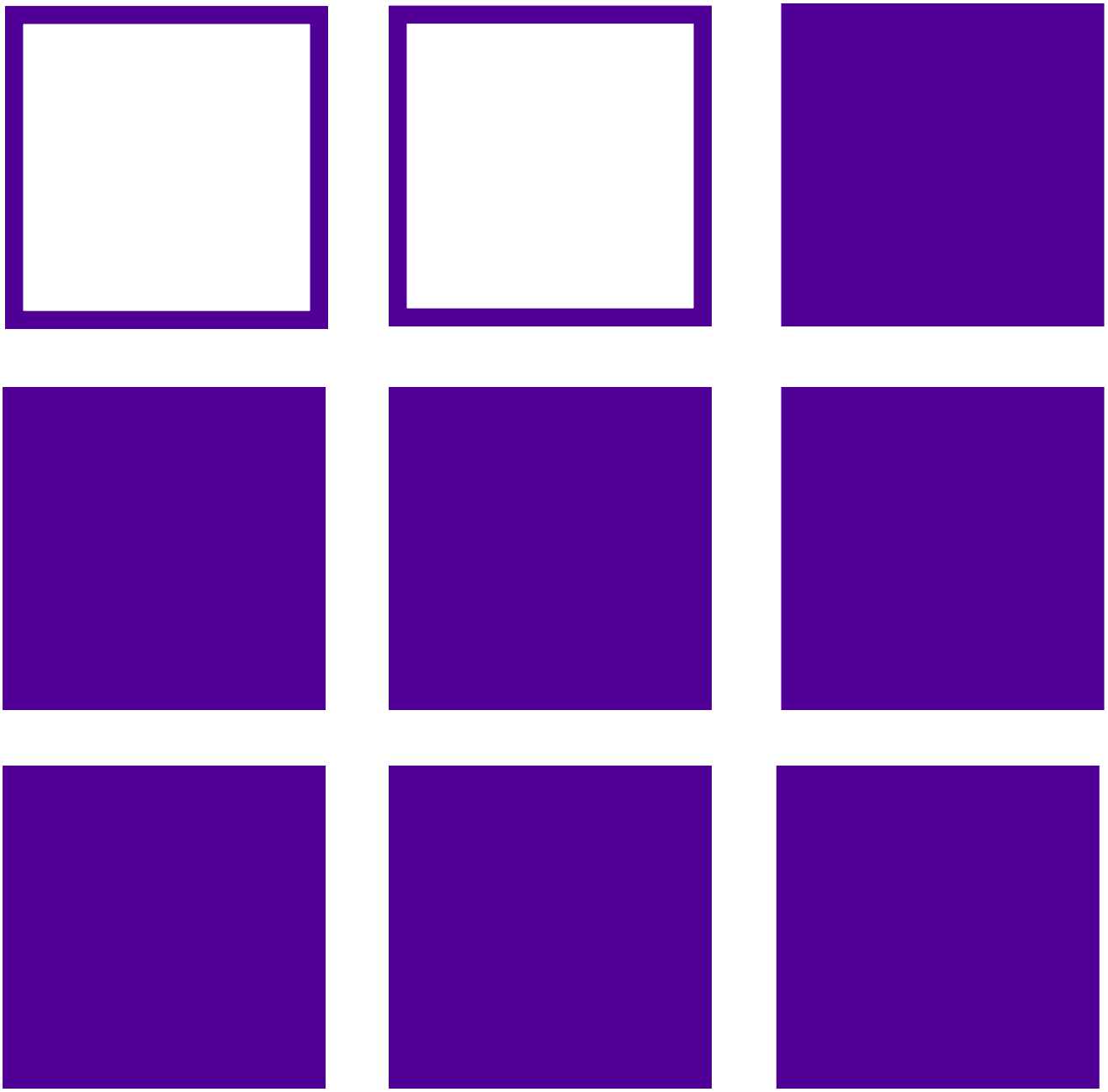
TOKIN

SUPERCAPACITOR
WORLD WIDE WEB
EC-200E

SUPERCAPACITORS

ELECTRIC DOUBLE-LAYER CAPACITORS Vol.02



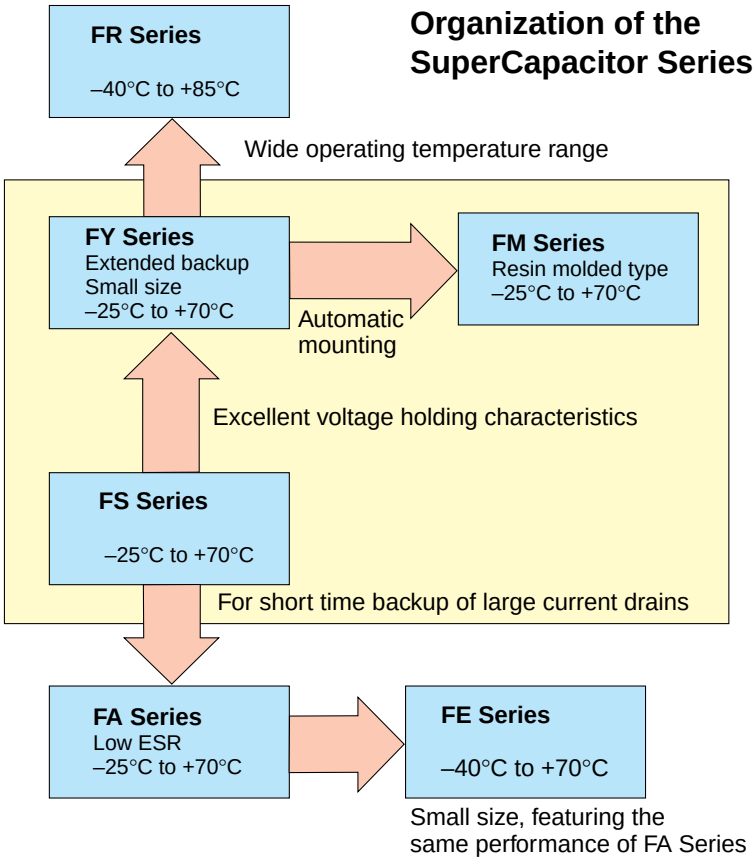
CORRECT USE OF SUPERCAPACITORS

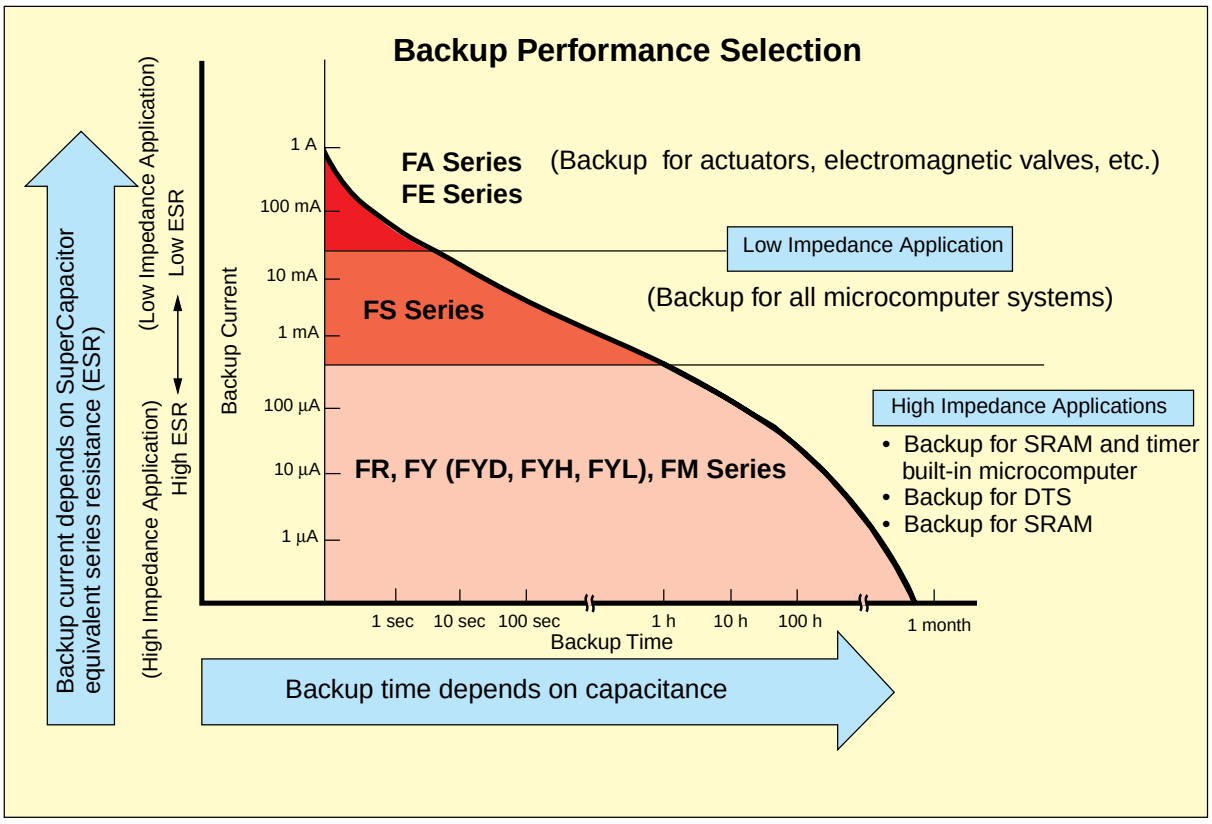
Please confirm the operating condition and the specifications of the SuperCapacitors when you use SuperCapacitors.

This capacitor contains an electrolyte sealed by rubber and other materials. When you use the capacitors for long time at high temperatures, the moisture of electrolyte evaporates and the equivalent series resistance (E.S.R.) increases. The fundamental failure mode is the open mode depending on E.S.R. increase.

Please read “Notes on Using the SuperCapacitor” on page 31 when you design circuits using SuperCapacitors.

Organization of the SuperCapacitor Series





Operating Principles

SuperCapacitor is the most prominent capacitor concept to appear in the past decade. The large capacitance, slow rate of discharge and the small package make it useful as a non-battery reserve power source that can provide currents (1 -100 mA) and protect microcomputers from power shutdowns lasting several seconds.

It is also possible to maintain the contents of low dissipation volatile memories (i. e. CMOS) for several months. (For more detailed applications, refer to the table shown below.)

The operating principle of the SuperCapacitor is based on an electric double layer appearing at the interface between activated carbon particles and sulfuric acid solution as electrolyte. The two electrodes are separated by an ionically conducting but electrically insulating porous membrane.

Conductive rubber membranes contain the electrode and electrolyte material and rnake contact to the cell. Several cells are stacked in series to achieve the 5.5 V and 11 V rated voltages.

Since SuperCapacitors exhibit relatively high ESR, they are not recommended for ripple absorption in DC power supply applications.

In some manufacturing operations it has been polarized with the following voltage direction:

Shorter lead : positive
Longer lead (connected to case): negative

Therefore, the use of SuperCapacitor in that direction is recommended in actual usage.

