

Overview

FMU Series Supercapacitors, also known as Electric Double-Layer Capacitors (EDLCs), are intended for high temperature automotive applications.

Enhancements to the design and selected material upgrades were introduced to deliver 1,000 hours at 85°C/85% RH rated voltage and and to AEC-Q200 compliance with maximum operational temperature life up to 105°C.

These capacitors are manufactured in an ISO TS 16949 certified plant and are subjected to PPAP/PSW, as well as change control.

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.

FMU type Automotive grade Supercapacitor can be stable under harsh environmental conditions such as high humidity and high temperature.

Benefits

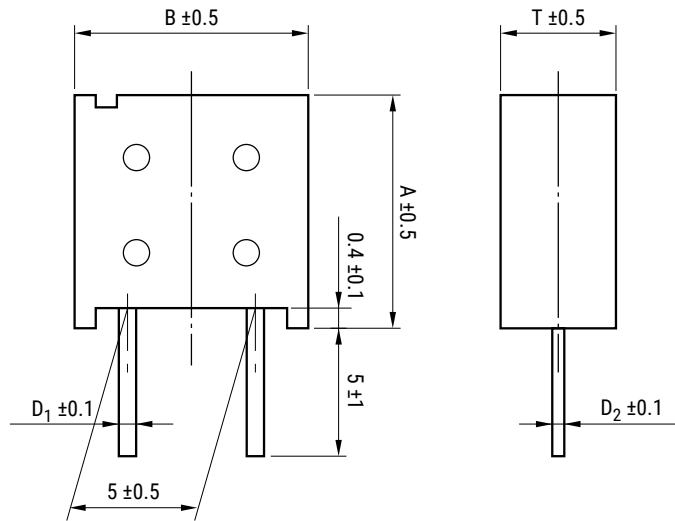
- AEC-Q200 rev E compliant
- TS 16949 certified plant
- Subject to PPAP/PSW and change control
- Wide range of temperature from -40°C to +105°C
- Maintenance free
- Maximum operating voltage of 5.5 VDC
- Highly reliable against liquid leakage
- Lead-free and RoHS compliant



Part Number System

| FMU | 0H | 334 | Z | F | TP | 18 |
|--------|---------------------------|--|-----------------------|---------------|---------------------------|----------------------------|
| Series | Maximum Operating Voltage | Capacitance Code | Capacitance Tolerance | Environmental | Tape Type | Height (excluding lead) |
| FMU | 0H = 5.5 VDC | First two digits represent significant figures. Third digit specifies number of zeros to follow µF code. | Z = -20/+80% | F = Lead-free | TP = Ammo Blank = Bulk | 18 = 18 mm Blank = Bulk |

Dimensions – Millimeters



| Part Number | A | B | T | D ₁ | D ₂ |
|-------------|------|------|-----|----------------|----------------|
| FMU0H334ZF | 15.0 | 14.0 | 9.0 | 0.6 | 0.6 |

Environmental Compliance

All KEMET supercapacitors are 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) | Reference Weight (g) |
|-------------|---------------------------------|---------------------|----------------------|-----------------------------------|------------------------------------|----------------------|
| | | Charge System (F) | Discharge System (F) | | | |
| FMU0H334ZF | 5.5 | - | 0.33 | 25 | 0.50 | 3.8 |

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 +105°C (FMU Type) |
| 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 | Memory, RTC backup for automotive | Automotive applications, medical, measurement and infrastructure, telecommunications equipment, medical equipment | FMU Series |

