SANYO

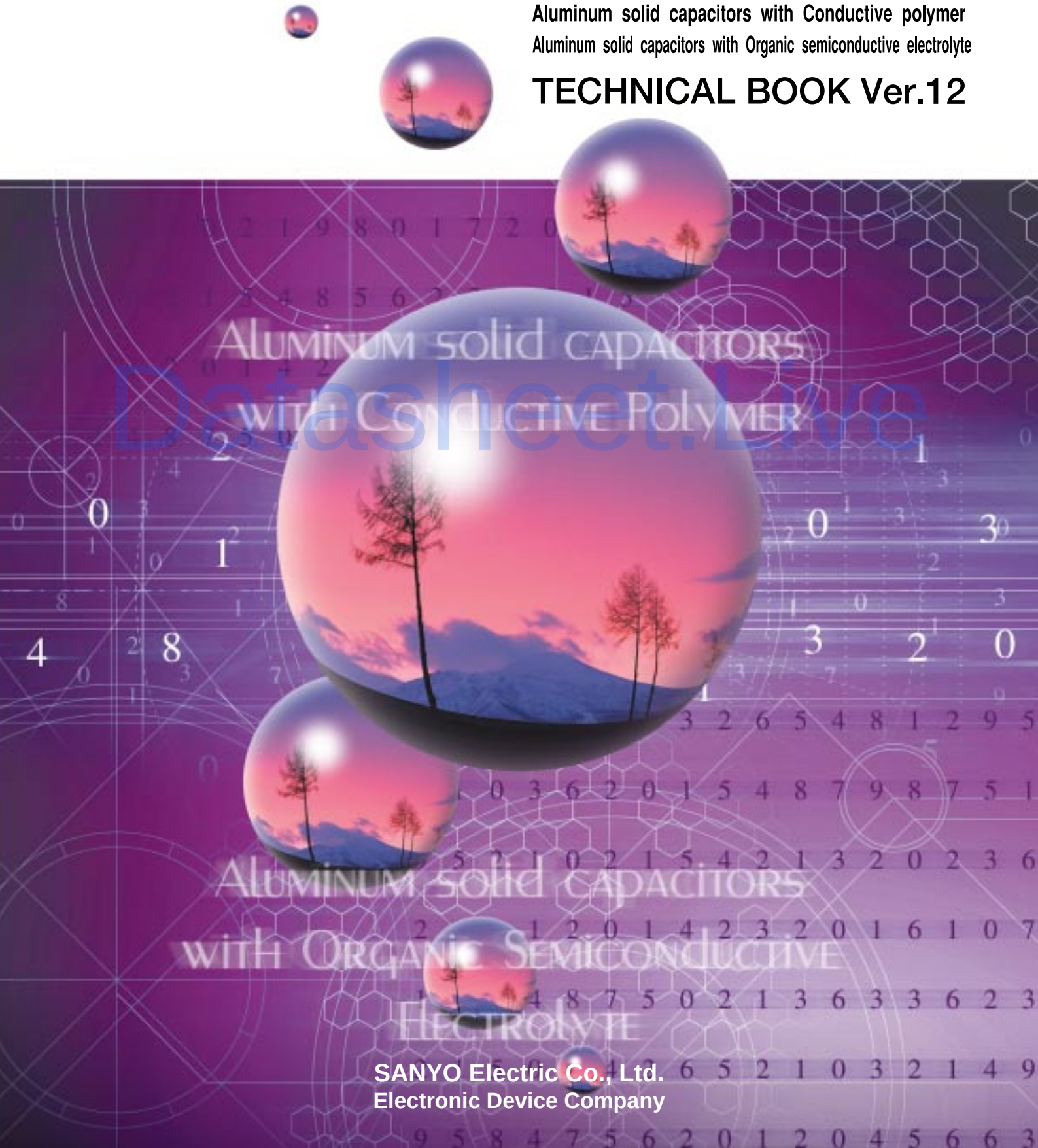
'04-10

OS-CON™

Aluminum solid capacitors with Conductive polymer

Aluminum solid capacitors with Organic semiconductive electrolyte

TECHNICAL BOOK Ver.12



SANYO Electric Co., Ltd.
Electronic Device Company

About this catalog

■The contents of this catalog are current as of September 2004, but product names and specifications are subject to change for improvement or discontinuation without notice. When ordering products, please be sure to request a delivery specifications form and read it carefully.

■Do not use the OS-CON for life-threatening applications (space equipment, aerial equipment, nuclear equipment, life-threatening medical equipment, vehicle control equipment, etc.).
However, since there may be cases where conductive polymer aluminum solid electrolytic capacitors (SVP, SVQP, SVPD, SEP and SEQP) are adaptable with our special levels, be sure to consult with us, and exchange delivery specifications with us before use.

■The performance, characteristics, and features of the products described in this catalog are based on the products working alone under prescribed conditions. Data listed here is not intended as a guarantee of performance when working as part of any other product or device. In order to detect problems and situations that cannot be predicted beforehand by evaluation of supplied data, please always perform necessary performance evaluations with these devices as part of the product that they will be used in.

■When using the products listed in this catalog, please always be sure to try to prevent any possible accidents or injury by designing products in a careful and safe manner. If you have any questions concerning the use of these products, please contact any of our sales representatives.

■For any products listed in this catalog that may constitute restricted trade goods under overseas exchange or service trade laws, permission to deliver according to law may be required before importing.

■Please understand that we cannot be held responsible for any damages to the industrial properties of any third party that arise from the use or application of the products listed in this catalog, with the exception of those items directly related to method of construction.

Introduction of OS-CON™

Aluminum solid capacitors with Conductive polymer

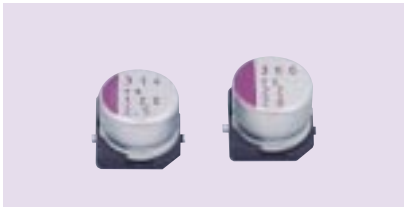
SVPD SERIES
P18～19

Guaranteed at 125°C
85°Cx 85% guaranteed and rated 35V max.

SVPC SERIES
P20～21

Large capacitance and low ESR

SVPB SERIES
P22～23



Low profile

SVPA SERIES
P24～25

Low ESR and large ripple current

SVQP SERIES
P26～27

Guaranteed at 125°C

SVP SERIES
P28～29

SMD standard product

SEPC SERIES
P30～31

Large capacitance and low ESR

SEQP SERIES
P32～33

Guaranteed at 125°C
High voltage resistant

SEP SERIES
P34～35

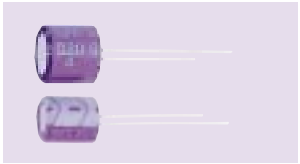
Standard radial lead type
Guaranteed at 105°C for 3,000h

Aluminum solid capacitors with Organic semiconductive electrolyte

SF SERIES
P36～37

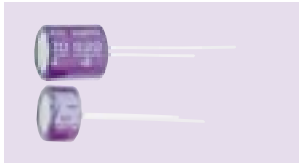
5 mm height (max.)

SPA SERIES
P36～37



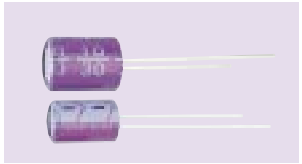
Low ESL and low ESR

SP SERIES
P38～39



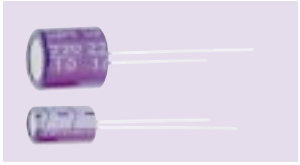
Large capacitance and low ESR

SC SERIES
P40～41



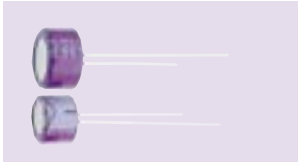
Standard product

SA SERIES
P42～43



Large capacitance and miniaturization

SL SERIES
P44～45

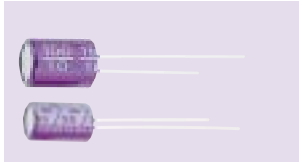


Low profile

SH SERIES
P46～47

Long life span

SS SERIES
P48～49



Miniaturization

For information on integration of OS-CON models and discontinued series, please see page 86

OS-CON

Aluminum solid capacitors with Conductive polymer
Aluminum solid capacitors with Organic semiconductive electrolyte

Contents

Contents

The data listed here is only representative of OS-CON, and does NOT show any guaranteed value. Change in product specifications, dimensions, etc. may occur without prior notice. Be sure that when placing order, please ask for specifications of each series in delivery, and read them well before use.

Ⅰ. Operating Precautions

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

Circuit designing

Crucial precautions [Important]

1. Polarity

OS-CON is a solid aluminum electrolytic capacitor 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.

2. Prohibited circuits

The OS-CON leakage current may become greater even if the soldering conditions adhere to the specification requirements. The high temperature no-load test, high temperature and high humidity no-load test, rapidly changing temperature test, etc may cause leakage current to become larger. Therefore, do not use the OS-CON in the following circuits because trouble or failure may occur.

(a) High impedance voltage retention circuits
(b) Coupling circuits
(c) Time constant circuits
In addition to the leakage current fluctuation, capacitance may also fluctuate depending on operational temperature and humidity. The fluctuation of the capacitance may cause problem if it is used as a time constant capacitor, which is extremely sensitive to the fluctuation of the capacitance. Do not use it as a time constant capacitor.

Do not use the OS-CON in circuits except those above if changes in the leakage current affects circuit operations.
If you plan to use 2 or more OS-CONs in a series connection, please contact us before use.

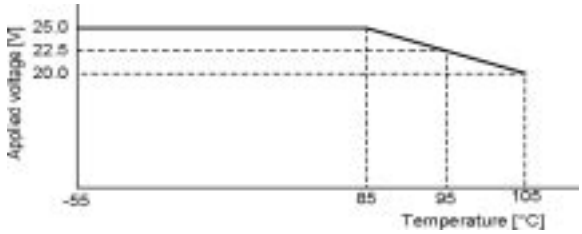
3. Compliance with rated performance

OS-CON must be used under rated performance prescribed in the specification. Operational and installation condition must be carefully examined.

(a) Over-voltage exceeding the rated voltage should not be applied even for an instance since it may cause a short circuit.
(b) Operating temperature (ambient of OS-CON) must be within the category temperature range of specification.
(c) Do not apply current that exceeds the rated ripple current. When excessive ripple current is applied, the OS-CON may result in shorter life due to the internal heat increase.

4. Applied voltage

(a) OS-CON can be applied with 100% of rated voltage except for 25V product.
In case of 25 V product, if the operating temperature is above 85 deg.C, derating voltage shown in the following figure must be applied. If the temperature is below 85 deg.C, derating is not necessary. In any event, over voltage exceeding the rated voltage must not be applied even for a moment.



* Concerning SVPD series 25V products, there are no problems using them at 100% of the rated voltage.

(b) Sum of the DC voltage value and the ripple voltage peak values must not exceed the rated voltage.
(c) When DC voltage is low, negative ripple voltage peak value must not become a reverse voltage that exceeds 10 % of the rated voltage.
(d) Use the OS-CON within 20 % of the rated voltage for applications which may cause the reverse voltage during the transient phenomena when the power is turned off or the source is switched.

Ⅰ. Operating Precautions

5. Sudden charge and discharge

Sudden charge and discharge may result in short circuits and the large Leakage current. Therefore, protection circuits are recommended to design in when the following conditions are available.

(a) The rush current is over 10 A.

(b) The rush current is over 10 times of allowable ripple current of **OS-CON**.

A protection resistor (1 kΩ) must be inserted to the circuit during the charge and discharge when measuring the leakage current.

6. Failure and life-span

The **OS-CON** failure rate in use is based on the failure rate level in the specification requirements (Upper category temperature and category voltage adhere to JIS C 5003. The confidence level is 60% and the failure rate is 0.5 %/1000h.) and this ratio is low, however, failures may occur.

It is possible to cause a failure circuit even if **OS-CON**s have a lowest failure rate. As the above reason, please insert a protection circuit to prevent unlikely event by accident. Meanwhile, please design your circuit using **OS-CON** which cause no damage to social or person directly, or use after checking that it causes no problem even if it fails.

The failure modes mainly have two types (a) and (b) as follows.

(a) Contingency failure

The contingency failure mainly has short circuit. The phenomenon of after short is on following.

(1) Phenomenon of after short circuit mode

(a) Resin sealing type (SC, SA, SL, SH, SS, SP, SPA, and SF series)

In the event a short circuit causes the current to become relatively small (less than approximately 3A for ϕ10 and less than approximately 1A for ϕ6.3), the **OS-CON** itself will generate a little heat, but its appearance will not be affected even when electricity is supplied continuously.

However, if the short circuit current value exceeds the mentioned values above, the temperature inside the **OS-CON** 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 are released from the space between the sealant and the aluminum case and lead terminals. In this case, keep your face and hands away from the area.

(b) Rubber sealing type (SEP, SEQP, SEPC, SVP, SVQP, SVPA, SVPB, SVPC, and SVPD series)

In the event a short circuit causes the current to become relatively small (less than approximately 1A for ϕ10, less than approximately 0.5A for ϕ8 and less than approximately 0.2A for ϕ6.3), the **OS-CON** itself will generate a little heat, but its appearance will not be affected even when electricity is supplied continuously.

However, if the short circuit current value exceeds the mentioned values above, the temperature inside the **OS-CON** will increase, the internal pressure is raised, rubber sealing is turned over, and odorous gas is released. 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 main power of the equipment or unplug the power cord from the outlet.

(3) If a short circuit occurs, it may take from a few seconds to a few minutes before the organic semiconductor liquefies and an odorous gas produces, depending on the conditions. It is recommended to set up a power protection circuit to function during this time.

(4) If the gas comes in contact with eyes, rinse immediately. If the gas is inhaled, gargle immediately.

(5) Do not lick the **OS-CON**s electrolyte. If the electrolyte comes in contact with skin, wash it off with soap immediately.

(6) The electrolyte, electrolytic paper, resin, sleeve, sealing rubber, and plastic spacer used in the **OS-CON** are all combustible. When the current is extraordinarily large after a short circuit, in the worst case, the shorted-out section in the lead terminal or inside the capacitor may ignite the resin and/or rubber. Pay attention to the capacitor mounting method, mounting position, pattern design, etc.

(b) Performance characteristic and failure (life-span)

The **OS-CON**s characteristics can possibly change (Capacitance reduction and ESR increase) within the specified range in specifications when it is used in the condition of Rated voltage, Electric and mechanical performance.

When life span exceeded the specified guarantee time of Endurance and Damp heat, electric characteristic might change and cause electrolyte insulation. This is called Open circuit mode.

Ⅰ. Operating Precautions

(1) Please confirm the following item when select and design **OS-CON**.

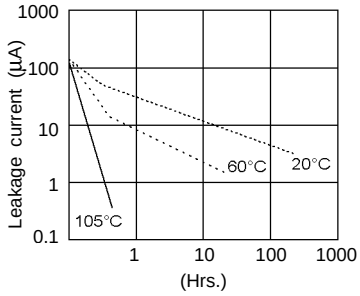
	Electric performance	Confirmation Item
Delivery	Capacitance	Capacitance tolerance of rated capacitance.
Mounting SMD type: Reflow soldering Radial lead type: Flow soldering	Capacitance	Change rate in Capacitance to initial value after mounting. Note: This item also applied to SMD type-reflow mounting of SANYO Recommended reflow condition. Heat stress to **OS-CON** will be influenced by the different of reflow equipment, board material, size, and numbers of mounting. Please check your reflow condition whether it is within the above SANYO Recommendable Reflow Condition or not and confirm **OS-CON**'s electric characteristic change before and after reflow.
	ESR	The specification after mounting.
	Leakage current	Leakage current less than or equal to the value of specification after voltage treatment. Leakage current may increase and exceed the specification value after mounting. In such a case, Leakage current will decrease and return back to specification after applying voltage.
In use	Capacitance	(1) Change rate in Capacitance before and after Endurance test (2) Change rate in Capacitance before and after Damp heat test
	ESR	(1) The specification after Endurance test. (2) The specification after Damp heat test.
	Leakage current	(1) Leakage current is less than or equal to specification after Endurance test. (2) Leakage current may increase and exceed the specification value after Damp heat test. In such case, Leakage current will decrease and return back to specification after applying voltage.
Others	Ripple current	It is necessary to apply a frequency coefficient according to an usable frequency which is beside 100kHz to 500kHz.

Cautions

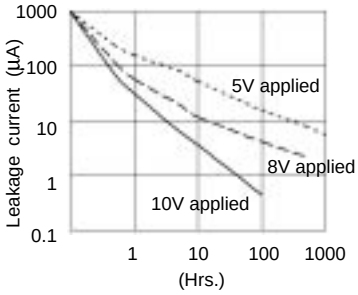
1. Leakage current

Heat pressure from soldering and mechanical stress from transportation may cause the leakage current to become large. In such a case, leakage current will gradually decrease by applying voltage less than or equal to the rated voltage at a temperature within the upper category temperature. In close conditions to the upper category temperature, the nearer the applied voltage is to the rated voltage, the faster the leakage current recovery speed is. (Refer to below.)

OS-CON leakage current restoration characteristics
10μF/16V (16V DC applied)



OS-CON leakage current restoration characteristics
33μF/10V (Ambient temperature:65°C)
(Measured voltage:10V)



*A sample that had stress intentionally applied to make the leakage current larger was used to make leakage current recovery easy to understand.

2. Capacitor insulation

(a) Insulation in the marking sleeve and the laminate resin is not guaranteed. Be aware that the space between the case and the negative electrode terminal is not insulated and has some resistance.

(b) Be sure to completely separate the case, negative lead terminal, positive lead terminal and PC board patterns with each other.

3. Operating environmental restrictions

Do not use the **OS-CON** 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.

Ⅰ. Operating Precautions

4. PCB (PC board) design

(a) Avoid locating heat-generating components around the **OS-CON** and on the underside of the PC board (underneath the **OS-CON**).
(b) Follow the recommendations given in the specifications for land patterns for SMD type PC board when designing circuits.
(c) The pitch and diameter of PCB holes to which radial lead type of **OS-CON** is mounted should be designed to conform to the dimensional tolerance stipulated in the specifications.

5. Parallel connection

A large amount of ripple current may be applied to the **OS-CON** when it is used in parallel with another capacitor. Carefully select the type of capacitor.

6. Others

Design circuits after checking the following items.
(a) Electric characteristics are affected by temperature and frequency fluctuations. Design circuits after checking the following items.
(b) When mounting an **OS-CON** on a double-sided PC board, extra PC board holes and the through holes for connecting the front and back of the PCB must not exist underneath the **OS-CON**.

Mounting precautions

1. Considerations when soldering

The soldering conditions are to be within the range prescribed in specifications. If the specifications are not followed, there is a possibility of the cosmetic defection, the intensive increase of leakage current, and the capacitance reduction.

2. Things to be noted before mounting

(a) Do not reuse **OS-CON**s that have been assembled in a set and energized. Excluding **OS-CON**s that have been removed for measuring electrical characteristics during a periodic inspection, **OS-CON**s cannot be reused.
(b) Leakage current may increase when **OS-CON**s are stored for long periods of time. In this case, we recommend that you apply the rated voltage for 1 hour at 60°C – 70°C with a resistor load of 1 kΩ.

3. Mounting-1

(a) Mount after checking the capacitance and the rated voltage.
(b) Mount after checking the polarity.
(c) Do not drop the **OS-CON** on the floor. Do not use **OS-CON**s that have been dropped.
(d) Do not deform the **OS-CON**.

4. Mounting-2

(a) Mount after checking that SMD types of the **OS-CON**s terminal pitch and the PCB land pattern.
(b) Mount after checking that radial lead types of the **OS-CON**s terminal pitch and diameter of PCB holes. When an automatic inserter is used to clinch the **OS-CON**s lead terminals, make sure it is not set too strong.
(c) Be careful to the shock force that can be produced by absorbers, product checkers, and centers on automatic inserters and installers.
(d) Do not apply excessive external force to the lead terminal and the **OS-CON** itself.

Ⅰ. Operating Precautions

5. Soldering with a soldering iron

(a) Set the soldering conditions (temperature, time) so that they fall within the stipulated range in the specifications.
(b) When the lead terminal for radial lead type must be processed because the lead pitch and the PCB holes in spacing do not match, process it before soldering so that no stress is applied to the **OS-CON** itself.
(c) Do not subject the **OS-CON** itself to excessive stress when soldering.
(d) When a soldering iron is used to repair an **OS-CON** 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 **OS-CON**s lead terminal.
(e) Do not let the tip of the soldering iron touch the **OS-CON** itself.
(f) The leakage current 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, PCB material and thickness, etc.). The leakage current can be reduced through self-repair by applying voltage.

6. Flow soldering

(a) Do not use flow soldering for SMD type.
(b) Do not solder the **OS-CON** by submerging it in melted solder. Use the PCB to protect the **OS-CON** and only solder the opposite side that the **OS-CON** is mounted on.
(c) Set the soldering conditions (soldering temperature, terminal immersion time) so that they fall within the stipulated range in the specifications. The leakage current value after soldering may increase (from a few μA to a few mA) depending on the soldering conditions (preheating and solder temperature and time, PCB material and thickness, etc.). However, the leakage current can be reduced by applying voltage to set into operating condition.
In regards to flow soldering, be sure to solder within the following conditions.

	Temperature	Duration	Flow number
Preheating	120°C or less (ambient temperature)	120 sec. or less	1 time
Soldering conditions	260 + 5°C or less	10 + 1 sec. or less	2 times or less *1

*1 When soldering 2 times, immersion time should be 10 + 1 sec. or less.

(d) Take care that flux does not adhere to anywhere expect the lead terminal.
(e) When soldering, take care that other components do not fall over and touch the **OS-CON**.
(f) Flow soldering under extremely abnormal conditions may reduce the capacitance of products after soldering.

7. Reflow soldering

(a) Reflow soldering is unapplicable to Radial lead type.
(b) Set the soldering conditions (soldering temperature, terminal submersion time) so that they fall within the stipulated range in the specifications. The leakage current value after soldering may increase a little (from a few μA to several mA) depending on the soldering conditions (preheating and solder temperature and time, PCB material and thickness, etc.). The leakage current can be reduced through self-repair by applying voltage.
(c) Please contact SANYO for setting VPS soldering conditions
(d) In the case of reflow soldering, capacitive static electricity may decrease after soldering even when the soldering conditions are within the required values.

8. Handling after soldering

(a) Do not tilt, bend or twist the **OS-CON** after it has been soldered on the PCB.
(b) Do not move the PCB with catching **OS-CON** itself by hand after soldering.
(c) Do not dump the **OS-CON** with objects after it has been soldered to the PCB. When stacking PCBs, make sure that the **OS-CON** does not touch other PCBs or components.
(d) Do not subject the **OS-CON** to excessive stress after it has been soldered to PCB.

Ⅰ. Operating Precautions

9. Washing the PCB

Check the following items before washing the PCB with these detergents: high quality alcohol-based cleaning fluid such as Pine-α ST-100S, Clean thru 750H, 750L, 710M, 750K, or Techno Care FRW 14 through 17; or detergents including substitute freon as AK-225AES and IPA.

(a) Use immersion or ultrasonic waves to clean for a total of less than five minutes. (SVP,SVQP,SVPA,SVPB, SVPC,SVPD,SEP,SEQP and SEPC series are less than two minutes.)

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

(c) Watch the contamination of the detergent (conductivity, pH, specific gravity, water content, etc.).

(d) After cleaning, do not store the **OS-CON** in a location subject to gases from the cleaning fluid or in an airtight container. Dry the PCB and **OS-CON** with hot air (less than the maximum operating temperature). Please do not heat (heat run, dry, etc.) soon after cleaning.

(e) Please contact SANYO for details about detergents and cleaning methods, and about detergents other than those listed above.

10. Fixatives and coatings

(a) Select the appropriate covering and sealant materials for **OS-CON**s. In particular, make sure the fixative, coating and thinner do not contain acetone.

(b) Before applying a fixative or coating, completely remove any flux residue and foreign matter from the area where the board and **OS-CON** will be jointed together.

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

(d) Please contact SANYO for fixative and coating heat curing conditions.

11. Precautions with completed board

(a) Do not touch the lead terminals of **OS-CON** directly.

(b) Do not use electric conductors to cause short circuits between the **OS-CON**s lead terminals. Do not subject the **OS-CON** to conductive solutions such as acids and alkaline water solutions.

(c) Check the installation environment of the board the **OS-CON** is installed in.

(d) Age the board at conditions that fall below the capacitors ratings.

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

Storage and Disposal

1. Storage conditions

(a) Do not store the **OS-CON** at high temperatures and high humidity. Store it in a location that is not subject to direct sunlight and that has temperatures less than 5°C to 35°C and a relative humidity less than 75 % generally.