Typical Applications

Functions	Backup Current	Applications	Equipment	Adequate Series
Large current supply	Up to 1A	Actuator applications (Large current in a short period)	Actuators Relays / Solenoid Starters	FA and FE Series
		Primary power supply for LED displays, toys, electric buzzers, etc.	Handheld toys Displays, Smoke detectors, Alarm devices, Emergency displays	
Medium capacity power supply	Up to 50 mA	Secondary power source for undesirable voltage drops	Vehicle radio back-up at engine start, etc.	FS Series 3.5V • 6.5V Series (FSH)
		Motor start	VCRs, video disks, record players	
Power backup for primary power outages	Less than 500µA	CMOS Microcomputers	Phones (Memory dial, Auto-answering) Electric cash registers, Electric typewriters Computer terminals Automatic measuring instruments, etc.	FY Series: FYD Type FYH Type FYL Type 3.5V • 6.5V Series (FYD) FM Series
		CMOS RAMs ICs for clocks	Digital tuning audio systems LW-MW-FM Radio, Car Radio, Stereo, etc.) Programmable consumer electronic products (VCRs, Microwave ovens, Games, etc.)	
		• CMOS RAMs • High operating temperature (85˚C)	Measuring instruments, Automatic controls, Communications, Automotive	FR Series
Other possible applications: Programmable Thermostats, Copiers, Vending Machines, Automatic Electricity Counters, Traffic Signals, Taxi Meters, Fuel Management Systems, Process Monitoring or Control Systems, Satellite Communications, Portable "Battery" Operated Equipment, Fare Collection Systems, POS Terminals, Mail Sorters, Scale, Flow Metering, Electronic Slot Machines, Water Heat Controllers.				

The FA series is suitable for supplying a large current in a short time.
These capacitors are ideal for backing up a high-current, short-time load in electronic systems, to guard against sudden power failures.

Features

- ❑ Extremely low equivalent series resistance (ESR), ideal for supplying backup current of 10mA to 1A for a short time.
- ❑ High breakdown voltage (maximum operating voltage: 11V) that can drive microcomputers and actuators.

Applications

- ❑ Momentary backup of microcomputers and DRAMs.
- ❑ Auxiliary power supply of mechanical systems (motors, relays, electromagnetic valves).

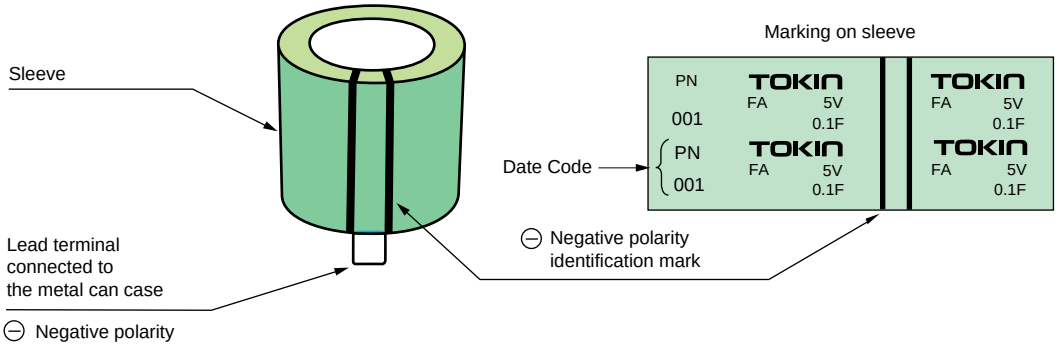
Part Numbering System

FA 0H 473 Z

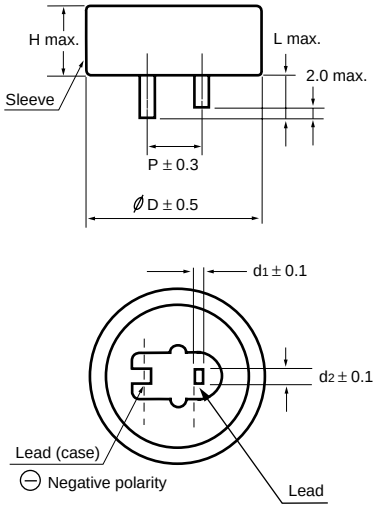
- Z: Capacitance tolerance: +80%, -20%
- 473: Capacitance: 0.047 F
  First two digits represent significant figures.
  Third digit specifies number of zeros to follow microfarad code.
- 0H: Maximum rated voltage:: 0H : 5.5V (Marking 5V)
  1A : 11V (Marking 10V)
- FA: SuperCapacitor: FA Series

Markings

Markings are made with black ink on the green sleeve.



Dimensions and Standard Ratings



Part No.	Dimensions mm (inch)						Weight
	D	H	P	d_1	d_2	L	g (oz.)
FA0H473Z	16.0 (0.630)	15.5 (0.610)	5.1 (0.2)	0.4 (0.016)	1.2 (0.047)	5.0 (0.197)	6.2 (0.219)
FA0H104Z	21.5 (0.846)	15.5 (0.610)	7.6 (0.3)	0.6 (0.024)	1.2 (0.047)	5.5 (0.217)	12 (0.423)
FA0H224Z	28.5 (1.122)	16.5 (0.650)	10.2 (0.4)	0.6 (0.024)	1.4 (0.055)	9.5 (0.374)	25 (0.882)
FA0H474Z	36.5 (1.437)	16.5 (0.650)	15.0 (0.591)	0.6 (0.024)	1.7 (0.067)	9.5 (0.374)	42 (1.482)
FA0H105Z	44.5 (1.752)	18.5 (0.728)	20.0 (0.787)	1.0 (0.039)	1.4 (0.055)	9.5 (0.374)	65 (2.293)
FA1A223Z	16.0 (0.630)	25.0 (0.984)	5.1 (0.2)	0.4 (0.016)	1.2 (0.047)	5.0 (0.197)	7.5 (0.265)
FA1A104Z	28.5 (1.122)	25.5 (1.004)	10.2 (0.4)	0.6 (0.024)	1.4 (0.055)	9.5 (0.374)	32 (1.129)
FA1A224Z	36.5 (1.437)	27.5 (1.083)	15.0 (0.591)	1.0 (0.039)	1.4 (0.055)	9.5 (0.374)	55 (1.940)
FA1A474Z	44.5 (1.752)	28.5 (1.122)	20.0 (0.787)	1.0 (0.039)	1.4 (0.055)	9.5 (0.374)	83 (2.928)

Note: Weight values are typical.

Part Number	Max Rated Voltage (V)	Nominal Capacitance (F)	Max. Current at 30 minutes (mA)	Max. ESR (at 1 kHz) (Ω)
FA0H473Z	5.5	0.047	0.071	20
FA0H104Z	5.5	0.10	0.15	8
FA0H224Z	5.5	0.22	0.33	5
FA0H474Z	5.5	0.47	0.71	3.5
FA0H105Z	5.5	1.0	1.5	2.5
FA1A223Z	11	0.022	0.066	20
FA1A104Z	11	0.10	0.3	8
FA1A224Z	11	0.22	0.66	6
FA1A474Z	11	0.47	1.41	4

Item		Specification		Test Conditions
Operating Temp. Range		–25 to 70˚ C		
Max. Rated Voltage		5.5Vdc, 11.0Vdc		
Capacitance Range		0.022 to 1.0F (Refer to standard ratings)		
Capacitance Tolerance		+80%, –20%		Refer to measuring method
ESR*		Refer to standard ratings		
Current (at 30 minutes)				
Temperature Characteristics	at min. temp. –25˚ C Step 2	Capacitance	More than 70% of initial value	Step 1 : + 25˚ C Step 2 : -–25˚ C Step 3 : + 25˚ C Step 4 : + 70˚ C Step 5 : + 25˚ C
		ESR	Not to exceed 3 times initial value	
	at max. temp. +70˚ C Step 4	Capacitance	Not to exceed 150% of initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.	Not to exceed 1.5 CV (mA)	
	at room temp. +25˚ C Step 5	Δ C /C	Not to change more than ±20% from initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.		
Lead Strength (Tensile)		There shall be no loosening nor permanent damage of the leads		
Vibration		Capacitance	Shall meet initial requirement	10 to 55 Hz Double amplitude 1.5 mm 2 hours per each one of 3 directions
		ESR		
		Current at 30 min.		
Solderability		Immersed lead surface shall be at least 75% covered with new solder		230 ± 5˚ C, 5 ± 0.5 sec. Immersion depth: 2.5 mm from body
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	260 ±10˚ C, 10 ± 1 sec. Immersion depth: 2.5 mm from body
		ESR		
		Current at 30 min.		
Temperature Cycling		Capacitance		–25 to 70˚ C, 5 cycles
		ESR		
		Current at 30 min.		
Moisture Resistance (Steady State)		Capacitance	More than 90% of initial requirement	40 ± 2˚ C, 90 to 95% RH 240 hours
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Load Life		Capacitance	More than 85% of initial requirement	70 ± 2˚ C 5.5V applied for 5V type 11V applied for 10V type 1,000 hours
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.	Not to exceed 200% of initial requirement	

*ESR : Equivalent series resistance

The FE Series offers small, high-capacitance electric double-layer capacitors suitable for supplying a large current in a short time.
These capacitors are ideal for backing up a high-current, short-time load in electronic systems, to guard against sudden power failures.

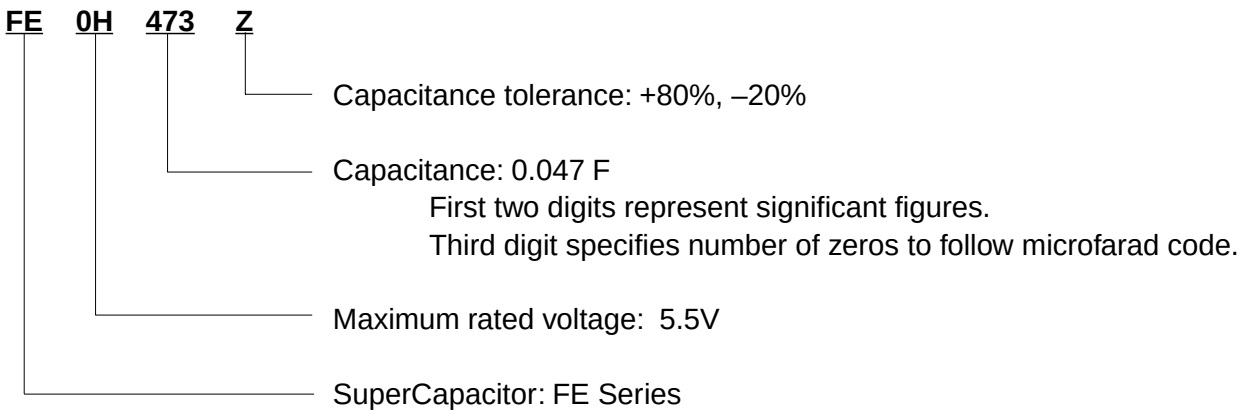
Features

- ❑ Extremely low equivalent series resistance (ESR), ideal for supplying backup current of 10mA to 1A for a short periods of time (about half the CV value compared to FA Series).
- ❑ Small (about 1/4 in volume of aluminum electrolytic capacitor and 3/5 of FA Series of same CV value).
- ❑ Wide choice of specifications, including low-capacitance and high-capacitance models (0.047 F to 1.5 F).

