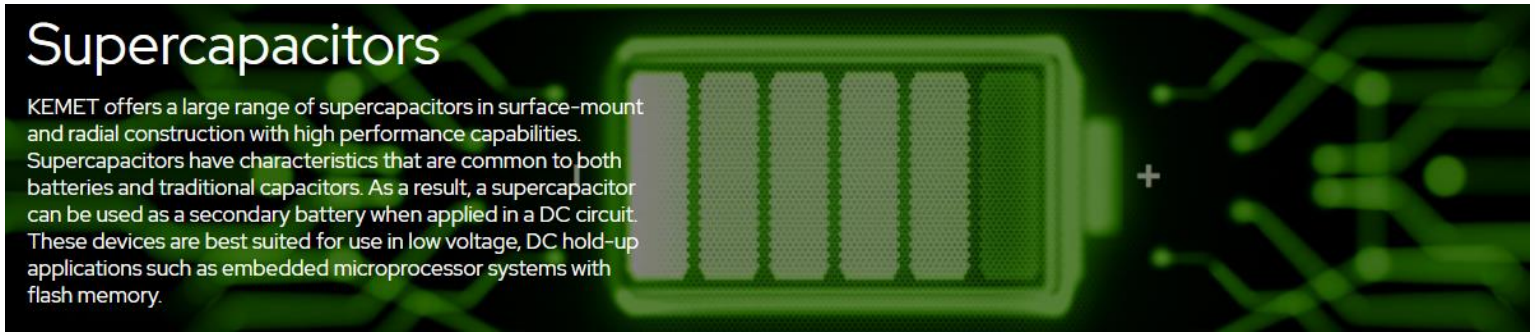
KEMET
a YAGEO company

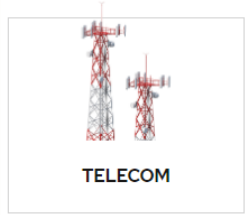
Automotive Grade Supercapacitors
FMD, FU0H and FMU series

Product Overview

Portfolio, Markets & NPIs

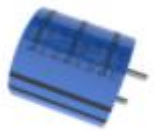


https://www.kemet.com/en/us/capacitors/supercapacitors.html



LEGACY MARKETS

SMD
FC
5,5V, 70ºC



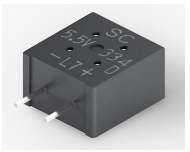
Radial - Molded
FA,FE;FG, FM, FS, FY – (5,5 -12V) , 70ºC
FR,FT – 5,5V , 85ºC, 1000h

Snap-in
HV
5,5V, 70ºC

LEGACY PRODUCT OFFERING

Automotive Grade
Harsh Environmental
85ºC/85%Ur/Ur/1000h
-40ºC to 85ºC or 105ºC Temp Range