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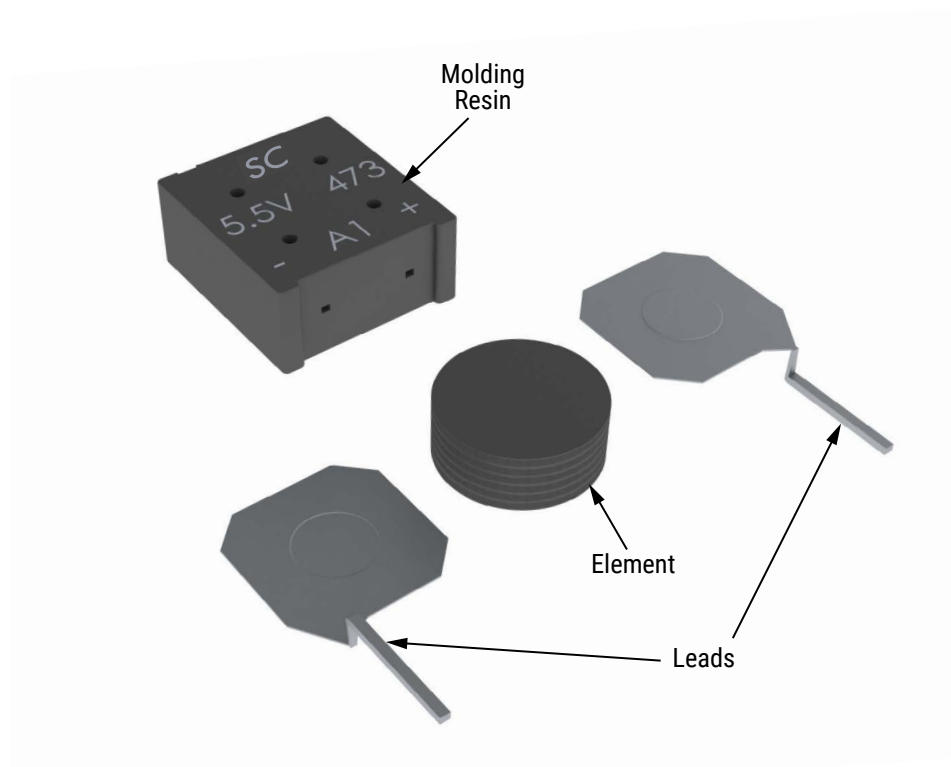
Specifications

| Item | | Specifications | Test Conditions |
|-------------------------------------|------------------------|---------------------------|---|
| Category temperature range | | -40°C to +105°C | |
| MAX operating voltage | | Refer to standard ratings | |
| Capacitance | | Refer to standard ratings | Refer to "Measurement Conditions" |
| Capacitance allowance | | +80%, -20% | Refer to "Measurement Conditions" |
| ESR | | Refer to standard ratings | Measured at 1 kHz, 10 mA, See also "Measurement Conditions" |
| Current (30 minute value) | | Refer to standard ratings | Refer to "Measurement Conditions" |
| High Temperature Exposure (Storage) | MIL-STD-202 Method 108 | Capacitance | Within ±30% of initial measured value |
| | | ESR | Less than 200% of initial limit |
| | | Current | Less than 200% of initial limit |
| Temperature Cycling | JESD22 Method JA-104 | Capacitance | Temperature condition: Lower -40°C » Upper +105°C |
| | | ESR | Dwell Time: 30 minutes |
| | | Current | Transition time: Maximum 1 minute |
| Biased Humidity | MIL-STD-202 Method 103 | Capacitance | Number of cycles: 1,000 Cycles |
| | | ESR | Temperature: 85 ±2°C |
| | | Current | Relative humidity: 80 to 85%RH |
| Operational Life | MIL-STD-202 Method 108 | Capacitance | Voltage applied: MAX operating voltage |
| | | ESR | Series protection resistance: 0 Ω |
| | | Current | Testing time: 1,000 ⁺⁴⁸ ₋₀ hours |
| Lead Strength (Tensile) | MIL-STD-202 Method 211 | No terminal damage | Test leaded device lead integrity only. |
| | | | A (454 g), C (227 g) |
| Mechanical Shock | MIL-STD-202 Method 213 | Capacitance | Figure 1 of Method 213 Condition C |
| | | ESR | |
| | | Current | |
| Solderability | J-STD-002 | Appearance | Minimum 95% of the terminal should be covered by the new solder |
| Vibration | MIL-STD-202 Method 204 | Capacitance | Conforms to Method A1 (Through Hole Technology) |
| | | ESR | Solder temp: 245±5°C |
| | | Current | Dipping time: 5 +0/-0.5 second |
| Vibration | MIL-STD-202 Method 204 | Capacitance | Frequency: 10 to 2,000 Hz (5 g's) |
| | | ESR | |
| | | Current | |

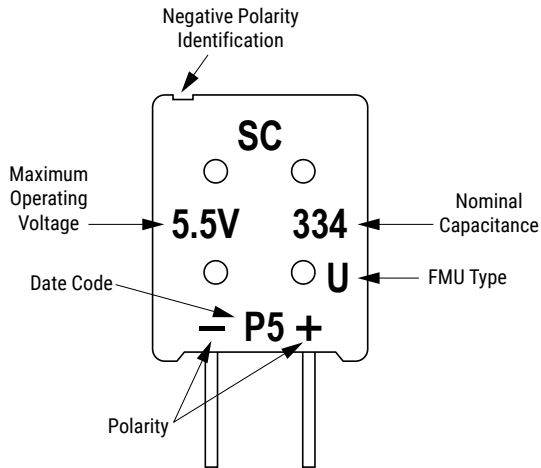
Specifications cont.