Applications

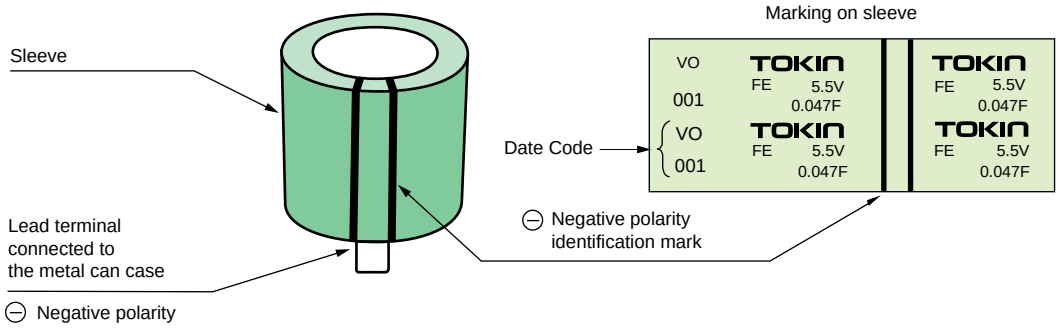
- ❑ Momentary backup of microcomputers, SRAMs, DRAMs.
- ❑ Auxiliary power source for mechanical systems (motors, relays, electromagnetic valves).

Part Numbering System

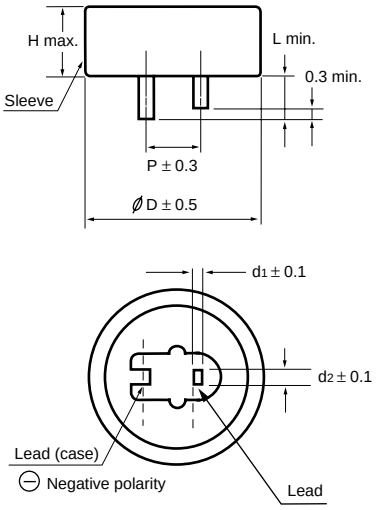


Markings

Markings are made with black ink on the green sleeve.



Dimensions and Standard Ratings



Part No.	Dimensions mm (inch)						Weight
	D	H	P	d_1	d_2	L	g (oz.)
FE0H473Z	14.5 (0.57)	14.0 (0.55)	5.1 (0.2)	0.4 (0.016)	1.2 (0.047)	2.2 (0.087)	3.9 (0.138)
FE0H104Z	16.5 (0.65)	14.0 (0.55)	5.1 (0.2)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	5 (0.177)
FE0H224Z	21.5 (0.85)	15.5 (0.61)	7.6 (0.3)	0.6 (0.024)	1.2 (0.047)	3.0 (0.118)	9.5 (0.336)
FE0H474Z	28.5 (1.12)	16.5 (0.65)	10.2 (0.4)	0.6 (0.024)	1.4 (0.055)	6.1 (0.240)	16 (0.565)
FE0H105Z	36.5 (1.44)	18.5 (0.73)	15.0 (0.59)	0.6 (0.024)	1.7 (0.067)	6.1 (0.240)	38 (1.343)
FE1A155Z	44.5 (1.75)	18.5 (0.73)	20.0 (0.79)	1.0 (0.039)	1.4 (0.055)	6.1 (0.240)	72 (2.544)

Note: Weight values are typical.

Part Number	Max Rated Voltage (V)	Nominal Capacitance (F)	Max. Current at 30 minutes (mA)	Max. ESR (at 1 kHz) (Ω)
FE0H473Z	5.5	0.047	0.071	14.0
FE0H104Z	5.5	0.10	0.15	6.5
FE0H224Z	5.5	0.22	0.33	3.5
FE0H474Z	5.5	0.47	0.71	1.8
FE0H105Z	5.5	1.0	1.5	1.0
FE0H155Z	5.5	1.5	2.3	0.6

Item		Specification		Test Conditions
Operating Temp. Range		–40 to 70˚ C		
Max. Rated Voltage		5.5 Vdc		
Capacitance Range		0.047 to 1.5 F (Refer to standard ratings)		
Capacitance Tolerance		+80%, –20%		Refer to measuring conditions
ESR*		Refer to standard ratings		
Current (at 30 minutes)				
Surge voltage		Capacitance	More than 90% of initial requirement	At 70˚ C Surge voltage 6.3V Charge: 30 sec. Discharge: 9 min.30 sec. 1,000 cycles Charge resistance: 0.047 F 300Ω 0.22 F 56Ω 0.10 F 150Ω 0.47 F 30Ω 1.0, 1.5 F 15Ω No discharge res.
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Stability at Low and High Temperature	Step 2	Capacitance	More than 40% of initial value	Step 1 : + 25˚ C Step 2 : – 40˚ C Step 3 : + 25˚ C Step 4 : + 70˚ C Step 5 : + 25˚ C
		ESR	Not to exceed 4 times initial value	
	Step 4	Capacitance	Not to exceed 200% of initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.	Not to exceed 1.5 CV (mA)	
	Step 5	ΔC /C	Not to change more then ±20% from initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.		
Lead Strength (Tensile)		There shall be no loosening nor permanent damage of the leads		
Vibration		Capacitance	Shall meet initial requirement	10 to 55 Hz Double amplitude 1.5 mm 2 hours per each one of 3 directions
		ESR		
		Current at 30 min.		
Solderability		Immersed lead surface shall be at least 75% covered with new solder		230 ±5˚ C, 10 ± 1 sec. Immersion depth: 1.6 mm from body
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	260 ±10˚ C, 10 ± 1 sec. Immersion depth: 1.6 mm from body
		ESR		
		Current at 30 min.		
Temperature Cycling		Capacitance		-40 to +70˚ C, 5 cycles
		ESR		
		Current at 30 min.		
Moisture Resistance		Capacitance change	Within ±20% of initial value	40 ± 2˚ C, 90 to 95% RH 240 hours
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Load Life		Capacitance change	Within ±30% of initial value	70 ± 2˚ C 5.5V applied 1,000 hours
		ESR	Not to exceed 300% of initial requirement	
		Current at 30 min.	Not to exceed 200% of initial requirement	

*ESR : Equivalent series resistance

FM Series (for Automatic Assembly)

The FM Series includes small, resin-molded electric double-layer capacitors suitable for automatic assembly.
These capacitors are ideal as long-time backup devices for minute-current loads in VCRs, audio systems, cordless telephones and compact electronic systems.

Features

- ❑ High adaptability to automatic assembly.
- ❑ Can be cleaned.
- ❑ Excellent voltage holding characteristics, ideal for long-time supply of 1μA to several hundred μA.
- ❑ Small size.

Applications

- ❑ Backup of CMOS microcomputers, static RAMs and DTSs.

Part Numbering System

❑ Bulk

FM 0H 223 Z

- Z: Capacitance tolerance: Z: +80%, –20%
- 223: Capacitance: 0.022 F
  First two digits represent significant figures.
  Third digit specifies number of zeros to follow microfarad code.
- 0H: Maximum rated voltage: 0H: 5.5Vdc
- FM: SuperCapacitor: FM Series

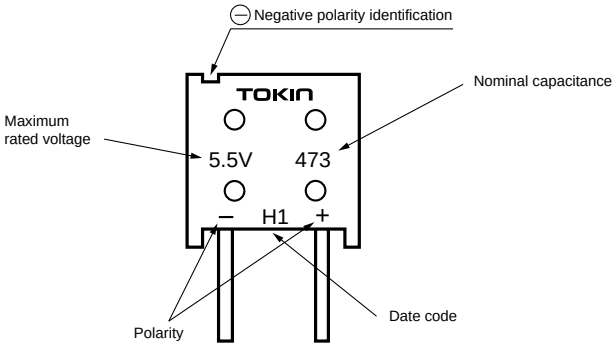
❑ Tape (Ammo Pack)

FM0H223Z TP 16

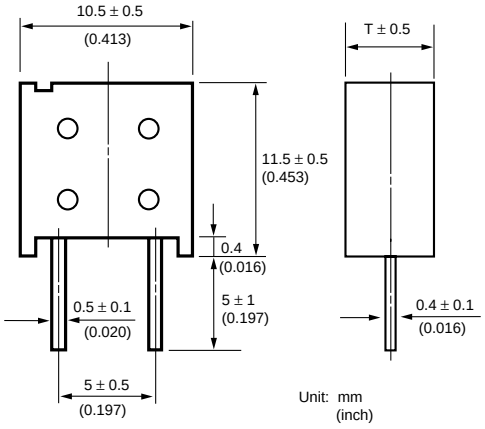
- 16: Height of component from tape center (16: 16 mm, 18: 18 mm)
- TP: Tape packaging
- FM0H223Z: Part number of bulk packaging

Number of Packed Capacitors Tape: 1,000 pcs./box

Markings



Dimensions and Standard Ratings

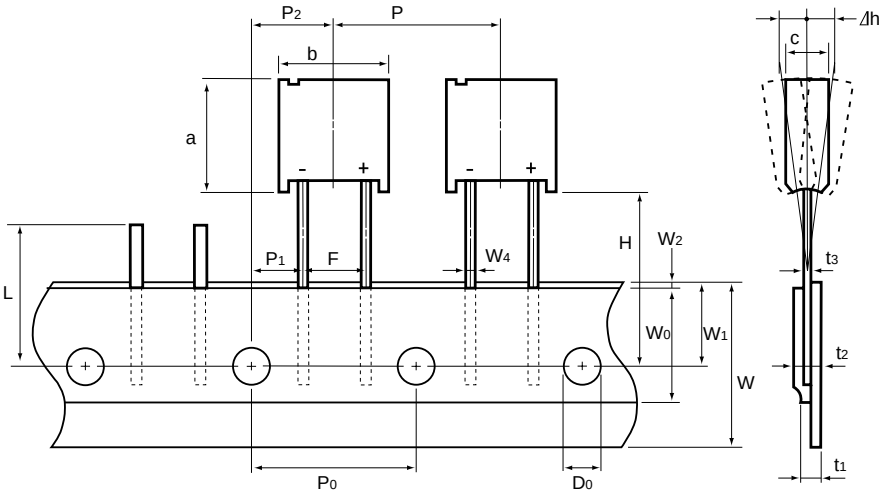


Part No.	Part No. Ammo Pack	Max. Rated Voltage (Vdc)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)	Voltage Holding Characteristic min. (V)	T mm (inch)	Weight g (oz)
FM0H103Z	FM0H103ZTP ( )	5.5	0.01	300	0.015	4.2	5.0 (0.197)	1.3 (0.046)
FM0H223Z	FM0H223ZTP ()	5.5	0.022	200	0.033	4.2	5.0 (0.197)	1.3 (0.046)
FM0H473Z	FM0H473ZTP ( )	5.5	0.047	200	0.071	4.2	5.0 (0.197)	1.3 (0.046)
FM0H104Z	FM0H104ZTP ( )	5.5	0.10	100	0.15	4.2	6.5 (0.256)	1.6 (0.056)

Note: To complete part number, insert lead length H (16 to 18 mm: refer to Taping Specifications, page 14).