FU0H 5,5V
85ºC / 4000h

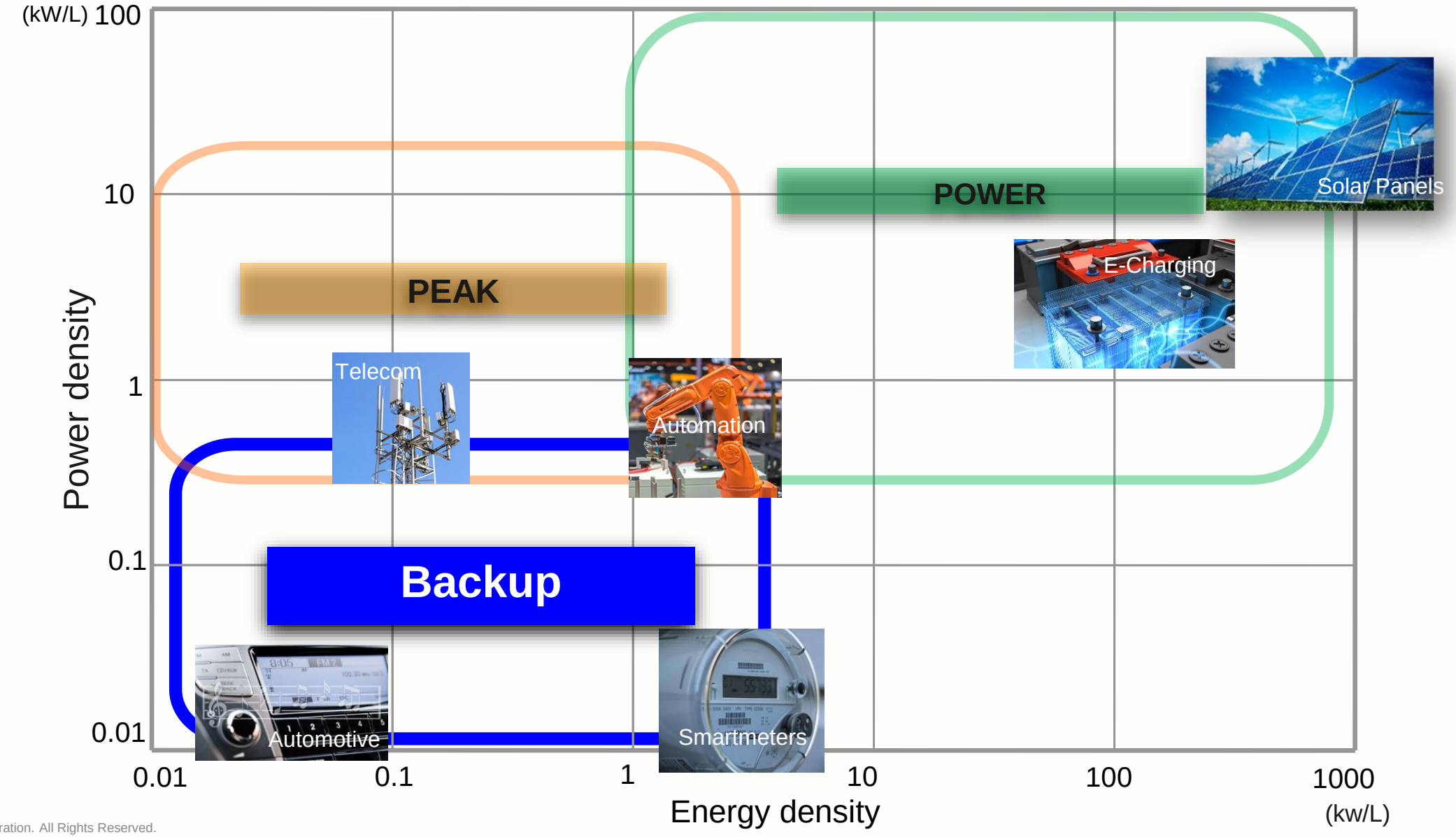


FMD 5,5V
85ºC / 1000h

FMU 5,5V
105ºC / 1000h

NPI 31st August 2021(FU0H, FMD)
20th March 2023(FMU)

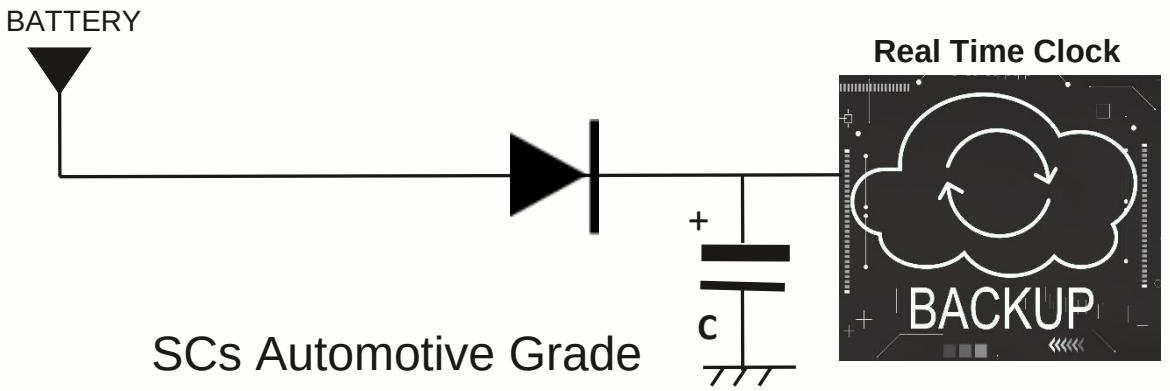
Supercapacitors Application Focus: Backup



Applications

- Supercapacitors' characteristics range from traditional capacitors to batteries.
- Supercapacitors can be used like a second battery when applied in a DC circuit.
- FMD, FU0H and FMU series Supercapacitors are best suited for RTC back-up or low current (under mA) - low voltage DC hold-up applications, such as embedded microprocessor systems.
- FMD, FU0H and FMU series Automotive Grade Supercapacitors are stable in harsh environments, such as high humidity and high temperature.

