Panasonic INDUSTRY

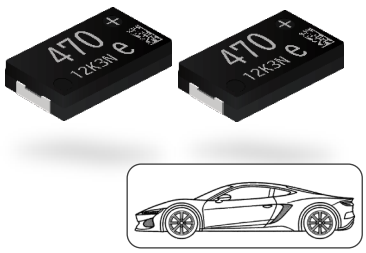
NEW

SP-Cap

Conductive Polymer Aluminum Electrolytic Capacitors

Surface Mount Type

AX series **[Automotive Grade (ex. ADAS, IVI)]**



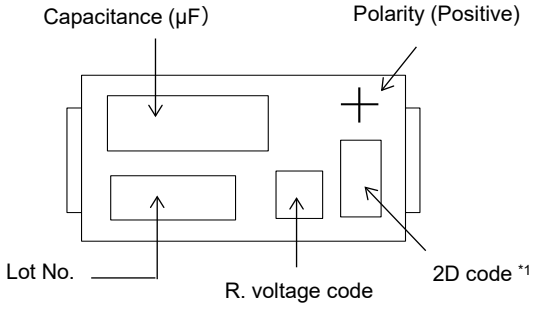
Features

- Compliant with AEC-Q200-Rev E
- Endurance 125 °C 2000 h
- Damp heat 85°C 85% 1000 h
- Low ESR (3 to 6 mΩ)
- RoHS compliance, Halogen free

Specifications

Series	AX	
Category temp. range	–55 °C to +125 °C	
Rated voltage range	2.5 V	
Category voltage range	2.0 V	
Rated cap. range	470 µF	
Capacitance tolerance	±20 % (120 Hz / +20 °C)	
DC leakage current	I ≤ 0.1 CV (µA) 2 minutes	
Dissipation factor (tan δ)	≤ 0.06 (120 Hz / + 20 °C)	
Surge voltage (V)	3.1 V (15 °C to 35 °C)	
Endurance	+125 °C 2000 h, category voltage applied	
	Capacitance change	Within -20 %, +10 % of the initial value
	Dissipation factor (tan δ)	≤ 2 times of the initial limit
	DC leakage current	≤ 2 times of the initial limit
Damp heat (Steady state)	+85 °C, 85 % RH, 1000 h, No-applied voltage	
	Capacitance change	Within -5 %, +35 % of the initial value
	Dissipation factor (tan δ)	≤ 2 times of the initial limit
	DC leakage current	≤ 5 times of the initial limit
Temperature cycling	Test Temperature: -55 °C to 125 °C, High and low temperature exposure times:15 min or more each Cycle: 1000 cycles	
	Capacitance change	Within -20 %, +10 % of the initial value
	Dissipation factor (tan δ)	≤ 2 times of the initial limit
	DC leakage current	Within the initial limit

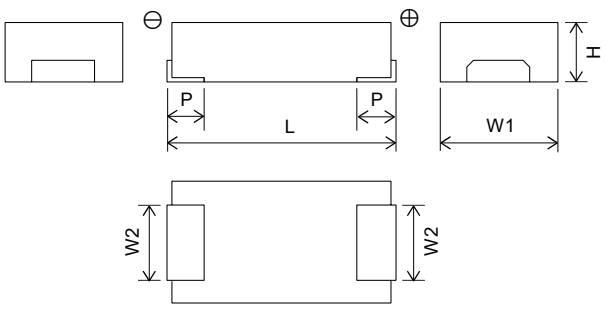
Marking



Rated voltage code	Unit : V
e	2.5

*1: Internal management information

Dimensions (not to scale)



Unit : mm

Series	L±0.2	W1±0.2	W2±0.1	H±0.1	P±0.3
AX	7.3	4.3	2.4	1.9	1.3

✻ Externals of figure are the reference.