Item		Specification		Test Conditions	
Operating Temp. Range		–25 to 70° C			
Max. Rated Voltage		5.5 Vdc			
Capacitance Range		0.01 to 0.1 F (Refer to standard ratings)			
Capacitance Tolerance		+80%, –20%		Refer to measuring conditions	
ESR*		Refer to standard ratings			
Current at 30 minutes					
Surge Voltage		Capacitance	More than 90% of initial requirement	Surge voltage : 6.3V Temperature: 70 ± 2° C Charging time : 30 sec. Discharging time : 9 min. 30 sec. No. of cycles: 1,000 Charging resistance: 0.01 F 150Ω 0.047 F 300 Ω 0.022 F 560Ω 0.10 F 150 Ω No discharging resistance.	
		ESR	Less than 120% of initial requirement		
		Current at 30 min.			
		Visual appearance	No significant change		
Temperature Characteristics	Step 2	Capacitance	More than 50% of initial value	Step 1 : + 25 ± 2° C Step 2 : –25 ± 2° C Step 3 : + 25 ± 2° C Step 4 : + 70 ± 2° C Step 5 : + 25 ± 2° C	
		ESR	Less than 400% of initial value		
	Step 4	Capacitance	Less than 200% of initial value		
		ESR	Not to exceed initial requirement		
		Current at 30 min.	Less than 1.5 CV (mA)		
	Step 5	Capacitance Change	Within ±20% of initial value		
		ESR	Not to exceed initial requirement		
		Current at 30 min.			
Vibration		Capacitance	Shall meet initial requirements	Frequency: 10 to 55 Hz Time of test: 6 hours	
		ESR			
		Current at 30 min.			
		Visual appearance	No significant change		
Solderability		Over 75% of surface shall be covered with new solder		Temperature of solder: 230 ± 5° C Time of immersion: 5 ± 0.5 seconds To immerse capacitors up to 1.6 mm from the bottom	
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	Temperature of solder: 260 ± 10° C Time of immersion: 10 ± 1 seconds To immerse capacitors up to 1.6 mm from the bottom of the part	
		ESR			
		Current at 30 min.			
		Visual appearance	No significant change		
Temperature Cycling		Capacitance	Shall meet initial requirement	Temperature condition: –25° C Number of cycles: 5	
		ESR			
		Current at 30 min.			
		Visual appearance	No significant change		
Moisture Resistance (Steady state)		Capacitance Change	Within ±20% of initial value	Temperature: 70 ± 2° C Humidity: 90 to 95% RH Time of test: 240 ±8 hours	
		ESR	Less than 120% of initial requirement		
		Current at 30 min.			
		Visual appearance	No significant change		
Load Life		Capacitance Change	Within ±30% of initial value	Temperature: 70 ± 2° C Series resistance: 0 Applied voltage: 5.5V DC Time of test: 1,000 + 48 –0 hours	
		ESR	Less than 200% of initial requirement		
		Current at 30 min.			
		Visual appearance	No significant change		
Voltage Holding Characteristics (Self Discharge)		Voltage between terminals shall be higher than 4.2V		Charging condition	Applied voltage: 5.0V DC Series resistance: 0 Charging time: 24 hours
				Storage	Load: nothing Temperature: lower than 25° C Humidity: lower than 70% RH Time: 24 hours

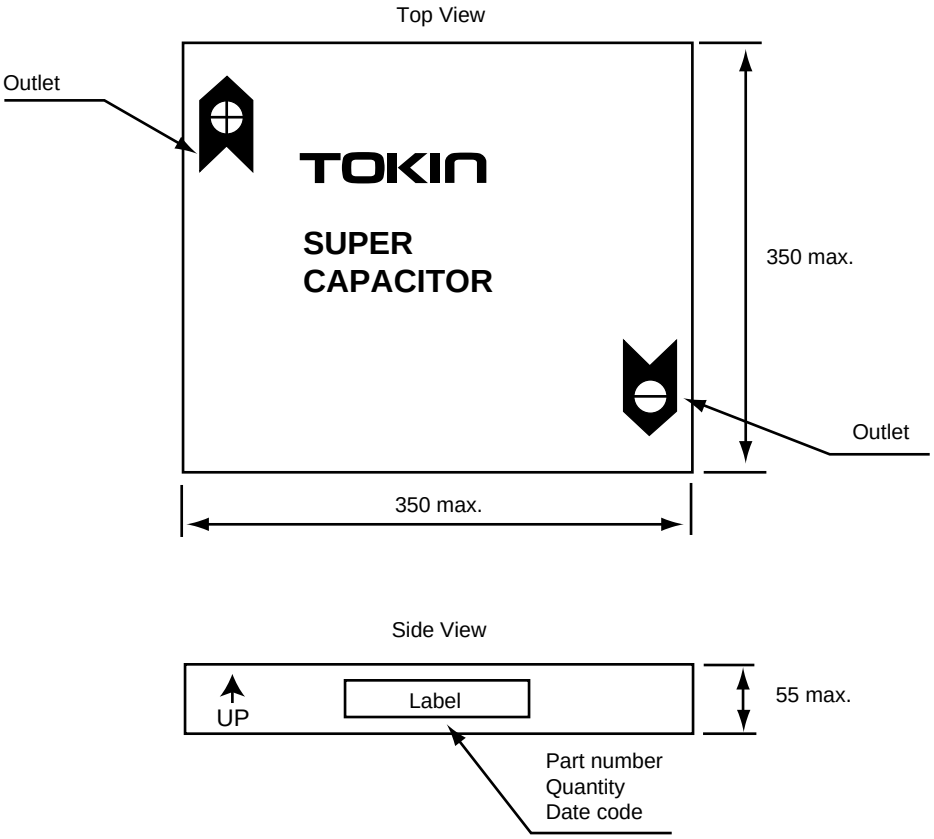
Taping Specifications (Ammo Pack)



Unit: mm

Item	Symbol	Value	Tolerance	Remarks
Component Height	a	11.5	±0.5	
Component Width	b	10.5	±0.5	
Component Thickness	C	5.0	±0.5	0.01F to 0.047F
		6.5	±0.5	0.1F
Lead-wire Width	W_4	0.5	±0.1	
Lead-wire Thickness	t_3	0.4	±0.1	
Pitch of Component	P	12.7	±1.0	
Sprocket Pitch	P_0	12.7	±0.3	
Sprocket Hole Center to Lead	P_1	3.85	±0.7	
Sprocket Hole to Component Center	P_2	6.35	±1.3	
Lead Spacing	F	5.0	±0.5	
Component Alignment	Δh	2.0 max.	-	
Tape Width	W	18.0	+1.0 – 0.5	
Hold-down Tape Width	W_0	12.5 min.	-	
Sprocket Hole Position	W_1	9.0	±0.5	
Hold-down tape position	W_2	3.0 max.	-	
Height of Component from Tape Center	H	16.0	±0.5	
		18.0	±0.5	
Sprocket Hole Diameter	D_0	4.0 dia.	±0.2	
Total Tape Thickness	t_1	0.7	±0.2	
	t_2	1.5 max.	-	
Length fo Shipped Lead	L	11 max.	-	

Packing Dimensions



Marking of Box

Markings shows the following:

a) Terminal direction
b) Part Number
c) Quantity
d) Date code
e) Company logo

Packing Quantity:

1,000 pcs./Box

The FS Series SuperCapacitors are ideal as short-time (30 minutes maximum) backup devices in small and lightweight systems.

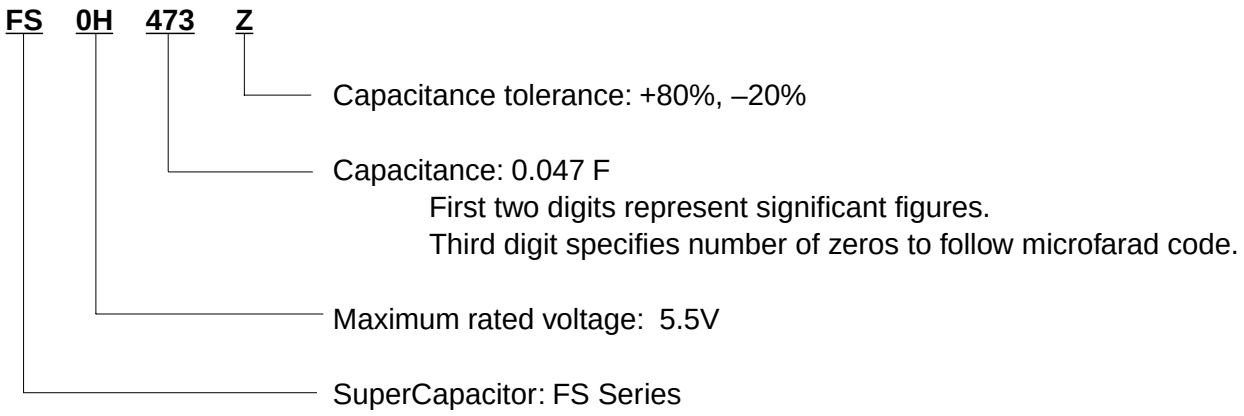
Features

- ❑ Ideal for supplying current of several hundred μA to several mA for a short time.

Applications

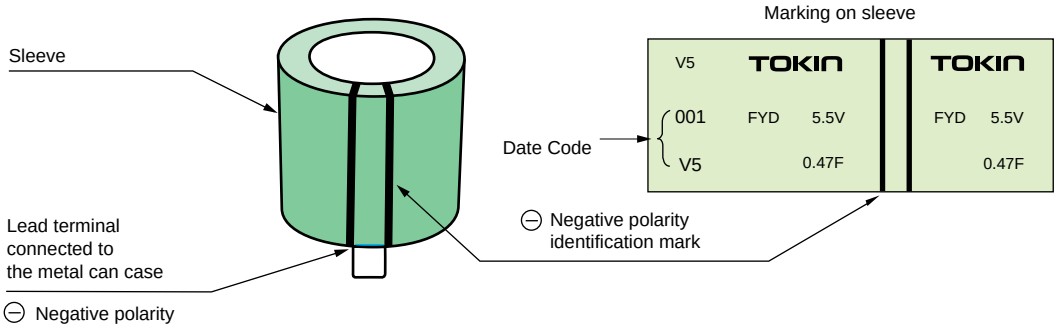
- ❑ Backup source for microcomputers and buffer for momentary high current loads (for example, motors).

