Solid Aluminum Capacitors with Organic Semiconductor Electrolyte

INTRODUCTION

Vishay OS-CON capacitors are electrolytic capacitors. Up to now, an electrolytic solution and manganese dioxide have been used as the electrolyte in electrolytic capacitors. In development of a new highly efficient electrolytic capacitor which has a high conductivity (organic semi-conductor) when compared to earlier electrolytes, we have successfully worked out the Vishay OS-CON electrolytic capacitors with low impedance, using an organic semiconductor for the electrolyte.

FEATURES

- Vishay OS-CON capacitors are low ESR capacitors. Impedance frequency characteristics are plotted in a highly desirable curve. (Best suited to use as de-coupling capacitors for removing such noise as ripple, spike, digital, static and audio.)
  Able to flow large ripple current. (Best suited for miniaturization, used as smoothing capacitor of switching power supply.)
  Able to discharge rapidly. (Best suited for use as back- up capacitor in a circuit where large current is consumed at high-speed.)
- Equivalent Series Resistance (ESR) is not dependent on temperature. (Best suited for devices that have low temperature specifications of 0° Centigrade or less.).
- Vishay OS-CON capacitors have long life. You can expect to use the capacitors for 50 000 hours at + 85 °C (Type 94SH). (Best suited for industrial devices that shall be used for a long period.)
- Vishay OS-CON capacitors have polarity but that is strong against reverse voltage. (Best suited for a circuit that needs capacitance and where electric potentia slightly oscillates with reverse voltage.)
- Vishay OS-CON capacitors costs "Price x ESR (Ω)". They are inexpensive. (Pricewise advantageous for capacitors of 10 µF or more.)

APPLICATION NOTES

The Vishay OS-CON capacitor is a uniquely structured solid aluminum electrolytic capacitor. Please note the following points in order to take full advantage of the capacitors performance and ensure the most stable quality possible.

Polarity:
Vishay OS-CON capacitors are solid aluminum electrolytic capacitors with positive and negative electrodes. Do not reverse the polarity when using. If it is used with the polarities reversed, increased leakage current or a decreased life span may result.

Prohibited Circuits:
Since problems can be expected due to the leakage current fluctuations that occur during soldering and other processes, the capacitors cannot be used on the following circuits.

1. High impedance voltage retention circuits.
2. Coupling circuits.
3. In addition to the leakage current fluctuation above, the operational conditions such as characteristics of temperature, anti-humidity and high temperature loads stipulated in the delivery specifications will affect the electrostatic capacity. This electrostatic capacity fluctuation may cause problems if it is used as a time constant capacitor, which is extremely sensitive to the fluctuation of electrostatic capacity. Do not use it as a time constant capacitor.
4. Circuits greatly affected by leakage current.
5. The circuit in which two or more capacitors are connected in series so as to raise the endurance voltage of them.

Overvoltage Prohibited During Design:
Overvoltage exceeding the rated voltage may not be applied even for an instant as it may cause a short circuit.

Sudden Charge and Discharge Restricted:
Sudden charge and discharge restricted (for maintenance of high-proof reliability). A protection circuit is recommended when a sudden charge or discharge causes excessive rush current because this is a main cause of short circuits and large leakage current. Use protection circuits when the rush current value is ten times larger than the allowable ripple current value and for circuits whose rush current value exceeds 10 A. (Refer to pages 43 - 45.) Be sure to insert a protection resistor of about 1 kilohm for charge and discharge when measuring the leakage current.

Considerations When Soldering:
The soldering conditions are to be within the range prescribed in the delivery specification. If the specifications are not followed, there is the possibility of the appearance becoming defective and of increase of abnormal leakage current and capacity reduction when soldering is conducted under conditions that are harsher than those stipulated.

Sufficient PC Board Installation Space:
The design must give consideration to the standard of lead position displacement given in the delivery specification. The capacitors may not be able to be inserted in the PC board if there is insufficient space.

Considerations When Using in Industrial Equipment:
To insure reliability when the capacitor is used in industrial equipment, design must allow for its capacitance, impedance and other characteristics.

Using in Equipment Regarding Human Life:
If using in equipment regarding human life (e.g. space, aeronautic and atomic equipment, etc.), contact the factory for more information. Do not use without recognition document of Vishay OS-CON.