(b) To keep good solderability, store the **OS-CON**s in its plastic bag under shipping condition. SMD types (SVP, SVQP, SVPA, SVPB, SVPC and SVPD series) are sealed up in specifically designed aluminum laminate bags to prevent deterioration in characteristic and solderability before and after reflows resulting from moisture absorption.

(c) To keep good solderability, store radial lead types packed in bags for not more than one year (after delivery), and radial lead types with taping and SMD types for not more than six months (after delivery) before opening.(Refer to the table on the next page.)

(d) Open the bags just before mounting, and use up all products once opened. In case of leftovers, put radial lead types packed in bags, SMD types and unpackaged ones back into the storage bags (specifically designed aluminum laminate bags for SMD types), and seal up the opening with tape etc. Put radial lead types with taping in plastic bags as they are put into storage boxes and seal up the opening with tape etc. In case of storage after opening, please follow the storage term as stated in the table below.

(e) Do not store the **OS-CON** in damp conditions such as with water, salt spray, or oil spray, and high humidity.

(f) Do not store the **OS-CON** in places filled with noxious gas (hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonia, etc.).

Ⅰ. Operating Precautions

(g) Do not store the **OS-CON** in places susceptible to ozone, ultraviolet rays and radiation.

	Before unseal	After unseal
SMD type	Within 6 months after delivery (Unopened condition)	Within 30 days from opening (Packaged condition with carrier tape)
Radial lead type bag packing product	Within 1 year after delivery (Unopened condition)	Within 7 days from opening (1 week)
Radial lead type taping product	Within 6 months after delivery (Unopened condition)	Within 7 days from opening (1 week)

The moisture absorption level of the SMD type is shown below.

LEVEL	Floor Life		Storage Condition
	Time	Condition	
2a	4Week	≦30℃/60%RH	Packed with carrier tape

(Required standard : IPC/JEDEC J-STD-020B)

2. Disposal

OS-CON comprises solid organic compounds, various metals, resin, rubber, etc. Treat it as industrial waste when disposing of it. In case of disposing a large amount of **OS-CON**, SANYO can dispose on behalf.

Note:
In case of some problems concerning industrial possessive rights of third party by using this product, we don't take responsibility except for what to be directly conceded with structure processes **OS-CON**. Please design with safety measures taking into consideration any social damage, such as personal or fire accident when using this product.

Ⅱ. Measures to Protect the Environment

We are working on complete removal of environmental hazardous substances from the **OS-CON**, in order to conform to EU RoHS Directive (refer to below) coming into effect from July 2006 and to green procurement introduced in many companies.

【RoHS Directive】
【Restriction of the use of certain hazardous substances in electrical and electronic equipment】

- EU environmental regulation
- RoHS aims to improve the regulations for hazardous substances in electrical and electronic equipment, and to minimize the hazardous effects on environment and to people's health from the production process up to and including the disposal process.
- RoHS prohibits the use of 6 substances including cadmium, lead, hexavalent chromium, mercury, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs).

	Measures status *1
Conductive polymer **OS-CON**	Already in conformation
Organic semiconductor **OS-CON**	Sleeve material is being changed from PVC to PET (Complete removal of lead and phtalic esters)

*1 Contact us about the detailed status because a few specific special products do not meet the RoHS Directive yet.
Also, contact us concerning the status of sleeve material change.

Ⅲ. SERIES SYSTEM DIAGRAM

〈Aluminum solid capacitors with Conductive polymer〉

· Environmental product · Lead-free reflow product

SVPB Series
P22~23
Low profile

Low profile

SVPA Series
P24~25
Low ESR and large ripple current

Large Cap.

SVPC Series
P20~21
Large capacitance and low ESR

Low ESR

SVQP Series
P26~27
Guaranteed at 125℃

High Temp.

SVP Series
P28~29
standard

High Voltage

SVPD Series
P18~19
High voltage resistant and guaranteed at 125℃

SMD

〈Aluminum solid capacitors with Conductive polymer〉

· Environmental product · Lead-free flow product

Radial

SEQP Series
P32~33
Guaranteed at 125℃
High voltage resistant

High Temp.

SEP Series
P34~35
Guaranteed for 3,000h

Low ESR

SEPC Series
P30~31
Large capacitance and low ESR

〈Aluminum solid capacitors with Organic semiconductive electrolyte〉

Radial

SH Series
P46~47
Long life span

Long life.

SA Series
P42~43
Large capacitance and miniaturization

Long life.

Large Cap.

SC Series
P40~41
Standard

Low ESR

SP Series
P38~39
Large capacitance and low ESR

Low ESL

SPA Series
P36~37
Low ESL and low ESR

Low profile

Low profile

Low profile

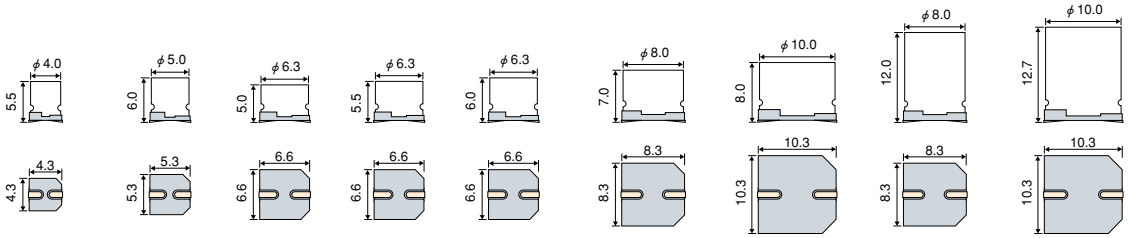
SS Series
P48~49
Miniaturization

SL Series
P44~45
Low profile

SF Series
P36~37
5mm height (max.)

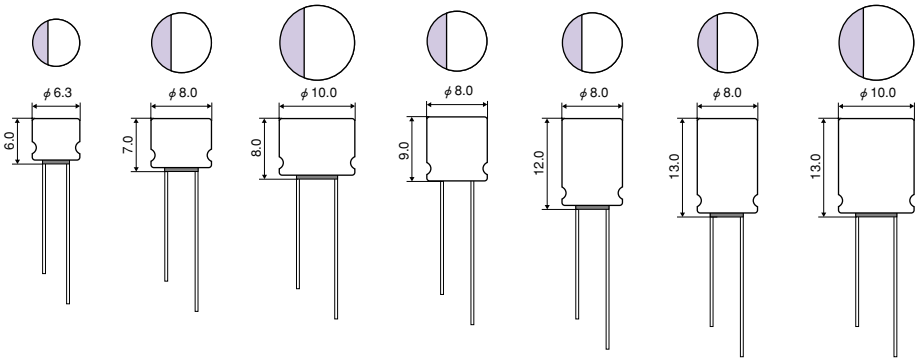
• Sketch of Case Size (unit : mm)

SMD type with conductive polymer electrolyte



(Size code)

Radial lead type with conductive polymer electrolyte



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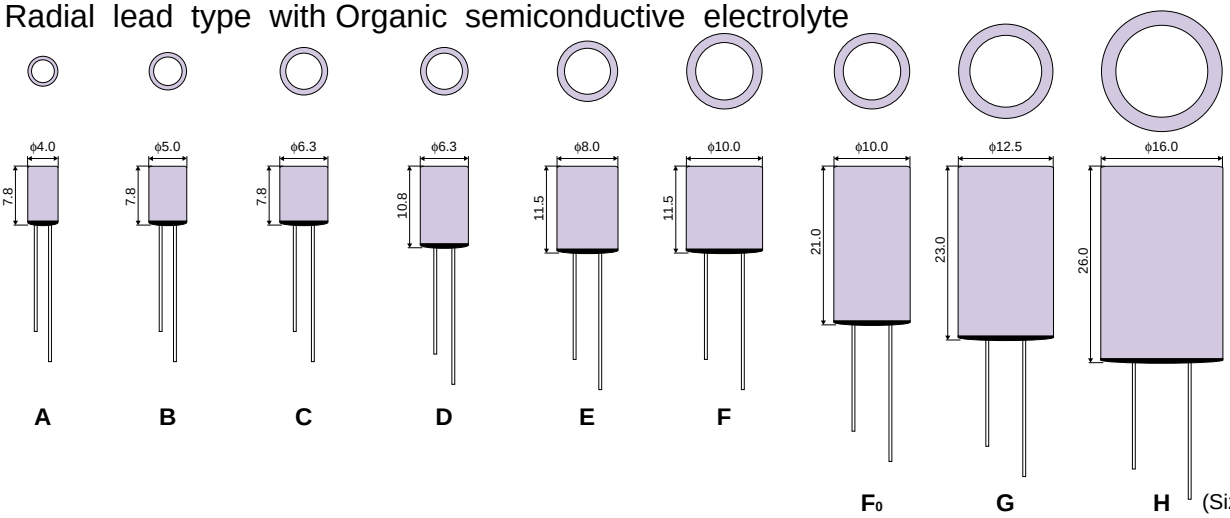
Radial lead type with Organic semiconductive electrolyte



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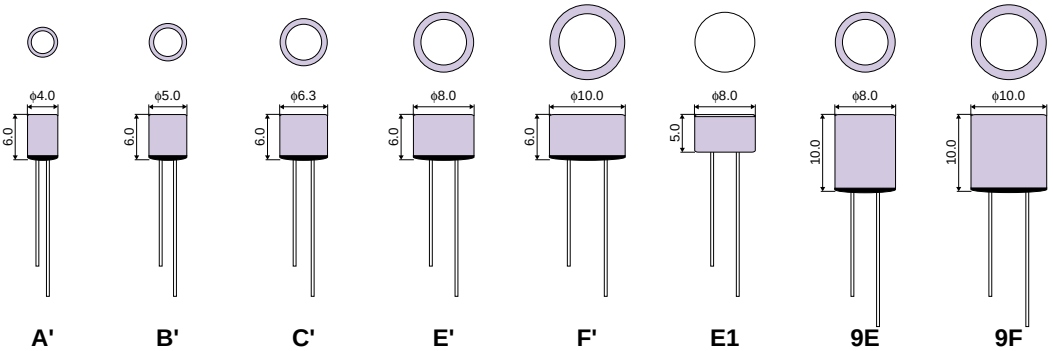


(Size code)

※Profile of case size are all expressed in maximum values.

Ⅲ. SERIES SYSTEM DIAGRAM

■Size List

μF \ V	2	2.5	4	6.3	10
1					
1.5					
2.2					
3.3					
4.7					SVP(A5), SC(A), SL(A'), SH(A)
6.8				SC(A), SL(A'), SH(A)	SVP(A5)
8.2					
10					SVP(A5), SC(B), SL(B'), SH(B), SS(A')
15				SC(B), SL(B'), SH(B), SS(A')	SVP(A5)
18					
22				SVP(A5)	SC(C), SL(C'), SS(B')
27					
33			SVP(A5)	SC(C), SS(B')	SVP(B6), SL(C')
39			SVP(B6)		
47				SVPA(B6), SVP(B6), SA(C), SH(C)	SVP(C6), SC(D), SL(C')
56					SVPD(C6), SEQP(C6), SVP(C6), SVPB(C5), SVQP(C6), SEP(C6), SP(C')
68			SVPA(B6), SVP(B6), SS(C')	SP(C')	SVPA(C6), SVPC(B6) SA(D), SL(E'), SH(D)
82		SVPA(B6)		SVPB(C5), SEQP(C6) SVP(C6), SVQP(C6), SEP(C6)	SP(C)
100			SVPB(C5), SEP(C6), SP(C')	SVPC(B6), SVP(C6), SVQP(C6), SL(E')	SP(E'), SL(F'), SS(D)
120		SVPB(C5)		SVPA(C6), SVP(C6), SP(C)	SEQP(F7), SVP(E7), SVPC(C6) SVQP(E7), SEP(E7)
150			SVPA(C6), SVPC(B6), SEQP(C6), SVP(C6, E7), SVQP(C6), SEP(C6), SP(C), SL(E'), SS(D)	SEQP(E7), SVQP(E7), SEP(E7), SF(E1), SP(E'), SA(E), SL(F'), SH(E)	SVPA(E7), SVP(E7, F8), SVQP(E7), SP(D), SS(E)
180		SVPA(C6), SVPC(B6)			SP(F')
220		SVP(C6)	SVQP(E7), SEP(E7), SF(E1), SP(E'), SL(F')	SVPA(E7), SVPC(C6), SVP(E7, F8), SVQP(E7), SP(F', D), SS(E)	SA(F), SH(F)
270			SVPA(E7), SP(D)		SEQP(F8), SVP(F8), SVPC(E7) SEP(F8), SP(E)
330		SVPA(E7)	SVPC(C6), SEQP(E7), SVP(E7), SEP(E7), SP(F')	SEQP(F8), SVP(F8), SEP(F8), SA(F), SH(F)	SVPA(F8), SEQP(E12), SVP(F8, E12), SEP(E12), SS(F)
390		SVPC(C6)		SVPC(E7), SP(E)	
470			SEP(F8), SS(F)	SVPA(F8), SEQP(E12), SVP(F8, E12), SEPC(E9, E13), SEP(E12)	SP(F)
560		SEPC(E9)	SEPC(E9,E12,E13), SVPC(E7), SEQP(E12), SVP(E12), SEP(E12), SPA(9E), SP(E)		SEQP(F13), SVP(F12), SEP(F13)
680		SVPC(E7), SVP(E12), SEP(E12)	SEPC(E13), SVPA(F8), SVPC(E7), SEQP(F8), SVP(F8), SEP(F8)	SEPC(F13), SP(F)	
820		SEPC(E9,E13), SVPA(F8), SVPC(E12)	SEPC(F13), SPA(9F), SP(F)	SVPC(E12), SEQP(F13), SVP(F12), SEP(F13)	
1000	SP(F)		SP(F)		
1200		SP(F)	SVPC(E12), SEQP(F13), SVP(F12), SEP(F13)		
1500		SVPC(E12), SVP(F12), SEP(F13)	SP(F_0)	SEPC(F13)	
1800	SP(F_0)				
2200			SP(G)	SA(H)	
2700		SEPC(F13), SVPC(F12)			

●···Conductive polymer type ●···Organic semiconductor type

Ⅲ. SERIES SYSTEM DIAGRAM

■Size List

16	20	25	30	32	35	V / μF
		SC(A), SL(A'), SH(A)	SC(A)			1
		SC(A), SL(A'), SH(A)	SC(B)			1.5
SC(A), SL(A'), SH(A)	SS(A')	SC(B), SL(B'), SH(B)	SC(B)			2.2
SVP(A5), SC(A), SL(A'), SH(A)	SS(A')	SC(B), SL(B'), SH(B)	SC(C)			3.3
SC(B), SL(B'), SH(B), SS(A')	SS(B')	SC(C), SL(C'), SH(C)	SC(D)			4.7
SC(B), SL(B'), SH(B), SS(A')	SS(B')	SVP(C6), SEP(C6), SP(C'), SC(C), SL(C'), SH(C)	SC(D)	SEQP(E7)		6.8
					SVPD(E7)	8.2
SL(C'), SS(B')	SVP(B6), SS(C')	SVPD(C6), SVP(E7), SEP(E7), SP(C), SC(C), SH(C)	SC(E)			10
SVP(B6), SC(C), SL(C'), SS(B')	SVPB(C5), SA(C), SH(C), SS(C')	SC(D), SL(E'), SH(D)		SEQP(F8)		15
		SP(D)		SEQP(E12)	SVPD(F8)	18
SVP(B6), SC(D)	SVPB(C55), SEQP(C6), SVP(C6), SVQP(C6), SEP(C6), SP(C'), SA(C), SH(C), SS(C')	SVPD(E7), SVP(F8), SEP(F8), SC(E), SL(F')	SC(F)		SVPD(E12)	22
	SVP(C6)					27
SVPB(C5), SP(C'), SC(D), SA(C), SH(C), SS(C')	SVP(E7), SEP(E7), SP(C), SA(D), SH(D)	SVP(E12), SEP(E12), SP(E), SC(F)				33
SVPA(C6), SEQP(C6), SVP(C6), SVQP(C6), SEP(C6), SVPC(B6)		SVPD(F8)				39
SP(C), SA(D), SL(E'), SH(D)	SEQP(E7), SVP(E7), SVQP(E7), SEP(E7), SP(E'), SA(E), SH(E), SS(D)	SVPD(E12), SC(F)				47
SVP(E7)	SVP(F8), SEP(F8)	SVP(F12), SEP(F13), SP(F)				56
SVPC(C6), SP(E'), SL(F'), SS(D)	SEQP(F8), SVP(F8), SEP(F8), SP(F', D), SA(E), SH(E)					68
SVPD(E7), SVPA(E7), SEQP(E7), SVP(E7), SVQP(E7), SEP(E7)		SVPD(F12)				82
SVP(F8), SP(F', D), SA(E), SH(E)	SVP(E12), SEQP(E12), SEP(F8, E12), SA(F), SH(F), SS(E)					100
SVPC(E7)	SP(E)					120
SEQP(F8), SVP(F8), SEP(F8), SA(F), SH(F)	SEQP(F13), SVP(F12), SEP(F13), SS(F)					150
SVPA(F8), SEQP(E12), SVP(F8, E12), SEP(E12), SP(E)	SP(F)					180
						220
SEPC(E12), SP(F)						270
SEQP(F13), SVP(F12), SEP(F13)						330
						390
SEPC(E13), SA(G)						470
						560
						680
						820
SA(H)						1000
						1200
						1500
						1800
						2200
						2700

●…Conductive polymer type ●…Organic semiconductor type

Ⅲ. SERIES SYSTEM DIAGRAM

■ESR Matrix

V / mΩ	2V/2.5V	4V	6.3V	10V
7	SEPC(E9, E13)	SEPC(E9, E13, F13)	SEPC(F13)	
8	SEPC(E9), SP(F₀)	SP(F₀)	SEPC(E9, E13)	
9	SVPC(E12)	SVPC(E12)		
10	SVPC(E12), SEPC(F13)	SP(G)	SEPC(F13)	
11	SP(F)	SPA(9F)		
12	SVP(F12), SEP(F13), SP(F)	SVPC(E12, F12), SEQP(F13), SVP(F12), SEP(F13), SPA(9E), SP(F)	SVPC(E12), SEQP(F13), SVP(F12), SEP(F13),	
13	SVP(E12), SEP(E12)	SEQP(E12), SVP(E12), SEP(E12),	SP(F)	SEQP(F13), SVP(E12), SEP(F13)
14		SP(E)		
15			SVPC(C6), SEQP(E12), SVP(E12), SEP(E12), SA(H)	SP(F)
16			SP(E)	
17			SVP(C6)	SEQP(E12), SVP(E12), SEP(E12),
18				SP(E)
19	SVPA(F8)			
20	SVPA(C6, E7), SVPC(E7)	SVPA(F8), SP(D)	SVPA(F8), SP(D)	
21		SVPC(C6)		
22		SVPA(C6, E7), SVPC(E7)	SVPA(C6, E7), SVPC(E7)	SVPC(E7)
23	SVP(C6)	SVPC(B6)		
24	SVPC(B6)	SP(F')		SVPA(F8)
25	SVPC(C6)	SEQP(F8), SVP(F8), SEP(F8), SS(F)	SVPC(B6), SEQP(F8), SVP(F8), SEP(F8), SA(F), SH(F)	SEQP(F8), SVP(F8), SEP(F8), SP(D), SS(F)
27		SVPC(C6)	SVPC(C6)	SVPC(C6), SA(F), SH(F)
28		SP(E')	SP(F')	
29				SP(F')
30	SVPA(B6), SVPC(B6)	SVPA(B6), SVPC(B6), SF(E1)	SVPA(B6), SVPC(B6), SP(E'), SA(E), SH(E), SS(E)	SVPA(C6, E7), SVPC(B6) SVP(F8), SS(E)
32			SF(E1)	SP(E')
34				
35		SEQP(E7), SVP(E7), SVQP(E7) SEP(E7), SP(C)	SEQP(E7), SVP(E7), SVQP(E7), SEP(E7), SP(C)	SEQP(E7), SVP(E7), SVQP(E7), SEP(E7)
36				
40	SVPB(C5)	SVPB(C5), SEQP(C6), SVP(C6), SVQP(C6), SEP(C6), SP(C'), SS(D)	SVPB(C5), SVP(C6), SVQP(C6), SP(C')	SVPB(C5), SP(C), SS(D)
45			SVP(C6), SVQP(C6), SEP(C6)	SVPD(C6), SEQP(C6), SVP(C6), SVQP(C6), SEP(C6), SP(C')
48				
50				SVP(C6), SA(D), SH(D)
55		SL(F')		
60		SVP(B6), SL(E')	SA(C), SL(F'), SH(C)	SC(D), SL(F')
65			SL(E')	SL(E')
70		SVP(B6), SS(C')	SVP(B6), SC(C)	SVP(B6), SC(C), SL(C')
75				
80				SL(C')
90				
100				
110				
120			SC(B), SL(B'), SH(B)	
150			SS(B')	SC(B), SL(B'), SH(B), SS(B')
180				
200		SVP(A5)	SVP(A5)	SVP(A5)
220				SVP(A5)
240				SVP(A5)
250			SC(A), SH(A)	
260				
280				SC(A), SH(A)
300				
350			SL(A'), SS(A')	SS(A')
400				SL(A')
450				

●…Conductive polymer type ●…Organic semiconductor type

Ⅲ. SERIES SYSTEM DIAGRAM

■ESR Matrix

16V	20V	25V	30V	32V	35V	V / mΩ
						7
						8
						9
SEPC(F13)						10
SEPC(E12)						11
						12
						13
						14
SA(H)						15
SEQP(F13), SVP(F12), SEP(F13)						16
						17
SP(F)						18
						19
SEQP(E12), SVP(E12), SEP(E12), SP(E), SA(G)	SEQP(F13), SVP(F12), SEP(F13), SP(F)					20
						21
						22
						23
SVPA(C6)	SEQP(E12), SVP(E12), SEP(E12), SP(E)					24
SP(D)		SP(F)				25
SVPC(E7)						27
SA(F), SH(F)		SVPD(F12), SVP(F12), SEP(F13)				28
SVPA(F8)						29
SVPA(E7), SEQP(F8), SVP(F8), SEP(F8), SA(E), SVPC(C6), SH(E)	SP(D), SA(F), SH(F), SS(E, F),	SVPD(E12), SVP(E12), SEP(E12), SP(E)				30
SP(F')						32
SP(E')	SP(F')					34
SVPA(C6), SVPC(B6), SVP(F8)	SVPB(C55), SEP(F8)	SC(F)				35
	SP(E'), SA(E), SH(E)					36
SVPD(E7), SEQP(E7), SVP(E7), SVQP(E7), SVPB(C5), SEP(E7)	SEQP(F8), SVP(F8), SEP(F8), SA(E), SH(E)	SP(D), SC(E)				40
SVP(E7), SP(C)	SVPB(C5), SEQP(E7), SVP(E7), SVQP(E7), SEP(E7), SP(C)	SVPD(F8)				45
		SVPD(E7)				48
SEQP(C6), SVP(C6), SVQP(C6), SEP(C6), SP(C'), SS(D)	SP(C')	SVP(F8), SEP(F8)		SEQP(E12)	SVPD(E12)	50
		SP(C)				55
SA(D), SH(D)	SEQP(C6), SVP(C6), SVQP(C6), SEP(C6), SS(D)	SVP(E7), SEP(E7), SP(C')			SVPD(F8)	60
SL(F')		SVPD(C6)				65
SC(D), SA(C), SL(E'), SH(C)	SA(C, D), SH(C, D)	SC(D), SL(F'), SH(D)			SVPD(E7)	70
		SL(E')				75
		SVP(C6), SEP(C6)	SC(F)	SEQP(F8)		80
SVP(B6), SC(C)	SA(C), SH(C)	SC(C), SH(C)				90
SL(C'), SS(C')	SS(C')	SC(C), SL(C'), SH(C)		SEQP(E7)		100
			SC(E)			110
SVP(B6)	SVP(B6)		SC(D)			120
SC(B), SH(B), SS(B')						150
SC(B), SL(B'), SH(B),	SS(B')					180
		SC(B), SH(B)	SC(C)			200
						220
						240
SL(B')	SS(B')	SL(B')	SC(B)			250
SVP(A5)						260
SC(A), SH(A)						280
		SC(A), SH(A)	SC(B)			300
		SC(A), SH(A)	SC(A)			350
SL(A'), SS(A')	SS(A')	SL(A')				400
		SL(A')				450

●···Conductive polymer type ●···Organic semiconductor type

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SVPD Series

Guaranteed at 125°C, 85°C×85% guaranteed,Rated 35V, Rated 35V max.

The SVQP series guaranteed 125°C high voltage resistance was improved to a rated maximum of 35V.This product is very reliable, guaranteeing 85°C × 85% performance. Suitable for use in smoothing circuits of vehicle-mounted equipment, industrial equipment, etc.
This product can support lead free-reflow.(※2).