Part Numbering System

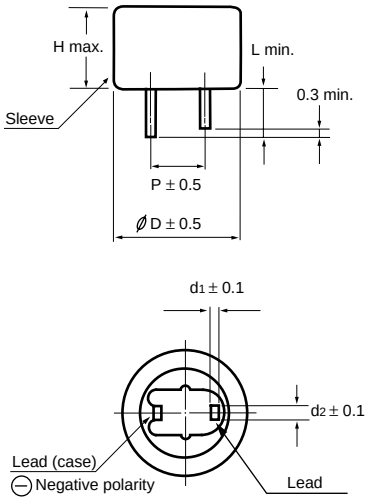


Markings

Markings are made with black ink on the green sleeve.



Dimensions and Standard Ratings



Part No.	Dimensions mm (inch)						Weight g (oz)
	D	H	P	d_1	d_2	L	
FS0H223Z	11.5 (0.453)	8.5 (0.335)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	1.6 (0.057)
FS0H473Z	13.0 (0.512)	8.5 (0.335)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.2 (0.087)	2.6 (0.092)
FS0H104Z	16.5 (0.650)	8.5 (0.335)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	4.1 (0.145)
FS0H224Z	16.5 (0.650)	13.0 (0.512)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	5.3 (0.187)
FS0H474Z	21.5 (0.846)	13.0 (0.512)	7.62 (0.300)	0.6 (0.024)	1.2 (0.047)	3.0 (0.118)	10 (0.353)
FS0H105Z	28.5 (1.122)	14.0 (0.551)	10.16 (0.400)	0.6 (0.024)	1.4 (0.055)	6.1 (0.240)	18 (0.635)

Note: Weight values are typical.

Part No.	Max. Rated Voltage (Vdc)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)
FS0H223Z	5.5	0.022	60	0.033
FS0H473Z	5.5	0.047	40	0.071
FS0H104Z	5.5	0.10	25	0.15
FS0H224Z	5.5	0.22	25	0.33
FS0H474Z	5.5	0.47	13	0.71
FS0H105Z	5.5	1.0	7	1.5

Item		Specification		Test Conditions
Operating Temp. Range		–25 to 70° C		
Max. Rated Voltage		5.5 Vdc		
Capacitance Range		0.022 to 1.0 F (Refer to standard ratings)		
Capacitance Tolerance		+80%, –20%		Refer to measuring conditions
ESR*		Refer to standard ratings		
Current (at 30 minutes)				
Surge voltage		Capacitance	More than 90% of initial requirement	At 70° C Surge voltage 6.3V Charge:30 sec. Discharge: 9 min.30 sec. 1,000 cycles Charge resistance: 0.022 F 560Ω 0.22 F 56Ω 0.047 F 300Ω 0.047 F 30Ω 0.10 F 150Ω 1.0, 0.5 F 15Ω No discharge resistance
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Stability at Low and High Temperature	Step 2	Capacitance	More than 50% of initial value	Step 1 : +25° C Step 2 : –25° C Step 3 : +25° C Step 4 : +70° C Step 5 : +25° C
		ESR	Not to exceed 3 times initial value	
	Step 4	Capacitance	Not to exceed 150% of initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.	Not to exceed 1.5 CV (mA)	
	Step 5	Capacitance Change	Within ±20% of initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.		
Lead Strength (Tensile)		There shall be no loosening nor permanent damage of the leads		0.047 to 0.22 F : 1 kg, 10 sec. 0.47 F, 1.0 F : 2.5 kg, 10 sec.
Vibration		Capacitance	Shall meet initial requirement	10 to 55 Hz Double amplitude 1.5 mm 2 hours per each one of 3 directions
		ESR		
		Current at 30 min.		
Solderability		Immersed lead surface shall be at least 75% covered with new solder		230 ± 5° C, 5 ± 0.5 sec. Imm. depth: 1.6 mm from body
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	260 ±10° C, 10 ± 1 sec. Immersion depth: 1.6 mm from body
		ESR		
		Current at 30 min.		
Temperature Cycling		Capacitance		–25 to +70° C, 5 cycles
		ESR		
		Current at 30 min.		
Moisture Resistance		Capacitance	More than 90% of initial requirement	40 ± 2° C, 90 to 95% RH 240 hours
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Load Life		Capacitance	More than 85% of initial requirement	70 ± 2° C 5.5V applied 1,000 hours
		ESR	Not to exceed 200% of initial requirement	
		Current at 30 min.	Not to exceed 200% of initial requirement	

*ESR : Equivalent series resistance

FR Series (Wide Temperature Range Capacitor)

The FR Series SuperCapacitors are small-sized electric double-layer capacitors that can operate in a temperature range as wide as –40°C to +85°C.

These capacitors are ideal as long-time backup devices for minute current loads in industrial equipment such as measuring instruments, control equipment and communications equipment.

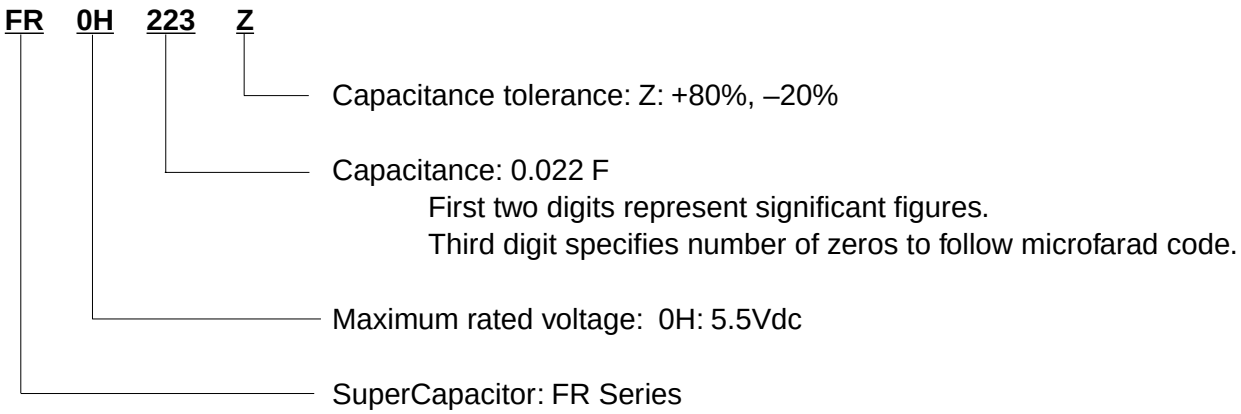
Features

- ❑ Wide operating temperature range: –40°C to +85°C.
- ❑ High reliability (load life of 85°C, 5.5V, 1,000 hours guaranteed).
- ❑ Excellent voltage holding characteristics, ideal for long-time supply of 1μA to several hundred μA.

Applications

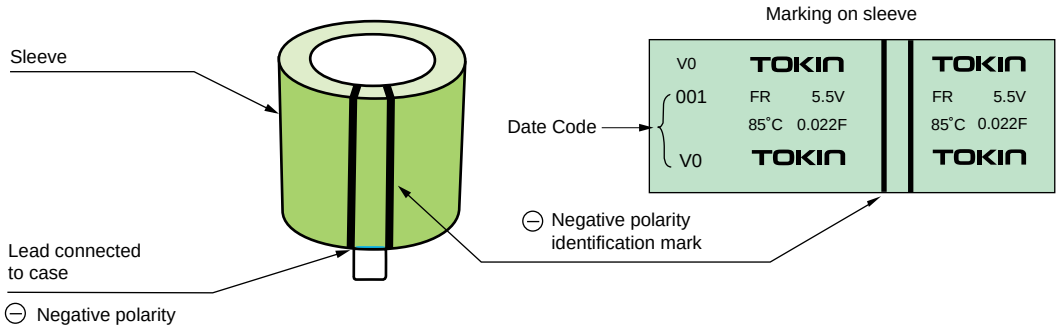
- ❑ Backup of CMOS microcomputers, static RAMs and DTSs (digital tuning systems).

Part Numbering System

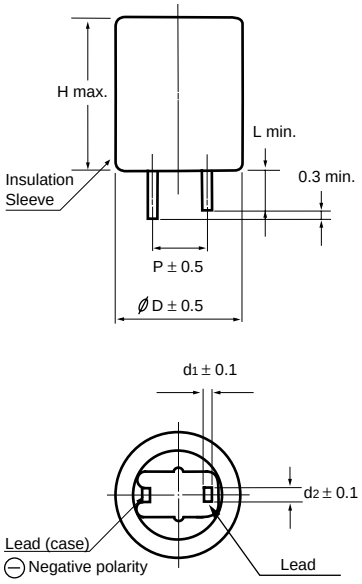


Markings

Markings are made with black ink on the green sleeve.



Dimensions and Standard Ratings



Part No.	Dimensions mm (inch)						Weight g (oz)
	D	H	P	d_1	d_2	L	
FR0H223Z	11.5 (0.453)	14.0 (0.551)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	2.3 (0.081)
FR0H473Z	14.5 (0.571)	14.0 (0.551)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.4 (0.095)	3.9 (0.138)
FR0H104Z	14.5 (0.571)	15.5 (0.610)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.4 (0.095)	4.3 (0.152)
FR0H224Z	14.5 (0.571)	21.0 (0.827)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.4 (0.095)	5.3 (0.187)
FR0H474Z	16.5 (0.650)	21.5 (0.846)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	7.5 (0.265)
FR0H105Z	21.5 (0.850)	22.0 (0.866)	7.62 (0.300)	0.6 (0.024)	1.2 (0.047)	3.0 (0.118)	13.3 (0.470)

Note: Weight values are typical.

Part No.	Max. Rated Voltage (Vdc)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)	Voltage Holding Characteristic min. (V)
FR0H223Z	5.5	0.022	220	0.033	4.2
FR0H473Z	5.5	0.047	110	0.071	4.2
FR0H104Z	5.5	0.10	150	0.15	4.2
FR0H224Z	5.5	0.22	180	0.33	4.2
FR0H474Z	5.5	0.47	100	0.71	4.2
FR0H105Z	5.5	1.0	60	1.5	4.2

