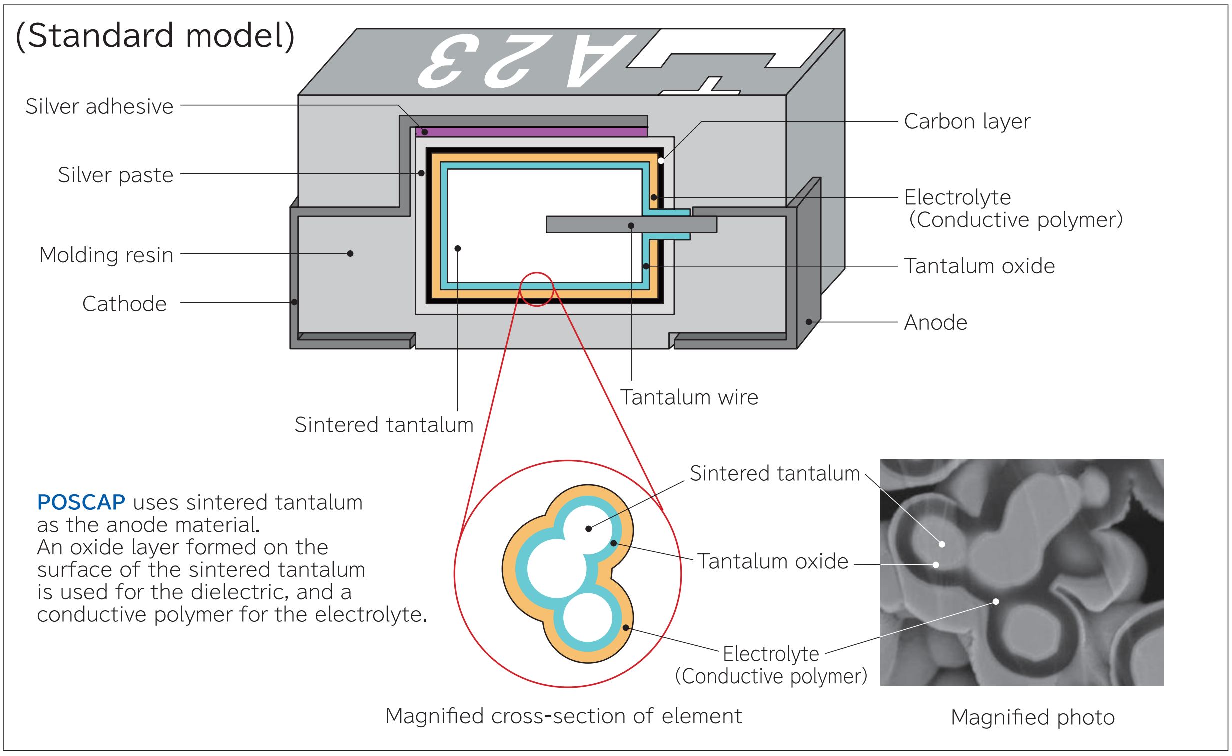
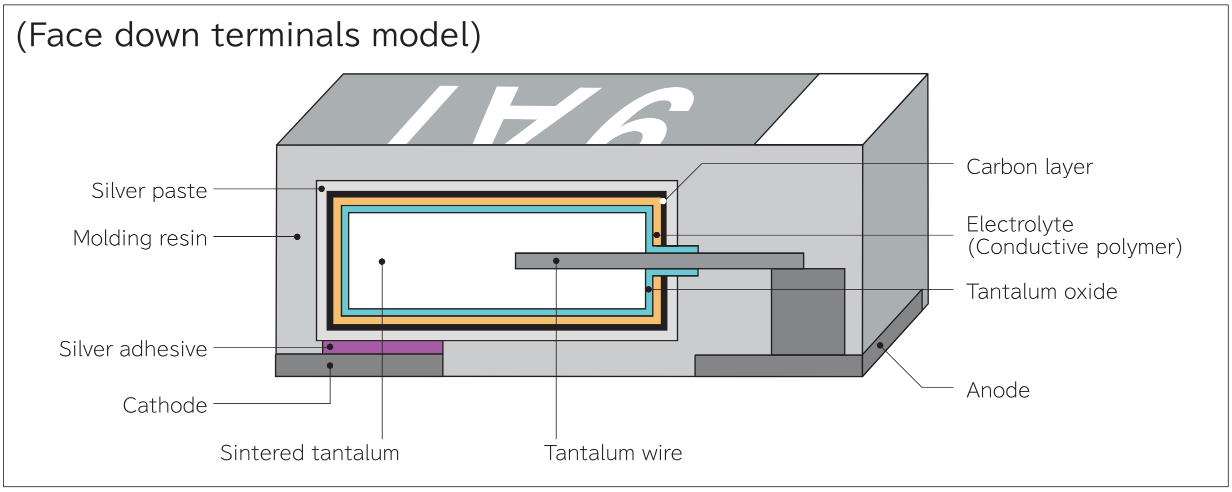
1. Basic structure of POSCAP