Explanation of part numbers

◇ Part number system

e.g.: EEFAX0E471RD

EEF	
Series	Product classifi-cation
AX	EEF

AX	
Series	Code
AX	AX

0E	
Rated Voltage (V)	Code
2.5	0E

471	
Capacitance (µF)	Code
470	471

RD	
ESR (mΩ)	Special code
3	RB
4.5	RC
6	RD

Characteristics list

Series	Rated voltage [105 °C] (V)	Category voltage [125 °C] (V)	Capacitance (µF)	Case size (mm)			Specification		Part number	Min. Packaging Q'ty (pcs)
				L	W	H	Ripple current*1 (mA rms)	ESR*2 (mΩ max.)		
AX	2.5	2.0	470	7.3	4.3	1.9	8090	6	EEFAX0E471RD	3500
				7.3	4.3	1.9	9190	4.5	EEFAX0E471RC	3500
				7.3	4.3	1.9	11030	3	EEFAX0E471RB	3500

*1: Ripple current (100 kHz / +85 °C)

*2: ESR (100 kHz / +20 °C)

◆ Please refer to each page in this catarog for “Reflow conditions” and “Taping specifications”.

Temperature coefficient of ripple current

Temperature		T ⩽ 85 °C	85 °C < T ⩽ 105 °C	105 °C < T ⩽ 125 °C
2.5 V	Coefficient	1.0	0.7	0.25

◆ Ripple current should be controlled so that surface temperature of capacitor does not exceed the category temperature.

Matters to Be Observed When Using This Product
(Conductive Polymer Aluminum Electrolytic Capacitors / SP-Cap)

Intended use

Adoption of this product requires the execution of a delivery specification document (hereinafter referred to as the “Specification”).If this product is adopted without execution of the Specification, we will not supply the product.

■ Make sure to use SP-Cap only under the specified conditions in the specification document. If SP-Cap is used outside the specified conditions, Our company will assume no liability or compensation whatsoever.
Make sure to evaluate SP-Cap in a state mounted in your product under the worst conditions in the actual use.
If SP-Cap is used without sufficient evaluation and testing by your company, if SP-Cap is used, even for a moment, out of the standard values (e.g., maximum rated operating condition range) described in the specification document, or if SP-Cap is used against precautions described in the specification document, Our company will assume no liability for any resulting damage.

■ If any incident threatening human life, any smoke or fire incident, or any incident damaging other items is caused by a failure of SP-Cap or a defect of a device resulting from such failures, due to the use of SP-Cap without taking sufficient safety measures by your company, Our company will assume no liability.

■ Reproduction or duplication, in whole or in part, of the specification document is prohibited without the permission of our company.

■ If non-conformity with the specification document at the time of delivery is found in SP-Cap within 24 months from the date of manufacture (excluding non-conformity that can be found in the acceptance inspection), and Our company receives a notice specifically pointing out the non-conformity from your company, and also determines that the non-conformity is attributable to our company, Our company will deliver an alternative free of charge after discussion with your company.

■ Although your company incurs damages due to a failure of SP-Cap and it is apparent that Our company bears the responsibility in accordance with the content of the specification document and other agreements with your company, your company shall be able to charge us only within the total sales amount of SP-Cap of specified part number related to applicable damage to your company by our company, for 12 months before the occurrence of the damage.

■ Even if any damage is incurred in the following cases, Our company will assume no liability.

(a) Use of SP-Cap outside the specified conditions specified in the specification document
(b) Failure caused by a design defect of your product
(c) Due to a phenomenon unforeseeable by the technology being put into practice at the time of delivery of SP-Cap
(d) Damage that was avoidable if your device is equipped with a function, structure, or the like commonly used in the industry when SP-Cap is assembled in your device for use
(e) Due to natural disaster or force majeure

Compliant with AEC-Q200-Rev E

The SP-Cap (AX series) complies with AEC-Q200-Rev E.

Safety design and product evaluation

■ All possible measures are taken to maintain and improve the quality and reliability of SP-Cap. However, an accidental fault accompanying short circuit may occur, which is a major failure mode of SP-Cap. If SP-Cap is used outside the conditions guaranteed (temperature and time), an abrasion fault in the open mode may occur.
Please ensure safety by your product system design so that a failure of SP-Cap will not endanger human life or cause other serious damages.

(a) Provide a protection circuit and protection device to ensure safety design of the system.
(b) Provide a redundant circuit to ensure safety design of the system so that a single failure does not lead to any unsafe event.

■ The specification document shows the quality and performance of an individual component.
Before use, ensure to evaluate and confirm SP-Cap in the state of being mounted in your product and in the actual use environment.