Item		Specification		Test Conditions
Operating Temp. Range		–40 to 85° C		
Max. Rated Voltage		5.5 Vdc		
Capacitance Range		0.022 to 1.0 F (Refer to standard ratings)		
Capacitance Tolerance		+80%, –20%		Refer to measuring conditions
ESR*		Refer to standard ratings		
Current (at 30 minutes)				
Surge voltage		Capacitance	More than 90% of initial requirement	Temperature 85° C Surge voltage 6.3V Charge: 30 sec. Discharge: 9 min.30 sec. 1,000 cycles Charge resistance: 0.022 F 560Ω 0.22 F 56Ω 0.047 F 300Ω 0.47 F 30Ω 0.10 F 150Ω 1.0 F 15Ω No discharge resistance
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Temperature Characteristics	Step 2	Capacitance	More than 50% of initial value	Step 1 : +25° C Step 2 : –25° C Step 3 : –40° C Step 4 : +25° C Step 5 : +85° C Step 6 : +25° C
		ESR	Not to exceed 4 times initial value	
	Step 3	Capacitance	More than 30% of initial value	
		ESR	Not to exceed 7 times initial value	
	Step 5	Capacitance	Not to exceed 200% of initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.	Not to exceed 1.5 CV (mA)	
	Step 6	Capacitance Change	Within ±20% of initial value	
		ESR	Not to exceed initial requirement	
		Current at 30 min.		
Lead Strength (Tensile)		There shall be no loosening nor permanent damage of the leads		0.022 to 0.47 F : 1 kg, 10 sec. 1.0 F : 2.5 kg, 10 sec.
Vibration		Capacitance	Shall meet initial requirement	10 to 55 Hz Double amplitude 1.5 mm 2 hours per each one of 3 directions
		ESR		
		Current at 30 min.		
Solderability		Immersed lead surface shall be at least 75% covered with new solder		230 ± 5° C, 5 ± 0.5 sec. Immersion depth: 1.6 mm from body
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	260 ±10° C, 10 ± 1 sec. Immersion depth: 1.6 mm from body
		ESR		
		Current at 30 min.		
Temperature Cycling		Capacitance	Shall meet initial requirement	–40 to +85° C, 5 cycles
		ESR		
		Current at 30 min.		
Moisture Resistance (Steady State)		Capacitance	Within ±20% of initial value	40 ± 2° C, 90 to 95% RH 240 hours
		ESR	Not to exceed 120% of initial requirement	
		Current at 30 min.		
Load Life		Capacitance	Within 30% of initial value	
		ESR	Not to exceed 200% of initial requirement	
		Current at 30 min.		
Voltage Holding Characteristics		Voltage between terminal leads shall be higher than 4.2V		Charging: 1)Applied Voltage: 5.0V 2) Series Resistance: 0Ω 3) Charging time: 24 hours
				Storage: 1) Load: nothing 2) Temp.: less than 25° C 3) Humidity: less than 70% RH 4) Storage time: 24 hours

*ESR : Equivalent series resistance

FYD Type: **Small diameter, excellent voltage holding characteristics**
FYH and FYL Type: **Low profile, excellent voltage holding characteristics**

The FY Series includes small electric double-layer capacitors with excellent voltage holding characteristics. The FYD type has a very small footprint, and the FYH and FYL types feature a low profile, suitable for various systems with space constraints.

These capacitors are ideal as long-time backup devices for minute current loads in small and lightweight systems.

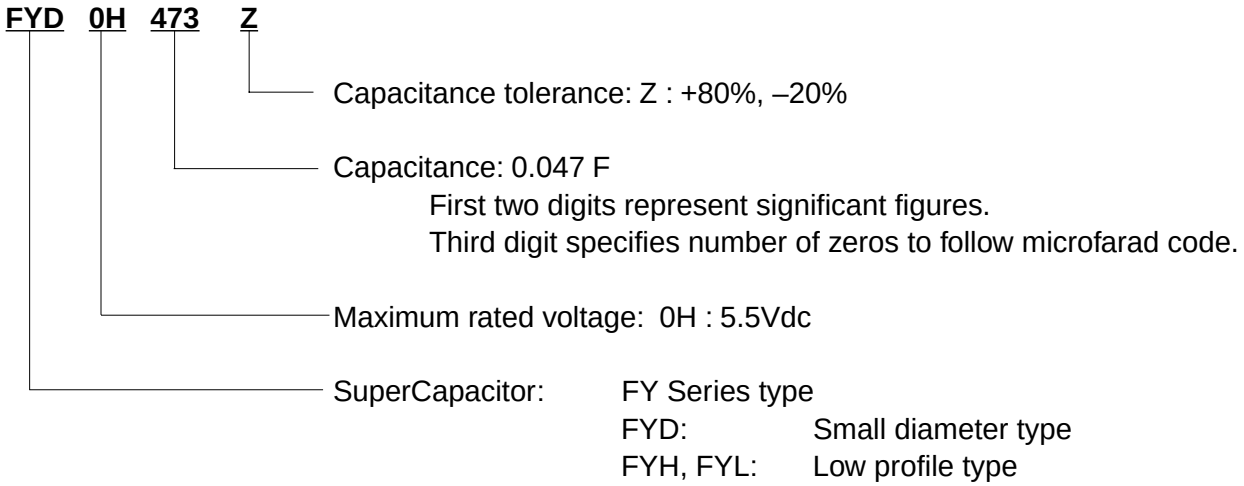
Features

- ❑ Wide range of specifications makes the FYD, FYH, FYL types suitable for many types of systems.
- ❑ Excellent voltage holding characteristics, ideal for long-time supply of 1μA to several hundred μA.
- ❑ Smaller than other SuperCapacitors (25% smaller in volume than the FS Series)

Applications

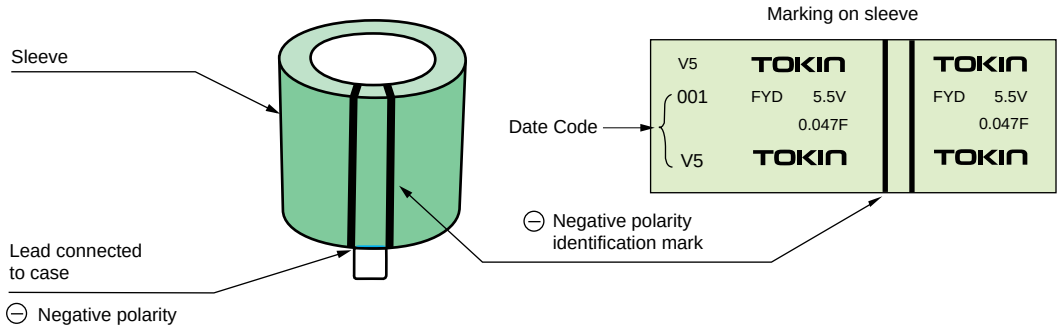
- ❑ Backup of CMOS microcomputers, static RAMs and DTSs (digital tuning systems).
- ❑ Memory backup of remote controllers and portable casette players during battery replacement.

Part Numbering System



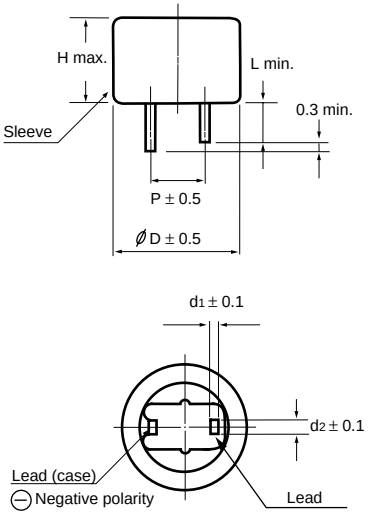
Markings

Markings are made with black ink on the green sleeve.



Dimensions and Standard Ratings

FYD Type

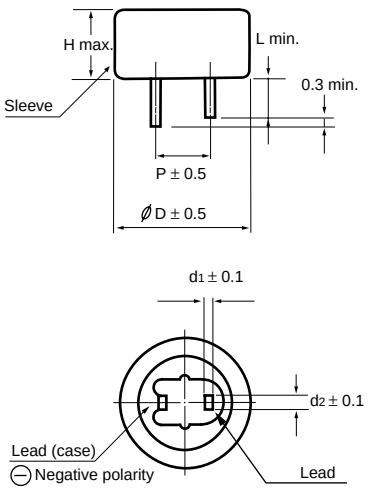


Part No.	Dimensions mm (inch)						Weight g (oz)
	D	H	P	d_1	d_2	L	
FYD0H223Z	11.5 (0.453)	8.5 (0.335)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	1.6 (0.056)
FYD0H473Z	11.5 (0.453)	8.5 (0.335)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	1.65 (0.058)
FYD0H104Z	13.0 (0.512)	8.5 (0.335)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.2 (0.087)	2.4 (0.085)
FYD0H224Z	14.5 (0.571)	15.0 (0.591)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.4 (0.095)	4.3 (0.152)
FYD0H474Z	16.5 (0.650)	15.0 (0.591)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	6.0 (0.212)
FYD0H105Z	21.5 (0.850)	16.0 (0.829)	7.62 (0.300)	0.6 (0.024)	1.2 (0.047)	3.0 (0.118)	11.0 (0.338)
FYD0H145Z	21.5 (0.850)	19.0 (0.748)	7.62 (0.300)	0.6 (0.024)	1.2 (0.047)	3.0 (0.118)	12.0 (0.424)
FYD0H225Z	28.5 (1.122)	22.0 (0.866)	10.16 (0.400)	0.6 (0.024)	1.4 (0.055)	6.1 (0.240)	22.9 (0.809)

Note: Weight values are typical.

Part No.	Max. Rated Voltage (Vdc)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)	Voltage Holding Characteristic min. (V)
FYD0H223Z	5.5	0.022	220	0.033	4.2
FYD0H473Z	5.5	0.047	110	0.071	4.2
FYD0H104Z	5.5	0.10	100	0.15	4.2
FYD0H224Z	5.5	0.22	120	0.33	4.2
FYD0H474Z	5.5	0.47	65	0.71	4.2
FYD0H105Z	5.5	1.0	35	1.5	4.2
FYD0H145Z	5.5	1.4	45	2.1	4.2
FYD0H225Z	5.5	2.2	35	3.3	4.2

FYH Type

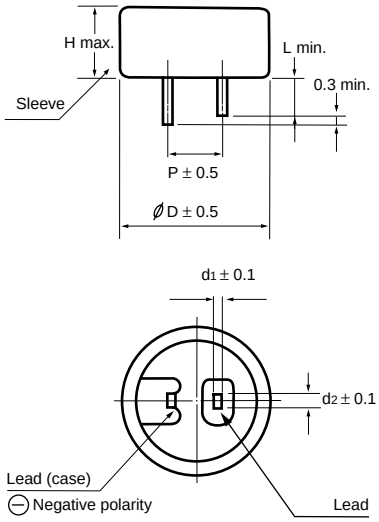


Part No.	Dimensions mm (inch)						Weight g (oz)
	D	H	P	d_1	d_2	L	
FYH0H223Z	11.5 (0.453)	7.0 (0.276)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	1.5 (0.053)
FYH0H473Z	13.0 (0.512)	7.0 (0.276)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.2 (0.087)	2.2 (0.078)
FYH0H104Z	16.5 (0.650)	7.5 (0.295)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	3.4 (0.120)
FYH0H224Z	16.5 (0.650)	9.5 (0.374)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	3.6 (0.127)
FYD0H474Z	21.5 (0.846)	10.0 (0.394)	7.62 (0.300)	0.6 (0.024)	1.2 (0.047)	3.0 (0.118)	7.2 (0.255)
FYD0H105Z	28.5 (1.122)	11.0 (0.433)	10.16 (0.400)	0.6 (0.024)	1.4 (0.055)	6.1 (0.240)	13.9 (0.491)

Note: Weight values are typical.

