

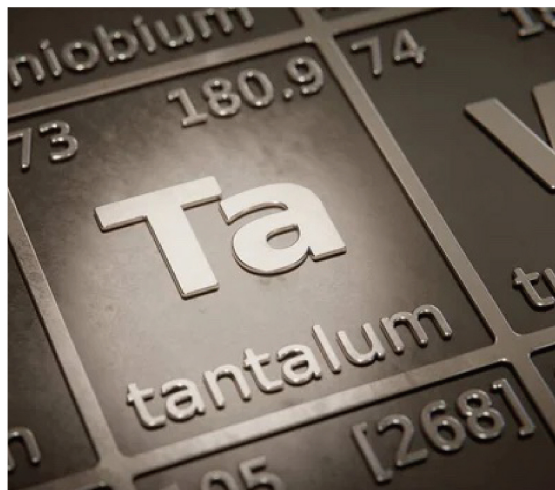
Tantalum vs aluminum capacitors: which one is right for you?

WHAT IS AN ELECTROLYTIC CAPACITOR?

An electrolytic capacitor is a polarized capacitor with an oxide layer deposited over an anode or a positive metal plate to provide capacitance. In flash memory manufacturing, electrolytic capacitors are deployed to store and release electric charges to provide emergency power supplies in the event of a sudden power failure.

A capacitor's dielectric material can be solid or non-solid. High-end motherboards tend to favor solid capacitors made from aluminum, tantalum, or polymer, as the absence of liquid can mitigate the risks of leakage or even explosion caused by electrolytes expanding due to overheating.

At Exascend, we leverage both aluminum and tantalum electrolytic capacitors for their unique advantages.



ADVANTAGES OF TANTALUM ELECTROLYTIC CAPACITORS

● Smaller size for high capacitance

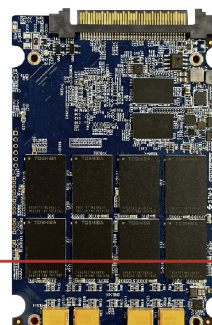
Because tantalum capacitors have very thin dielectric layers, they offer higher capacitance values per unit volume. This gives tantalum capacitors a case size advantage over other capacitor types and makes them a good match for weight-sensitive applications.

● Withstands higher temperatures

A standard tantalum capacitor has a rated operating temperature range of -55–125°C, which covers most use cases across the industrial, enterprise, automotive, commercial and consumer electronics sectors. Due to their wide operating temperature range, tantalum capacitors are best utilized in rugged applications such as those which require industrial-grade SSDs.

● Excellent reliability

A tantalum capacitor's capacitance rises with temperature. The capacitance also increases as the power supply load gets heavier. With this property, they are an ideal choice for energy storage and switched-mode power supplies with variable loads – offering long service life and high reliability.



Tantalum capacitors

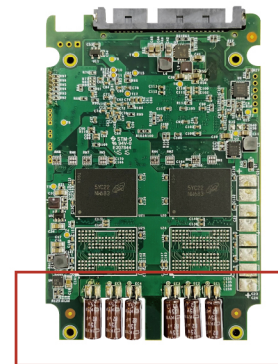
ADVANTAGES OF ALUMINUM ELECTROLYTIC CAPACITORS

- **Large capacitance at an attractive price**

While aluminum capacitors do not have tantalum capacitors' capacitance-to-size edge, they are compact and can offer a large amount of capacitance at a competitive price.

- **Great reliability under normal use**

The life of aluminum electrolytic capacitors is very dependent on environmental and electrical factors. Environmental factors include temperature, humidity, atmospheric pressure, and vibration. Electrical factors include operating voltage, ripple current, and charge-discharge duty cycle. Among these factors, temperature (ambient temperature and internal heating due to ripple current) is the most critical to the life of aluminum electrolytic capacitors.



Aluminum capacitors

Exascend used the following formula to estimate capacitor life

$$Lx = Lo \times 2^{\frac{To - Tx}{10}} \times 2 \left[1 - \frac{Ix^2}{Is^2} \right]$$

Lx: The actual presumption life (unit: hours)

Lo: The assurance of life under the condition of the highest temperature and allowable Ripple electricity (unit: hours)

To: The highest temperature that the capacitor can work on (unit: degree)

Tx: The environment temperature that the capacitor actually works under (unit: degree)

Ix: The actual Ripple electricity

Is: The allowable Ripple electricity

The aluminum capacitors used by Exascend are specified at 5000h@105°C. Because the capacitor is fully charged upon SSD power on, and once it is charged, it does not continuously go through charge and discharge cycles, thus the actual ripple current is very small after the capacitor charges completely, resulting in the value of Ix/Is to be very small.

When the drive operates under 85°C, we expect the actual life of the capacitor to be close to $5000 \times 22 \times 2 = 40000h = 4.6$ years. If working under 25°C, the MTBF of the drive will be close to $5000 \times 28 \times 2 = 2,560,000$ hours.

EXASCEND'S USE OF TANTALUM & ALUMINUM CAPACITORS

Exascend SSDs that feature **Wide Temperature (-40–85°C)** and **Extended Temperature (-20–85°C)** operating ranges can be customized to accommodate a tantalum capacitor, offering an extra line of defense against unexpected power losses.