| Item | | Specifications | | Test Conditions | |
|------------------------------|---------------------------------|----------------|-----------------------|---|---|
| Resistance to Soldering Heat | MIL-STD- 202 Method 210 | Capacitance | Satisfy initial limit | Solder temp: 260 ±10°C Dipping time: 3 seconds 2.0 mm from the bottom should be dipped. Condition B no pre-heat of samples. Note: Single Wave Solder. Procedure 1 with solder within 1.5 mm of device body for Leaded. | |
| | | ESR | | | |
| | | Current | | | |
| Temperature Stability | IEC-62391-1 | Capacitance | Phase 2 | More than 50% of initial measured | Phase 1: +25±2°C Phase 2: -25±2°C Phase 3: -40±2°C Phase 4: +25±2°C Phase 5: +105±2°C Phase 6: +25±2°C |
| | | ESR | | Less than 400% of initial measured | |
| | | Capacitance | Phase 3 | More than 30% of initial measured | |
| | | ESR | | Less than 700% of initial measured | |
| | | Capacitance | Phase 5 | Less than 200% of initial measured | |
| | | ESR | | Satisfy initial specified value | |
| | | Current | | 1.5 CV (mA) or below | |
| | | Capacitance | Phase 6 | Within ±20% of initial measured value | |
| | | ESR | | Satisfy initial specified value | |
| Current | Satisfy initial specified value | | | | |

Construction



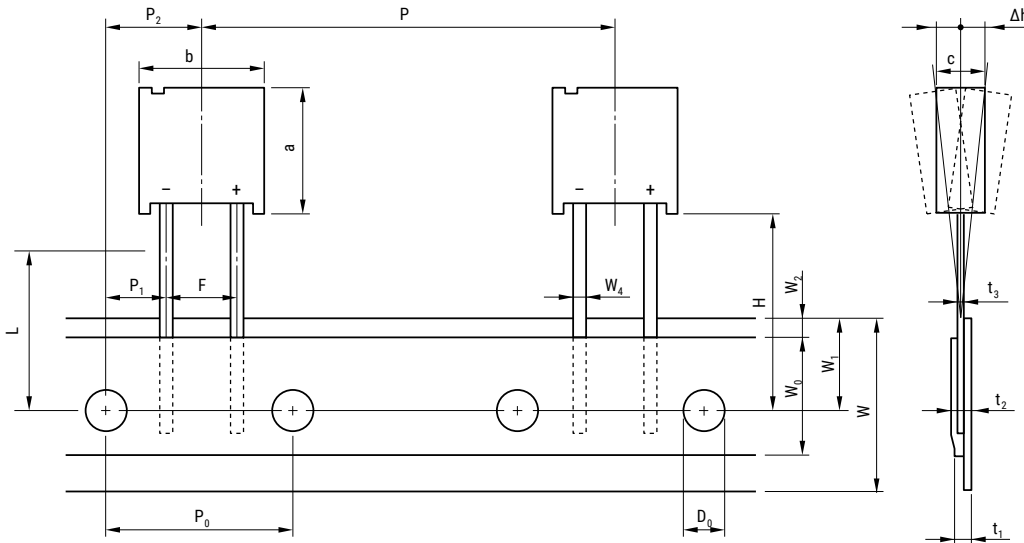
Marking



Packaging Quantities

| Part Number | Bulk Quantity per Box Straight Lead | Ammo Pack Quantity |
|-------------|--|--------------------|
| FMUD0H334ZF | 400 pieces | 400 pieces |

Ammo Pack Taping Format



Ammo Pack Taping Specifications

| Item | Symbol | Dimensions (mm) |
|---|------------|-------------------|
| Component Height | a | 15.0±0.5 |
| Component Width | b | 14.0±0.5 |
| Component Thickness | c | 9.0±0.5 |
| Lead-Wire Width | W_4 | 0.6±0.1 |
| Lead-Wire Thickness | t_3 | 0.6±0.1 |
| Component Pitch | P | 25.4±1.0 |
| Sprocket Hole Pitch | P_0 | 12.7±0.3 |
| Sprocket Hole Center to Lead Center | P_1 | 3.85±0.7 |
| Sprocket Hole Center to Component Center | P_2 | 6.35±0.7 |
| Lead Spacing | F | 5.0±0.5 |
| Component Alignment (side/side) | Δh | 2.0 Maximum |
| Carrier Tape Width | W | 18.0+1.0/-0.5 |
| Hold-Down Tape Width | W_0 | 12.5 Minimum |
| Sprocket Hole Position | W_1 | 9.0±0.5 |
| Hold-Down Tape Position | W_2 | 3.0 Maximum |
| Height to Seating Plane (lead length) | H | 16.0±0.5/18.0±0.5 |
| Sprocket Hole Diameter | D_0 | ∅ 4.0±0.2 |
| Carrier Tape Thickness | t_1 | 0.67±0.2 |
| Total Thickness (Carrier Tape, Hold-Down Tape and Lead) | t_2 | 1.7 Maximum |
| Cut Out Length | L | 11.0 Maximum |

