.5 V Type, 6.5 V Type, FMC Type		FML Type, FME Type		Test Conditions (conforming to JIS C 5160-1)
Category Temperature Range		−25°C to +70°C		−25°C to +70°C		
Maximum Operating Voltage		5.5 VDC, 3.5 VDC, 6.5 VDC		5.5 VDC		
Capacitance		Refer to Table 1		Refer to Table 1		Refer to “Measurement Conditions”
Capacitance Allowance		+80%, −20%		+80%, −20%		Refer to “Measurement Conditions”
ESR		Refer to Table 1		Refer to Table 1		Measured at 1 kHz, 10 mA; See also “Measurement Conditions”
Current (30 minutes value)		Refer to Table 1		Refer to Table 1		Refer to “Measurement Conditions”
Surge	Capacitance	> 90% of initial ratings		> 90% of initial ratings		Surge voltage: 4.0 V (3.5 V type) 6.3 V (5.5 V type) 7.4 V (6.5 V type) Charge: 30 seconds Discharge: 9 minutes 30 seconds Number of cycles: 1,000 Series resistance: 0.010 F 1,500 Ω 0.022 F 560 Ω 0.033 F 510 Ω 0.047 F 300 Ω 0.068 F 240 Ω 0.10 F 150 Ω 0.22 F 56 Ω 0.33 F 51 Ω Discharge resistance: 0 Ω Temperature: 70±2°C
	ESR	≤ 120% of initial ratings		≤ 120% of initial ratings		
	Current (30 minutes value)	≤ 120% of initial ratings		≤ 120% of initial ratings		
	Appearance	No obvious abnormality		No obvious abnormality		
Characteristics in Different Temperature	Capacitance	Phase 2	≥ 50% of initial value	Phase 2	≥ 50% of initial value	Conforms to 4.17 Phase 1: +25±2°C Phase 2: −25±2°C Phase 4: +25±2°C Phase 5: +70±2°C Phase 6: +25±2°C
	ESR		≤ 400% of initial value		≤ 400% or less than initial value	
	Capacitance	Phase 3		Phase 3		
	ESR					
	Capacitance	Phase 5	≤ 200% of initial value	Phase 5	≤ 200% of initial value	
	ESR		Satisfy initial ratings		Satisfy initial ratings	
	Current (30 minutes value)		≤ 1.5 CV (mA)		≤ 1.5 CV (mA)	
	Capacitance	Phase 6	Within ±20% of initial value	Phase 6	Within ±20% of initial value	
	ESR		Satisfy initial ratings		Satisfy initial ratings	
	Current (30 minutes value)		Satisfy initial ratings		Satisfy initial ratings	
Vibration Resistance	Capacitance	Satisfy initial ratings		Satisfy initial ratings		Conforms to 4.13 Frequency: 10 to 55 Hz Testing Time: 6 hours
	ESR					
	Current (30 minutes value)					
	Appearance	No obvious abnormality		No obvious abnormality		
Solderability		Over 3/4 of the terminal should be covered by the new solder		Over 3/4 of the terminal should be covered by the new solder		Conforms to 4.11 Solder temp: +245±5°C Dipping time: 5±0.5 seconds 1.6 mm from the bottom should be dipped.

Specifications – All Types Except FMR cont'd

Item		FM 5.5 V Type, 3.5 V Type, 6.5 V Type, FMC Type	FML Type, FME Type	Test Conditions (conforming to JIS C 5160-1)
Solder Heat Resistance	Capacitance	Satisfy initial ratings	Satisfy initial ratings	Conforms to 4.10 Solder temp: +260±10°C Dipping time: 10±1 seconds
	ESR			
	Current (30 minutes value)			
	Appearance	No obvious abnormality	No obvious abnormality	1.6 mm from the bottom should be dipped.
Temperature Cycle	Capacitance	Satisfy initial ratings	Satisfy initial ratings	Conforms to 4.12 Temperature Condition: −25°C » Room temperature » +70°C » Room temperature Number of cycles: 5 cycles
	ESR			
	Current (30 minutes value)			
	Appearance	No obvious abnormality	No obvious abnormality	
High Temperature and High Humidity Resistance	Capacitance	Within ±20% of initial value	Within ±20% of initial value	Conforms to 4.14 Temperature: +40±2°C Relative humidity: 90 to 95% RH Testing time: 240±8 hours
	ESR	≤ 120% of initial ratings	≤ 120% of initial ratings	
	Current (30 minutes value)	≤ 120% of initial ratings	≤ 120% of initial ratings	
	Appearance	No obvious abnormality	No obvious abnormality	
High Temperature Load	Capacitance	Within ±30% of initial value	Within ±30% of initial value	Conforms to 4.15 Temperature: +70±2°C Voltage applied: Maximum operating voltage Series protection resistance: 0 Ω Testing time: 1,000 +48 (+48/−0) hours
	ESR	< 200% of initial ratings	< 200% of initial ratings	
	Current (30 minutes value)	< 200% of initial ratings	< 200% of initial ratings	
	Appearance	No obvious abnormality	No obvious abnormality	
Self Discharge Characteristics (Voltage Holding Characteristics)		5.5 V type: Voltage between terminal leads > 4.2 V 3.5 V type: Not specifed 6.5 V type: Not specifed		Charging condition Voltage applied: 5.0 VDC (Terminal at the case side must be negative) Series resistance: 0 Ω Charging time: 24 hours Storage Let stand for 24 hours in condition described below with terminals opened. Ambient temperature: < 25°C Relative humidity: < 70% RH