Part No.	Max. Rated Voltage (V)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)	Voltage Holding Characteristic min. (V)
FYH0H223Z	5.5	0.022	200	0.033	4.2
FYH0H473Z	5.5	0.047	100	0.071	4.2
FYH0H104Z	5.5	0.10	50	0.15	4.2
FYH0H224Z	5.5	0.22	60	0.33	4.2
FYH0H474Z	5.5	0.47	35	0.71	4.2
FYH0H105Z	5.5	1.0	20	1.5	4.2

FYL Type



Part No.	Dimensions mm (inch)						Weight g (oz)
	D	H	P	d_1	d_2	L	
FYL0H103Z	11.0 (0.43)	5.0 (0.197)	5.08 (0.200)	0.2 (0.008)	1.2 (0.047)	2.7 (0.106)	0.9 (0.032)
FYL0H223Z	11.0 (0.43)	5.0 (0.197)	5.08 (0.200)	0.2 (0.008)	1.2 (0.047)	2.7 (0.106)	1.0 (0.035)
FYL0H473Z	12.0 (0.47)	5.0 (0.197)	5.08 (0.200)	0.2 (0.008)	1.2 (0.047)	2.7 (0.106)	1.2 (0.042)

Note: Weight values are typical.

Part No.	Max. Rated Voltage (V)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)	Voltage Holding Characteristic min. (V)
FYL0H103Z	5.5	0.010	300	0.015	4.2
FYL0H223Z	5.5	0.022	200	0.033	4.2
FYL0H473Z	5.5	0.047	200	0.071	4.2

Item		Specification		Test Conditions
Operating Temp. Range		–25 to 70° C		
Max. Rated Voltage		5.5 Vdc		
Capacitance Range		Refer to standard ratings		
Capacitance Tolerance		+80%, –20%		Refer to measuring conditions
ESR*		Refer to standard ratings		
Current (at 30 minutes)				
Surge Voltage		Capacitance	More than 90% of initial requirement	Temp. 70° ± 2° C Surge voltage 6.3V Charge: 30 sec. Discharge: 9 min.30 sec. No of cycles: 1,000 Charge resistance: 0.01 F 1500Ω 0.47 F 30 Ω 0.022 F 560Ω 1.0 F 15 Ω 0.047 F 300Ω 1.4 F 15 Ω 0.10 F 150Ω 2.2 F 10 Ω 0.22 F 56 Ω No discharge resistance
		ESR	Less than 120% of initial requirement	
		Current at 30 min.	Less than 120% of initial requirement	
		Visual appearance	No significant change	
Temperature Characteristics	Step 2	Capacitance	More than 50% of initial value	Step 1 : + 25° C Step 2 : - 25° C Step 3 : + 25° C Step 4 : + 70° C Step 5 : + 25° C
		ESR	Not to exceed 400% initial value	
	Step 4	Capacitance	Less than 200% of initial value	
		ESR	Initial requirement	
		Current at 30 min.	Less than 1.5 CV (mA)	
	Step 6	Capacitance Change	Within ±20% of initial value	
		ESR	Initial requirement	
		Current at 30 min.		
Terminal Strength		Terminals shall not be broken		FYD0H105Z FYD0H145Z FYD0H225Z 2.5 kg-f 10 ± 1 sec. FYH0H474Z FYH0H105Z Others:1.0 kg-f 10 ± 1 sec.
Vibration		Capacitance	Shall meet initial requirement	Frequency: 10 to 55 Hz Time of test : 6 hours
		ESR		
		Current at 30 min.		
		Visual appearance	No significant change	
Solderability		Immersed lead surface shall be at least 75% covered with new solder		Solder Temp: 230 ± 5° C Imm.time: 5 ± 0.5 sec. Immersion depth:1.6 mm from bottom
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	Temperature of solder: 260 ± 10° C Time of immersion: 10 ± 1.0 sec. Immersion depth:1.6 mm from bottom
		ESR		
		Current at 30 min.		
		Visual appearance	No significant change	
Temperature Cycling		Capacitance	Shall meet initial requirement	Temperature condition: –25° C → +25° C → +70° C → +25° C Number of cycles: 5
		ESR		
		Current at 30 min.		
		Visual appearance	No significant change	
Moisture Resistance (Steady state)		Capacitance Change	Within ±20% of initial value	Temperature: 40 ± 2° C Humidity : 90 to 95% RH Time of test : 240 hours
		ESR	Less than 120% of initial requirement	
		Current at 30 min.		
		Visual appearance	No significant change	
Load Life		Capacitance Change	Within ±30% of initial value	Temperature : 70 ± 2° C Series resistance: 0Ω Applied voltage : 5.5V DC Time of test : 1,000 hours
		ESR	Less than 200% of initial requirement	
		Current at 30 min.		
		Visual appearance	No significant change	
Voltage Holding Characteristics (Self Discharge)		Voltage between terminal leads shall be higher than 4.2V		**Charging:** 1)Applied Voltage: 5.0V 2) Series Resistance: 0Ω 3) Time: 24 hours **Storage:** 1) Load: nothing 2) Temp.: less than 25° C 3) Humidity: less than 70% RH 4) Time: 24 hours

*ESR : Equivalent series resistance

These 3.5V and 6.5V rated SuperCapacitors are suitable for portable or battery-driven equipment. FSH and FYD type are especially ideal as backup devices for cameras, remote controllers, headphones, and stereos.

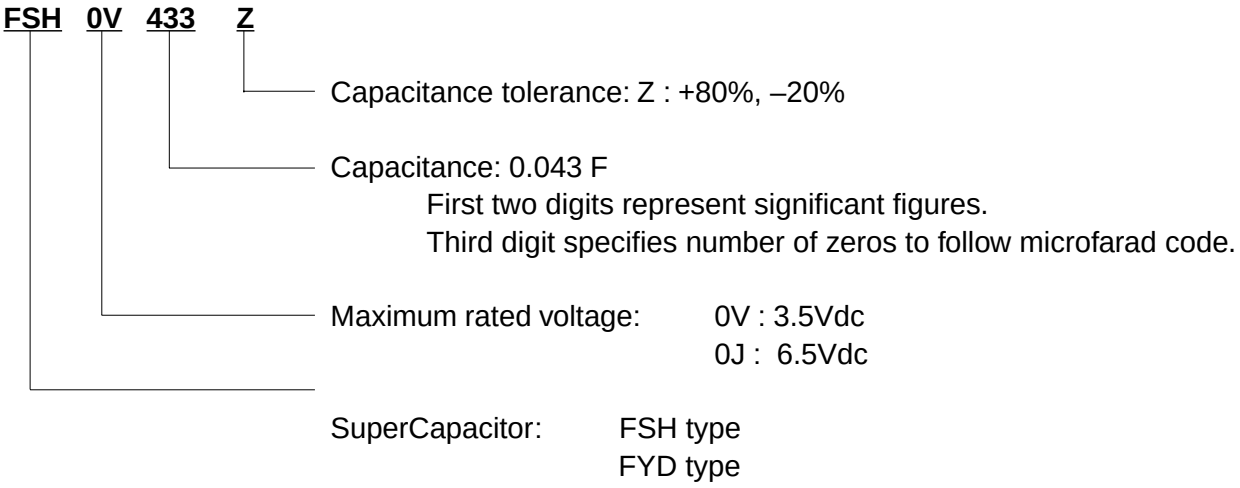
Features

- ❑ The FSH type is ideal for supplying several hundred μA to several mA for a short time. The FYD type is ideal for backup of 1 μA to several hundred μA for a long time.
- ❑ Smaller than other SuperCapacitors (25% smaller in volume than FS Series in C•V per volume).

Applications

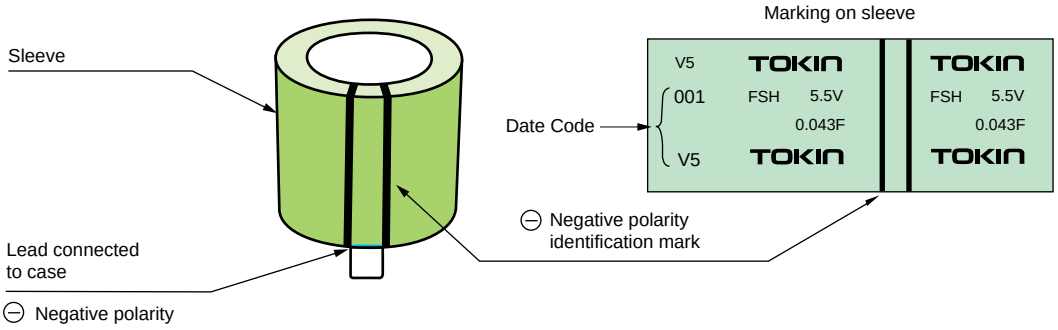
- ❑ Secondary backup power supply for cameras to charge an electronic flash (FSH type).
- ❑ Secondary backup power supply for motors (FSH type).
- ❑ Backup of CMOS microprocessors, SRAMs and DTS ICs to charge the battery.

Part Numbering System

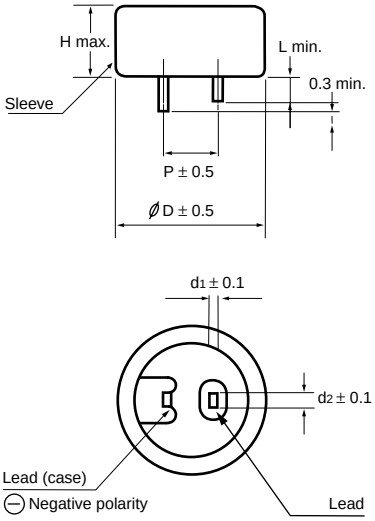


Markings

Markings are made with black ink on the green sleeve.



Dimensions and Standard Ratings



Part No.	Dimensions mm (inch)						Weight g (oz)
	D	H	P	d_1	d_2	L	
FSH0V433Z	11.0 (0.413)	5.2 (0.205)	5.08 (0.200)	0.2 (0.008)	1.2 (0.047)	2.7 (0.106)	1.0 (0.035)
FYD0V563Z	11.0 (0.413)	5.2 (0.205)	5.08 (0.200)	0.2 (0.008)	1.2 (0.047)	2.7 (0.106)	1.0 (0.035)
FSH0J223Z	11.5 (0.453)	8.5 (0.355)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	1.7 (0.060)
FYD0J273Z	11.5 (0.453)	8.5 (0.355)	5.08 (0.200)	0.4 (0.016)	1.2 (0.047)	2.7 (0.106)	1.6 (0.056)

Note: Weight values are typical.