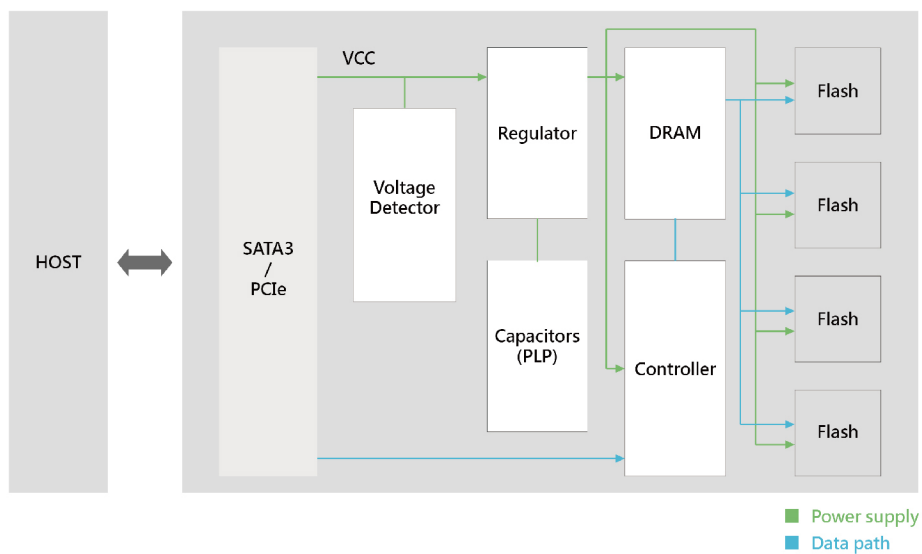
For SSDs that operate between 0–70°C, we recommend aluminum capacitors for their cost-effectiveness and reliability in applications without frequent charge and discharge cycles. Many of Exascend's enterprise SSDs are equipped with aluminum capacitors by default, including the **SE3 2.5"** SSDs and **PE3/PE4 U.2** and **E1.S** SSDs. Customization options are available upon request. Please contact us with any inquiries.

Technology: Dual Power Loss Protection (Dual PLP)

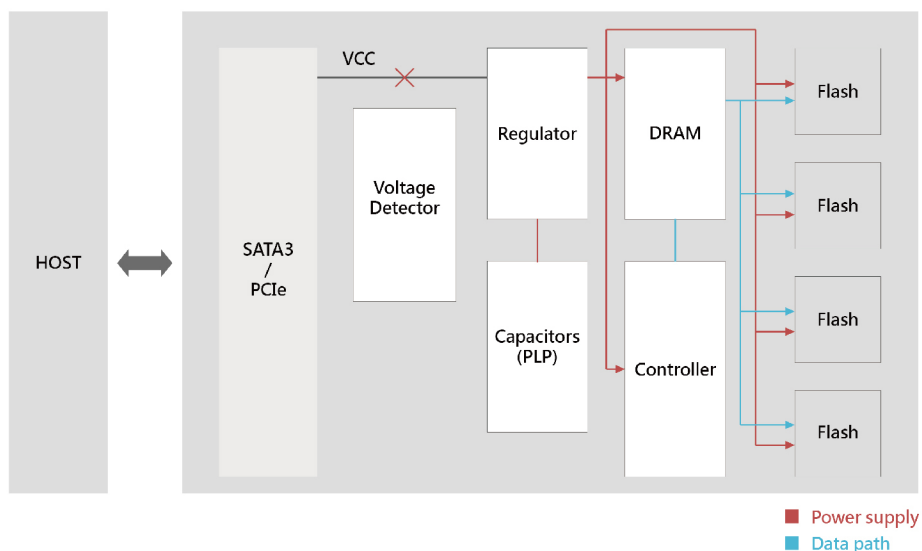


In the event of sudden loss of power, our hardware and firmware power loss protection provide two invaluable extra lines of defense against data integrity issues, guaranteeing that all in-flight data is safely stored before controlled storage device shutdown.

SSD during a standard power shutdown:



SSD with Hardware PLP during in an unexpected power shutdown:



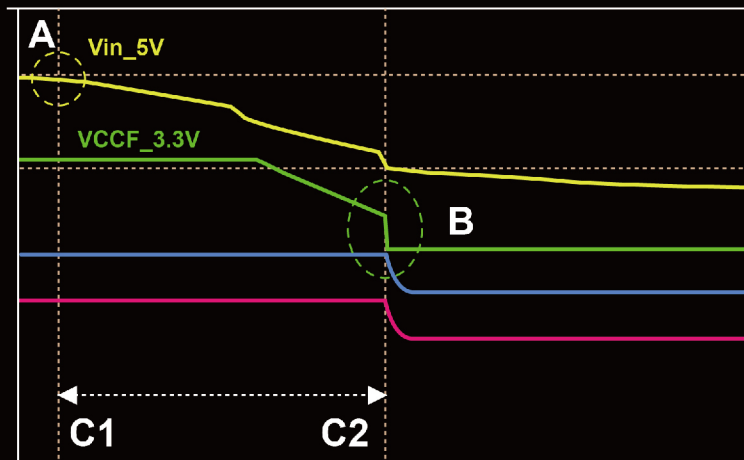
Technology: Dual Power Loss Protection (Dual PLP)



In the event of sudden loss of power, our hardware and firmware power loss protection provide two invaluable extra lines of defense against data integrity issues, guaranteeing that all in-flight data is safely stored before controlled storage device shutdown.

Power Loss Protection (PLP) at work:

— Power Supply — Reset in SSD — Flash mode
— Power in SSD gain from Capacitors



- A point, detect outside voltage drop (Threshold voltage = 4V)
- B point, release all power to prevent system power cycling issue. And, flash will go to Write Protect in 2.3V.
- Between C1 and C2, keep power to finish flush DRAM data into flash.