■ Our company strives to improve the quality and reliability. However, the durability of SP-Cap varies depending on the use environment and use conditions. Therefore, please ensure to confirm that the temperature is within the category temperature range in the state that SP-Cap is mounted in your product and in the actual use environment.

■ If you have any doubts about the safety of SP-Cap, please notify us immediately, and be sure to conduct a technical review including a protection circuit and redundant circuit at your company.

Items to be observed

The SP-Cap AX series is developed for the purpose of in-vehicle devices. Note that short circuits and open failures peculiar to the conductive polymer aluminum electrolytic capacitor may occur. To gain the appropriate characteristics of SP-Cap in the most stable quality for use, make sure to comply with the following items.

1. Use environment
The SP-Cap AX series is intended for use in in-vehicle electronic devices.
Never use the set product in which SP-Cap is mounted in the following environments.

(1) In liquid, such as water, oil, chemicals, and organic solvents
(2) In a place exposed to direct sunlight, an outdoor place with no shielding, or a dusty place
(3) In a wet place (dew concentration on a resistor, water leakage, etc.), a place exposed to sea breeze or a corrosive gas such as Cl2, H2, S, NH3, SO2, or NOx
(4) In an environment where static electricity or electromagnetic wave is strong
(5) In an environment where the top surface temperature of SP-Cap exceeds the category temperatures range
(6) SP-Cap is sealed or coated with resin
(7) In an environment where an acidic or alkali atmosphere is present
(8) In an extreme environment where vibration or impact exceeds the specified range in the specification document
(9) In an environment where SP-Cap is exposed to ozone, UV-rays, or radioactive rays
(10) Product in a contaminated state
(Example)Do not handle the product such that the product after mounting a printed circuit board is directly touched and sebum is left on the product.

2. Circuit design
2-1. Confirming rated performance
Confirm the rated performance specified in the specification document before designing the circuit, and use.

2-2. Prohibited circuits
The use of SP-Cap in the following circuits is prohibited. If used, a failure is predicted.

(1) Time constant circuit
(2) Coupling circuit
(3) 2 or more in series connection
(4) Circuit significantly affected by leakage current
(5) High-impedance voltage retention circuit

2-3. Voltage and polarity
Applying overvoltage or reverse voltage specified below may cause an increased leakage current, a short circuit failure, fire, or smoke.
The applied voltage refers to a voltage value including a peak value of transient instantaneous voltage and a peak value of ripple voltage.
It does not only indicate a steady line voltage value. Design a circuit whose peak value does not exceed the specified voltage.

[Overvoltage]
Avoid applying the overvoltage exceeding the rated voltage. Use the product by regulating the operating voltage to keep it lower than or equal to the rated voltage, even for impulse voltage circuits, applications involving transient phenomena where a considerably high voltage is applied in a short time, and cases where high pulse voltages are applied.

[Reverse voltage]
SP-Cap has preset polarity. Do not apply a reverse voltage.

2-4. Ripple current

Use SP-Cap within the specified rated ripple current.
Excessive ripple current causes increased leakage current, a short circuit failure, fire, or smoke due to self-heating.

Even if the ripple current is within the rated range, prevent the ripple voltage from applying the overvoltage or reverse voltage.
Design your device in consideration of keeping the temperature within the category temperature range, such as the ambient temperature where the device is placed, its internal temperature, and the top surface temperature of SP-Cap, increased by heat transferred from the heating element (power transistor, resistor, etc.) inside the device.

2-5. Parallel connection

When SP-Cap is used in parallel connection with another capacitor, the ripple current of the rating or higher may flow into SP-Cap. This causes a short circuit failure, fire, or smoke.
When selecting the part number, pay full consideration to the ripple current.

2-6. Change of electrical characteristics

Electrical characteristics change by temperature and fluctuation of frequency. Confirm changes in the electrical characteristics under the use conditions when you design a circuit.

2-7. Failure mode

Our company is taking all possible measures to maintain and improve the quality and reliability of SP-Cap. However, an accidental fault accompanying short circuit may occur, which is a major failure mode of SP-Cap.

In addition, there is an abrasion fault in the open mode mainly caused by temperature.