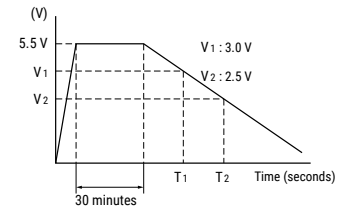
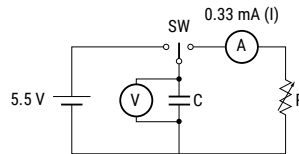
Measurement Conditions

Capacitance (Discharge System)

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 0.33 mA per 0.33 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.

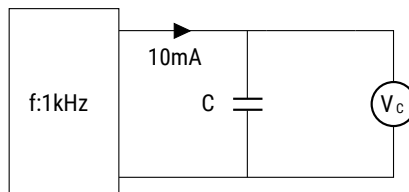
$$C = \frac{I \times (T_2 - T_1)}{V_1 - V_2} \text{ (F)}$$



Equivalent Series Resistance (ESR)

ESR shall be calculated from the equation below.

$$ESR = \frac{V_C}{0.01} \text{ (}\Omega\text{)}$$



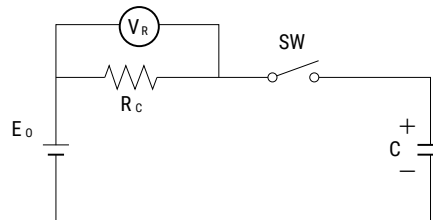
Current (at 30 minutes after charging)

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.

E_0 : 5.0 VDC

R_C : 100 Ω

$$\text{Current} = \frac{V_R}{R_C} \text{ (A)}$$



Self-Discharge Characteristic

The self-discharge characteristic is measured by charging a voltage of 5.0 VDC (charge protection resistance: 0 Ω) according to the capacitor polarity for 24 hours, then releasing between the pins for 24 hours and measuring the pin-to-pin voltage. The test should be carried out in an environment with an ambient temperature of 25° C or below and relative humidity of 70% RH or below. The soldering is checked.

Dismantling

There is a small amount of electrolyte stored within the capacitor. Do not attempt to dismantle as direct skin contact with the electrolyte will cause burning. This product should be treated as industrial waste and not is not to be disposed of by fire.

Notes on Using Supercapacitors or Electric Double-Layer Capacitors (EDLCs)

1. Circuitry Design

1.1 Useful life

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.

1.2 Fail rate in the field

Based on field data, the fail rate is calculated at approximately 0.006 Fit. We estimate that unreported failures are ten 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

Useful life of the supercapacitor will be significantly affected if used near heat emitting items (coils, power transistors 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.

Notes on Using Supercapacitors or Electric Double-Layer Capacitors (EDLCs) cont.

2. Mounting

2.1 Mounting onto a reflow furnace

Except for the FC series, it is not possible to mount this capacitor onto an IR / VPS reflow furnace. Do not immerse the capacitor into a soldering dip tank.

2.2 Flow soldering conditions

Keep solder under 260°C and soldering time to within 10 seconds when using the flow automatic soldering method. (Except for the FC and HV series)

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 iron under 400°C and soldering time to within 3 seconds. Always make sure that the temperature of the tip is controlled. 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. AEC-Q200 compliance FMD type is applicable to MIL-STD-202 option 4.

3. Storage

3.1 Temperature and humidity

Make sure that the supercapacitor is stored according to the following conditions: Temperature: 5 – 35°C (Standard 25°C), Humidity: 20 – 70% (Standard: 50%). Do not allow the build up of condensation through sudden temperature 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 loading, movement and/or knocks. Keep out of direct sunlight and away from radiation, static electricity and magnetic fields.

3.3 Maximum storage period

This item may be stored up to one year from the date of delivery if stored at the conditions stated above.

Dismantling

There is a small amount of electrolyte stored within the capacitor. Do not attempt to dismantle as direct skin contact with the electrolyte will cause burning. This product should be treated as industrial waste and not be disposed of by fire.

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