Circuit Designing Cautions:

1.Rated Performance

Check the rated performance. After checking the operation and installation environments, design the circuit so that it falls within the rated performance range stipulated in the catalog or delivery specification. The peak current value of the diode when absorbing counter electromotive force.

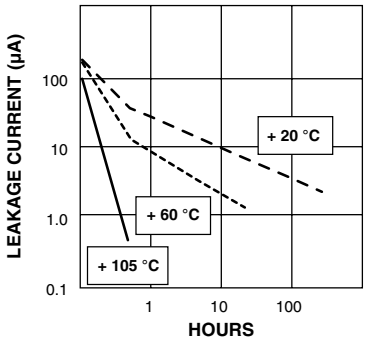
2.Operating temperature and ripple current.

a.Set the operating temperature so that it falls within the range stipulated in the catalog or delivery specification.

b.Do not supply current that exceeds the allowable ripple current. When excessive ripple current is supplied, internal heat increases and reduces the capacitor's life span.

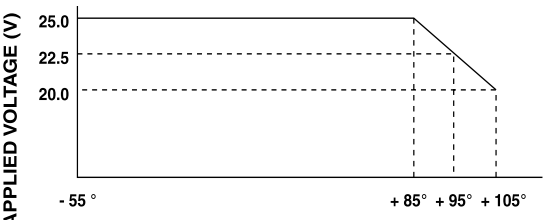
3.Leakage Current.
Even when the soldering conditions fall within the range of the delivery specification, leakage current increases a little on occasion. It also increases a little during high temperature no-load, moisture-proof no-load and temperature cycling tests with no voltage applied. In cases such as these, leakage current will decrease by applying voltage that falls below the capacitor's maximum operating temperature. The speed at which the leakage current is restored is increased by applying a high voltage under voltage rating when the capacitor's temperature is close to the maximum operating temperature. Refer to the following diagram.

LEAKAGE CURRENT
RESTORATION CHARACTERISTICS
10 µF/16 WV (16V DC Applied)



4.Applied voltage for designing.

a.Less than 80 % of the rated voltage is recommended to be applied to more than 10 WV products. Less than 90% is recommended for 6.3 WV products. For 4 WV products, 100 % of the rated voltage can be applied without causing any problems. Use less than 80 % of the following temperature reduction voltage for 25 WV products. This does not need to be applied to products between 4 and 20, 30 WV products. Refer to the following diagram.



b.Make sure the sum of the peak DC voltage and ripple voltage values does not exceed the rated voltage.

c.When the DC voltage is low, set it so that the negative ripple voltage peak value does not become a reverse voltage that exceeds 10 % of the rated voltage

d.Use the capacitor within 20 % of the rated voltage for application of reverse voltage during the transient phenomena caused when the power is turned off or the source is switched. Use it within 10 % of the rated voltage when reverse voltage is applied continuously.

5.Reduction of failure stress.

The main failure mode of the capacitor is open mode primarily caused by electrostatic capacity drop at high temperature (i.e. wear out failure), besides random short circuit mode failures primarily caused by over voltage occurs as minor one. The time it takes to reach the failure mode can be extended by using the capacitor with reduced ambient temperature, ripple current and applied voltage. The failure rate is less than 0.5 %/1000 hours when used at 60 % of the confidence level with the prescribed voltage applied at + 105 °C.

6.Capacitor insulation.

a.Insulation in the marking sleeve is not guaranteed. Be aware that the space between the case and the negative electrodes terminal is not insulated and has inconstant resistance.

b.Be sure to completely separate the case, negative electrode terminal, positive electrode terminal from adjacent and components and PC board foil.

7.Operating environment restrictions.
Do not use the capacitor in the following environments:

a.Places where water, salt water or oil can directly fall on it and places where condensation may form.

b.Places filled with noxious gas (hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonia, etc.).

c.Places susceptible to ozone, ultraviolet rays and radiation..

8.Lead Pitch.

The pitch and diameter of PCB holes to which the Vishay OSCON capacitor is mounted should be designed to conform to the dimensional tolerance stipulated in the delivery specifications.