1. **Central Gateway ECU**
2. **ADAS**
3. **Autonomous**
4. **Human machine interface**
5. **Driving video/Camera**



Overview: FMD, FU0H and FMU series

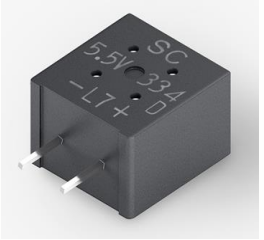
Automotive Grade Supercapacitors

✓ Automotive Testing Protocol
✓ ISO/TS16949 Certified Plant
✓ PPAP/PSW and Change Control

FMD0H334ZF 5.5V/0.33F

Benefits

- 85/85 rated voltage humidity bias, 1000 hours
- Wide range of temperature -40°C to +85°C
- Operational life at 85°C, 5.5V – 1,000hours
- High durability against vibration and mechanical shock



Size

5.0X14.0X9.0 mm

FU0H105ZF 5.5V/1F

Benefits

- 85/85 rated voltage humidity bias, 1000 hours
- Wide range of temperature -40°C to +85°C
- Operational life at 85°C, 5.5V-4000 hours
- High durability against vibration and mechanical shock

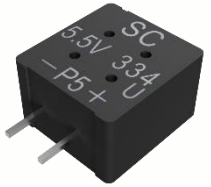
Size

φ21.5X15.0 mm

FMU0H334ZF 5.5V/0.33F

Benefits

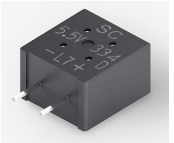
- 85/85 rated voltage humidity bias, 1000 hours
- Wide range of temperature -40°C to +105°C
- Operational life at 105°C, 5.5V – 1,000hours
- High durability against vibration and mechanical shock



Size

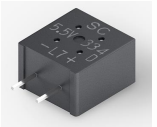
5.0X14.0X9.0 mm

Automotive Grade: Testing Protocol (a)



Stress	Reference	Test conditions	Standard Products	FMD0H334ZF	FU0H105ZF
High Temperature Exposure(Storage)	MIL-STD-202 Method 108	at 85°C.	1,000h	1,000h	4,000h
Temperature Cycling	JESD22 Method JA-104	-40°C to 85°C, 30min maximum dwell time at each temperature extreme. 1 min. maximum transition time.	5 cycles	1,000cycles	1,000cycles
Biased Humidity	MIL-STD- 202 Method 103	85°C/85%RH with 5.5V.	N/A	1,000h	1,000h
Passive Humidity	JIS-C5160-1	85°C/85%RH. 0V	240 Hours	1,000h	1,000h
Operational Life	MIL-STD- 202 Method 108	At 85°C 5.5V.	1,000h	1,000h	4,000h
Physical Dimension	JESD22 Method JB-100	Verify physical dimensions to the applicable device detail specification. Note: User(s) and Suppliers spec. Electrical Test not required.	✓	✓	✓
Terminal Strength (Leaded)	MIL-STD-202 Method 211	Test leaded device lead integrity only. Conditions: A (454 g), C (227 g)	IEC-62391-1	✓	✓
Mechanical Shock	MIL-STD-202 Method 213	Figure 1 of Method 213. Condition C	IEC-62391-1	✓	✓
Vibration	MIL-STD-202 Method 204	5g's for 20 minutes 12 cycles each of 3 orientations. 10-2000 Hz.	IEC-62391-1	✓	✓

Automotive Grade: Testing Protocol (b)