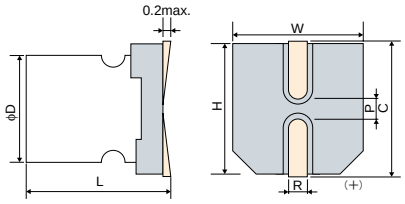
■Specifications

Marking : Polarity(⊖), Rated voltage, Capacitance, Lot.No.
(Purple) SVPD

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +125°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table1		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table1		
ESR	—	Less than or equal to the value of Table1		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	$Z / Z_{20°C}$	0.75 to 1.25
		+125°C	$Z / Z_{20°C}$	0.75 to 1.25
Endurance	125°C, 2,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		ESR	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	85°C, 85 to 90% RH, 1,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		ESR	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat ※2	(VPS) (230°C X 75s)	ΔC/C	Within ±10%	
		tanδ	1.3 times or less than an initial standard	
		ESR	1.3 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 125°C .
※2 Refer to Page 54 for reflow soldering conditions.

■Dimensions



(unit : mm)

Size Code	φD+0.5max.	L +0.1 -0.4	W±0.2	H±0.2	C±0.2	R	P±0.2
C6	6.3	5.9	6.6	6.6	7.3	0.5 to 0.8	2.1
E7	8.0	6.9	8.3	8.3	9.0	0.5 to 0.8	3.2
F8	10.0	7.9	10.3	10.3	11.0	0.5 to 0.8	4.6
E12	8.0	11.9	8.3	8.3	9.0	0.8 to 1.1	3.2
F12	10.0	12.6	10.3	10.3	11.0	0.8 to 1.1	4.6

■Size List

RV : Rated voltage
(SV) : Surge (125°C)

μF \ RV (SV)	10.0 (11.5)	16.0 (18.4)	25.0 (29.0)	35.0 (40.0)
8.2				E7
10			C6	
18				F8
22			E7	E12
39			F8	
47			E12	
56	C6			
82		E7	F12	

※For the minimum packing quantity, please refer to page 53.

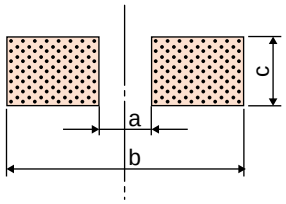
Ⅳ. SPECIFICATIONS FOR EACH SERIES

■Table1 SVPD Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current 100kHz (mArms) ※3 105℃<Tx≦125℃	Allowable ripple current 100kHz (mArms) ※3 Tx≦105℃	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C6	25SVPD10M	25	10	65	474	1500	0.10	50
	10SVPD56M	10	56	45	538	1700	0.12	112
E7	35SVPD8R2M	35	8.2	70	400	1300	0.10	57
	25SVPD22M	25	22	48	580	1835	0.10	110
	16SVPD82M	16	82	40	670	2120	0.12	262
F8	35SVPD18M	35	18	60	550	1800	0.10	126
	25SVPD39M	25	39	45	664	2100	0.10	195
E12	35SVPD22M	35	22	50	700	2300	0.12	154
	25SVPD47M	25	47	30	943	2980	0.12	235
F12	25SVPD82M	25	82	28	1202	3800	0.12	410

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 Tx : Ambient temperature

■Recommended land pattern dimension of PWB



(unit : mm)

Size Code	a	b	c
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
F8	4.3	13.1	1.9
E12	2.8	11.1	1.9
F12	4.3	13.1	1.9

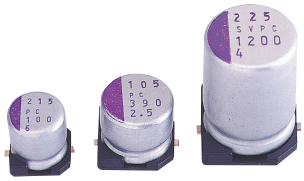
Frequency coefficient for ripple current

Frequency	120Hz≦ f <1kHz	1kHz≦ f <10kHz	10kHz≦ f <100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SVPC Series Large capacitance, low ESR



The SVPC series capacitor has larger capacitance than SVPA series.
Adopt this series to reduce the size of equipment and circuits.
This product can support lead free-reflow. (※2).

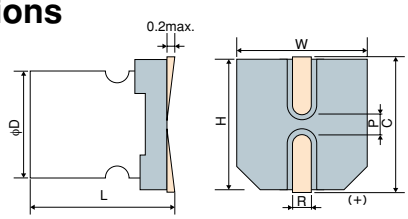
Marking : Polarity(⊖), Rated voltage (Purple) PC(B6, C6), SVPC(E7, E12), Rated capacitance, Lot.No.

■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55¡C to +105¡C		
Tolerance on rated capacitance	120Hz	M: –20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table5		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table5		
ESR	—	Less than or equal to the value of Table5		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55¡C	Z / Z 20¡C	0.75 to 1.25
		+105¡C	Z / Z 20¡C	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied	ΔC/C	Within –20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within –20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat ※2	(VPS) (230°C X 75s)	ΔC/C	Within –10% (–15% for 2.5V)	
		tanδ	1.3 times or less than an initial standard	
		ESR	1.3 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 105¡C .
※2 Refer to Page 54 for reflow soldering conditions.

■Dimensions



(unit : mm)

Size Code	φD+0.5max.	L +0.1 -0.4	W±0.2	H±0.2	C±0.2	R	P±0.2
B6	5.0	5.9	5.3	5.3	6.0	0.5 to 0.8	1.4
C6	6.3	5.9	6.6	6.6	7.3	0.5 to 0.8	2.1
E7	8.0	6.9	8.3	8.3	9.0	0.5 to 0.8	3.2
E12	8.0	11.9	8.3	8.3	9.0	0.8 to 1.1	3.2
F12	10.0	12.6	10.3	10.3	11.0	0.8 to 1.1	4.6

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	2.5 (3.3)	4 (5.2)	6.3 (8.2)	10.0 (11.5)	16.0 (18.4)
39					B6
68				B6	C6
100			B6		
120				C6	E7
150		B6			
180	B6				
220			C6		
270				E7	
330		C6			
390	C6		E7		
560		E7,E12			
680	E7				
820	E12		E12		
1200		E12			
1500	E12	E12			
2700	F12				

※For the minimum packing quantity, please refer to page 53.

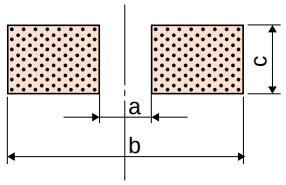
Ⅳ. SPECIFICATIONS FOR EACH SERIES

■Table5 SVPC Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR (mΩ) (max.)		Rated ripple current 100kHz (mArms) at 105℃	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
				100kHz	300kHz ※3			
B6	16SVPC39M	16	39	35	30	1820	0.12	300
	10SVPC68M	10	68	30	26	1970	0.12	300
	6SVPC100M	6.3	100	30	26	1970	0.12	300
	6SVPC100MY	6.3	100	25	21	2150	0.12	300
	4SVPC150M	4	150	30	26	1970	0.12	300
	4SVPC150MY	4	150	23	20	2240	0.12	300
	2R5SVPC180M	2.5	180	30	26	1970	0.12	300
	2R5SVPC180MY	2.5	180	24	20	2200	0.12	300
C6	16SVPC68M	16	68	30	26	2200	0.12	300
	10SVPC120M	10	120	27	23	2320	0.12	300
	6SVPC220M	6.3	220	27	23	2320	0.12	300
	6SVPC220MV	6.3	220	15	13	3110	0.12	300
	4SVPC330M	4	330	27	23	2320	0.12	300
	4SVPC330MY	4	330	21	18	2630	0.12	300
	2R5SVPC390M	2.5	390	25	22	2410	0.12	300
E7	16SVPC120M	16	120	27	23	2900	0.12	500
	10SVPC270M	10	270	22	19	3220	0.12	500
	6SVPC390M	6.3	390	22	19	3220	0.12	491
	4SVPC560M	4	560	22	19	3220	0.12	500
	2R5SVPC680M	2.5	680	20	17	3370	0.12	500
E12	6SVPC820M	6.3	820	12	10	4700	0.15	1033
	4SVPC560MX	4	560	9	8	5380	0.15	500
	4SVPC1200M	4	1200	12	10	4700	0.15	960
	4SVPC1500M	4	1500	12	10	4700	0.15	1200
	2R5SVPC820M	2.5	820	9	8	5380	0.15	500
	2R5SVPC1500M	2.5	1500	10	9	5150	0.15	750
F12	2R5SVPC2700M	2.5	2700	12	10	5080	0.15	1350

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 The ESR value in 300kHz is a reference one.

■Recommended land pattern dimension of PWB



(unit : mm)

Size Code	a	b	c
B6	1.4	7.4	1.6
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
E12	2.8	11.1	1.9
F12	4.3	13.1	1.9

Frequency coefficient for ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SVPB Series Low profile

This is a low profile series based on the SVPA series. Suitable for miniaturizing devices and circuits.
This product can support lead free-reflow (※2).

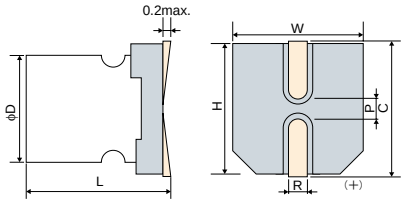
■Specifications

Marking : Polarity(⊖), Rated voltage, (Purple) PB Rated capacitance, Lot.No.

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M :±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table2		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table2		
ESR	—	Less than or equal to the value of Table2		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 1,000h, Rated voltage applied	ΔC/C	Within ±20% (±30% for C5 size)	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95% RH, 500h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat ※2	(VPS) (215°C X 90s)	ΔC/C	Within ±10% (±20% for C5 size)	
		tanδ	1.3 times or less than an initial standard	
		ESR	1.3 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 105°C .
※2 Refer to Page 54 for reflow soldering conditions.

■Dimensions



(unit : mm)

Size Code	φD+0.5max.	L +0.1 -0.4	W±0.2	H±0.2	C±0.2	R	P±0.2
C5	6.3	4.9	6.6	6.6	7.3	0.5 to 0.8	2.1
C55	6.3	5.4	6.6	6.6	7.3	0.5 to 0.8	2.1

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	2.5 (3.3)	4.0 (5.2)	6.3 (8.2)	10.0 (11.5)	16.0 (18.4)	20.0 (23.0)
15						C5
22						C55
33					C5	
56				C5		
82			C5			
100		C5				
120	C5					

※For the minimum packing quantity, please refer to page 53.

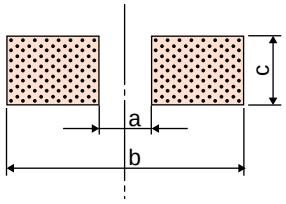
■Table2 SVPB Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current 100kHz (mArms) at 105°C	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C5	20SVPB15M	20	15	45	2000	0.12	120
	16SVPB33M	16	33	40	1670	0.12	211
	10SVPB56M	10	56	40	1670	0.12	224
	6SVPB82M	6.3	82	40	1670	0.12	207
	4SVPB100M	4	100	40	1670	0.12	160
	2R5SVPB120M	2.5	120	40	1670	0.12	120
C55	20SVPB22M	20	22	35	2000	0.12	88

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes

●The C5 size is also available upon request as a radial lead type. Please contact us if this type is required. Maximum height for radial lead types is 4.5 mm.
●The C55 size is also available upon request as 4V and 6.3V products.

■Recommended land pattern dimension of PWB



(unit : mm)

Size Code	a	b	c
C5	2.1	9.1	1.6
C55	2.1	9.1	1.6

Frequency coefficient for ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SVPA Series — Low ESR, Large ripple current

This is a low ESR series based on the SVP series. Suitable for miniaturizing devices and circuits.
This product can support lead free-reflow(※2).

Marking : Polarity(⊖), Rated voltage (Purple) PA(B6, C6), SVPA(E7, F8), Rated capacitance, Lot.No.

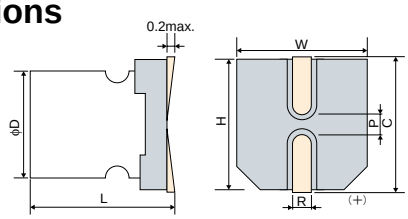
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table4		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table4		
ESR	—	Less than or equal to the value of Table4		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat ※2	(VPS) (230°C X 75s)	ΔC/C	Within ±10%	
		tanδ	1.3 times or less than an initial standard	
		ESR	1.3 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 105°C .
※2 Refer to Page 54 for reflow soldering conditions.

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	L +0.1 -0.4	W±0.2	H±0.2	C±0.2	R	P±0.2
B6	5.0	5.9	5.3	5.3	6.0	0.5 to 0.8	1.4
C6	6.3	5.9	6.6	6.6	7.3	0.5 to 0.8	2.1
E7	8.0	6.9	8.3	8.3	9.0	0.5 to 0.8	3.2
F8	10.0	7.9	10.3	10.3	11.0	0.5 to 0.8	4.6

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	2.5 (3.3)	4 (5.2)	6.3 (8.2)	10 (11.5)	16 (18.4)
39					C6
47			B6		
68		B6		C6	
82	B6				E7
120			C6		
150		C6		E7	
180	C6				F8
220			E7		
270		E7			
330	E7			F8	
470			F8		
680		F8			
820	F8				

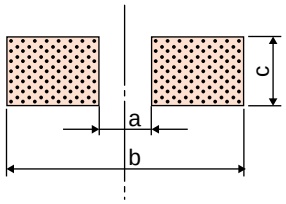
※For the minimum packing quantity, please refer to page 53.

■Table4 SVPA Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR (mΩ) (max.)		Rated ripple current 100kHz (mArms) at 105℃	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
				100kHz	300kHz ※3			
B6	6SVPA47MAA	6.3	47	30	26	1970	0.12	300
	4SVPA68MAA	4	68	30	26	1970	0.12	300
	2R5SVPA82MAA	2.5	82	30	26	1970	0.12	300
C6	16SVPA39MAA	16	39	35	31	2040	0.12	300
	16SVPA39MAAY	16	39	24	20	2460	0.12	300
	10SVPA68MAA	10	68	30	26	2200	0.12	300
	6SVPA120MAA	6.3	120	22	19	2570	0.12	300
	4SVPA150MAA	4	150	22	19	2570	0.12	300
	2R5SVPA180MAA	2.5	180	20	18	2690	0.12	300
E7	16SVPA82MAA	16	82	30	25	2760	0.12	262
	10SVPA150MAA	10	150	30	25	2760	0.12	500
	6SVPA220MAA	6.3	220	22	19	3220	0.12	500
	4SVPA270MAA	4	270	22	19	3220	0.12	500
	2R5SVPA330MAA	2.5	330	20	18	3370	0.12	500
F8	16SVPA180M	16	180	29	28	3430	0.12	576
	10SVPA330M	10	330	24	23	3770	0.12	660
	6SVPA470M	6.3	470	20	19	4130	0.12	592
	4SVPA680M	4	680	20	19	4130	0.12	544
	2R5SVPA820M	2.5	820	19	18	4240	0.12	500

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 The ESR value at 300kHz is a reference one.

■Recommended land pattern dimension of PWB



(unit : mm)

Size Code	a	b	c
B6	1.4	7.4	1.6
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
F8	4.3	13.1	1.9

Frequency coefficient for ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SVQP Series Guaranteed at 125°C

This series has advanced characteristics in resistance to heat compared with the SVP series. The SVQP series is best suited for devices that require enhanced reliability.
Following advantages of the improved heatproof characteristics, the SVQP series does not need derating on maximum ripple current. However, the series guarantees allowable ripple current differently in the temperature from 105°C to 125°C and in the temperature range lower than 105°C.
This product can support lead free-reflow.(※2).

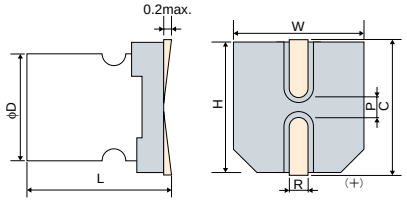
Marking : Polarity(⊖), Rated voltage
(Purple) QP, Rated capacitance, Lot.No.

■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +125°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table8		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table8		
ESR	—	Less than or equal to the value of Table8		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	$Z / Z_{20°C}$	0.75 to 1.25
		+125°C	$Z / Z_{20°C}$	0.75 to 1.25
Endurance	125°C, 1,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		ESR	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat ※2	(VPS) (230°C X 75s)	ΔC/C	Within ±10%	
		tanδ	1.3 times or less than an initial standard	
		ESR	1.3 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 125°C .
※2 Refer to Page 54 for reflow soldering conditions.

■Dimensions



(unit : mm)

Size Code	ϕD+0.5max.	L +0.1 -0.4	W±0.2	H±0.2	C±0.2	R	P±0.2
C6	6.3	5.9	6.6	6.6	7.3	0.5 to 0.8	2.1
E7	8.0	6.9	8.3	8.3	9.0	0.5 to 0.8	3.2

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	4 (5.2)	6.3 (8.2)	10 (11.5)	16 (18.4)	20 (23)
22					C6
39				C6	
47					E7
56			C6		
82		C6		E7	
100		C6			
120			E7		
150	C6	E7	E7		
220	E7	E7			

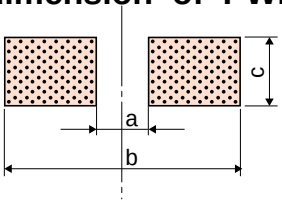
※For the minimum packing quantity, please refer to page 53.

■Table8 SVQP Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current 100kHz (mArms) ※3 105℃<Tx≦125℃	Allowable ripple current 100kHz (mArms) ※3 Tx≦105℃	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C6	20SVQP22M	20	22	60	459	1450	0.10	220
	16SVQP39M	16	39	50	512	1620	0.10	312
	10SVQP56M	10	56	45	538	1700	0.12	280
	6SVQP82M	6.3	82	45	538	1700	0.12	258
	6SVQP100M	6.3	100	40	572	1810	0.12	315
	4SVQP150M	4	150	40	572	1810	0.12	300
E7	20SVQP47M	20	47	45	598	1890	0.12	470
	16SVQP82M	16	82	40	670	2120	0.12	656
	10SVQP120M	10	120	35	810	2560	0.12	600
	10SVQP150M	10	150	35	810	2560	0.12	750
	6SVQP150M	6.3	150	35	810	2560	0.12	472
	6SVQP220M	6.3	220	35	810	2560	0.12	693
	4SVQP220M	4	220	35	810	2560	0.12	440

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 Tx : Ambient temperature

■Recommended land pattern dimension of PWB



(unit : mm)

Size Code	a	b	c
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9

Frequency coefficient for ripple current

Frequency	120Hz≦ f <1kHz	1kHz≦ f <10kHz	10kHz≦ f <100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SVP Series Standard SMD type

Standard SMD type product
Use for surface mounted type switching power supplies. The rated ripple current value is assured at 105°C, so that it is not necessary to apply a temperature correction coefficient such as that defined for other series.
This product can support lead free-reflow. (※2).

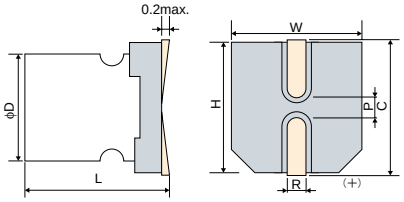
Marking : Polarity(⊖), Rated voltage, Lot.No.
(Purple) SVP(Upper E7), Rated capacitance.

■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M: ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table7		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table7		
ESR	—	Less than or equal to the value of Table7		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied (25V→20V applied)	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat ※2	(VPS) (230°C X 75s)	ΔC/C	Within ±10%	
		tanδ	1.3 times or less than an initial standard	
		ESR	1.3 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 2.5 to 20V products or 20V for 25V products for 120 minutes at 105°C .
※2 Refer to Page 54 for reflow soldering conditions.

■Dimensions



(unit : mm)

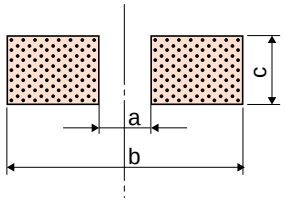
Size Code	ϕD+0.5max.	L +0.1 -0.4	W±0.2	H±0.2	C±0.2	R	P±0.2
A5	4.0	5.4	4.3	4.3	5.0	0.5 to 0.8	1.0
B6	5.0	5.9	5.3	5.3	6.0	0.5 to 0.8	1.4
C6	6.3	5.9	6.6	6.6	7.3	0.5 to 0.8	2.1
E7	8.0	6.9	8.3	8.3	9.0	0.5 to 0.8	3.2
F8	10.0	7.9	10.3	10.3	11.0	0.5 to 0.8	4.6
E12	8.0	11.9	8.3	8.3	9.0	0.8 to 1.1	3.2
F12	10.0	12.6	10.3	10.3	11.0	0.8 to 1.1	4.6

■Size List RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	2.5 (3.3)	4 (5.2)	6.3 (8.2)	10 (11.5)	16 (18.4)	20 (23.0)	25 (25.0)
3.3					A5		
4.7				A5			
6.8				A5			C6
10				A5		B6	E7
15				A5	B6		
22			A5		B6	C6	F8
27						C6	
33		A5		B6		E7	E12
39		B6			C6		
47			B6	C6		E7	
56				C6	E7	F8	F12
68		B6				F8	
82			C6		E7		
100			C6		F8	E12	
120			C6	E7			
150		C6,E7		E7,F8	F8	F12	
180					F8,E12		
220	C6		E7,F8				
270				F8			
330		E7	F8	F8,E12	F12		
470			F8,E12				
560		E12		F12			
680	E12	F8					
820			F12				
1200		F12					
1500	F12						

※For the minimum packing quantity, please refer to page 53.

■Recommended land pattern dimension of PWB



(unit : mm)

Size Code	a	b	c
A5	1.0	6.2	1.6
B6	1.4	7.4	1.6
C6	2.1	9.1	1.6
E7	2.8	11.1	1.9
F8	4.3	13.1	1.9
E12	2.8	11.1	1.9
F12	4.3	13.1	1.9

■Table7 SVP Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current (mArms)	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
A5	16SVP3R3M	16	3.3	260	660	0.07	26.4
	10SVP4R7M	10	4.7	240	670	0.08	23.5
	10SVP6R8M	10	6.8	240	670	0.09	34.0
	10SVP10M	10	10	220	700	0.10	50.0
	10SVP15M	10	15	200	740	0.10	75.0
	6SVP22M	6.3	22	200	740	0.12	69.3
	4SVP33M	4	33	200	740	0.15	66.0
B6	20SVP10M	20	10	120	1020	0.10	100
	16SVP15M	16	15	120	1020	0.10	120
	16SVP22M	16	22	90	1060	0.10	176
	10SVP33M	10	33	70	1100	0.12	165
	6SVP47M	6.3	47	70	1100	0.12	148
	4SVP39M	4	39	70	1100	0.12	78
	4SVP68M	4	68	60	1400	0.12	136
C6	25SVP6R8M	25	6.8	80	1200	0.10	85
	20SVP22M	20	22	60	1450	0.10	88
	20SVP27M	20	27	60	1450	0.10	108
	16SVP39M	16	39	50	1620	0.10	125
	10SVP47M	10	47	50	1620	0.12	94
	10SVP56M	10	56	45	1700	0.12	112
	6SVP82M	6.3	82	45	1700	0.12	103
	6SVP100M	6.3	100	40	1810	0.12	126
	6SVP120MV	6.3	120	17	2780	0.12	151
	4SVP150MX	4	150	40	1810	0.12	120
	2R5SVP220M	2.5	220	23	2390	0.12	110
E7	25SVP10M	25	10	60	1500	0.10	125
	20SVP33M	20	33	45	1890	0.12	132
	20SVP47M	20	47	45	1890	0.12	188
	16SVP56M	16	56	45	1890	0.12	179
	16SVP82M	16	82	40	2120	0.12	262
	10SVP120M	10	120	35	2560	0.12	240
	10SVP150MX	10	150	35	2560	0.12	300
	6SVP220MX	6.3	220	35	2560	0.12	277
	4SVP150M	4	150	35	2560	0.12	120
	4SVP330M	4	330	35	2560	0.12	264
F8	25SVP22M	25	22	50	2000	0.10	275
	20SVP56M	20	56	40	2400	0.12	224
	20SVP68M	20	68	40	2400	0.12	272
	16SVP100M	16	100	35	2670	0.12	320
	16SVP150M	16	150	30	3020	0.12	480
	16SVP180MX	16	180	30	3020	0.12	576
	10SVP150M	10	150	30	3020	0.12	300
	10SVP270M	10	270	25	3700	0.12	540
	10SVP330MX	10	330	25	3700	0.12	660
	6SVP220M	6.3	220	25	3700	0.12	277
	6SVP330M	6.3	330	25	3700	0.12	416
	6SVP470MX	6.3	470	25	3700	0.12	592
	4SVP680M	4	680	25	3700	0.12	544
E12	25SVP33M	25	33	30	2980	0.12	413
	20SVP100M	20	100	24	3320	0.15	400
	16SVP180M	16	180	20	3640	0.15	576
	10SVP330M	10	330	17	3950	0.15	660
	6SVP470M	6.3	470	15	4210	0.15	592
	4SVP560M	4	560	13	4520	0.15	448
	2R5SVP680M	2.5	680	13	4520	0.15	340
F12	25SVP56M	25	56	28	3800	0.12	700
	20SVP150M	20	150	20	4320	0.15	600
	16SVP330M	16	330	16	4720	0.15	792
	10SVP560M	10	560	13	5230	0.15	840
	6SVP820M	6.3	820	12	5440	0.15	775
	4SVP1200M	4	1200	12	5440	0.18	960
	2R5SVP1500M	2.5	1500	12	5440	0.18	750

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes

Frequency coefficient for ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SEPC Series Large capacitance, low ESR

This is an even lower ESR series based on our SEP series. Suitable for use with motherboards, servers, VGA, etc.
Lead free-flow is supported.