2-8. Range of Use

Make sure to use SP-Cap within the operating temperature range specified the specification document. In addition, make sure to use SP-Cap within the vibration range (frequency and total amplitude) specified.

2-9. Safety design and precautions

(1) Fully implement the following measures to ensure safety.

(a) Fully consider the functional safety of the device, and make sure to provide protection circuits and redundant circuits to stop the device safely or minimize harm. Further, provide safety design and periodic maintenance.
(b) In the safety design, include a protection circuit that can shut off the current supply to SP-Cap when SP-Cap shows a short-circuit tendency.
(c) Design the protection circuit to operate before smoke is generated.
(d) In case smoke gets into your eyes or you inhale smoke, immediately wash your eyes with water or gargle.

(2) Abrasion fault

(a) When the guaranteed time of durability, high temperature and high humidity, or sudden temperature change is exceeded, the electrical characteristics will significantly change. In the ultimate, the electrolyte is insulated (deteriorated) and the open mode occurs.
(b) The electrical characteristics including capacitance and ESR may change within the specified range even within the ratings and under conditions that meet the electrical and mechanical performance.

2-10. Leakage current

The leakage current may increase even if the following use environment is within the category temperature range. However, although the leakage current increases, it will decrease in most cases by its self-recovery action when voltage is applied.

(1) After reflow soldering
(2) Shelf conditions such as high temperature with no load, high temperature high humidity with no load and sudden temperature changes.

2-11. Operating temperature

Use SP-Cap within the category temperature range.
The use of SP-Cap at a temperature exceeding the category temperature range causes a failure due to a significant change in the electrical characteristics or deterioration.
The operating temperature for SP-Cap includes not only the ambient temperature where the device is placed and its internal temperature,but also the radiant heat from heating elements (power transistors, resistors, etc.) inside the device, and self-heating due to ripple current.

2-12. Failure rate

Most of the failure modes are "short circuit" or "increased leakage current."
The main causes of failures are thermal stress, electrical stress, and mechanical stress due to reflow and operating temperature environment.
Even within the category range, the failure rate can be reduced by mitigating the operating conditions such as the temperature and voltage.Therefore, please design your device with a sufficient margin.

The failure rate level is shown below.

0.5% / 1000 h (Ambient temperature: 105°C, rated voltage)
Confidence level: 60%

2-13. Design for mounting position

Insulate the circuit board surface directly under the mounting area of SP-Cap.

2-14. Expected Lifetime Formula (Reference)

(1) Expected life is affected by operating temperature. Generally, each 10 °C reduction in temperature will double the expected life. Use capacitors at the lowest possible temperature below the upper category temperature.

(2) If operating temperatures exceed the upper category limit, rapid deterioration of electrical parameter will occur and irreversible damage will result.
Measure not only the ambient temperature but also the surface temperature of the capacitor’s case top, which has effects of ripple current and radiated heat from power transistors, IC's, and/or resistors.
Avoid placing components, which could conduct heat to the capacitor from the back side of the circuit board.

(3) The formula for calculating expected life is as follows
Expected life formula is subject to change without prior notice to your company.

$L_2 = L1 \times 2^{((To-Tx)/10)}$

L_2 : Life expectance in actual use (temperature Tx) (h)
L_1 : Guaranteed life at maximum temperature in use (h)
To : Maximum operating temperature (°C)
Tx : Temperature in actual use (SP-Cap top surface temperature) (°C)

- The minimum temperature of Tx applied to this calculation formula is 45°C.
- The expected lifetime is limited up to 15 years.

[Caution]
The expected lifetime and the above formulas are for reference only and do not guarantee the market life of the product. Tx is the average temperature at the top of the product. It is NOT the maximum temperature. Expected lifetime depends on temperature acceleration and may vary depending on the operating environment temperature, Therefore,please use the expected life as a reference value.
Ripple current should not exceed the specifications.Prior to mass production,
please check, evaluate, and verify compatibility with products already incorporated in the system.

(4) Using the capacitor beyond the expected lifetime will result in short circuit, open, and large deterioration of characteristics.

3. Storage and Mounting

3-1. Storage

SP-Cap should be stored in the moisture barrier bag. Storage conditions before and after opening the moisture barrier bag as follows. (If these conditions are exceeded, the package may absorb moisture and there is a risk of damage to the exterior due to heat stress during mounting, so affect reliability.)
Do not touch the SP-Cap with the bare hands.