The electrolytes make the difference in structure between the POSCAP and the standard tantalum capacitor.

Capacitor	Electrolyte
Tantalum capacitor	Manganese dioxide
POSCAP	Conductive polymer





- The sintered tantalum has a porous structure, it makes a large surface area, which enables to have large capacitance.
- The conductive polymer used for the electrolyte is high in electric conductivity and enables the low ESR.

1. POSCAP Electrical characteristics

1-1. Frequency characteristics

Fig.A Impedance frequency characteristics (POSCAP vs other type)

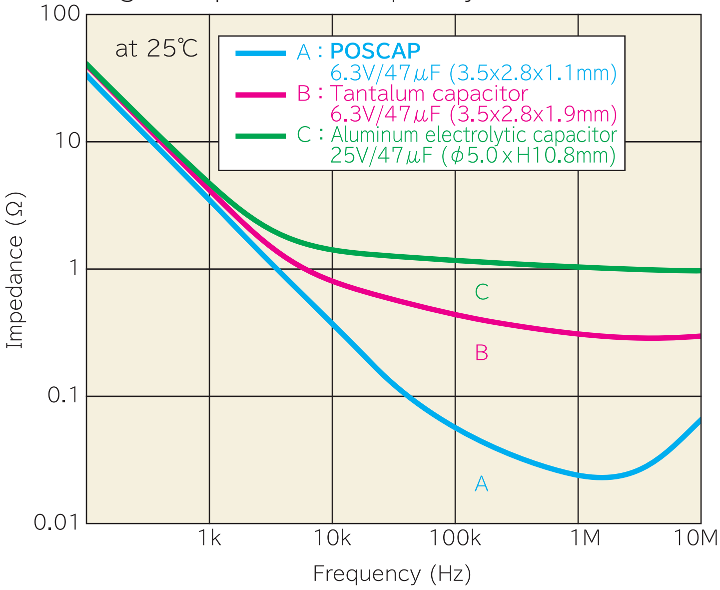
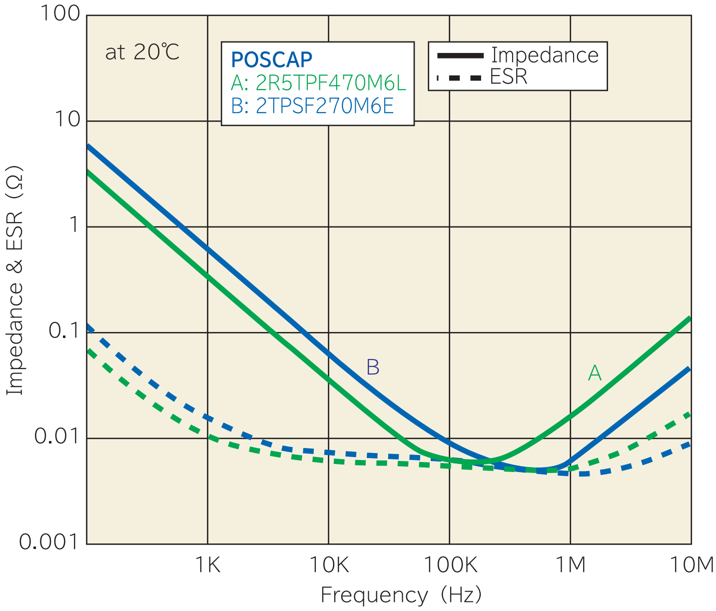


Fig.B Impedance & ESR frequency characteristics (Several POSCAP models)



The greatest characteristic of **POSCAP** is the excellent frequency characteristics.
Using a high conductive polymer for the electrolyte greatly improves the ESR characteristics and enables the **POSCAP** to perform at the higher frequency levels.