■Specifications

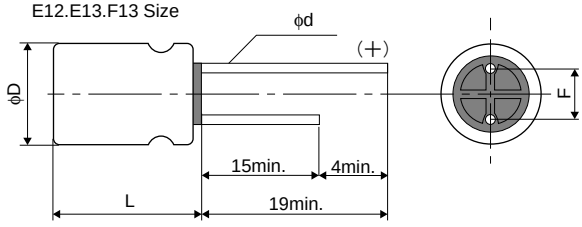
Marking (Purple) : Polarity(⊖), Rated voltage, Rated Capacitance SANYO, **OS-CON**, Lot.No. SEPC.

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table3		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table3		
ESR	—	Less than or equal to the value of Table3		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	$Z / Z_{20°C}$	0.75 to 1.25
		+105°C	$Z / Z_{20°C}$	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90% RH, 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	Below an initial standard	
		ESR	Below an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

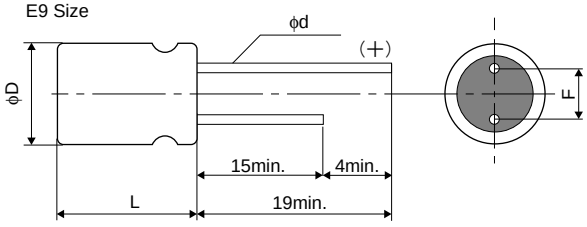
※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 105°C .

■Dimensions

E12.E13.F13 Size



E9 Size



E9 size flat rubber is used.

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

μF \ RV (SV)	2.5 (3.3)	4.0 (5.2)	6.3 (8.2)	16.0 (18.4)
270				E12
470			E9 , E13	F13
560	E9	E9 , E13		
680		E13	F13	
820	E9 , E13	F13		
1500			F13	
2700	F13			

※For the minimum packing quantity, please refer to page 51.

(unit : mm)

Size Code	φD+0.5max.	Lmax.	F	φd±0.05
E9	8.0	9.0	3.5±0.5	0.6
E12	8.0	12.0	3.5±0.5	0.6
E13	8.0	13.0	3.5±0.5	0.6
F13	10.0	13.0	5.0±0.5	0.6

Ⅳ. SPECIFICATIONS FOR EACH SERIES

■Table3 SEPC Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current 100kHz (mArms) at 105℃	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
E9	6SEPC470MX	6.3	470	8	5700	0.10	592
	4SEPC560MX	4	560	7	6100	0.10	500
	2SEPC560MX	2.5	560	8	4700	0.10	280
	2SEPC820MX	2.5	820	7	6100	0.10	500
E12	16SEPC270M	16	270	11	5000	0.10	864
E13	6SEPC470M	6.3	470	8	5700	0.10	592
	4SEPC560M	4	560	7	6100	0.10	500
	4SEPC680M	4	680	7	6100	0.10	544
	2R5SEPC820M	2.5	820	7	6100	0.10	500
F13	16SEPC470M	16	470	10	6100	0.10	1504
	6SEPC680M	6.3	680	7	6640	0.10	857
	6SEPC1500M	6.3	1500	10	5560	0.10	1890
	4SEPC820M	4	820	7	6640	0.10	656
	2SEPC2700M	2.5	2700	10	5560	0.10	1350

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes

Frequency coefficient for ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SEQP Series 125°C guaranteed, 32V product

This series has advanced characteristics in resistance to heat compared with the SEP series, and adds a rated voltage of 32V. Suitable for use in increasing device reliability, 32V products may be used on 16 to 24V line industrial devices.
Lead free-flow is supported.

■Specifications

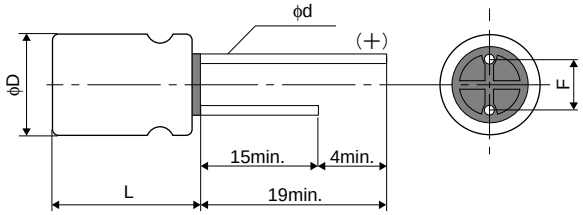
Marking : Polarity(⊖), Rated voltage
(Purple) SEQP, Rated capacitance, Lot.No.

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +125°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table6		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table6		
ESR	—	Less than or equal to the value of Table6		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+125°C	Z / Z 20°C	0.75 to 1.25
Endurance	125°C, 1,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		ESR	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95% RH, 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	Below an initial standard	
		ESR	Below an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 120 minutes at 125°C .

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	Lmax.	F	φd±0.05
C6	6.3	6.0	2.5±0.5	0.45
E7	8.0	7.0	3.5±0.5	0.45
F8	10.0	8.0	5.0±0.5	0.50
E12	8.0	12.0	3.5±0.5	0.60
F13	10.0	13.0	5.0±0.5	0.60

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	4.0 (5.2)	6.3 (8.4)	10 (11.5)	16 (18.4)	20 (23)	32 (37)
6.8						E7
15						F8
18						E12
22					C6	
39				C6		
47					E7	
56			C6			
68					F8	
82		C6		E7		
100					E12	
120			E7			
150	C6	E7		F8	F13	
180				E12		
270			F8			
330	E7	F8	E12	F13		
470		E12				
560	E12		F13			
680	F8					
820		F13				
1200	F13					

※For the minimum packing quantity, please refer to page 51.

■Table6 SEQP Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current 100kHz (mArms) ※3 105°C<Tx≦125°C	Allowable ripple current 100kHz (mArms) ※3 Tx≦105°C	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C6	20SEQP22M	20	22	60	458	1450	0.10	220
	16SEQP39M	16	39	50	512	1620	0.10	312
	10SEQP56M	10	56	45	537	1700	0.12	280
	6SEQP82M	6.3	82	45	537	1700	0.12	258
	4SEQP150M	4	150	40	572	1810	0.12	300
E7	32SEQP6R8M	32	6.8	100	440	1400	0.10	44
	20SEQP47M	20	47	45	598	1890	0.12	470
	16SEQP82M	16	82	40	670	2120	0.12	656
	10SEQP120M	10	120	35	810	2560	0.12	600
	6SEQP150M	6.3	150	35	810	2560	0.12	472
	4SEQP330M	4	330	35	810	2560	0.12	660
F8	32SEQP15M	32	15	80	560	1800	0.10	96
	20SEQP68M	20	68	40	759	2400	0.12	272
	16SEQP150M	16	150	30	955	3020	0.12	480
	10SEQP270M	10	270	25	1170	3700	0.12	540
	6SEQP330M	6.3	330	25	1170	3700	0.12	416
	4SEQP680M	4	680	25	1170	3700	0.12	544
E12	32SEQP18M	32	18	50	790	2500	0.12	115
	20SEQP100M	20	100	24	1050	3320	0.15	400
	16SEQP180M	16	180	20	1151	3640	0.15	576
	10SEQP330M	10	330	17	1250	3950	0.15	660
	6SEQP470M	6.3	470	15	1332	4210	0.15	592
	4SEQP560M	4	560	13	1430	4520	0.15	448
F13	20SEQP150M	20	150	20	1367	4320	0.15	600
	16SEQP330M	16	330	16	1493	4720	0.15	792
	10SEQP560M	10	560	13	1655	5230	0.15	840
	6SEQP820M	6.3	820	12	1721	5440	0.15	775
	4SEQP1200M	4	1200	12	1721	5440	0.18	960

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 Tx : Ambient temperature

Frequency coefficient for ripple current

Frequency	120Hz≦ f <1kHz	1kHz≦ f <10kHz	10kHz≦ f <100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

Conductive polymer type

SEP Series — Standard radial lead type, Guaranteed at 105°C for 3,000h

This is a radial lead type using conductive polymer based on the SVP series.
Because of its improved heat-proof characteristics, the rated ripple current values are guaranteed at 105°C. Furthermore, there is no need to apply a temperature-compensating coefficient.
Lead free-flow is supported.

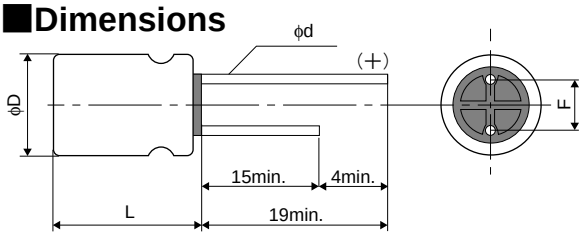
Marking : Polarity(⊖), Rated voltage, Rated capacitance (Purple) Lot.No., SEP

■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M :±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table9		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table9		
ESR	—	Less than or equal to the value of Table9		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	$Z / Z_{20°C}$	0.75 to 1.25
		+105°C	$Z / Z_{20°C}$	0.75 to 1.25
Endurance	105°C, 3,000h, Rated voltage applied (2.5V→2,000h), (25V→20V applied)	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		ESR	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	Below an initial standard	
		ESR	Below an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 2.5 to 20V products or temperature derating voltage for 25V products for 120 minutes at 105°C .

■Dimensions



(unit : mm)

Size Code	φD+0.5max.	Lmax.	F	φd±0.05
C6	6.3	6.0	2.5±0.5	0.45
E7	8.0	7.0	3.5±0.5	0.45
F8	10.0	8.0	5.0±0.5	0.50
E12	8.0	12.0	3.5±0.5	0.60
F13	10.0	13.0	5.0±0.5	0.60

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	2.5 (3.3)	4 (5.2)	6.3 (8.2)	10 (11.5)	16 (18.4)	20 (23.0)	25 (25.0)
6.8							C6
10							E7
22						C6	F8
33						E7	E12
39					C6		
47						E7	
56				C6		F8	F13
68						F8	
82			C6		E7		
100		C6				F8,E12	
120				E7			
150		C6	E7		F8	F13	
180					E12		
220		E7					
270				F8			
330		E7	F8	E12	F13		
470		F8	E12				
560		E12		F13			
680	E12	F8					
820			F13				
1200		F13					
1500	F13						

※For the minimum packing quantity, please refer to page 51.

Ⅳ. SPECIFICATIONS FOR EACH SERIES

■Table9 SEP Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Rated ripple current 100kHz (mArms) at 105℃	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C6	25SEP6R8M	25	6.8	80	1200	0.10	170
	20SEP22M	20	22	60	1450	0.10	220
	16SEP39M	16	39	50	1620	0.10	312
	10SEP56M	10	56	45	1700	0.12	280
	6SEP82M	6.3	82	45	1700	0.12	258
	4SEP100M	4	100	40	1810	0.12	200
	4SEP150M	4	150	40	1810	0.12	300
E7	25SEP10M	25	10	60	1500	0.10	250
	20SEP33M	20	33	45	1890	0.12	330
	20SEP47M	20	47	45	1890	0.12	470
	16SEP82M	16	82	40	2120	0.12	656
	10SEP120M	10	120	35	2560	0.12	600
	6SEP150M	6.3	150	35	2560	0.12	472
	4SEP220M	4	220	35	2560	0.12	440
	4SEP330M	4	330	35	2560	0.12	660
F8	25SEP22M	25	22	50	2000	0.10	275
	20SEP56M	20	56	40	2400	0.12	224
	20SEP68M	20	68	40	2400	0.12	272
	20SEP100MX	20	100	35	2570	0.12	400
	16SEP150M	16	150	30	3020	0.12	480
	10SEP270M	10	270	25	3700	0.12	540
	6SEP330M	6.3	330	25	3700	0.12	416
	4SEP470M	4	470	25	3700	0.12	376
	4SEP680M	4	680	25	3700	0.12	544
E12	25SEP33M	25	33	30	2980	0.12	413
	20SEP100M	20	100	24	3320	0.15	400
	16SEP180M	16	180	20	3640	0.15	576
	10SEP330M	10	330	17	3950	0.15	660
	6SEP470M	6.3	470	15	4210	0.15	592
	4SEP560M	4	560	13	4520	0.15	448
	2R5SEP680M	2.5	680	13	4520	0.15	340
F13	25SEP56M	25	56	28	3800	0.12	700
	20SEP150M	20	150	20	4320	0.15	600
	16SEP330M	16	330	16	4720	0.15	792
	10SEP560M	10	560	13	5230	0.15	840
	6SEP820M	6.3	820	12	5440	0.15	775
	4SEP1200M	4	1200	12	5440	0.18	960
	2R5SEP1500M	2.5	1500	12	5440	0.18	750

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes

Frequency coefficient for ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.3	0.7	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

SF Series

●Radial lead type.
5mm height (max.)

SPA Series

●Radial lead type.
Low ESL and low ESR

The SF series is low-profile, having a maximum height of 5mm. Use this series for smooth power supply of notebook PCs.
The SPA series is a lower ESL and ESR based on the SP series. Use this series for motherboards, etc.

Common to SF series and SPA series
Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance SANYO, **OS-CON**, Lot.No.
Upper category temp.(105°C)

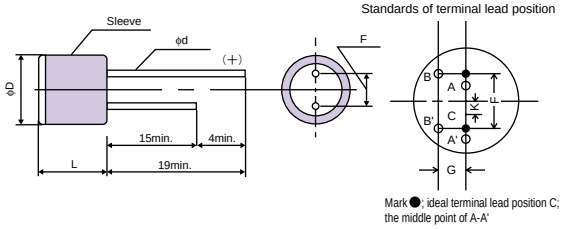
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of SF : Table10, SPA : Table11		
Leakage current ※1	After 2 minutes	Less than or equal to the value of SF : Table10, SPA : Table11		
ESR	—	Less than or equal to the value of SF : Table10, SPA : Table11		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, No-applied voltage SF : 500h SPA : 1,000h	ΔC/C	Within ±20% for SF (10% for SPA)	
		tanδ	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 30 minutes at 105°C .

■Dimensions

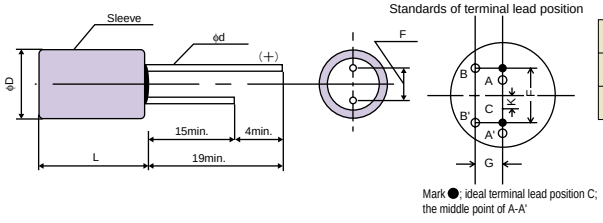
SF series



(unit : mm)

Size Code	φD+0.5max.	Lmax.	F	φd±0.05
E1	8.0	5.0	3.5±0.5	0.6

SPA series



(unit : mm)

Size Code	φD+0.5max.	Lmax.	F	φd±0.05
9E	8.0	10.0	3.5±0.5	0.6
9F	10.0	10.0	5.0±0.5	0.6

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

SF series

μF \ RV (SV)	4.0 (5.2)	6.3 (8.2)
150		E1
220	E1	

SPA series

μF \ RV (SV)	4.0 (5.2)
560	9E
820	9F

※For the minimum packing quantity, please refer to page 51.

■Table10 SF Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms)※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
E1	6SF150M	6.3	150	32	2420	0.07	189
	4SF220M	4	220	30	2510	0.07	176

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 100kHz, +45°C

■Table11 SPA Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms)※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
9E	4SPA560M	4	560	12	4080	0.08	224
9F	4SPA820M	4	820	11	5040	0.08	328

※1 Capacitance tolerance : M ±20%
※2 After 2 minutes
※3 100kHz, +45°C

Approximate ESL values (unit : nH)

Size Code	Model	at 10MHz	at 40MHz	
9E	4SPA560M	2.6	2.4	Approx. 36% down
E	4SP560M	4	3.8	
9F	4SPA820M	3.6	3.4	Approx. 33% down
F	4SP820M	5.3	5.1	

※measuring position：roof of lead terminal
※All above values are not gurranteed, and there are some cases that the values differ in the measuring way. Please contact SANYO for detail.

Temperature coefficient for allowable ripple current

Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

SP Series — Large Capacitance, Low ESR Optimum for Audio etc.

The characteristics of SP series are large capacitance (about 2 times of previous value) and low ESR (about half of previous value). It is optimum to use around MPU of computer equipment. Also, suitable for audio because OFC is used as the lead wires.

Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance
SANYO, **OS-CON**, Lot.No., Series name
Upper category temp.(105°C)

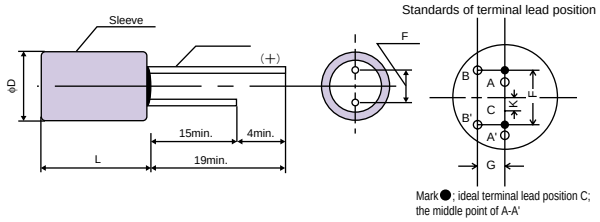
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table12		
Leakage current ※2	After 2 minutes	Less than or equal to the value of Table12		
ESR	—	Less than or equal to the value of Table12		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	$Z / Z_{20°C}$	0.75 to 1.25
		+105°C	$Z / Z_{20°C}$	0.75 to 1.25
Endurance ※3	105°C, 1,000 to 2,000h Rated voltage applied (25V→20V applied) ※1	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 Please reduce 0.25V per 1°C from over 85°C for 25V products.
※2 In case of some problems for measured values, measure after applying rated voltage for 2 to 20V products or temperature derating voltage for 25V products for 30 minutes at 105°C .
※3 C', E', F', C, D size : 1,000h. E, F, F_0, G size : 2,000h. (2V, 25V, 4SP1000M, 2R5SP1200M : 1,000h)

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	Lmax.	F	φd±0.05	Gmax.	Kmax.
C'	6.3	6.0	2.5±0.5	0.60	0.5	0.5
E'	8.0	6.0	3.5±0.5	0.60	0.8	0.8
F'	10.0	6.0	5.0±0.5	0.60	0.8	0.8
C	6.3	7.8	2.5±0.5	0.60	0.5	0.5
D	6.3	10.8	2.5±0.5	0.60	0.5	0.5
E	8.0	11.5	3.5±0.5	0.60	0.8	0.8
F	10.0	11.5	5.0±0.5	0.60	0.8	0.8
F_0	10.0	21.0	5.0±0.5	0.80	0.8	0.8
G	12.5	23.0	5.0±1.0	0.80	0.8	0.8

■Size List

RV : Rated voltage (SV) : Surge (room temperature)

μF \ RV (SV)	2 (2.6)	2.5 (3.3)	4 (5.2)	6.3 (8.2)	10 (11.5)	16 (18.4)	20 (23.0)	25 (25.0)
6.8								C'
10								C
18								D
22							C'	
33						C'	C	E
47						C	E'	
56					C'			F
68				C'		E'	F',D	
82					C			
100			C'		E'	F',D		
120				C			E	
150			C	E'	D			
180					F'	E	F	
220			E'	F',D				
270			D		E	F		
330			F'					
390				E				
470					F			
560			E					
680				F				
820			F					
1000	F		F					
1200		F						
1500			F_0					
1800	F_0							
2200			G					

※For the minimum packing quantity, please refer to page 51.

Ⅳ. SPECIFICATIONS FOR EACH SERIES

■Table12 SP Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms) ※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C'	25SP6R8M	25	6.8	60	1510	0.06	17.00
	20SP22M	20	22	50	1580	0.06	44.00
	16SP33M	16	33	50	1580	0.06	52.80
	10SP56M	10	56	45	1710	0.06	56.00
	6SP68M	6.3	68	40	1850	0.06	42.84
	4SP100M	4	100	40	1850	0.06	40.00
E'	20SP47M	20	47	36	2210	0.07	94.00
	16SP68M	16	68	34	2280	0.07	108.80
	10SP100M	10	100	32	2350	0.07	100.00
	6SP150M	6.3	150	30	2420	0.07	94.50
	4SP220M	4	220	28	2510	0.07	88.00
F'	20SP68M	20	68	34	2800	0.07	136.00
	16SP100M	16	100	32	2890	0.07	160.00
	10SP180M	10	180	29	2990	0.07	180.00
	6SP220M	6.3	220	28	3100	0.07	138.60
	4SP330M	4	330	24	3230	0.07	132.00
C	25SP10M	25	10	55	1560	0.07	25.00
	20SP33M	20	33	45	1710	0.07	66.00
	16SP47M	16	47	45	1710	0.07	75.20
	10SP82M	10	82	40	1850	0.07	82.00
	6SP120M	6.3	120	35	1930	0.07	75.60
	4SP150M	4	150	35	1930	0.07	60.00
D ※4	25SPS18M	25	18	40	2230	0.08	45.00
	20SPS68M	20	68	30	2580	0.08	136.00
	16SPS100M	16	100	25	2820	0.08	160.00
	10SPS150M	10	150	25	2820	0.08	150.00
	6SPS220M	6.3	220	20	3160	0.08	138.60
	4SPS270M	4	270	20	3160	0.08	108.00
E	25SP33M	25	33	30	2780	0.08	82.50
	20SP120M	20	120	24	3110	0.08	240.00
	16SP180M	16	180	20	3410	0.08	288.00
	10SP270M	10	270	18	3600	0.08	270.00
	6SP390M	6.3	390	16	3810	0.08	245.70
	4SP560M	4	560	14	4080	0.08	224.00
F	25SP56M	25	56	25	3260	0.08	140.00
	20SP180M	20	180	20	4280	0.08	360.00
	16SP270M	16	270	18	4400	0.08	432.00
	10SP470M	10	470	15	4510	0.08	470.00
	6SP680M	6.3	680	13	4840	0.08	428.40
	4SP820M	4	820	12	5040	0.08	328.00
	4SP1000M	4	1000	12	5040	0.08	400.00
	2R5SP1200M	2.5	1200	12	5040	0.08	450.00
	2SP1000M	2	1000	11	5260	0.08	400.00
F_0	4SP1500M	4	1500	8	6500	0.10	600.00
	2SP1800M	2	1800	8	6500	0.10	720.00
G	4SP2200M	4	2200	9	7100	0.12	880.00

※1 Tolerance on rated capacitance : M ±20%
※2 After 2 minutes
※3 100kHz, +45°C
※4 D size is SPS series.

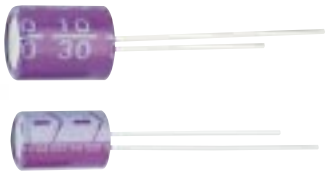
Temperature coefficient for allowable ripple current

Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

SC Series Standard Products



Suitable for noise limiters and switching power supplies that make a point of high frequency characteristics. Also, make use of it when needed long life span and high reliability.

Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance
SANYO, **OS-CON**, Lot.No.
Upper category temp.(105°C)

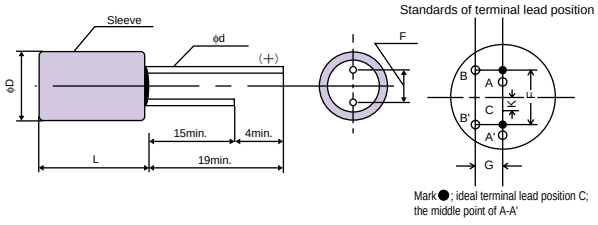
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table13		
Leakage current ※2	After 2 minutes	Less than or equal to the value of Table13		
ESR	—	Less than or equal to the value of Table13		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	$Z / Z_{20°C}$	0.75 to 1.25
		+105°C	$Z / Z_{20°C}$	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied (25V→20V applied) ※1	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within ±10%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	Below an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 Please reduce 0.25V per 1°C from over 85°C for 25V products.
※2 In case of some problems for measured values, measure after applying rated voltage for 6.3 to 16 and 30V products or temperature derating voltage for 25V products for 30 minutes at 105°C.

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	Lmax.	F	φd±0.05	Gmax.	Kmax.
A	4.0	7.8	2.0±0.5	0.45	0.5	0.5
B	5.0	7.8	2.0±0.5	0.45	0.5	0.5
C	6.3	7.8	2.5±0.5	0.45	0.5	0.5
D	6.3	10.8	2.5±0.5	0.60	0.5	0.5
E	8.0	11.5	3.5±0.5	0.60	0.8	0.8
F	10.0	11.5	5.0±0.5	0.60	0.8	0.8

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

μF \ RV (SV)	6.3 (7.2)	10 (11.5)	16 (18.4)	25 (25.0)	30 (34.5)
1.0				A	A
1.5				A	B
2.2			A	B	B
3.3			A	B	C
4.7		A	B	C	D
6.8	A		B	C	D
10		B		C	E
15	B		C	D	
22		C	D	E	F
33	C		D	F	
47		D		F	

※For the minimum packing quantity, please refer to page 51.