[Environment of Storage]
Temperature: 5°C to 30°C without direct sunlight
Humidity: Less than 60%
Maximum storage term before opening the moisture barrier bag. (2 years after manufactured)
Maximum storage condition after opening the moisture barrier bag. (7 days after opening)
SP-Cap should be all used within the storage term after opening the moisture barrier bag.

3-2. When mounting

(1) Check the SP-Cap ratings (capacitance and voltage) before mounting.
(2) Check the SP-Cap polarity before mounting.
(3) Check the land size for the SP-Cap before mounting.
(4) When using a mounter, if the pressure for mounting is too high, then the current leak may increase, short-circuiting may occur, or the SP-Cap may break down or come off.
(5) Do not apply pressure stress (board division etc.) to the SP-Cap.
(6) Do not disassemble or modify the SP-Cap.

3-3. Soldering

(1) Reflow soldering
Be performed by one of following methods.
(a) Ambient heat conduction reflow (IR / Hot-air)
Please refer to the page of "Reflow Soldering Recommended Conditions".
(b)Vapor phase reflow
Please contact Panasonic for details of allowable vapor phase reflow condition.

(2) Wave soldering and dip soldering
Please remind SP-Cap is NOT compatible.

(3) Hand soldering
Excessive force stress to the SP-Cap should be avoided
Conditions: Tip temperature of soldering iron : 350°C max.
Exposure time: 10 s max.
*Once removed from the printed circuit board for any reason, please do not use the SP-Cap again.

(4) Do not drop the SP-Cap on the floor.
If the SP-Cap is dropped, it can be damaged mechanically or electrically. Avoid using the dropped the SP-Cap.

(5) Use flux that is less corrosive, more fluid than solder, and has a melting point lower than that of solder. When using highly active halogen-based (chlorine-based, bromine-based, etc.) flux, please be aware that residual flux may affect performance and reliability.

3-4. Mechanical stress

Do not apply excessive force to the SP-Cap this can damage the electrodes and badly affect the SP-Cap mount ability. It can also cause the increase of leakage current and affect reliability, separation of the lead wire and element, and damage to the SP-Cap body, all of which can badly affect the electrical performance of the SP-Cap.

3-5. Circuit board cleaning

SP-Cap should be cleaned after soldering in accordance with the following conditions.

Temperature: Less than 60°C

Time: Within 5min

Be sure to sufficiently wash and dry (20min at 100°C) the board afterward.

Temperature: Less than 60°C

Time: Within 5min

Be sure to sufficiently wash and dry (20min at 100°C) the board afterward.

[Recommended Cleaning Solvents]

Pine Alpha ST-100S, Clean-thru 750H / 750L / 710M, Aqua Cleaner 210SEP, Sunelec B-12
DK Beclear CW-5790, Techno Cleaner 219, Cold Cleaner P3-375, Telpene Cleaner EC-7R
Technocare FRW-17 / FRW-1 / FRV-1, AXREL 32, IPA (Isopropyl alcohol)

(1) Consult our factory when performing processes with cleaning solvents other than those listed above or deionized water.
(2) The use of ozone depleting cleaning agents are not recommended in the interest of protecting the environment.
(3) In the case of using ultrasonic cleaning, the terminals may be broken. Therefore, please test before using in mass production.

4. Transportation

Take sufficient care during handling because excessive vibration, or shock can cause the reliability of the SP-Cap to decrease.

5. Emergency procedures

If the SP-Cap is overheated, the resin case may emit smoke. If this occurs, immediately switch off the unit's main power supply to stop operation. Keep your face and hands away from the SP-Cap the temperature may be high enough to cause the SP-Cap to ignite and burn.

6. Discarding

Since SP-Cap are composed of various metals and resins, treat them as industrial waste when arranging for their disposal. Do not throw the SP-Cap into the fire or heat it.

Important safety precautions

The precautions for the use of conductive polymer aluminum electrolytic capacitors follow the “Precautionary guidelines for the use of fixed aluminum electrolytic capacitors for electronic equipment”, RCR- 2367D issued by EIAJ in March 2019. Please refer to the above guidelines for details.