Fig. A: Compares the **POSCAP** to an aluminum electrolytic and a tantalum capacitor.
The **POSCAP**'s impedance is remarkably lower than the other capacitors at the periphery of the resonance frequency.

Fig. B: Compares the impedance and ESR frequency characteristics of three different **POSCAP** series.
The TPSF series has a low ESL characteristic which brings it to high resonance frequency, it makes impedance be much lower in the range of high - frequency wave.

1-2. Characteristics at high and low temperature

Fig.A ESR temperature characteristics
(**POSCAP** vs Ceramic capacitor)

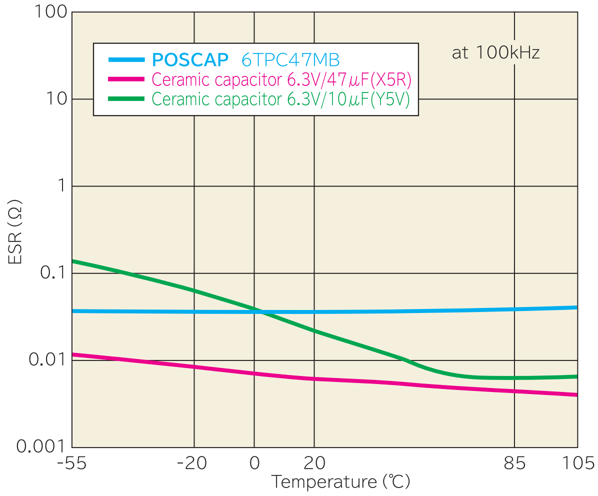
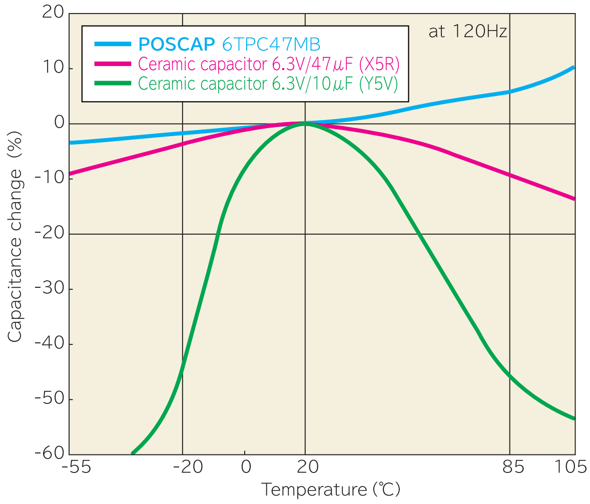


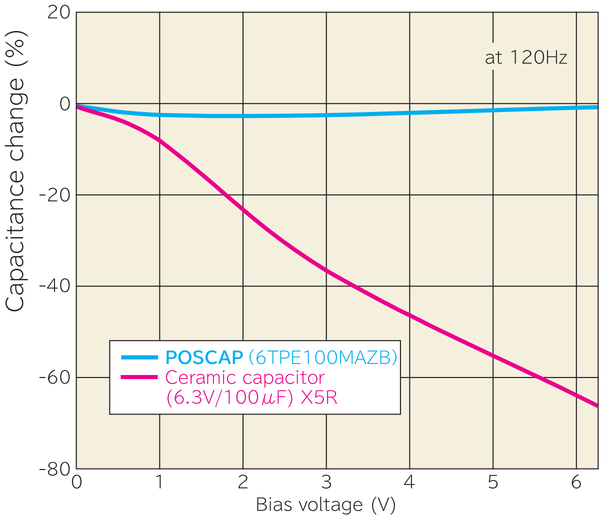
Fig.B Capacitance temperature characteristics
(**POSCAP** vs Ceramic capacitor)



The **POSCAP** has a characteristics of low and high temperature, which is little change against temperature for the ESR.
The stability of ESR's temperature characteristics means the noise-clearing ability is little change against temperature.
The **POSCAP** is suitable for outdoor equipment which requires the temperature characteristic flexibility.