9.PC Board Design.

a.Avoid locating heat-generating components around the Vishay OS-CON capacitor and on the under side of the PC board underneath the capacitor.

b.Follow the recommendations given in the catalog or delivery specification for land patterns for chip-type (94SM, 94SN and 94SV Series) PC boards when designing circuits.

10.Parallel connection.

A large amount of ripple current may be applied to the capacitor when it is used in parallel connection with another capacitor. Carefully select the type of capacitor. (Refer to page 45 for details.)

11.Design circuits after checking the following items:

a.Electrical characteristics are affected by temperature and frequency fluctuations. Design circuits after checking the amount of fluctuation.

b.When mounting a Vishay OS-CON on a double-sided PC board, design it so that extra PC board holes and the through

holes for connecting the front and back of the PC board are not located underneath the capacitor.

Mounting Precautions:

1.Things to know before mounting:

a.Do not reuse Vishay OS-CON capacitors that have been assembled in a set and energized. Excluding capacitors that have been removed for measuring electrical characteristics during a periodic inspection, they cannot be reused.

b.Leakage current may have increased in capacitors that have been stored for a long period of time. In this case, use after treatment of rated voltage with an approximately 1 kilohm resistor at about + 60 °C to + 70 °C for 1 hour.

2.Mounting (1).

a.Mount after checking the capacitance and the rated voltage.

b.Mount after checking the polarity.

c.Do not drop the capacitor on the floor. Do not use capacitors that have been dropped.

d.Do not deform and then mount a Vishay OS-CON capacitor.

3.Mounting (2).

a.Mount after checking that the capacitor's lead pitch and the PC board holes pitch match.

b.When an automatic inserter is used to clinch the capacitor's lead wires, make sure it is not set too strong.

c.Be careful of the shock force that can be produced by absorbers, product checkers and centerers on automatic inserters and installers.

d.Do not apply excessive external force to the lead wires, the capacitor itself, and electrode terminals.

4.Soldering with a soldering iron.

a.Set the soldering conditions (temperature, time) so that they fall within the range stipulated in the delivery specification.

b.When the lead wire terminal must be processed because the terminal spacing and the PC board holes spacing do not match, process it before soldering so that no stress is applied to the capacitor itself.

c.Do not subject the capacitor itself to excessive stress when soldering with a soldering iron.

d.When a soldering iron is used to repair a capacitor that has already been soldered once and needs to be removed, remove it after the solder has been completely melted so that no stress is applied to the capacitor's terminal.

e.Do not let the tip of the soldering iron touch the capacitor itself.

f. The LC value after soldering may increase a little (from a few µA to several hundred µA) depending on the soldering conditions (preheating and solder temperature and time, PC boards material and thickness, etc.). The leakage current can be reduced through self-repair by applying voltage.

5.Flow soldering.

a.Do not solder the capacitor by submerging it in melted solder. Use the PC board to protect the capacitor and only solder the opposite side that the capacitor is mounted on.

b.Set the soldering conditions (soldering temperature, terminal submersion time) so that they fall within the range stipulated in the delivery specification. Types 94SC, 94SA, 94SH, 94SS (larger than size D), 94SP (sizes E, F, G) at + 260° for less than 10 seconds, 94SL, 94SS (smaller than size C'), 94SP (sizes C', E', F') at + 260 °C for less than 5 seconds. The LC value after soldering may increase a little (from a few µA to several hundred µA) depending on the soldering conditions (preheating and solder temperature and time, PC boards material and thickness, etc.). The leakage current can be reduced through self-repair by applying voltage.

c.Take care that flux does not adhere to any place other than the terminal.

d.When soldering, take care that other components do not fall over and touch the capacitor.

e.Flow soldering under extremely abnormal conditions may reduce the electrostatic capacity of the products before or after soldering.