■Table13 SC Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms) ※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
A	30SC1M	30	1.0	350	430	0.03	1.00
	25SC1M	25	1.0	350	430	0.03	0.50
	25SC1R5M	25	1.5	300	435	0.03	0.50
	16SC2R2M	16	2.2	280	450	0.04	0.50
	16SC3R3M	16	3.3	280	500	0.04	0.53
	10SC4R7M	10	4.7	280	540	0.05	0.50
	6SC6R8M	6.3	6.8	250	560	0.05	0.50
B	30SC1R5M	30	1.5	300	435	0.03	1.00
	30SC2R2M	30	2.2	250	695	0.03	1.32
	25SC2R2M	25	2.2	200	695	0.03	0.55
	25SC3R3M	25	3.3	200	700	0.03	0.83
	16SC4R7M	16	4.7	180	720	0.04	0.75
	16SC6R8M	16	6.8	150	745	0.04	1.09
	10SC10M	10	10	150	780	0.05	1.00
	6SC15M	6.3	15	120	815	0.05	0.95
C	30SC3R3M	30	3.3	200	820	0.03	1.98
	25SC4R7M	25	4.7	100	1130	0.03	1.18
	25SC6R8M	25	6.8	100	1140	0.03	1.70
	25SC10M	25	10	90	1150	0.03	2.50
	16SC15M	16	15	90	1230	0.04	2.40
	10SC22M	10	22	70	1270	0.05	2.20
	6SC33M	6.3	33	70	1320	0.05	2.08
D	30SC4R7M	30	4.7	120	1300	0.04	2.82
	30SC6R8M	30	6.8	120	1340	0.04	4.08
	25SC15M	25	15	70	1650	0.04	3.75
	16SC22M	16	22	70	1800	0.05	3.52
	16SC33M	16	33	70	1900	0.06	5.28
	10SC47M	10	47	60	2020	0.06	4.70
E	30SC10M	30	10	110	1380	0.06	6.00
	25SC22M	25	22	40	2330	0.06	5.50
F	30SC22M	30	22	80	1830	0.06	13.20
	25SC33M	25	33	35	2900	0.06	8.25
	25SC47M	25	47	35	2980	0.06	11.75

※1 Tolerance on rated capacitance : M ±20%, Product “K” (Tolerance on rated capacitance : ±10%) is optionally available.
※2 After 2 minutes
※3 100kHz, +45°C

Temperature coefficient for allowable ripple current

Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

SA Series — Large capacitance and miniaturized products

SA series is miniaturized SC series with large capacitance. Suitable for high frequency switching power supplies, etc.

Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance SANYO, **OS-CON**, Lot.No.
Upper category temp.(105°C)

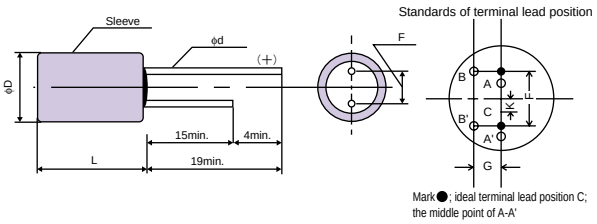
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table14		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table14		
ESR	—	Less than or equal to the value of Table14		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH, 1,000h, No-applied voltage	ΔC/C	Within ±10%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	Below an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 30 minutes at 105°C.

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	Lmax.	F	φd±0.05	Gmax.	Kmax.
C	6.3	7.8	2.5±0.5	0.45	0.5	0.5
D	6.3	10.8	2.5±0.5	0.60	0.5	0.5
E	8.0	11.5	3.5±0.5	0.60	0.8	0.8
F	10.0	11.5	5.0±0.5	0.60	0.8	0.8
G	12.5	23.0	5.0±1.0	0.80	0.8	0.8
H	16.0	26.0	7.5±1.0	0.80	0.8	0.8

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

μF \ RV (SV)	6.3 (7.2)	10 (11.5)	16 (18.4)	20 (23.0)
15				C
22				C
33			C	D
47	C		D	E
68		D		E
100			E	F
150	E		F	
220		F		
330	F			
470			G	
1000			H	
2200	H			

※For the minimum packing quantity, please refer to page 51.

■Table14 SA Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms) ※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
C	20SA15M	20	15	90	1200	0.06	6.00
	20SA22M	20	22	70	1300	0.06	8.80
	16SA33M	16	33	70	1370	0.06	10.56
	6SA47M	6.3	47	60	1430	0.07	5.92
D	20SA33M	20	33	70	1710	0.06	13.20
	16SA47M	16	47	60	1830	0.06	15.04
	10SA68M	10	68	50	2000	0.07	13.60
E	20SA47M	20	47	40	2450	0.06	18.80
	20SA68M	20	68	36	2600	0.06	27.20
	16SA100M	16	100	30	2740	0.06	32.00
	6SA150M	6.3	150	30	2780	0.07	18.90
F	20SA100M	20	100	30	3210	0.06	40.00
	16SA150M	16	150	28	3260	0.06	48.00
	10SA220M	10	220	27	3370	0.07	44.00
	6SA330M	6.3	330	25	3500	0.07	41.58
G	16SA470M	16	470	20	6080	0.08	300.80
H	16SA1000M	16	1000	15	9750	0.09	640.00
	6SA2200M	6.3	2200	15	9750	0.13	554.40

※1 Tolerance on rated capacitance : M ±20%, Product “K” (Tolerance on rated capacitance : ±10%) is optionally available. However, the exception regarding G and H size.
※2 After 2 minutes
※3 100kHz, +45°C

Temperature coefficient for allowable ripple current

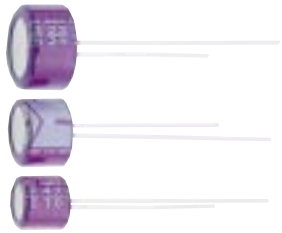
Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

Ⅳ. SPECIFICATIONS FOR EACH SERIES

SL Series Low-profile products.



The SL series is low profile with a category upper limit temperature of 105°C. Use the SL series for compact and slim designs, such as VTRs, video cameras, car stereos, etc.

Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance SANYO, **OS-CON**, Lot.No. Upper category temp.(105°C)

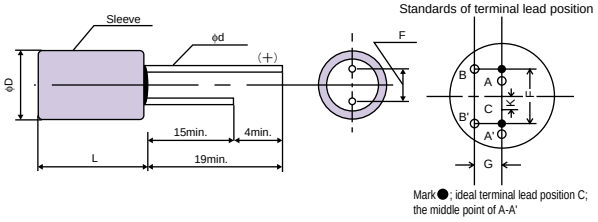
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table15		
Leakage current ※2	After 2 minutes	Less than or equal to the value of Table15		
ESR	—	Less than or equal to the value of Table15		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 2,000h, Rated voltage applied (E', F' size ; 1,000h) (25V→20V applied) ※1	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 Please reduce 0.25V per 1°C from over 85°C for 25V products.
※2 In case of some problems for measured values, measure after applying rated voltage for 4 to 16V products or temperature derating voltage for 25V products for 30 minutes at 105°C.

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	Lmax.	F	φd±0.05	Gmax.	Kmax.
A'	4.0	6.0	1.5±0.5	0.45	0.5	0.5
B'	5.0	6.0	2.0±0.5	0.45	0.5	0.5
C'	6.3	6.0	2.5±0.5	0.45	0.5	0.5
E'	8.0	6.0	3.5±0.5	0.50	0.8	0.8
F'	10.0	6.0	5.0±0.5	0.50	0.8	0.8

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

μF \ RV (SV)	4 (4.6)	6.3 (7.2)	10 (11.5)	16 (18.4)	25 (25.0)
1.0					A'
1.5					A'
2.2				A'	B'
3.3				A'	B'
4.7			A'	B'	C'
6.8		A'		B'	C'
10			B'	C'	
15		B'		C'	E'
22			C'		F'
33			C'		
47			C'	E'	
68			E'	F'	
100		E'	F'		
150	E'	F'			
220	F'				

※For the minimum packing quantity, please refer to page 51.

■Table15 SL Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms) ※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
A'	25SL1M	25	1	450	430	0.05	0.50
	25SL1R5M	25	1.5	400	435	0.05	0.75
	16SL2R2M	16	2.2	400	450	0.05	0.70
	16SL3R3M	16	3.3	400	500	0.06	1.06
	10SL4R7M	10	4.7	400	540	0.06	0.94
	6SL6R8M	6.3	6.8	350	560	0.06	0.86
B'	25SL2R2M	25	2.2	250	695	0.05	1.10
	25SL3R3M	25	3.3	250	700	0.05	1.65
	16SL4R7M	16	4.7	250	720	0.05	1.50
	16SL6R8M	16	6.8	180	745	0.05	2.18
	10SL10M	10	10	150	780	0.05	2.00
	6SL15M	6.3	15	120	815	0.06	1.89
C'	25SL4R7M	25	4.7	100	1130	0.06	2.35
	25SL6R8M	25	6.8	100	1140	0.06	3.40
	16SL10M	16	10	100	1150	0.06	3.20
	16SL15M	16	15	100	1230	0.06	4.80
	10SL22M	10	22	80	1270	0.06	4.40
	10SL33M	10	33	80	1350	0.06	6.60
	10SL47M	10	47	70	1430	0.06	9.40
E'	25SL15M	25	15	75	1400	0.07	7.50
	16SL47M	16	47	70	1550	0.07	15.04
	10SL68M	10	68	65	1600	0.07	13.60
	6SL100M	6.3	100	65	1600	0.07	12.60
	4SL150M	4	150	60	2000	0.07	12.00
F'	25SL22M	25	22	70	1600	0.07	11.00
	16SL68M	16	68	65	1850	0.07	21.76
	10SL100M	10	100	60	2100	0.07	20.00
	6SL150M	6.3	150	60	2100	0.07	18.90
	4SL220M	4	220	55	2400	0.07	17.60

※1 Tolerance on rated capacitance : M ±20%,
Product “K” (Tolerance on rated capacitance : ±10%) is optionally available except for E' and F' size.
※2 After 2 minutes
※3 100kHz, +45°C

Temperature coefficient for allowable ripple current

Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

SH Series Long Life (105°C X 5,000h)

SH series has a long life (guaranteed at 105°C for 5,000h) with keeping high frequency characteristics. Suitable for industrial equipment which needed high reliability.

Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance
SANYO, **OS-CON**, Lot.No., Series name
Upper category temp.(105°C)

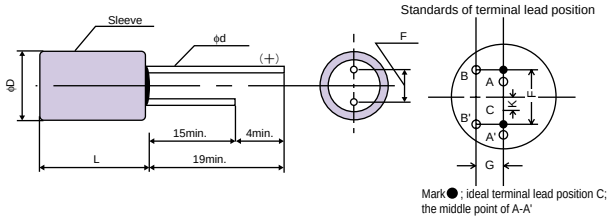
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table16		
Leakage current ※2	After 2 minutes	Less than or equal to the value of Table16		
ESR	—	Less than or equal to the value of Table16		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 5,000h, Rated voltage applied (25V→20V applied) ※1	ΔC/C	Within ±30%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	5 times or less than an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH 1,000h, No-applied voltage	ΔC/C	Within ±10%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	Below an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 Please reduce 0.25V per 1°C from over 85°C for 25V products.
※2 In case of some problems for measured values, measure after applying rated voltage for 6.3 to 20V products or temperature derating voltage for 25V products for 30 minutes at 105°C .

■Dimensions

(unit : mm)



Size Code	ϕD+0.5max.	Lmax.	F	ϕd±0.05	Gmax.	Kmax.
A	4.0	7.8	2.0±0.5	0.45	0.5	0.5
B	5.0	7.8	2.0±0.5	0.45	0.5	0.5
C	6.3	7.8	2.5±0.5	0.45	0.5	0.5
D	6.3	10.8	2.5±0.5	0.60	0.5	0.5
E	8.0	11.5	3.5±0.5	0.60	0.8	0.8
F	10.0	11.5	5.0±0.5	0.60	0.8	0.8

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

μF \ RV (SV)	6.3 (7.2)	10 (11.5)	16 (18.4)	20 (23.0)	25 (25.0)
1.0					A
1.5					A
2.2			A		B
3.3			A		B
4.7		A	B		C
6.8	A		B		C
10		B			C
15	B			C	D
22				C	
33			C	D	
47	C		D	E	
68		D		E	
100			E	F	
150	E		F		
220		F			
330	F				

※For the minimum packing quantity, please refer to page 51.

■Table16 SH Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms)※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
A	25SH1M	25	1.0	350	430	0.03	0.50
	25SH1R5M	25	1.5	300	435	0.03	0.75
	16SH2R2M	16	2.2	280	450	0.04	0.70
	16SH3R3M	16	3.3	280	500	0.04	1.06
	10SH4R7M	10	4.7	280	540	0.05	0.94
	6SH6R8M	6.3	6.8	250	560	0.05	0.86
B	25SH2R2M	25	2.2	200	695	0.03	1.10
	25SH3R3M	25	3.3	200	700	0.03	1.65
	16SH4R7M	16	4.7	180	720	0.04	1.50
	16SH6R8M	16	6.8	150	745	0.04	2.18
	10SH10M	10	10	150	780	0.05	2.00
	6SH15M	6.3	15	120	815	0.05	1.89
C	25SH4R7M	25	4.7	100	1130	0.03	2.35
	25SH6R8M	25	6.8	100	1140	0.03	3.40
	25SH10M	25	10	90	1150	0.03	5.00
	20SH15M	20	15	90	1200	0.05	6.00
	20SH22M	20	22	70	1300	0.05	8.80
	16SH33M	16	33	70	1370	0.06	10.56
	6SH47M	6.3	47	60	1430	0.07	5.92
D	25SH15M	25	15	70	1650	0.04	7.50
	20SH33M	20	33	70	1710	0.06	13.20
	16SH47M	16	47	60	1830	0.06	15.04
	10SH68M	10	68	50	2000	0.07	13.60
E	20SH47M	20	47	40	2450	0.06	18.80
	20SH68M	20	68	36	2600	0.06	27.20
	16SH100M	16	100	30	2740	0.06	32.00
	6SH150M	6.3	150	30	2780	0.07	18.90
F	20SH100M	20	100	30	3210	0.06	40.00
	16SH150M	16	150	28	3260	0.06	48.00
	10SH220M	10	220	27	3370	0.07	44.00
	6SH330M	6.3	330	25	3500	0.07	41.58

※1 Tolerance on rated capacitance : M ±20%,
Product “K” (Tolerance on rated capacitance : ±10%) is optionally available.
※2 After 2 minutes
※3 100kHz, +45°C

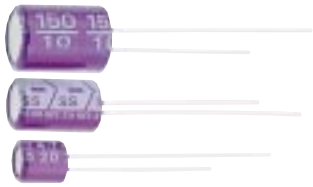
Temperature coefficient for allowable ripple current

Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

SS Series — Miniaturized Products of SC, SA and SL series



SS series is a miniaturized version of SC, SA and SL series. Suitable for switching power supplies, etc. to make more compact.

Sleeve color : Purple
Marking (White) : Polarity(⊖), Rated voltage, Rated Capacitance
SANYO, **OS-CON**, Lot.No., Series name
Upper category temp.(105°C)

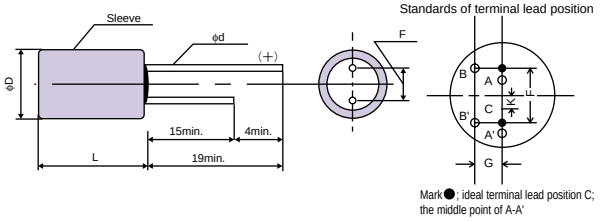
■Specifications

Items	Conditions	Characteristics		
Category temperature range	—	-55°C to +105°C		
Tolerance on rated capacitance	120Hz	M : ±20%		
Tangent of loss angle	120Hz	Less than or equal to the value of Table17		
Leakage current ※1	After 2 minutes	Less than or equal to the value of Table17		
ESR	—	Less than or equal to the value of Table17		
Characteristics of impedance ratio at high temp. and low temp.	Based the value at 100KHz, +20°C	-55°C	Z / Z 20°C	0.75 to 1.25
		+105°C	Z / Z 20°C	0.75 to 1.25
Endurance	105°C, 1,000h, Rated voltage applied (E, F size : 2,000h)	ΔC/C	Within ±20%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard	
Damp heat (Steady state)	60°C, 90 to 95%RH 1,000h, No-applied voltage	ΔC/C	Within ±20%	
		tanδ	2 times or less than an initial standard	
		Leakage current	Below an initial standard	
Resistance to soldering heat	Flow method (260±5°C X 10s)	ΔC/C	Within ±5%	
		tanδ	1.5 times or less than an initial standard	
		Leakage current	Below an initial standard (after voltage processing)	

※1 In case of some problems for measured values, measure after applying rated voltage for 30 minutes at 105°C .

■Dimensions

(unit : mm)



Size Code	φD+0.5max.	Lmax.	F	φd±0.05	Gmax.	Kmax.
A'	4.0	6.0	1.5±0.5	0.45	0.5	0.5
B'	5.0	6.0	2.0±0.5	0.45	0.5	0.5
C'	6.3	6.0	2.5±0.5	0.45	0.5	0.5
D	6.3	10.8	2.5±0.5	0.60	0.5	0.5
E	8.0	11.5	3.5±0.5	0.60	0.8	0.8
F	10.0	11.5	5.0±0.5	0.60	0.8	0.8

■Size List

RV : Rated voltage
(SV) : Surge (room temperature)

μF \ RV (SV)	4 (4.6)	6.3 (7.2)	10 (11.5)	16 (18.4)	20 (23.0)
2.2					A'
3.3					A'
4.7				A'	B'
6.8				A'	B'
10			A'	B'	C'
15		A'		B'	C'
22			B'		C'
33		B'		C'	
47					D
68	C'			D	
100			D		E
150	D		E		F
220		E			
330			F		
470	F				

※For the minimum packing quantity, please refer to page 51.

■Table17 SS Series Characteristics List

Size Code	Part Number ※1	Rated Voltage (V)	Rated Capacitance (μF)	ESR 100kHz to 300kHz (mΩ) (max.)	Allowable ripple current (mArms) ※3	Tangent of loss angle (max.)	Leakage current (μA) (max.)※2
A'	20SS2R2M	20	2.2	400	450	0.05	2.20
	20SS3R3M	20	3.3	400	500	0.06	3.30
	16SS4R7M	16	4.7	400	540	0.06	3.76
	16SS6R8M	16	6.8	400	540	0.06	5.44
	10SS10M	10	10	350	560	0.06	5.00
	6SS15M	6.3	15	350	560	0.06	4.73
B'	20SS4R7M	20	4.7	250	720	0.05	4.70
	20SS6R8M	20	6.8	180	745	0.05	6.80
	16SS10M	16	10	150	780	0.05	8.00
	16SS15M	16	15	150	780	0.05	12.00
	10SS22M	10	22	150	780	0.05	11.00
	6SS33M	6.3	33	150	780	0.05	10.40
C'	20SS10M	20	10	100	1150	0.06	10.00
	20SS15M	20	15	100	1230	0.06	15.00
	20SS22M	20	22	100	1230	0.06	22.00
	16SS33M	16	33	100	1230	0.06	26.40
	4SS68M	4	68	70	1430	0.06	13.60
D	20SS47M	20	47	60	1830	0.06	47.00
	16SS68M	16	68	50	2000	0.07	54.40
	10SS100M	10	100	40	2100	0.07	50.00
	4SS150M	4	150	40	2100	0.08	30.00
E	20SS100M	20	100	30	2740	0.07	100.00
	10SS150M	10	150	30	2780	0.07	75.00
	6SS220M	6.3	220	30	3000	0.07	69.30
F	20SS150M	20	150	30	3200	0.07	150.00
	10SS330M	10	330	25	3500	0.07	165.00
	4SS470M	4	470	25	3500	0.07	94.00

※1 Tolerance on rated capacitance : M ±20%
※2 After 2 minutes
※3 100kHz, +45°C

Temperature coefficient for allowable ripple current

Ambient Temp.	Tx≦45°C	45°C＜Tx≦65°C	65°C＜Tx≦85°C	85°C＜Tx≦95°C	95°C＜Tx≦105°C
Coefficient	1	0.85	0.7	0.4	0.25

Frequency coefficient for allowable ripple current

Frequency	120Hz≦ f ＜1kHz	1kHz≦ f ＜10kHz	10kHz≦ f ＜100kHz	100kHz≦ f ≦500kHz
Coefficient	0.05	0.2	0.5	1

V. SPECIFICATIONS FOR THE RADIAL LEAD TYPE

1. Explanation of Part Number (Radial Lead Type)

1	6	S	L	4	R	7	M	+	T	S
Rated voltage		Series name		Rated Capacitance			Capacitance tolerance		Taping or forming of terminal code	

Rated volt.	Code
2.0	2
2.5	2R5 ※1
4.0	4
6.3	6
10	10
16	16
20	20
25	25
30	30
32	32

Series
SC Series
SA Series
SL Series
SH Series
SP Series
SS Series
SEP Series
SEQP Series
SEPC Series
SF Series
SPA Series

Example

Rated Cap.(μF)	Code
1	1
2.2	2R2
4.7	4R7
10	10
22	22
100	100
220	220
1000	1000
2700	2700

Cap. tolerance	Code
±20%	M

Taping or lead terminal wire process code
None suffix for regular length lead type products

*1 Code 2 is used for 2.5V products of E9 and F13 size in SEPC series.

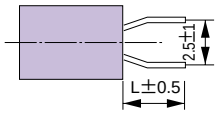
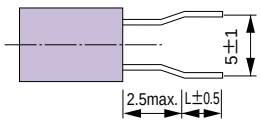
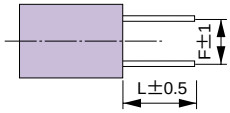
2. Radial lead terminal process

1) Applications

* SP, SPA, and SF series are not applicable to the process.
* SEP, SEQP, and SEPC series are not applicable to the forming cut.
* The other series are applied to the all of the process. Refer to 2) and 3).
* The following table is a standard specification. Please contact us concerning other specifications.