1-3. Bias characteristics

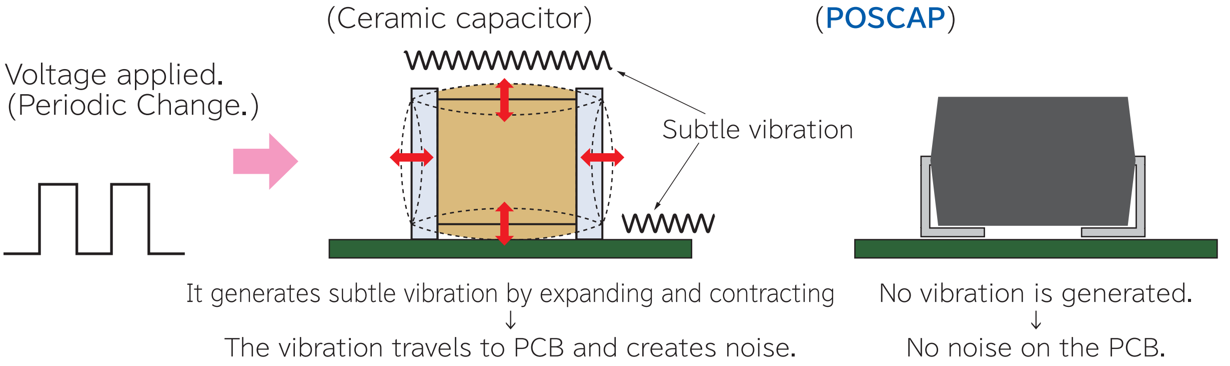
Comparison of bias characteristics
(**POSCAP** vs Ceramic capacitor)



The ceramic capacitor has bias characteristics, which makes the capacitance decrease when voltage is applied to it. However, **POSCAP**s will show no reduction in capacitance for applied voltage, as long as the applied voltage is within its rating. Therefore, you will be able to design without worrying about capacitance changing when voltage is applied.

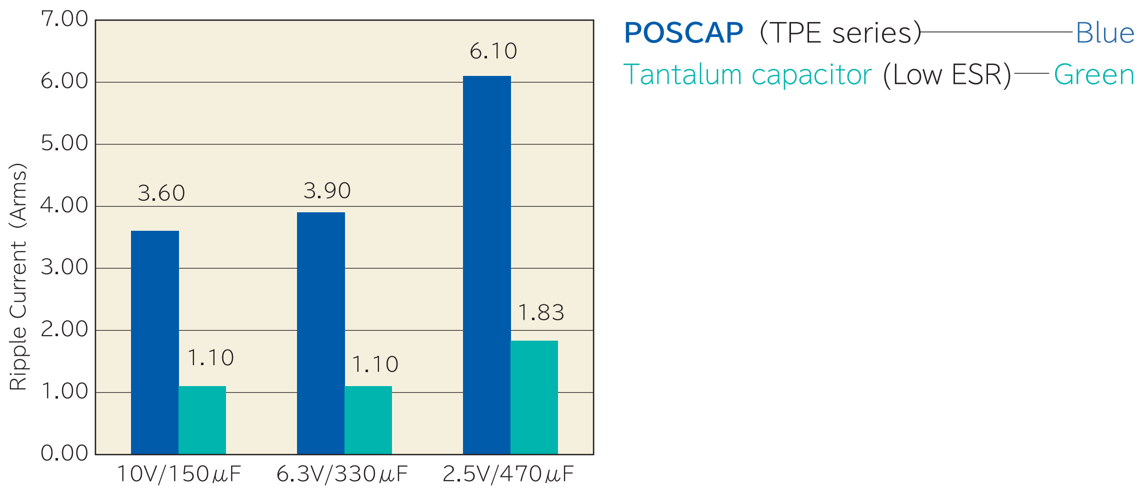
1-4. Piezoelectric effect of the capacitor

When variable voltage is applied to ceramic capacitors that uses dielectrics with piezoelectric characteristics (e.g. barium titanate), the voltage will cause vibration due to the elasticity in the dielectric.
If the cyclic change is within the audio-frequency (20Hz to 20kHz), the vibration from the capacitor travels to the PCB and it could generate noise inside the equipment.
This may be an unwanted effect depending on the product you are developing. Our **POSCAP**'s dielectric layer is composed of tantalum oxide which does not have piezoelectric characteristics. Silence is thus assured by use of our product.