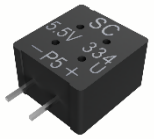


Stress	Reference	Test conditions	Standard Products	FMD0H334ZF	FU0H105ZF
Resistance to Soldering Heat	MIL-STD- 202 Method 210	Condition B no pre-heat of samples. Note: Single Wave Solder. Procedure 1 with solder within 1.5mm of device body for Leaded and 0.75mm for SMD. SMD – remove carrier. - Solder temp: 260±10 °C - Dipping time: 3sec. - 2.0mm from the bottom should be dipped.	IEC-62391-1	✓	✓
Solderability	J-STD 002D	Test A -Tin/Lead Solder – Solder Bath/Dip and Look Test - Solder temp: 235±5 °C - Dipping time:5±0.5sec. - Magnification 50 X - Minimum 95% of the terminal should be covered by the new solder.	✓	✓	✓
Electrical Characterization	User Spec.	Parametrically test per lot and sample size requirements, summary to show Min, Max, Mean and Standard deviation at room as well as Min and Max operating temperatures.		✓	✓
Surge Voltage	JIS-C-5101-1	6.3V, Charge:30sec, Discharge: 9.5min, 1000cycle, Series resistance:51Ohm, Temp:85°C		✓	✓

Automotive Grade: Testing Protocol (c)

Stress	Reference	Test conditions	FMU0H334ZF
High Temperature Exposure(Storage)	MIL-STD-202 Method 108	at 105°C.	1,000h
Temperature Cycling	JESD22 Method JA-104	-40°C to 105°C, 30min maximum dwell time at each temperature extreme. 1 min. maximum transition time.	1,000cycles
Biased Humidity	MIL-STD- 202 Method 103	85°C/85%RH with 5.5V.	1,000h
Passive Humidity	JIS-C5160-1	85°C/85%RH. 0V	1,000h
Operational Life	MIL-STD- 202 Method 108	at 105°C 5.5V.	1,000h
Physical Dimension	JESD22 Method JB-100	Verify physical dimensions to the applicable device detail specification. Note: User(s) and Suppliers spec. Electrical Test not required.	✓
Terminal Strength (Leaded)	MIL-STD-202 Method 211	Test leaded device lead integrity only. Conditions: A (454 g), C (227 g)	✓
Mechanical Shock	MIL-STD-202 Method 213	Figure 1 of Method 213. Condition C	✓
Vibration	MIL-STD-202 Method 204	5g's for 20 minutes 12 cycles each of 3 orientations. 10-2000 Hz.	✓

Automotive Grade: Testing Protocol (d)



Stress	Reference	Test conditions	FMU0H334ZF
Resistance to Soldering Heat	MIL-STD- 202 Method 210	Condition B no pre-heat of samples. Note: Single Wave Solder. Procedure 1 with solder within 1.5mm of device body for Leaded and 0.75mm for SMD. SMD – remove carrier. - Solder temp: 260±10 °C - Dipping time: 3sec. - 2.0mm from the bottom should be dipped.	✓
Solderability	J-STD 002D	Test A -Tin/Lead Solder – Solder Bath/Dip and Look Test - Solder temp: 235±5 °C - Dipping time:5±0.5sec. - Magnification 50 X - Minimum 95% of the terminal should be covered by the new solder.	✓
Electrical Characterization	User Spec.	Parametrically test per lot and sample size requirements, summary to show Min, Max, Mean and Standard deviation at room as well as Min and Max operating temperatures.	✓
Surge Voltage	JIS-C-5101-1	6.3V, Charge:30sec, Discharge: 9.5min, 1000cycle, Series resistance:51Ohm, Temp:85°C	✓

Why Not AEC-Q200?

AEC-Q200 Rev D – June 2010
(Supercapacitor technology not included)

In the last decade, AUTOMOTIVE usage requirements have been significantly increasing:

- ✓ Automotive Testing Protocol
- ✓ ISO/TS16949 Certified Plant
- ✓ PPAP/PSW and Change Control

Product Reliability evidence supports customer adoption

AEC-Q200 Category will be updated and communicated externally when AEC-Q200 Rev E is officially issued by the AEC Committee (forthcoming).