Series		Size	Bag-packed products (lead terminal cutting)			Taping
			Not processed	Straight cut	Forming cut	
Organic semiconductor	SP	C',C,D,E',E	○	×	×	+TS
		C',C,D,E',E,F',F	○	×	×	+T
	SPA	9E	○	×	×	+T, +TS
		9F	○	×	×	+T
	SF	E1	○	×	×	+T, +TS
Conductive polymer	SEP SEQP	E12	○	+C, +C1, +C2, +C3	×	+TSS
		F13	○	+C, +C1, +C2, +C3	×	+T
	SEPC	E9,E12	○	+C, +C1, +C2, +C3	×	+TSS
		E13	○	+C, +C1, +C2, +C3	×	+TS
		F13	○	+C, +C1, +C2, +C3	×	+T

2) Specifications for lead terminal cutting

Process names	Applicable Case size (Size code)	Lead terminal cutting code	Dimensions (unit : mm)
Lead space : 2.5mm forming cut	φ4 (A, A') φ5 (B, B')	+CA +CC +CD	
Lead space : 5mm forming cut	φ4 (A, A') φ5 (B, B') φ6.3 (C, C', D) φ8 (E, E')	+F +F1 +F2	
Straight cut	φ4 (A) φ5 (B, B') φ6.3 (C, C', C6, D) φ8 (E, E', E7, E12, E13) φ10 (F, F', F8, F13)	+C +C1 +C2 +C3	

	CA	CC	CD
L	5.5	4.0	2.5

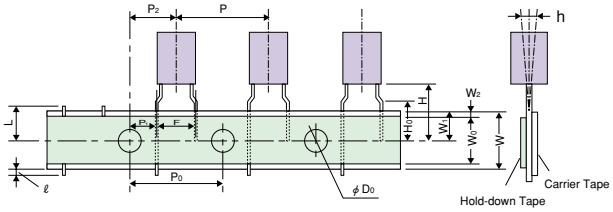
	F	F1	F2
L	5.5	4.5	3.0

	C	C1	C2	C3
L	5.5	4.0	2.5	3.5

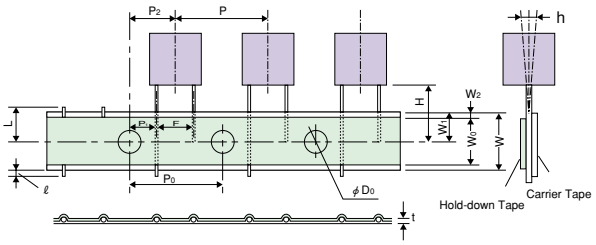
Size Code	A	B, B'	C,C',C6,D	E, E', E7, E12, E13	F, F', F8, F13
F	2.0	2.0	2.5	3.5	5.0

3) Specifications for Taping

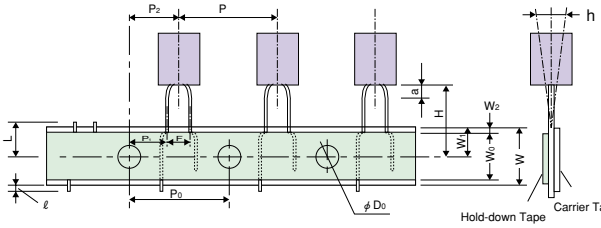
a) F=5.0mm Taping code +T
(Size Code A,B,C,D,E,A',B',C',E')



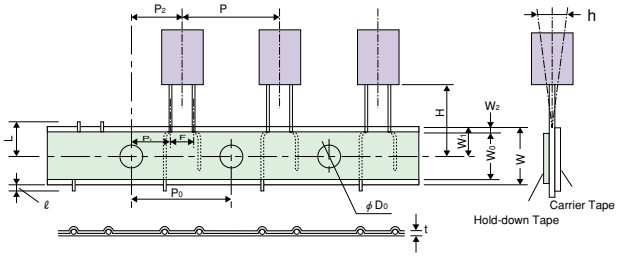
(Size Code F,F',F8,F13,9F)



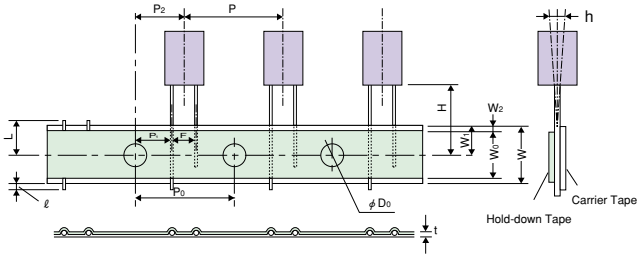
b) F=2.5 or 3.5mm Taping code +TS
(Size Code A,A',B,B')



(Size Code C,C',D,E,E',E1,E13,9E)



c) F=2.5 or 3.5mm Taping code +TSS
(Size Code C6,E7,E9,E12)



(unit : mm)

Code			F	P	P₀	P₁	P₂	Δh	W	W₀	W₁	W₂	H	H₀	φD₀	t	ℓ	L	a
Tolerance			$\pm^{0.8}_{0.2}$	±1.0	±0.2	±0.5	±1.0	±1.0	±0.5	min.	±0.5	max.	±0.75	±0.5	±0.2	±0.2	max.	max.	max.
Taping Code	φ4	+T	5.0	12.7	12.7	3.85	6.35	0	18.0	9.5	9.0	2.5	18.5	16.0	4.0	0.7	0	11.0	-
	φ5	+T	5.0	12.7	12.7	3.85	6.35	0	18.0	9.5	9.0	2.5	18.5	16.0	4.0	0.7	0	11.0	-
	φ6.3	+T	5.0	12.7	12.7	3.85	6.35	0	18.0	9.5	9.0	2.5	18.5	16.0	4.0	0.7	0	11.0	-
	φ8	+T	5.0	12.7	12.7	3.85	6.35	0	18.0	9.5	9.0	2.5	20.0	16.0	4.0	0.7	0	11.0	-
	φ10	+T	5.0	12.7	12.7	3.85	6.35	0	18.0	9.5	9.0	2.5	18.5	-	4.0	0.7	0	11.0	-
	φ4	+TS	2.5	12.7	12.7	5.10	6.35	0	18.0	9.5	9.0	2.5	17.5	-	4.0	0.7	0	11.0	1.5
	φ5	+TS	2.5	12.7	12.7	5.10	6.35	0	18.0	9.5	9.0	2.5	17.5	-	4.0	0.7	0	11.0	1.5
	φ6.3	+TS	2.5	12.7	12.7	5.10	6.35	0	18.0	9.5	9.0	2.5	17.5	-	4.0	0.7	0	11.0	-
	φ8	+TS	3.5	12.7	12.7	4.60	6.35	0	18.0	9.5	9.0	2.5	17.5	-	4.0	0.7	0	11.0	-
	φ6.3	+TSS	2.5	12.7	12.7	5.10	6.35	0	18.0	9.5	9.0	2.5	17.5	-	4.0	0.7	0	11.0	-
	φ8	+TSS	3.5	12.7	12.7	4.60	6.35	0	18.0	9.5	9.0	2.5	17.5	-	4.0	0.7	0	11.0	-

3. Minimum Packing Quantity

Packing quantities standard • Processed type discrete lead terminals

Size Code	Case Size	pcs./Bag
A,A'	φ 4	500
B,B'	φ 5	500
C,C',C6,D	φ 6.3	500
E,E',E7,E9,E12,E13,E1,9E	φ 8	200
F,F',F8,F13,9F	φ10	200
F0	φ10	100
G	φ12.5	50
H	φ16	25

Zig-zag pack taping type

Size Code	Case Size	Quantity (pcs.)
A,A'	φ 4	2,000
B,B'	φ 5	2,000
C,C',C6,D	φ 6.3	1,500
E,E',E7,E9,E12,E13,E1,9E	φ 8	1,000
F,F',F8,F13,9F	φ10	500

※Ordering information

φ10(Fo), φ12.5 and φ16 are packing type only.

Ⅵ. SPECIFICATIONS FOR THE SMD TYPE

1. Explanation of Part Number (SMD Type)

1	6	S	V	P	3	R	3	M

Rated voltage | Series name | Rated capacitance | Capacitance tolerance

Rated volt.	Code
2.5	2R5
4.0	4
6.3	6
10	10
16	16
20	20
25	25
35	35

Series
S V P Series
SVQP Series
SVPA Series
SVPB Series
SVPC Series
SVPD Series

Example

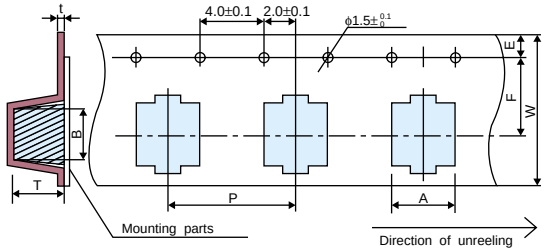
Rated Cap.(μF)	Code
3.3	3R3
4.7	4R7
10	10
22	22
100	100
220	220
470	470
1500	1500

Cap. tolerance	Code
±20%	M

2. Specifications for Taping (SMD Type)

1) Carrier tape

SVP, SVQP, SVPA, SVPB, SVPC, SVPD series

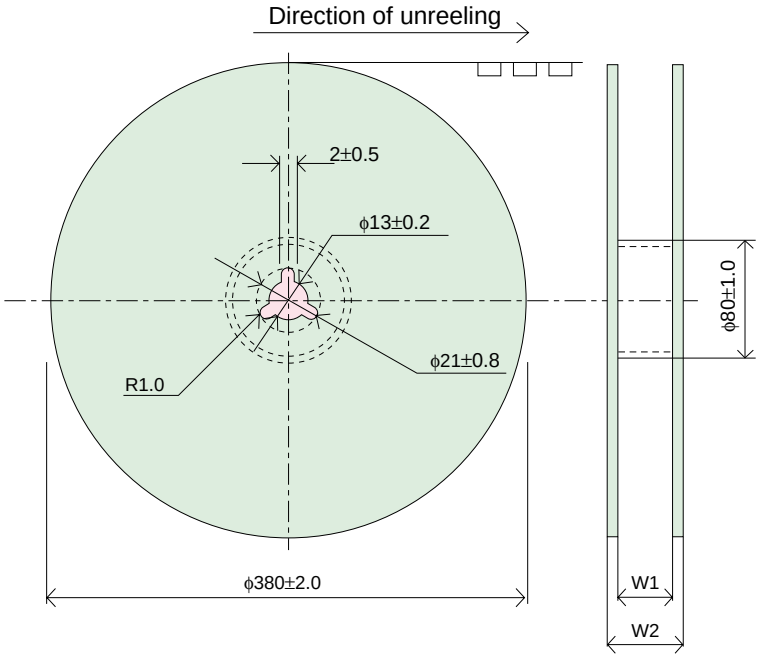


(unit : mm)

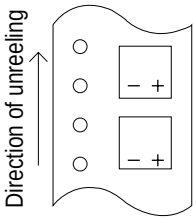
Dimension / Size code	A	B	W	F	E	P	t	T
A5	4.7 ±0.2	4.7 ±0.2	12.0 ±0.3	5.5 ±0.1	1.75 ±0.1	8.0 ±0.1	0.4 ±0.1	5.8 ±0.2
B6	5.6 ±0.2	5.6 ±0.2	16.0 ±0.3	7.5 ±0.1	1.75 ±0.1	8.0 ±0.1	0.4 ±0.1	6.2 ±0.2
C5	6.9 ±0.2	6.9 ±0.2	16.0 ±0.3	7.5 ±0.1	1.75 ±0.1	12.0 ±0.1	0.4 ±0.1	5.3 ±0.2
C55	6.9 ±0.2	6.9 ±0.2	16.0 ±0.3	7.5 ±0.1	1.75 ±0.1	12.0 ±0.1	0.4 ±0.1	6.2 ±0.2
C6	6.9 ±0.2	6.9 ±0.2	16.0 ±0.3	7.5 ±0.1	1.75 ±0.1	12.0 ±0.1	0.4 ±0.1	6.2 ±0.2
E7	8.6 ±0.2	8.6 ±0.2	24.0 ±0.3	11.5 ±0.1	1.75 ±0.1	12.0 ±0.1	0.4 ±0.1	7.2 ±0.2
F8	10.7 ±0.2	10.7 ±0.2	24.0 ±0.3	11.5 ±0.1	1.75 ±0.1	16.0 ±0.1	0.4 ±0.1	8.2 ±0.2
E12	8.6 ±0.2	8.6 ±0.2	24.0 ±0.3	11.5 ±0.1	1.75 ±0.1	16.0 ±0.1	0.5 ±0.1	12.3 ±0.2
F12	10.7 ±0.2	10.7 ±0.2	24.0 ±0.3	11.5 ±0.1	1.75 ±0.1	16.0 ±0.1	0.4 ±0.1	13.0 ±0.2

Ⅵ. SPECIFICATIONS FOR THE SMD TYPE

2) Reel



3) Polarity



- SVP Series
- SVQP Series
- SVPA Series
- SVPB Series
- SVPC Series
- SVPD Series

(unit : mm)

Series	Size Code	W1	W2
SVP SVQP SVPA SVPB SVPC SVPD	A5	13.0±0.5	17.5±1.0
	B6, C5, C55, C6	17.0±0.5	21.5±1.0
	E7, F8, E12, F12	25.0±0.5	29.5±1.0

3. Minimum Packing Quantity

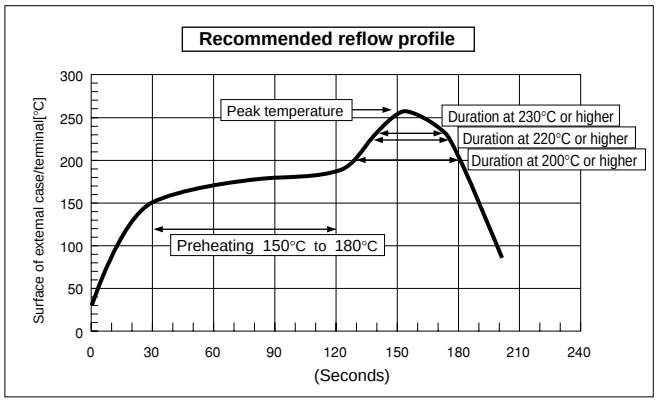
SVP, SVQP, SVPA, SVPB, SVPC, SVPD series

Size Code	pcs./Reel (ϕ380)
A5	2,000
B6	1,500
C5	1,300
C55	1,000
C6	1,000
E7	1,000
F8	500
E12	400
F12	400

Ⅵ. SPECIFICATIONS FOR THE SMD TYPE

4. Recommended Reflow Condition of SMD Type

OS-CON has different characteristics against soldering heat from conventional aluminum electrolytic capacitors or tantalum capacitors because of its unique materials and structure.
Please note the following points on soldering of **OS-CON** SVP, SVQP, SVPA, SVPB, SVPC and SVPD series to draw out the best performance.



Item \ Series	SVP, SVQP, SVPA, SVPC, SVPD Series		SVPB Series	
Peak temperature (MAX.)	250°C	260°C	240°C	250°C
Preheat	150°C to 180°C 90 ± 30 sec.		150°C to 180°C 90 ± 30 sec.	
200°C over time (MAX.)	60 sec.	60 sec.	50 sec.	60 sec.
220°C over time (MAX.)	50 sec.	50 sec.	40 sec.	50 sec.
230°C over time (MAX.)	40 sec.	40 sec.	30 sec.	40 sec.
Reflow number	twice or less	Only 1 time	twice or less	Only 1 time

Note1. All temperatures are measured on the topside of the Al-can and terminal surface.

Note2. Concerning SVPB series, if 260°C peak Reflow condition is necessary, please consult with us.

Attention : Reflow soldering may reduce the capacitance of products before or after soldering even if soldering conditions stipulated in Recommended Reflow Condition are met.
Though the actual reflow conditions are subject to change depending on the kind of reflow soldering method, please be aware that the peak temperature at the top of Al-case and electrode terminals should not exceed peak temperature.
Particular notice should be given to the time that **OS-CON** is heated at 200°C or higher during reflow.
Be aware that soldering considerably deviating from these conditions will cause problems such as a 50% reduction in capacitance, and a considerable increase in leakage current.

The leakage current value may increase (from a few μA to a few mA) even within the above conditions. When the **OS-CON** is used in a DC circuit, the leakage current will decrease gradually through self-recovery after voltage is applied. If your reflow profile (reflow temperature, number of reflows, etc.) deviates from the above conditions for mounting the SVP, SVQP, SVPA, SVPB, SVPC and SVPD series, please consult with SANYO.

Ⅶ. CONSTRUCTION AND CHARACTERISTICS

1. Development of OS-CON

OS-CON is an electrolytic capacitor. 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 semiconductor) when compared to earlier electrolytes, we have successfully designed the electrolytic capacitor **OS-CON**, featuring low impedance, using an organic semiconductor for the electrolyte.

Features of Organic Semiconductive Electrolyte

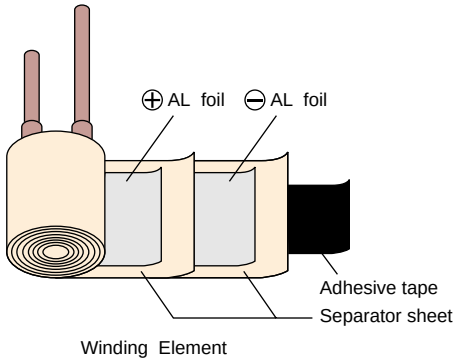
- High conductivity (low resistance value) compared to other electrolytes.
- High conductivity is stability against temperature.

Type of capacitor	Type of electrolyte	Conductivity (mS/cm)
Non-solid electrolytic capacitor	Electrolyte solution	3
Solid electrolytic capacitor	Manganese dioxide	30
OS-CON	Organic semiconductor (TCNQ complex salt)	300
	Conductive polymer	3,000

The comparisons of conductivity is general.

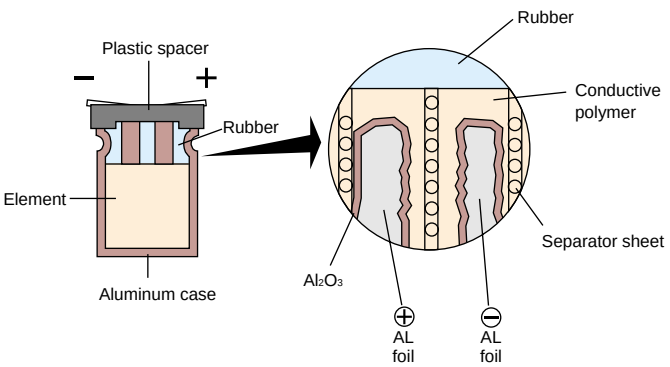
2. Construction and Manufacturing Method of OS-CON

2-1. Construction of OS-CON

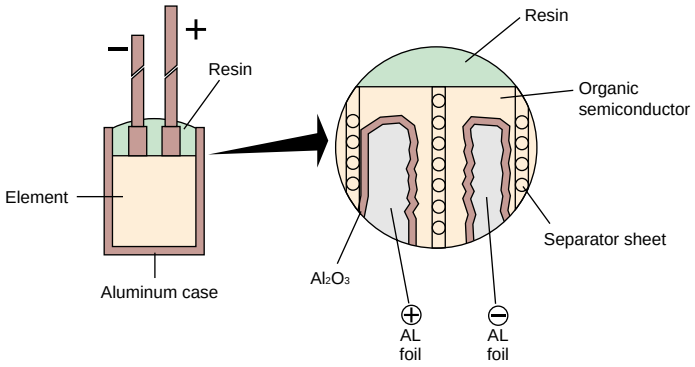


OS-CON has almost the same construction as an aluminum electrolytic capacitor, and the element consists of rolled aluminum foils. The difference between **OS-CON** and the aluminum electrolytic capacitor is that organic semiconductive electrolyte is impregnated in behalf of electrolyte solution. Also, SVP, SVQP, SVPA, SVPB, SVPC, SVPD, SEP, SEQP, and SEPC series are sealed using rubber sealing, and others are sealed using resin sealing.

Rubber sealing

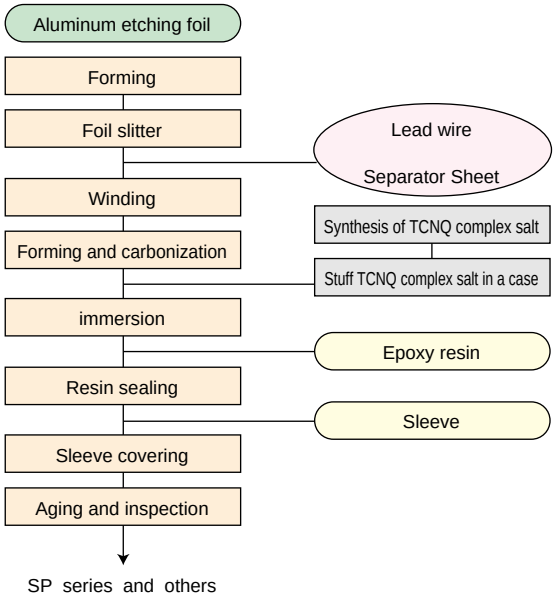


Resin sealing



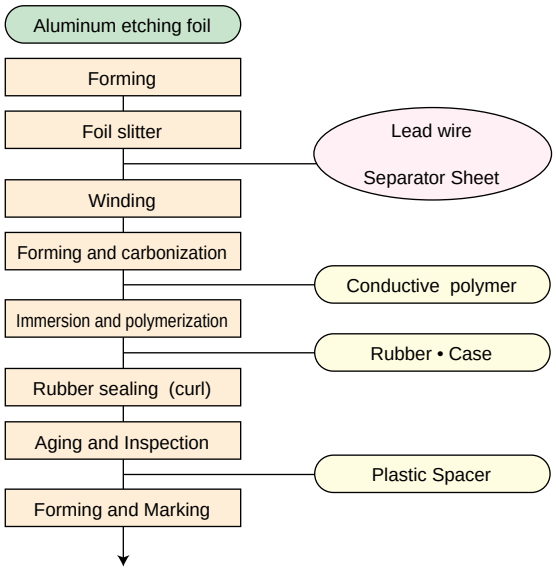
2-2. OS-CON Manufacturing Method

Type :Organic semiconductor (TCNQ complex salt)

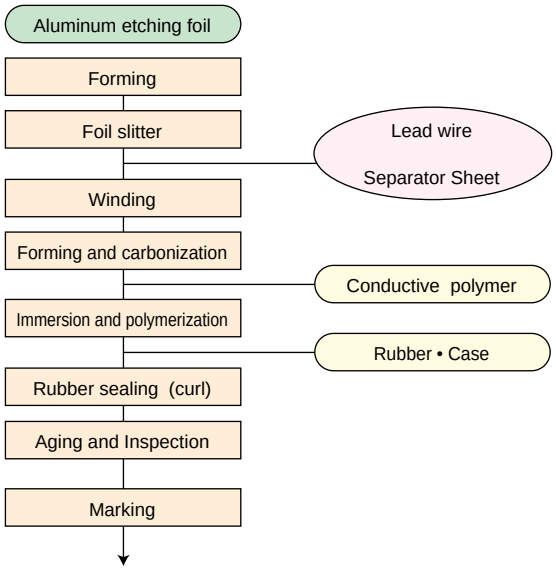


SP series and others

Type : Conductive polymer



SVP, SVQP, SVPA, SVPB, SVPC and SVPD series



SEP, SEQP and SEPC series

1. OS-CON Electrical Characteristics

1-1. Frequency Characteristics

Fig.A
(at 25°C)

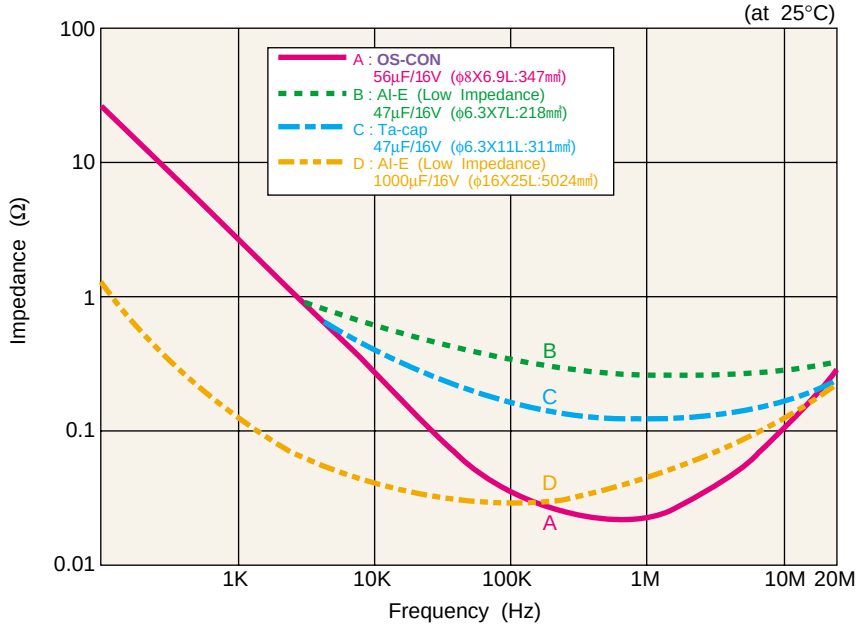
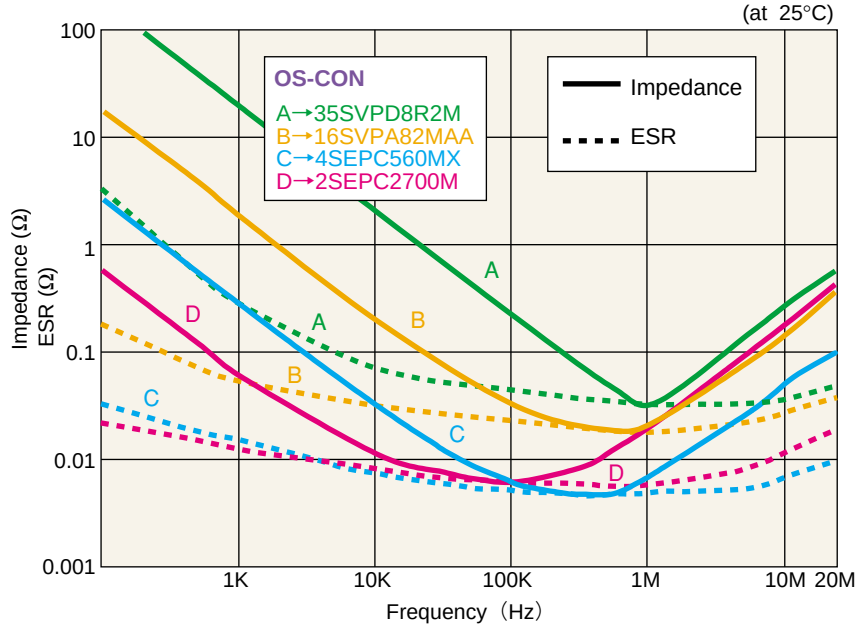


Fig.B
(at 25°C)

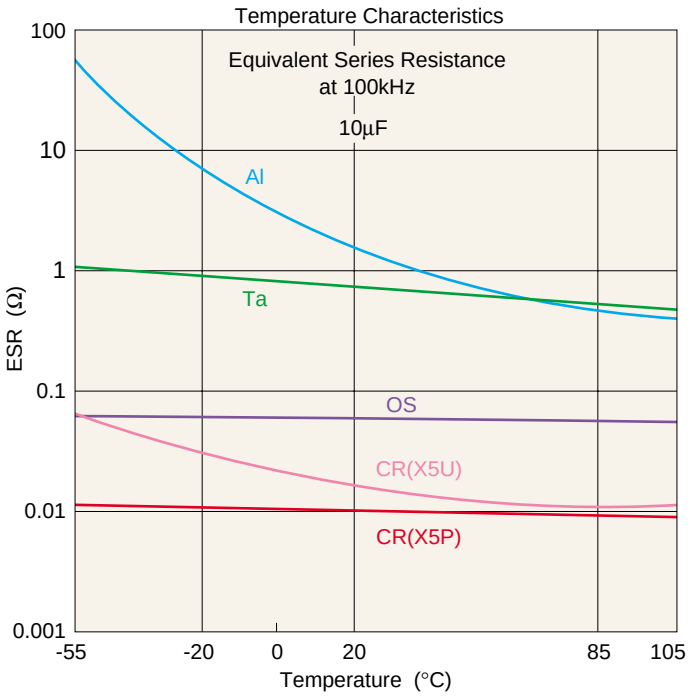


The OS-CON is an electrolytic capacitor, however, it has excellent frequency characteristics. Using a high conductive organic semiconductor as the electrolyte, and the thin electrolyte layer brought by the adoption of winding element, improves ESR (Equivalent Series Resistance) greatly, and provides the excellent frequency characteristics.