1-5. Allowable ripple current

Comparison of allowable ripple current
(**POSCAP** vs Tantalum capacitor)

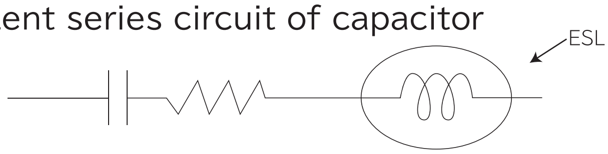


The allowable ripple current of a capacitor is an important characterisitc when selecting a smoothing capacitor for a power supply.
The allowable value of ripple current is decided by the generated heat of the capacitor.
This generated heat is relevant to the ESR value.
Since a large ESR capacitor generates a larger value of heat, it inhibits the ripple current value.
Because the ESR of the **POSCAP** is so small, it can reach a high ripple current rating compared to other electrolytic capacitors.

1-6. ESL characteristics

POSCAP is a high performing capacitor with low ESR and large capacitance.
In recent circuit technologies for electronic equipment, the ESL value is important when considering performance in the high frequency range.

(a) Eqivalent series circuit of capacitor



(b) Approximate ESL value of POSCAP

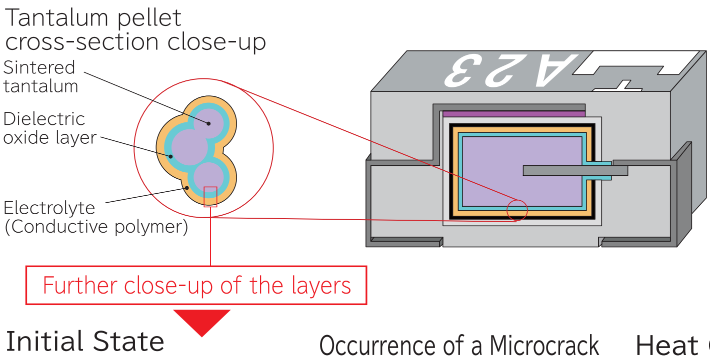
(unit: nH)

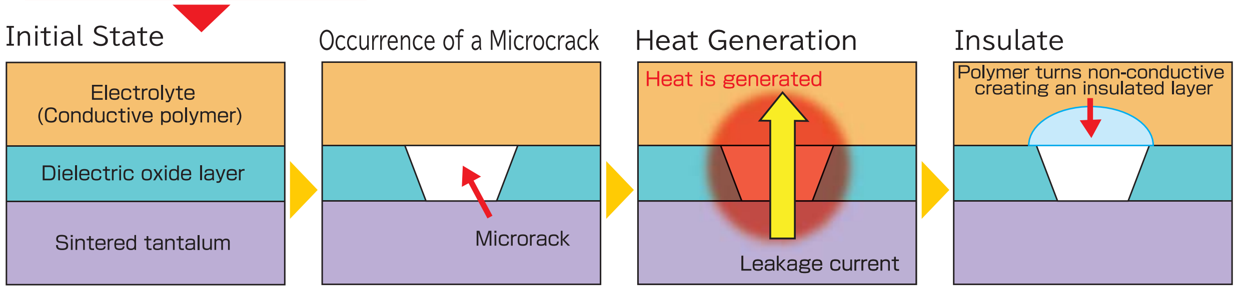
Size Code	at 10 MHz	Size Code	at 10 MHz
S09	0.8	D12	1.8
A09	1.2	D15E	2.0
A14	1.1	D15	1.8
B1	1.2	D2E	1.8
B1S	0.7	D2E (TPF)	1.5
B1G	1.1	D2	2.0
B15	1.3	D3L	2.3
B15G	1.4	D3L (TPF)	2.0
B2	1.3	D4	2.6
B2S	0.7	D4 (TPF)	2.5

※Measuring method and position
：Based on JEITA RC-2002
※All values on the left figure are not guaranteed but reference.
Please contact SANYO for details of measurement.

1-7. Self-Healing Mechanism

Conductive polymer is used as an electrolyte in our **POSCAP**s. As an organic material, conductive polymer becomes non-conductive and acts as an insulator against leakage current at a relatively low temperature of approximately 300℃.
As seen in the explanation below, this characteristic is used to suppress leakage current when there is microcrack in the dielectric oxide layer. We call this capability "self-healing mechanism." In addition to this characteristic, this conductive polymer has enough heat resistance to endure reflow soldering process and it is able to retain high specific electric conductivity even after going through such process.