FAQs

Q: What are KEMET Supercapacitors – Automotive Grade?
A: It is an Electric Double-Layer Capacitor (EDLC) which is intended for power back up in automotive applications. Enhancements to the design and material upgrades were introduced to deliver 1,000 hours at 85ºC/85% RH rated voltage and compliance with automotive tests and requirements with an operational temperature range of -40ºC to 85ºC or 105°C. FMD and FU0H series can cover up to 85°C and FMU series up to 105°C.

Q: What are the benefits of a Supercapacitor?
A: It has a large capacitance compared to aluminum electrolytic capacitors and a lower energy capacity than a battery. Supercapacitors have rapid charge and discharge characteristics.

Q: What are some of the suitable applications where Supercapacitors can be used?
A: FMD/FU0H/FMU series Automotive Grade Supercapacitors are best suited for RTC back-up or low current (under mA), low voltage DC hold-up applications such as embedded microprocessor systems, e.g., ADAS, IVI, Autonomous Driving, Central Gateway, ECUs. Also, FMD/FU0H/FMU series Automotive Grade Supercapacitors are suitable for military, aircraft, medical, industrial machines, and infrastructure in addition to automotive applications.

Q: Are these Supercapacitors AEC-Q200 complaint?
A: Although the current revision of the Q200 document does *not* include Supercapacitors, these Supercapacitors are qualified to an automotive testing protocol. They are manufactured at an ISO TS 16949-certified plant and are subjected to PPAP/PSW and change control. For further details on testing protocols, please refer to the sales presentation for Supercapacitors, which can be found on the Sales Resource Page.

Q: Where are Supercapacitors manufactured?
A: Supercapacitors are manufactured in Thailand.

Q: Is there a roadmap of high-capacity products?
A: There is none at this time.

AVAILABILITY

Q: How can Supercapacitors be ordered?
A: Supercapacitors can be ordered through our regular distribution channels. As future rollouts occur, more parts will become available. For samples, request, contact YAGEO Group sales.

Q: Which competitor series can be cross referenced?
A: EOL products from Panasonic (EECLF0H105)

TECHNICAL

Q: What are the benefits of the FMD/FU0H/FMU Automotive Grade series Supercapacitors compared to industrial grade?
A: For automotive Supercapacitors, enhancements to the design and material upgrades have been introduced to deliver 1,000 hours at 85ºC /85% RH rated voltage with an operational temperature range of -40ºC to 85ºC or 105°C.. At 85ºC, the FMD series is qualified for up to 1,000 hours, and the FU0H series of up to 4,000 hours operational lifetime. FMU series is also up to 1,000 hours at 105¸C. These capacitors are manufactured at an IATF16949-certified plant and are subjected to PPAP/PSW, as well as change control.

Q: Which electrolyte is used in Supercapacitors?
A: It's an aqueous acid solution, which is a different material than that used by competitors. Competitors use an organic electrolyte. Using aqueous electrolyte in Supercapacitors increases their life expectancy. Aqueous solution contains water, which enables Supercapacitors to have higher tolerance for humidity.

Q: What is the failure mode of Supercapacitors?
A: Usually it is open mode, not short mode. Supercapacitors do not have the same ignition failures as batteries. Also, the risk of electrolyte leakage in Supercapacitors is much lower than that of organic Supercapacitors.

Q: What is the defined end of life of Supercapacitors?
A: It is defined by 30% decrease from the initial measured value of capacitance.

Q: Are Automotive Grade Supercapacitors FMD/FU0H/FMU series RoHS-compliant?
A: Yes. They are also lead-free.

FAQs

Q: Who are target customers and their end products?
A: Automotive (Bosch, Conti, ZF), Industrial (Siemens) and D&A (Thales)customers**.**

Q. What is the target end product (s) and the specific function(s) in each end product?
A: FMU Supercapacitor is intendent to power back up in harsh automotive applications. Electronic devices require a RTC (real time clock) to track the current time on the system, in the even of power loss: power outage, main battery replacement, or an error the system has a back up to keep running.

Q: What problem(s) does this product solve for customers?
A: Extended Mission Profiles and Higher Temperature requirements.

Q:Which competitors have similar products and solutions?
A: FMU is the 1st to market SC with 105ºC capability. We are protected by patent!

Q: What technology trend(s) does this product address?
A: Automotive ADAS - back up system for increased support electronics.