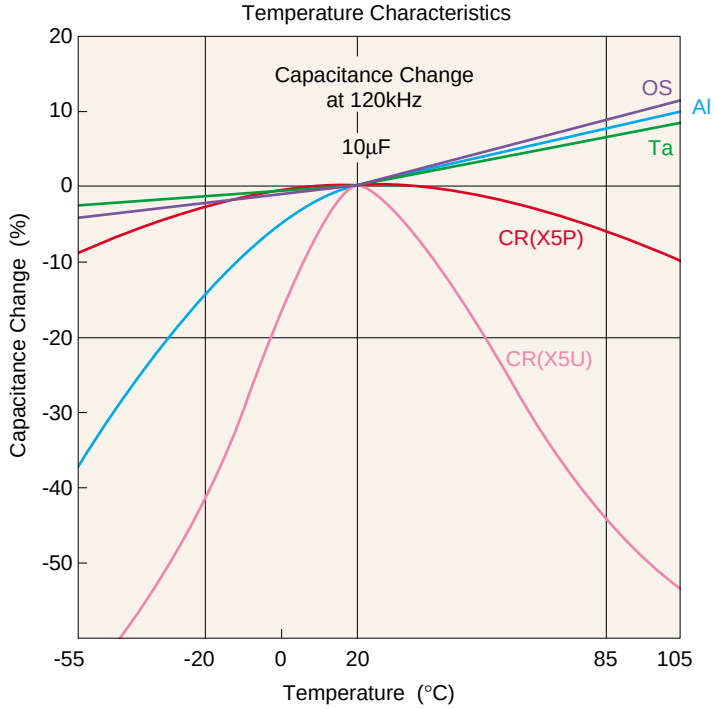
Fig.A shows the impedance frequency characteristics of OS-CON, compared to other types of capacitors. The OS-CON shows a nearly ideal curve. When compared at 100kHz, OS-CON 56µF, and low impedance aluminum electrolytic capacitor 1,000µF, nearly have the same feature. If the frequency gets higher, the capacitance ratio between OS-CON and aluminum electrolytic capacitor gets higher.

Fig.B shows the impedance and ESR frequency characteristics of OS-CON. The resonance point of the OS-CON is at 100kHz to 10MHz. The ESR becomes about 5mΩ or less at 100kHz (560µF products)- an extremely small value.

1-2 Characteristics at high temperature and low temperature



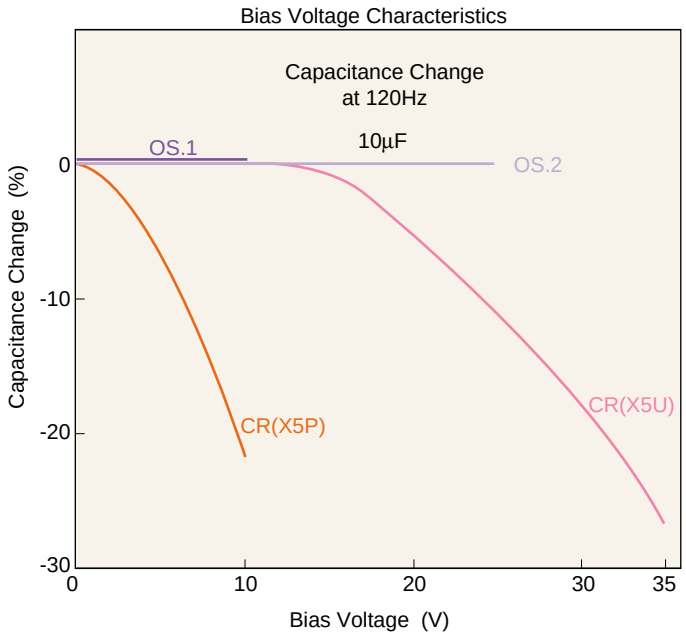
OS =**OS-CON** ——— Purple
Al =AL-E. Cap ——— Blue
Ta =Tantalum Cap. ——— Green
CR(X5P) =Cera Cap. ——— Red
(X5P Type)
CR(X5U) =Cera Cap. ——— Pink
(X5U Type)



Characteristics at high temperature and low temperature of the **OS-CON** is that it features little change in temperature for the ESR.
Since ESR is dominant at high range of impedance (near resonance point), the ESR value greatly affects noise clearing capacity. What ESR changes a little against temperature means that noise clearing ability changes a little against temperature as well.
The **OS-CON** is suitable for outdoor apparatus.

1-3 Bias Characteristics

1) Capacitance

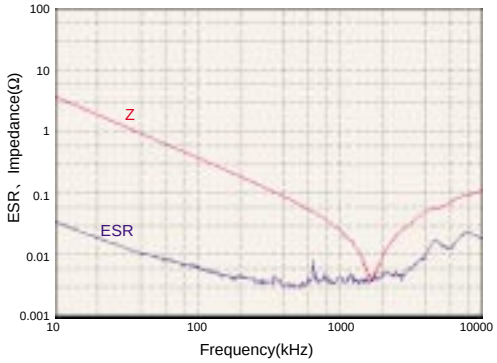


OS.1 =**OS-CON(10SVP10M)** —— Purple
OS.2 =**OS-CON(25SVPD10M)** — Light Purple
CR(X5P) =Cera Cap. ———— Red
(X5P Type ; 10V-10μF)
CR(X5U) =Cera Cap. ———— Pink
(X5U Type ; 50V-10μF)

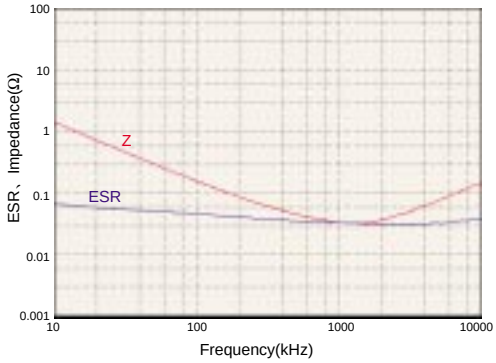
When voltage is applied to ceramic capacitors, they show a bias characteristics where static capacitance is reduced. Our **OS-CON** product, however, will show no reduction in capacitance for applied voltage within its rating (Note: our 25V product utilized temperature derated voltage).

2) Impedance, ESR

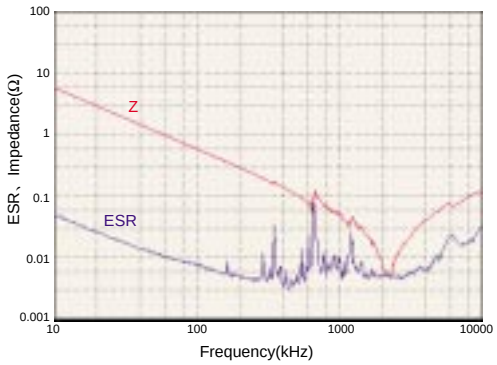
Multi-layer Ceramic capacitor (25V, 4.7μF)
0V bias



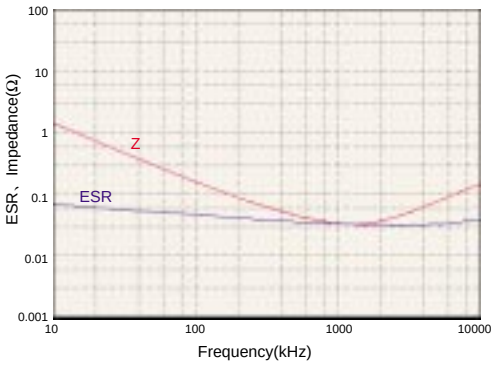
OS-CON (25SVPD10M)
0V bias



Multi-layer Ceramic capacitor (25V, 4.7μF)
20V bias



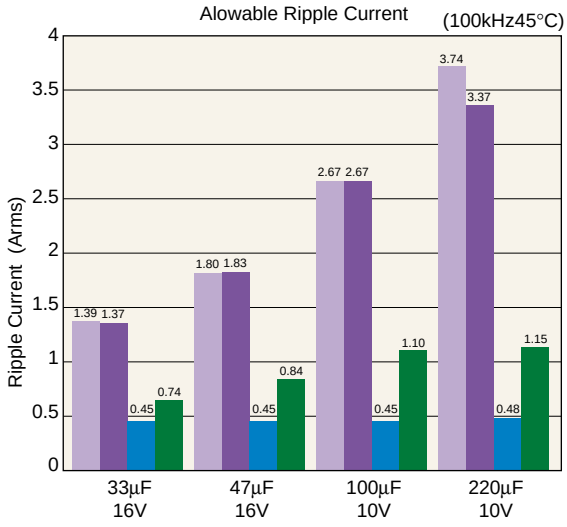
OS-CON (25SVPD10M)
20V bias

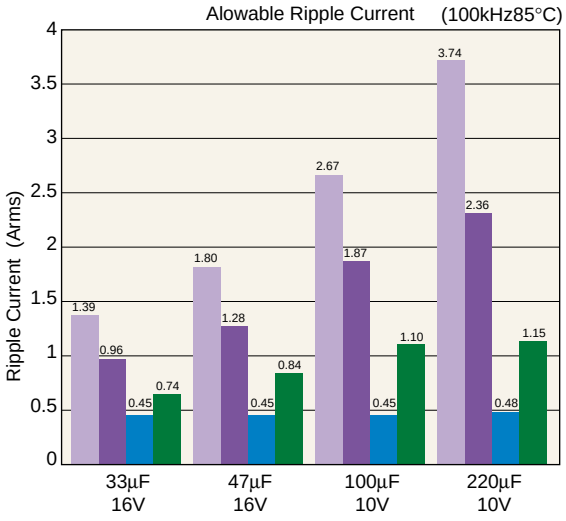


As bias is applied to multi-layer ceramic capacitor, ESR value changes considerably between 300kHz to 1MHz. Also, it brings change of Impedance value. There is not change of ESR value in **OS-CON**s even if applies bias.

Ⅶ. CONSTRUCTION AND CHARACTERISTICS

1-4 Allowable Ripple Current





When selecting smoothing capacitors for power supply, the allowable ripple current of the capacitor is one of the standard selections.
The allowable value of ripple current is decided by the generated heat of the capacitor, this heating is due to the ESR. Since a large ESR capacitor generates larger heat value, it can not make the flow of ripple current greater.
Compared to other electorolytic capacitors, ESR of **OS-CON** is so small that it can allow far more ripple currents.

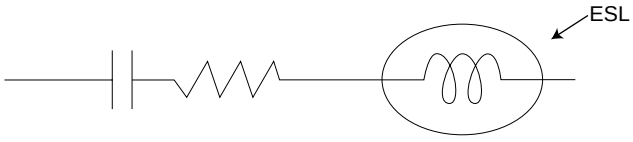
OS-CON (SVP series) —— Light Purple
OS-CON (SA series) ———— Purple
Al-E. Cap. (Low Impedance) —— Blue
Ta.Cap. (Low ESR) ———— Green

※SVP, SA series is almost same as the regulation.

1-5. ESL Characteristics

OS-CON is aluminum solid capacitor of high performance with large rated capacitance and low ESR. Recently in circuit technologies, the constituent of ESL is picked up in the domain of the high frequency with that of electronic equipment.

<Eqivalent series circuit of capacitor>



Approximate ESL values of SEP series

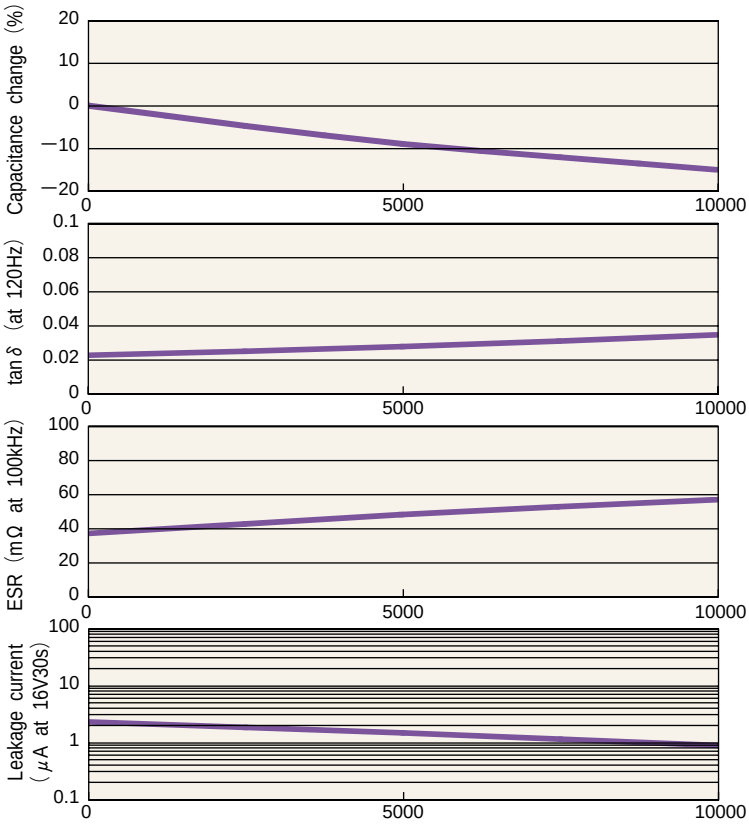
(unit：nH)

Size Code	at 10 MHz	at 40 MHz
C6	2.6	2.4
E7	4.0	3.8
F8	5.4	5.2
E12	4.0	3.8
F13	6.0	5.8

※Measuring position：roof of lead terminal
※All following values are not gurranteed, and there are some cases that the values differ in the measuring way. Please contact SANYO for detail.

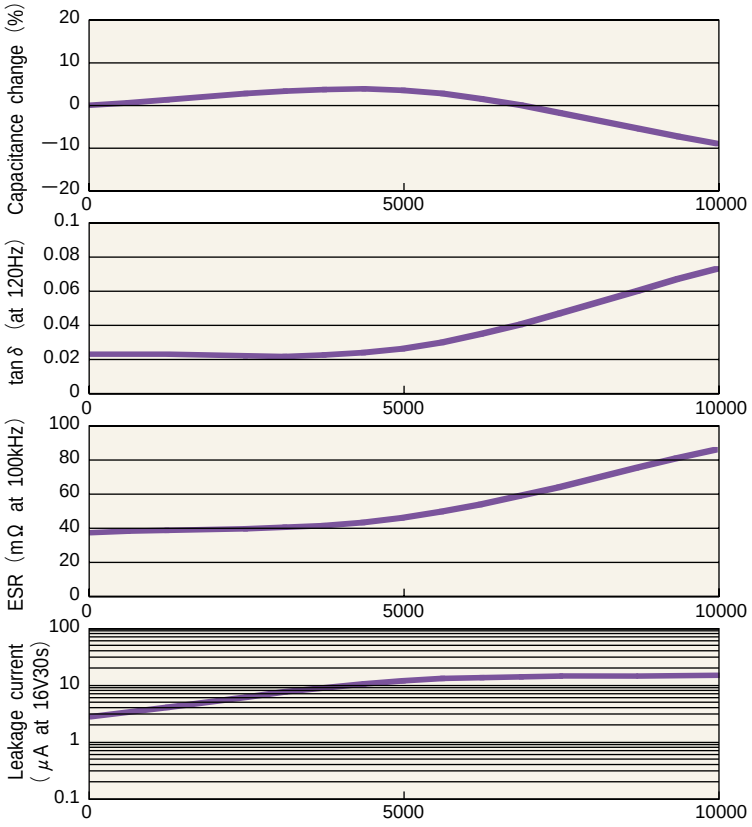
1. Organic semiconductor (TCNQ complex salt) type OS-CON (16SH33M)

1-1 Endurance (105°C, applied 16V)



The left fig. shows a tendency of each characteristics of OS-CON (Organic semiconductor type) in endurance test.
The tendency of capacitance change shows the same as aluminum electrolytic capacitor. However, aluminum electric capacitor has yield point (time) for dry-up of electrolytic solution, but OS-CON doesn't. The capacitance of OS-CON decreases gradually, which is semi-permanent. These changes are little difference if applied voltage or not, except for leakage current.

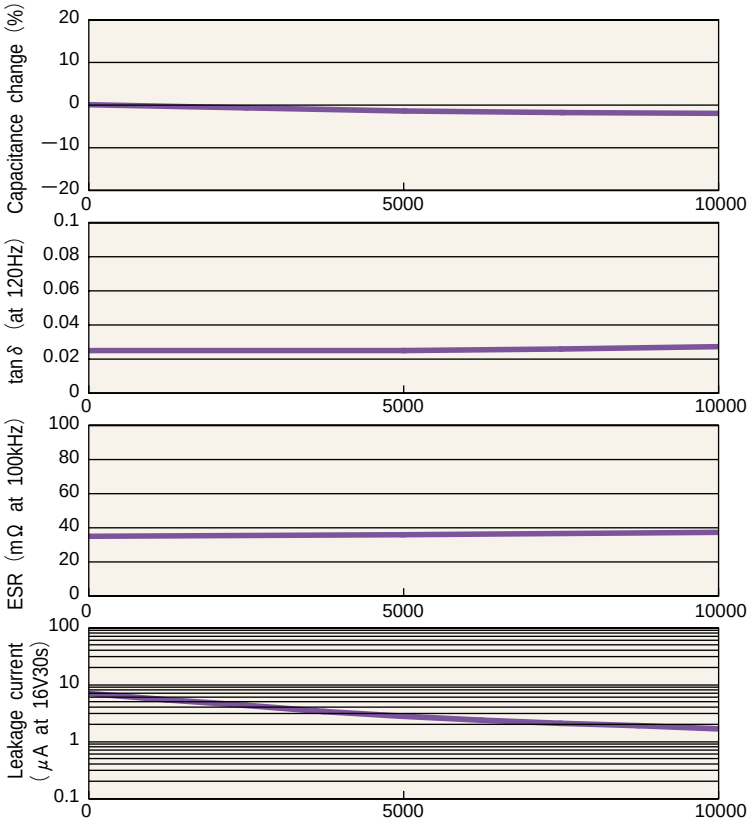
1-2 Damp heat (60°C90% RH, without load)



The left fig. shows a tendency of each characteristics of OS-CON (Organic semiconductor type) in damp heat test.
Compared with endurance, it seems that the characteristics is a little change. It is necessary to note using OS-CONs when it is damp heat environment, such as outdoors.

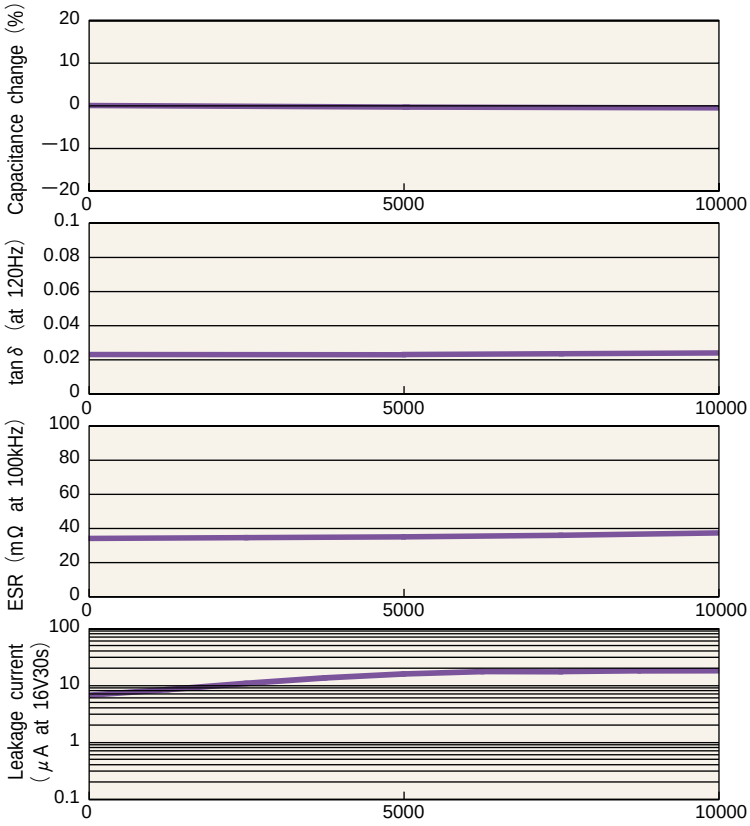
2. Conductive polymer type OS-CON (16SVP39M)

2-1 Endurance (105°C, 16V applied)



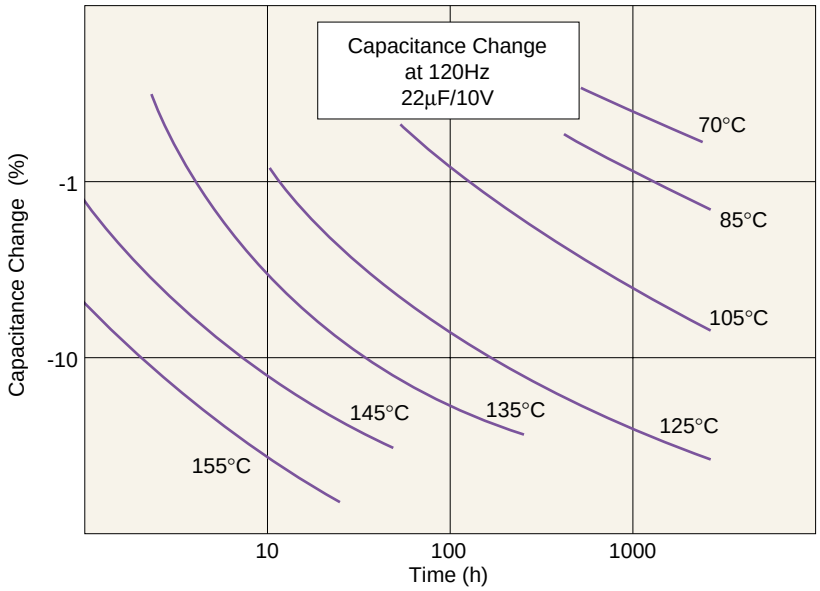
The figure on the left-hand side shows the tendencies of each characteristic of the conductive polymer type OS-CON in an endurance test.
Little change in characteristics can be seen after 10,000 hours because of adoption of conductive polymer that excels in thermal stability. Also, the change in characteristic is very little compared with Organic semiconductor type OS-CON.

2-2 High temperature and High humidity test (60°C90% RH, without load)



The figure on the left-hand side shows the tendencies of each characteristic of the conductive polymer type OS-CON in a high-temperature and high-humidity test.
As is the case with the endurance test, little change in characteristics can be seen after 10,000 hours in a high-temperature and high-humidity environment because of the excellent thermal stability of conductive polymer. Also, the change in characteristics is very little compared with Organic semiconductor type OS-CON.

3. Temperature Acceleration Test (Endurance)



The decrease in capacitance brings lifetime failure of **OS-CON**s, its main reason depends on temperature.
The left fig. shows the speed of decreasing at each temperature. This graph indicates that temperature coefficient of **OS-CON** lifetime is 10 times by 20°C reduction. Compared with this, aluminum capacitor's is 2 times by 10°C reduction. The followings are converted value at 85°C and 75°C by using 105°C X 2000h.
These values are not guaranteed but presumptive values. It means that the life time of **OS-CON** is longer than other 105°C X 2000h guaranteed products.

Estimation of life time

※**OS-CON**	※Aluminum electrolytic capacitor
105°C → 2,000h	105°C → 2,000h
95°C → 6,324h	95°C → 4,000h
85°C → 20,000h	85°C → 8,000h
75°C → 63,245h	75°C → 16,000h

※Guarantee temperature of **OS-CON** is 105°C, except for SEQP, SVQP and SVPD series.