The image above represents a close-up of the cross-section of the layers within the core of a **POSCAP**, which consists of sintered tantalum, dielectric oxide layer and an electrolyte (conductive polymer).

In rare cases, a microcrack could occur on the dielectric oxide layer by stress caused by rapid temperature change during the reflow soldering process or when excessive voltage is applied to the capacitor.

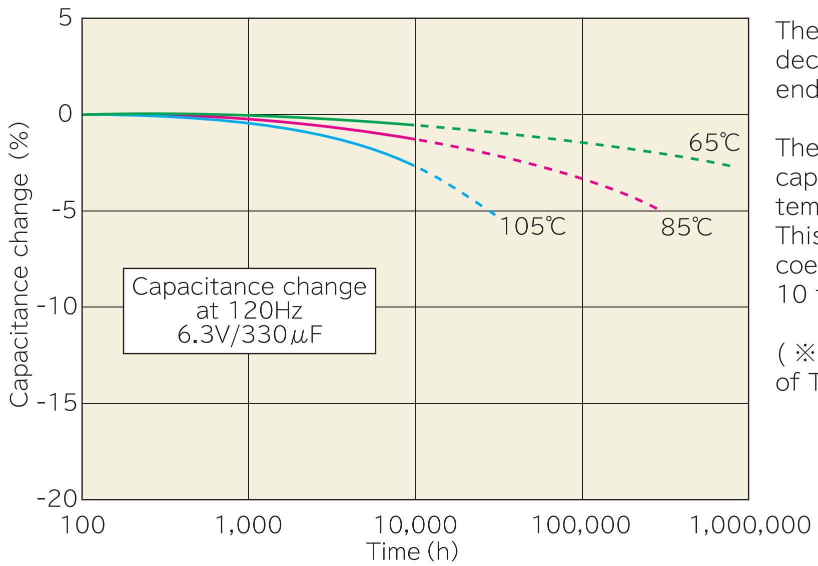
Joule heat is generated locally when leakage current flows into the microcrack as voltage is applied.

Conductive polymer around the microcrack turns non-conductive and creates an insulated layer at a relatively-low temperature of approximately 300℃ caused by Joule heat. It is at this point that the insulator suppresses the leakage current. This is called "self-healing mechanism" or "self-recovery function."

With this "self-healing mechanism" **POSCAP** is able to minimize stress induced failures and achieve high reliability.

Reliability

1. Temperature acceleration test (Endurance)



The **POSCAP** capacitance level decreases during a long term endurance test.

The left figure shows time variation of capacitance decrease at each temperature.
This graph indicates that temperature coefficient of **POSCAP**'s life time is 10 times by 20℃ reduction.※

(※ Please contact SANYO for details of TPU and TQC series.)

POSCAP	Aluminum electrolytic capacitor
105℃ ⇒ 2,000h 85℃ ⇒ 20,000h 65℃ ⇒ 200,000h	105℃ ⇒ 2,000h 85℃ ⇒ 8,000h 65℃ ⇒ 32,000h

※The following life time are not guaranteed but presumptive values.

Even if **POSCAP** and an aluminum electrolytic capacitor are guaranteed on 2,000 hours at 105℃, the life span results in big differences as temperature drops. (See left chart) POSCAP has a remarkably longer life span compared with an aluminum electrolytic capacitor.

2. Presumption of life for the POSCAP

As time increases during the endurance test, the capacitance of the **POSCAP** gets smaller. This means the eventual failure mode of **POSCAP** is open. The **POSCAP**'s cathode material is made of an organic matter (conductive polymer).
The life time is different by each operating temperature and self - heating by ripple current.
The following formula outline could make it possible to estimate the presumptive lifetime of **POSCAP** at ambient temperature Tx (℃).
The result of the following calculating formula estimation is not guaranteed but presumptive value based on actual measurement.
(Please contact SANYO as to TQC series)

2-1. Calculating formula for the presumtion of life

$$Lx = Lo \times 10^{\frac{To - Tx}{20}}$$

Lx : Life expectance in actual use (temperature Tx) (h)
Lo : Guaranteed life at maximum temperature in use (h)
To : Maximum operating temperature (℃)
Tx : Temperature in actual use (temperature of **POSCAP**) (℃)