6.Reflow soldering.

a.Do not use reflow soldering for lead-type Vishay OS-CON capacitors.

b.Set the soldering conditions (preheating, soldering temperature and time) so that they fall within the range stipulated in the catalog or delivery specification. SMD product (Type 94SVP) preheat for less than 120 seconds at + 150 °C the peak of case or terminal must be less than + 230 °C; retention time at temperatures exceeding + 220 °C shall be less than 15 seconds; retention time at temperatures exceeding + 200 °C shall be less than 20 seconds; and reflow time shall be less than 30 seconds. The LC value after soldering may increase a little (from a few µA to several hundred µA) depending on the soldering conditions (type of reflow furnace, reflow conditions, PC boards material and thickness, number of components, etc.). The leakage current can be reduced through selfrepair by applying voltage.

c.Reflow may only be conducted once. If reflow must be conducted twice, please contact Vishay OS-CON.

d.Set the VPS soldering conditions so that they fall within the range stipulated in the delivery specification.

e.Reflow soldering may reduce the electrostatic capacity of products before or after soldering even if soldering conditions stipulated in catalog and delivery specifications are met.

7.Handling after soldering.

a.Do not tilt, bend or twist the capacitor after it has been soldered on the PC board.

b.Do not use the capacitor like a handle to move the PC board after it has been soldered to it.

c.Do not bump the capacitor with objects after it has been soldered to the PC board. When stacking PC boards, make sure that the capacitor does not touch other PC boards or components.

d.Do not subject the capacitor to excessive stress after it has been soldered to the PC board.

8.Washing the PC board

Check the following items before washing the PC board with these detergents; High quality alcohol based cleaning fluid such as Pine-αST-100S, Clean thru 750H, 750L, 710M, 750K, or Techno Care FRW14 through 17; or detergents including substitute freon such as AK-225AES and IPA.

a. Use immersion or ultrasonic waves to clean for a total less than five minutes. (Less than two minutes for the 94 SV.)

b. The temperature of the cleaning fluid should be less than + 60 °C.

d. After cleaning, do not store the capacitor in a location subject to gases from the cleaning fluid or in an airtight container. Dry the PC board and capacitor with hot air (less than the maximum operating temperature). Note that when it is heated (heat run, dry, etc.) soon after cleaning, the sleeve may swell and shrink again.

9. Fixatives and coatings.

a. Select appropriate materials for the capacitor's material and sealant. In particular, make sure coating and thinner do not contain acetone.

b. Before applying the fixative or coating, completely remove any flux residue and foreign matter from the area where the PC board and the capacitor are to be joined together.

c. Allow any detergent to dry before applying the fixative or coating.

Precautions with Completed Board:

1. Do not directly touch the capacitor's terminals

2. Do not use electric conductors to cause short circuits between the capacitor's terminals. Do not subject the capacitor to conductive solutions such as acids and alkaline water solutions.

3. Check the installation environment of the board the capacitor is installed in.

4. Age the board at conditions that fall below the capacitors ratings.

5. It is recommended that the board be used at room temperature and in ordinary humidity.

In the Event that Something Unfortunate Should Occur:

1. In the event that a short circuit causes the current to become relatively small (less than approximately 3 A for Ø 10 and less than approximately 1 A for Ø 6.3), the capacitor itself will generate a little heat, but the appearance will not be affected even when electricity is supplied continuously.
   However, if the short circuits current value exceeds the above mentioned values, the temperature inside the capacitor will increase. When the temperature exceeds approximately + 220 °C, the impregnated organic semiconductor melts and liquefies, the internal pressure is raised, and the liquefied organic semiconductor and odorous gas is released from the space between the sealant and the aluminum case and lead wires. In this case, keep your face and hands away from the area.

2. If a short circuit occurs and odorous gas is released, either turn off the sets main power or unplug the power cord from the outlet.

3. If a short circuit should occur, it may take anywhere from a few seconds to a few minutes until the organic semiconductor liquefies and an odorous gas develops, depending on the conditions. Set it up so that a power protection circuit works during this time.

3. If the gas gets in your eyes, rinse them immediately. Gargle if it has been inhaled.

5. Do not lick the capacitor's electrolyte. When the electrolyte gets on your skin, wash it off with soap.

6. The electrolyte, separator, resin and tube used in the Vishay OS-CON capacitor are all combustible. When the current value is extraordinarily large after a short circuit, assuming the worst possibility, the shorted-out section in the lead wire or inside the capacitor has created a spark, and it may have caught fire to the resin and/or tube. Give consideration to the capacitors mounting method, mounting position, pattern design and such.