Part No.	Max. Rated Voltage (V)	Nominal Capacitance (F)	Max. ESR (at 1 kHz) (Ω)	Max. Current at 30 minutes (mA)
FSH0V433Z	3.5	0.043	50	0.039
FYD0V563Z	3.5	0.056	150	0.050
FSH0J223Z	6.5	0.022	60	0.040
FYD0J273Z	6.5	0.027	200	0.049

Item		Specification		Test Conditions
Operating Temp. Range		–25 to +70° C		
Max. Rated Voltage		3.5Vdc, 6.5Vdc		
Capacitance Range		Refer to standard ratings		
Capacitance Tolerance		+80%, –20%		Refer to measuring conditions
ESR*		Refer to standard ratings		
Current (at 30 minutes)				
Surge Voltage		Capacitance	More than 90% of initial requirement	Surge voltage: 4.0V (3.5Vdc), 7.4V (6.5Vdc) . rated part rated part Temperature: 70 ± 2° C Charging for 30 sec. Discharging 9 min. 30 sec. Number of cycles: 1,000 Charge resistance: 0.022 F 0.43 F 300 Ω 0.027 F 560Ω 0.56 F 240 Ω No discharge resistance.
		ESR	Less than 120% of initial requirement	
		Current at 30 min.	Less than 120% of initial requirement	
		Visual appearance	No significant change	
Temperature Characteristics	Step 2	Capacitance	More than 50% of initial value	Step 1 : +25° C Step 2 : –25° C Step 3 : +25° C Step 4 : +70° C Step 5 : +25° C
		ESR	Less than 400% initial value	
	Step 4	Capacitance	Less than 200% of initial value	
		ESR	Initial requirement	
		Current at 30 min.	Less than 1.5 CV (mA)	
	Step 5	Capacitance Change	Within ±20% of initial value	
		ESR	Initial requirement	
		Current at 30 min.		
Vibration		Capacitance	Shall meet initial requirement	Frequency: 10 to 55 Hz Time of test : 6 hours
		ESR		
		Current at 30 min.		
		Visual appearance	No significant change	
Solderability		Immersed lead surface shall be at least 75% covered with new solder		Temp. of solder: 230 ±5° C Imm. Time: 5 ± 0.5 sec. Immersion depth: 1.6 mm from the bottom
Soldering Heat Resistance		Capacitance	Shall meet initial requirement	Temperature of solder: 260 ±10° C Time of immersion: 10 ± 1.0 sec. Immersion depth: 1.6 mm from the bottom
		ESR		
		Current at 30 min.		
		Visual appearance	No significant change	
Temperature Cycling		Capacitance	Shall meet initial requirement	Temperature condition: –25° C → +25° C → +70° C → +25° C Number of cycles: 5
		ESR		
		Current at 30 min.		
		Visual appearance	No significant change	
Moisture Resistance (Steady state)		Capacitance Change	Within ±20% of initial value	Temperature: 40 ± 2° C Humidity : 90 to 95% RH Time of test : 240 hours
		ESR	Less than 200% of initial requirement	
		Current at 30 min.	Less than 120% of initial requirement	
		Visual appearance	No significant change	
Load Life		Capacitance Change	Within ±30% of initial value	Temperature : 70 ± 2° C Series resistance: 0Ω Applied voltage : 5.5V DC Time of test : 1,000 hours
		ESR	Less than 300% of initial requirement	
		Current at 30 min.	Less than 200% of initial requirement	
		Visual appearance	No significant change	

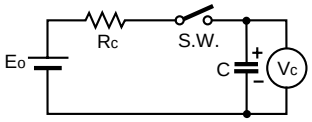
*ESR : Equivalent series resistance

Measurement Conditions

1) Capacitance

Capacitance can be calculated with the formula in Table 3 using the charging time constant (τ) being measured from the circuit diagram. 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 (except in the FM series).

$$C = \frac{\tau}{R_C} \ (F)$$



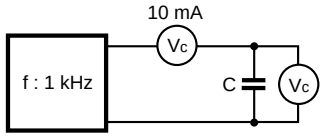
Eo : 3.0 Vdc for rated voltage code 0V (3.5 V)
: 5.0 Vdc for rated voltage code 0H (5.5 V)
: 6.0 Vdc for rated voltage code 0J (6.5 V)
: 10.0 Vdc for rated voltage code 1A (11 V)
τ : Time period (seconds) to reach Vc = 0.632 Eo
Rc : Refer to Table 3.

Series Cap	FA	FE	FS	FY			FM	FR	3.5 V, 6.5 V
				FYD	FYH	FYL			
0.01F	-	-	-	-	-	5 kΩ	5 kΩ	-	0.022 F
0.022F	1 kΩ	-	1 kΩ	2 kΩ	2 kΩ	2 kΩ	2 kΩ	2 kΩ	to 0.056 F
0.047F	1 kΩ	1 kΩ	1 kΩ	2 kΩ	1 kΩ	2 kΩ	2 kΩ	1 kΩ	2 kΩ
0.1F	510Ω	510 Ω	510 Ω	1 kΩ	510 Ω	-	1 kΩ	1 kΩ	-
0.22F	200Ω	200 Ω	200 Ω	510 Ω	510 Ω	-	-	510 Ω	-
0.47F	100Ω	100 Ω	100 Ω	200 Ω	200 Ω	-	-	200 Ω	-
1.0F	51Ω	100 Ω	100 Ω	100 Ω	100 Ω	-	-	100 Ω	-
1.4F	-	-	-	200 Ω	-	-	-	-	-
1.5F	-	51 Ω	-	-	-	-	-	-	-
2.2F	-	-	-	100 Ω	-	-	-	-	-

Table 3 - Capacitance measurement

(2) Equivalent Series Resistance (ESR)

$$ESR = \frac{V_C}{10^{-2}} \ (\Omega)$$



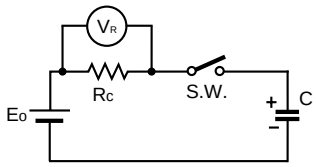
ESR Measurement

3) Current at 30 minutes

Current is defined after 30 minutes of charging. A measuring circuit and formula are shown as follows.
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 (except in the FM series).

Eo : The same as 4.2 (1) above
Rc : 0.01 to 0.056 F : 1,000 Ω
0.1 to 0.47 F 100 Ω
1 to 2.2 F 10 Ω

$$\text{Current} = \frac{V_R}{R_C} \times 10^3 \ (mA)$$



Current Measurement

(4) Voltage-holding Characteristics (except FA, FE, and FS Series and 3.5-V and 6.5-V models)

The capacitor is charged at 5.0 Vdc for 24 hours without series resistance. The case terminal is connected to the negative terrninal of the power supply (except in the FM series). The capacitor terminals are then opened and the capacitor is left for 24 hours at 25˚C max. and 70% RH max. At this time, the voltage held across the terminals is measured.

Notes on Using the Tokin SuperCapacitor (Electric Double-Layer Capacitor)

This capacitor uses an electrolyte and a rubber-sealed structure. Using it at a high temperature for many hours may cause water content in the electrolyte to evaporate and increase equivalent series resistance. The basic failure mode is an open mode caused by an increase of equivalent series resistance.

Failure rate

The field failure rate of a Super Capacitor is estimated to be 4 Fit or below. The failure rate calculated based on field data is approximately 0.4 Fit. However, 4 Fit is assumed because it is estimated that there are ten times as many latent claims that are not directly connected to returning of products.

Circuitry

a. Ensure that the maximum operating voltage and other rated values are selected reliably. Application of a voltage exceeding the maximum operating voltage may not only deteriorate performance but also damage the case, etc.
b. Since the equivalent series resistance (ESR) of the capacitor is relatively high, do not use it in a smoothing circuit such as a power supply circuit.
c. For reasons related to the marking display lamp, a sleeve is used for the capacitor, but its isolation is not guaranteed. Contact with adjacent components may cause leakage.
d. In the manufacturing process, the capacitor is processed with the pin on the case side designated as the (-) side. Note this (-) symbol when using the capacitor. A discharge may occur during shipment, but some residual potential may have an adverse effect on other components.
e. Use of a Super Capacitor in the vicinity of a heating element (coil, power transistor, posistor, etc.) may heat the capacitor itself and considerably shorten its service life.

Mounting

a. This capacitor cannot be mounted with a reflow furnace such as IR and VPS. Avoid dipping the capacitor in a solder dip bath.
b. When using flow automatic soldering, ensure that the soldering temperature is 260˚C or below and soldering duration at one point does not exceed 10 sec.
c. For soldering with a soldering rod, select a soldering rod with a capacity of approximately 30 W and ensure that the temperature at the rod tip does not exceed 350˚C and that the soldering duration does not exceed 5 sec. The rod temperature should be controlled reliably. Heating pins excessively may increase the equivalent series resistance (ESR).
d. Do not deform or file capacitor pins. Doing so may cause solder plating on the pin to fall off and prevent solder from sticking.

Cleaning

a. Basically do not apply washing to capacitors except the FM series. When washing is unavoidable, use a washing resistant product.
b. Drying after washing should be performed within the maximum operating temperature range.

Keeping

a. Store the product in an environment with a normal temperature and normal humidity without condensation.
b. Avoid exposing the product in direct sunlight for many hours. (Doing so may cause deterioration or discoloration of the sleeve.)

Taking the capacitors apart

a. The capacitor contains a trace of dilute sulfuric acid. Contact with hands,etc., may have a harmful effect. So do not disassemble it.
b. Do not use incineration for disposal. Instead, dispose of it as industrial waste.

(1) Safety design of an apparatus or a system should allow for failures of electronic components used in the system.

In general, failures will arise in electronic components at a certain probability. Tokin makes every effort to improve the quality and reliability of electronic component products. However, it is impossible to completely eliminate the probability of failures. Therefore, when using Tokin's electronic component products, systems should be carefully designed to ensure redundancy in the event of an accident which would result in injury or death, fire, or other damage, to ensure the prevention of the spread of fire, and the prevention of faulty operation. (Please refer to precautions to be taken when using SuperCapacitor capacitors for the details of failures.)

(2) Quality level of various kinds of parts, and equipment in which the parts can be utilized:

Electronic components have a standard quality level unless otherwise specified.

Tokin classifies the level of quality of electronic component products into three levels: a lower level, a standard quality level, and a special custom quality level where a customer individually specifies a quality assurance program. Each of the quality levels has recommended applications.
If a user wants to use the electronic parts having a standard quality level in applications other than the applications specified for the standard quality level, they should always consult a member of our staff before specifying or using the electronic parts.

Standard quality level	Computers, OA equipment, communications equipment, measuring instruments, AV equipment, household electrical appliances, machine tools, personal equipment, industrial robots.
Special quality level	Transportation equipment (automobiles, railways, shipping, or the like), traffic signals, disaster prevention/crime prevention systems, a variety of safety devices and medical equipment which is not directly intended for life-support purposes.
Custom quality level	Equipment for airplanes, aerospace equipment, nuclear power control systems, medical equipment and apparatus or systems for life-support purposes.

Unless otherwise shown, the quality level of Tokin's electronic component products included in documents such as catalogs, data sheets or data books is the standard quality level.

(3) Specifications are subject to change without notice.

Specifications and other information in this catalog may be changed without notice. If our products are used for mass-production design, please consult about the products with a member of our staff by way of precaution.

(4) This catalog can be downloaded from the internet for individual consultation and study. However, reprinting and copying of this catalog without prior permission in writing by Tokin Corporation is not permitted.

(5) Industrial property problems:

In the event any problems associated with industrial property of a third party arising as a result of the use of our products, Tokin assumes no responsibility for problems other than problems directly associated with the constitution and manufacturing of the products.

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Bravo Electro Components, Inc.

610 Palomar Avenue
Sunnyvale, CA 94086-2913

info@bravoelectro.com

(800) 392-6318