Storage Conditions:

1. Do not store the capacitor at high temperatures and high humidity. Store it in a location that is not subject to direct sunlight and that has low temperatures and humidity (generally, temperatures between + 15 °C and + 35 °C and a relative humidity of less than 75 %.).

2. Store the capacitor in an airtight plastic bag to keep the leads in good condition. There are special bags for Types 94SM, 94SN and 94SV.

3. To keep the leads in good condition, store lead-type capacitors for no more than one year, and SMD types for no more than six months.

4. For SMD types in particular, open the bag just before mounting and use up all the capacitors in the bag as far as is possible. If some are unavoidably left over, return them to the bag and seal the opening with tape.

5. Do not store the capacitors in places where water, salt water or oil can directly fall on it, or places where condensation may form.

6. Do not store the capacitors in places filled with noxious gas (hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonia, etc.).

7. Do not store the capacitor in places susceptible to ozone, ultraviolet rays and radiation.

Disposal:

The Vishay OS-CON capacitor is comprised of solid organic compounds, various metals and resin. Treat it as industrial waste when disposing of it.

For details, refer to the Operating Precaution Guidelines for the EIAJ RC-2367 Electronic Device Solid Aluminum Non-solid Capacitor.

PART NUMBER EXPLANATION

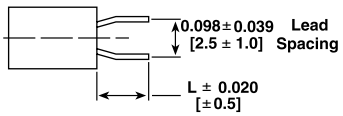
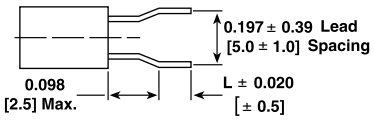
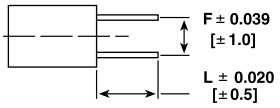
94SA	476	X0	6R3	A	xx OR xx
VISHAY OS-CON TYPE	CAPACITANCE	CAPACITANCE TOLERANCE	DC VOLTAGE RATING	CASE CODE	PROCESS CODE* / PACKAGING
94SA 94SC 94SH 94SL 94SS 94SP 94SVP	This is expressed in picofarads (pF). The first two digits are the significant figures. The third is the number of zeros to follow.	X0 = ± 20 %	This is expressed in volts. To complete the three digit block, zeros precede the voltage rating if the voltage is under 100. Example: 010 = 10 Volts. A decimal is expressed as follows: 6R3 = 6.3 Volts.	A, A' B, B' C, C' D E, E' F, F' G H	CA CC CD F0 F1 F2 C0 C1 C2 C3 / BP (Bulk) A1 (Ammo) A2 (Ammo)

* When using process codes, bulk packaging is assumed. See below.

MINIMUM PACKAGING QUANTITIES

Bulk Packaging		Ammo Packaging		Type 94 SVP Tape and Reel	
Case Code	Quantity	Case Code	Quantity	Case Code	Quantity
A	500	A	2000	A5	2000
B	500	B	2000	B6	1500
C	500	C	1500	C6	1000
D	500	D	1500	E7	1000
E	200	E	1000	F8	500
F	200	F	500	E12	400
G	50	-	-	F12	400
H	25	-	-	-	-

LEAD STYLE/SPACING in inches [millimeters]

LEAD SPACING (Ammo)	LEAD FORM DIMENSIONS		
A2 F = 0.098" [2.5 mm] Available in Case Sizes A, B, C, D **NOTE:** 'F' = Lead Spacing Dimensions	**Formed**  CASE CODES A, B	PROCESS CODE + CA + CC + CD	LEAD LENGTH (L) 0.217 [5.5] 0.157 [4.0] 0.098 [2.5]
A1 F = 0.197" [5.0 mm] Available in Case Sizes A, B, C, D, E, F	**Formed**  CASE CODES A, B, C, D, E	PROCESS CODE + F0 + F1 + F2	LEAD LENGTH (L) 0.217 [5.5] 0.177 [4.5] 0.118 [3.0]
A2 F = 0.138" [3.5 mm] For "E" Case Size only	**Cut** NOTE: Lead Spacingsame as Long Leads  CASE CODES A, B, C, D, E, F	PROCESS CODE + C0 + C1 + C2 + C3	LEAD LENGTH (L) 0.217 [5.5] 0.157 [4.0] 0.098 [2.5] 0.138 [3.5]