4. Reliability Presumption of life

As described on P61, 62, an item for endurance, capacitance of **OS-CON** is getting smaller as times go by. This means wear-failure of **OS-CON** is open mode for capacitance-decrease, which is a main failure factor of **OS-CON**.
The lifetime is different by each operating temperature and self-heating by ripple current.
The Presumptive lifetime of **OS-CON** is about 10 times 20°C reduction.
The following formula outline could make it possible to estimate the presumptive lifetime of **OS-CON** at ambient temperature Tx (°C).

※The result of the following page estimation is not guaranteed but presumptive values based on actual measurement. Then, the estimated life-span is limited up to 15years.

Organic Semiconductive electrolyte type (SC, SA, SL, SH, SS, SP, SF and SPA series)

$$Lx = Lo \times 10^{\frac{To-(Tx+\Delta Tx)}{20}}$$

Lx : Life expectance (h) in actual use (temperature Tx)

Lo : Guaranteed (h) at maximum temperature in use

To : Maximum operating temperature

Tx : Temperature in actual use (ambient temperature of **OS-CON**) (°C)

ΔTx : Self-heating temperature by Ripple current (°C)

$$\Delta Tx = (Ix/Io)^2 \times \Delta T \quad Ix \leqq Io$$

Io : Allowable ripple current at 45°C or less (Arms)

Ix : Actual flow of ripple current (Arms)

Note : The value of Ix should be below the value of Io with the coefficient

Ambient Temp. (°C)	≦45	45＜Tx≦65	65＜Tx≦85	85＜Tx≦95	95＜Tx≦105
Coefficient	1.0	0.85	0.7	0.4	0.25

Self-heating value ΔT by maximum allowable ripple current (45°C or less) varies according to case size. Refer to the rough values in the chart below :

Case size	A, A'	B, B'	C, C'	D	E, E', E1, 9E	F, F', F₀, G, H, 9F
ΔT (°C)	8	10	15	16	18	20

Conductive polymer electrolyte type (SVP, SVQP, SVPA, SVPB, SVPC, SVPD, SEP, SEQP and SEPC series)

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

Lx : Life expectance (h) in actual use (temperature Tx)

Lo : Guaranteed (h) at maximum temperature in use

To : Maximum operating temperature

Tx : Temperature in actual use (ambient temperature of **OS-CON**) (°C)

The following is the presumptive lifetime at over 105°C, which is concerned with the heat-proof characteristic of seal-rubber.

Presumptive lifetime / Temperature in actual use	Presumptive lifetime (Lx)				
	SVPB	SVP, SVPA, SVPC, SEP(2.5RV),SEPC	SEP(4～25RV)	SVQP, SEQP	SVPD
Tx＝105°C	1,000h	2,000h	3,000h	5,000h	5,000h
105°C＜Tx≦115(°C)	—	—	—	3,160h	3,160h
115°C＜Tx≦125(°C)	—	—	—	1,000h	2,000h

There is no need to apply a temperature-compensating coefficient for the ripple current in the SVP, SVQP, SVPA, SVPB, SVPC, SVPD, SEP SEQP and SEPC series, which use conductive polymer electrolyte.

The self-heating temperature under application of the rated ripple current is approx. 20°C in the SVP, SVPA, SVPB, SVPC, SEP and SEPC series (10°C in A5 and B6 sizes of SVP, SVPA and SVPC series), and approx. 2°C in the SVQP, SEQP and SVPD series, but the estimated life expectancy can be calculated without consideration of self-heating under application of the ripple current because of the excellent heat-proof characteristics of conductive polymer.

5. Factors of Short Circuit Mode

1. Applying voltage over the rated voltage.
2. Applying reverse voltage over the specification.
3. Excessive mechanical stress.
4. Applying rush current by sudden charge or discharge over the specification.

For details, please refer to “Operating Precautions” on page 4 to 10.

Summary of features for OS-CON

1	**OS-CON** is a low ESR capacitor.
	☆A frequency characteristics of impedance shows an ideal curve. Ideal to use as de-coupling capacitor for removing such noise as ripple, spike, digital, static, audio, etc.
	☆Able to flow large ripple current. Ideal for miniaturization, as a smoothing capacitor of switching power supply.
	☆Able to discharge rapidly. Ideal for use as back-up capacitor in a circuit where large current is consumed at high-speed.
2	ESR of **OS-CON** is not dependent on temperature.
	☆The **OS-CON** is useable for low temperature specification equipment. (0°C or less)
3	**OS-CON** has a long life.
	☆You can expect to use **OS-CON** for 50,000h at 85°C. (SVQP,SVPD,SEQP and SH series) Ideal for industrial devices that shall be used for a long period.

Explanation of the rush current suppression methods

When the OS-CON is used in the following circuit, an excessive rush current may flow because the ESR is extremely small. Therefore, consideration must be given to and measures be taken in design, and production facilities, etc. Maintain the rush current at 10A or less. If as long as 10 times of the allowable ripple current of the OS-CON exceeds 10A, reconfigure so that the ripple current does not exceed 10 times.

1. DC-DC converter input circuits

a. DC-DC converter circuits are usually a PCB block shape and use a low ESR capacitor in the input section for high performance and miniaturization.
b. Consideration must be given to the rush current that flows from the equipment when the DC-DC converter is adjusted and inspected.

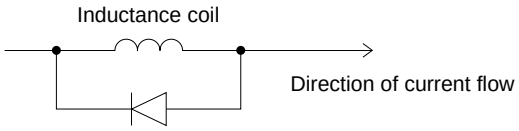
※There is the possibility that an extremely large amount of rush current will flow through the OS-CON during voltage adjustment or inspection of the DC-DC converter's circuit block when the power impedance supplied from the equipment being adjusted or inspected is exceedingly low and the current suppression function of the current limiter and such is provided.
(Refer to the example in Figure 1.)
※Rush current suppression measures must be taken for DC-DC converter adjustment and inspection equipment. (Refer to page 67.)

2. Circuits driven by chargeable batteries

a. Circuit power lines equipped with batteries or rechargeable batteries use capacitors such as the OS-CON with very low ESR to increase performance and facilitate miniaturization.

※There is the possibility of an extremely large amount of rush current flowing through the low ESR capacitors arranged along the power line when the power is turned on for circuits driven by nickel cadmium chargeable batteries etc. that have a very low internal resistance.
(Refer to the example in Figure 1.)

※A protection circuit like that is shown below is usually used to suppress rush current of charging battery.



Diode for absorbing counter electromotive force

The main points to be aware of are listed here.
- Normally, an inductance coil with a magnetic core is used, however, inductance sometimes drops depending on the frequency, so it must be checked.
- The peak current value of the diode when absorbing counter electromotive force.

3. No protection resistance rush current

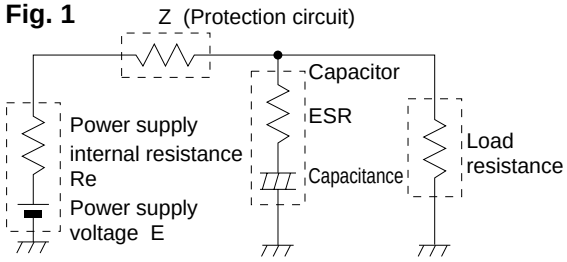
When there is no protection resistor Z as shown in Figure 1 and the power supply has Re nearly= 0Ω, the OS-CON's rush current is as follows.

$$\text{Rush current (A)} = \frac{\text{Supplied DC voltage (E)}}{\text{ESR+Re+Z (Ω)}}$$

Example : For 25SC10M
ESR=90mΩ, or less and
Supplied DC voltage=20V,

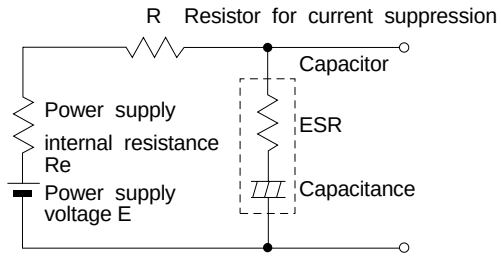
$$\frac{20\text{V}}{\text{less than } 0.09\Omega} = 222\text{A or more}$$

Fig. 1



Examples of rush current suppression methods

1) Resistor method



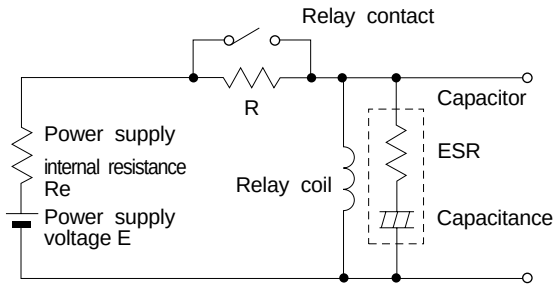
※Rush current is as shown below.

$$\text{Rush current (A)} = \frac{\text{E (V)}}{\text{Re+ESR+R } (\Omega)}$$

※Rush current is usually determined mainly by R as Re and ESR are low.

※Although the current is simply and clearly suppressed with this method, resistor R for suppressing current causes the voltage to drop.

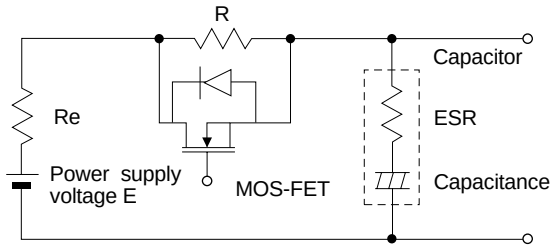
2) Resistor and relay method



※The rush current is exactly the same as in the resistor method, however, there is almost no voltage drop caused by the current suppression resistor from the time the relay contact goes ON.

※Note: After the capacitor has finished recharging, it may take some time or setting of voltage to turn the relay ON.

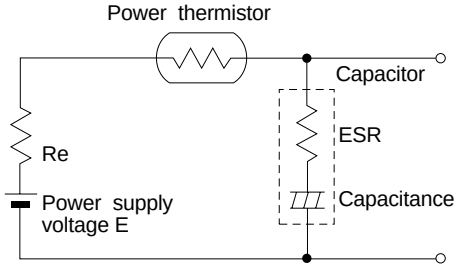
3) Resistor and MOS-FET method



※Rush current is exactly the same as in the resistor method, however, there is almost no voltage drop caused by R after rushing, the same as the resistor and relay method.

※Note: As with the resistor and relay method, after the capacitor has finished recharging, it may take some time or setting of voltage to turn the MOS-FET ON.

4) Power thermistor



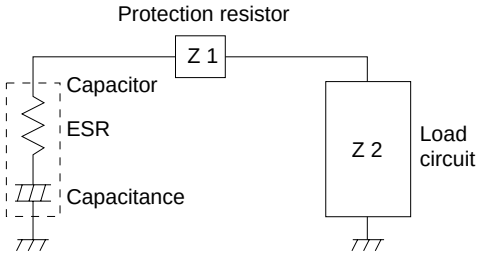
※Taking an example of a common power thermistor, the value is 8Ω at 25°C, but becomes 0.62Ω at 130°C.

※When the power thermistor is connected as shown in the above diagram, rush current is suppressed due to the large resistor value at the moment the switch is turned on.
After this, the output loss (voltage drop) is reduced.
However, the power thermistor has a heat constant, meaning that the large resistor value in the initial state cannot be regained the moment the switch is turned off.
As a result, the ability to suppress current is lost when the switch is turned off and on quickly.

Sudden discharge current suppression

OS-CON has an exceedingly low ESR. When the load impedance during discharge is extremely low, there is the chance that it allows a large amount of discharge current to flow for an instant.

Please note the following points when using the **OS-CON** in sudden discharge operations.



※The discharge equivalent circuit is as shown to the left.
※The formula for estimating discharge current is given below.

$$\text{Discharge current (A)} = \frac{\text{Charging voltage (V)}}{\text{ESR+Z1+Z2 (Ω)}}$$

Example : For 25SC10M
- ESR=90mΩ or less
- Charging voltage=20V
- Z1, Z2=0Ω

is set, then

$$\text{Discharge current (A)} = \frac{\text{Charging voltage 20V}}{\text{ESR 0.09Ω or less}} = \text{222A or more}$$

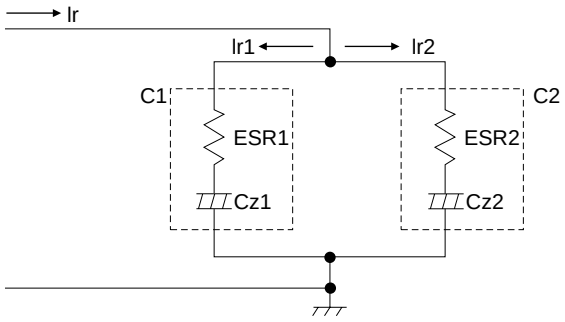
As shown in the above example, there is the chance an extremely large amount of discharge current will flow when electric charge is discharged with 0Ω loading.
When the **OS-CON** is to be used in sudden discharge operations, configure the circuit so that the peak discharge current becomes 10A or less, using the above mentioned rough estimate expression as a guide. However, if 10 times the allowable ripple current of the **OS-CON** exceeds 10A, reconfigure so that 10 times the allowable ripple current is not exceeded.

Precautions when connecting an OS-CON and an aluminum electrolytic capacitor in parallel

Aluminum electrolytic capacitors and OS-CONs are often connected in parallel to improve circuit density and cost performance of ripple absorbing capacitors.

Please give full consideration to the following.

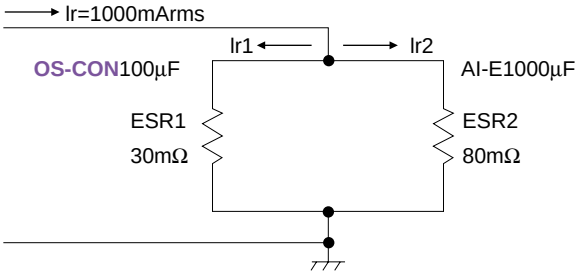
Fig.1



Ir : Total ripple current
ESR : Capacitor's equivalent series resistance
Cz : Impedance of the capacitor's capacitive components

※Ripple current flowing through each parallelly connected capacitor can be found by using the values symbolized in the reference equivalent circuit in Figure 1.
※The equivalent circuit in Figure 1 can be simplified as shown in Figure 2 when it is to be used for frequencies between 100kHz and a few MHz.
(Assuming the capacitor's capacitance is more than 10μF.)

Fig.2



※Since impedance becomes exceedingly low when the capacity is more than 10μF. And frequencies higher than 100kHz, each Cz in Figure 1 can be omitted changing the actual ripple current value to that shown in Figure 2.

Formula for calculating the ripple current value

$$Ir1 = Ir \times \frac{ESR2}{ESR1 + ESR2}$$

$$= 1000mA \times \frac{80m\Omega}{30m\Omega + 80m\Omega}$$

$$\fallingdotseq 727mArms$$

※As shown here, although the OS-CON has 1/10th of the capacity of that of the mated capacitor, it allows 73% of the ripple current to flow.

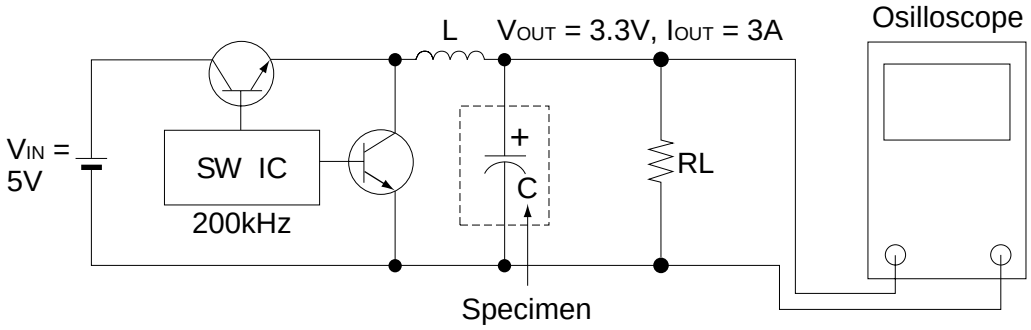
As explained here, when OS-CON and an aluminum electrolytic capacitor are to be used in parallel connection, select the appropriate type of OS-CON that has an extra margin of capacity since a large amount of ripple current flows through it.

Ripple removal capability of OS-CON

While there is a tendency to downsize switching power supplies capacitors still remain one of the parts occupying large areas of circuit boards. The working temperature is an important consideration when selecting a capacitor, since it generally results in widely varying capacitor characteristics. The following experiment shows the superior ripple removal capability of the **OS-CON** at high frequencies in wide range of working temperatures.

Experiment

A general chopper switching power supply was used to test the **OS-CON** against two alternatives. SANYO **OS-CON**, low-impedance aluminum electrolytic capacitor, and low-ESR tantalum capacitors were each connected as the capacitor in the output side smoothing circuit at working temperatures of –20°C, 25°C and 70°C to compare the output residual ripple voltage.



Initially SANYO **OS-CON** 100uF/6.3V (6SVP100M ϕ6.3mm×L6.0mm) was used as the output side smoothing capacitor (C) in the above test circuit, the residual ripple voltage was measured at ambient temperature of –20°C, 25°C, 70°C.

Low-impedance aluminum electrolytic capacitors and low-ESR tantalum capacitors were selected for measurement at each temperature –20°C, 25°C, 70°C so that the residual ripple voltage became equal to that achieved when the **OS-CON** 100uF/6.3V was used.

Finally, the residual ripple voltage was measured at each temperature (-20°C to 70°C) with an equal number of side smoothing capacitors to the 25°C conditions, and the rates of change in the ESR of the smoothing capacitors were calculated from the amounts of change.

Result

Table1 On-board area ratios of capacitors at each temperature (when the residual ripple voltage is on the same level)

Ambient temperature	OS-CON	Aluminum Electrolytic capacitor	Tantalum capacitor
25°C	1	7.15	1.46
- 20°C	1	16.7	1.46
70°C	1	4.77	1.46

Table2 Rates of change in ESR on the basis of 25°C※

Ambient temperature	OS-CON	Aluminum Electrolytic capacitor	Tantalum capacitor
25°C	1	1	1
- 20°C	1.14	3.03	1.27
70°C	0.952	0.587	0.85

※Rate of change in ESR= $\frac{\text{Residual ripple voltage at ambient temperature X Oscillation frequency at ambient temperature}}{\text{Residual ripple voltage at 25°C X Oscillation frequency at 25°C}}$

From the above results, it can be seen that SANYO **OS-CON** excels in temperature characteristics.

XI. Application

Table-1

Ambient temperature	25°C		
Capacitor type	OS-CON	Aluminum Electrolytic capacitor	Tantalum capacitor
capacitance/voltage	100μF/6.3V	680μF/6.3V	100μF/10V
Quantity	1pc	3pcs	2pcs
Residual ripple voltage	22.8mV	23.8mV	24.8mV
Size（※2）(mm)	6.6 X 6.6	10.5 X 10.5	7.5 X 4.5
On-board area ratio	1	7.15	1.46
Oscillation frequency	200kHz		
Fig	Fig1	Fig2	Fig3

Table-2

Ambient temperature	- 20°C			
Capacitor type	OS-CON	Aluminum Electrolytic capacitor		Tantalum capacitor
capacitance/voltage	100μF/6.3V	680μF/6.3V		100μF/10V
Quantity（※1）	1pc	7pcs	(3pcs)	2pcs
Residual ripple voltage	20.8mV	24.4mV	(57.6mV)	25.2mV
Size（※2）(mm)	6.6 X 6.6	10.5 X 10.5		7.5 X 4.5
On-board area ratio	1	16.7		1.46
Oscillation frequency	250kHz			
Fig	Fig4	Fig5	Fig6	Fig7

Table-3

Ambient temperature	70°C			
Capacitor type	OS-CON	Aluminum Electrolytic capacitor		Tantalum capacitor
capacitance/voltage	100μF/6.3V	680μF/6.3V		100μF/10V
Quantity（※1）	1pc	2pcs	(3pcs)	2pcs
Residual ripple voltage	25.6mV	24.0mV	(16.4mV)	24.8mV
Size（※2）(mm)	6.6 X 6.6	10.5 X 10.5		7.5 X 4.5
On-board area ratio	1	4.77		1.46
Oscillation frequency	170kHz			
Fig	Fig8	Fig9	Fig10	Fig11

※1）Figures in brackets ( ) are conditions at 25°C.
※2）For items other than Ta, rather than the element diameter, the base plate dimensions were taken as the maximum dimensions.

XI. Application

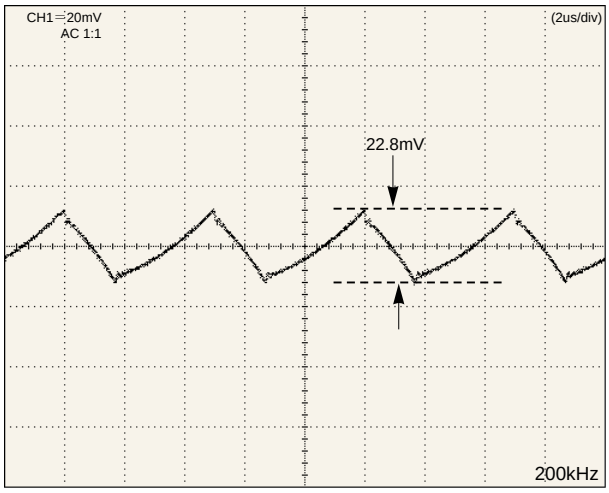
Ambient temperature	OS-CON	Aluminum Electrolytic capacitor	Tantalum capacitor
25 C		  	 
- 20 C		      	 
70 C		 	 

Ⅺ. Application

●Comparison at 25°C

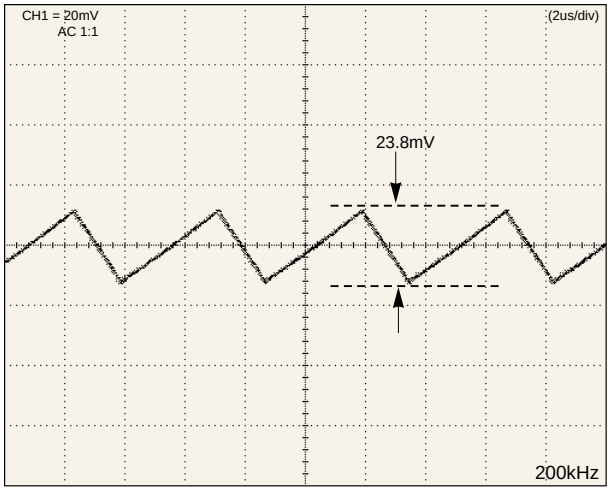
OS-CON 100μF/6.3V

Fig 1 **25°C (1pc)**



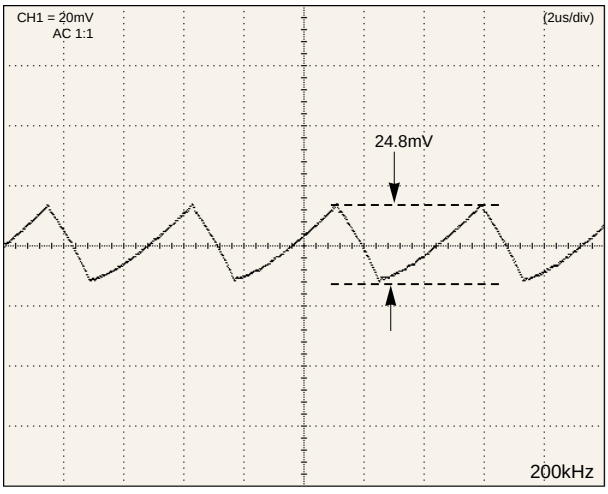
Low-impedance aluminum electrolytic capacitor 680μF/6.3V

Fig 2 **25°C (3pc)**



Low-ESR Tantalum capacitor 220μF/10V

Fig 3 **25°C (2pc)**

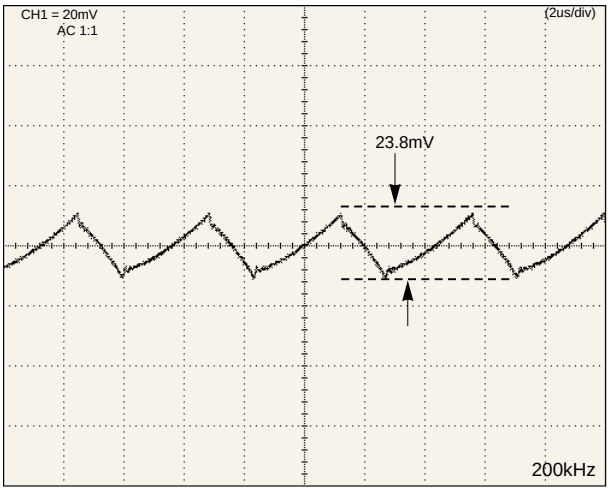


Ⅺ. Application

●Comparison at -20°C

OS-CON 100μF/6.3V

Fig 4 -20°C (1pc)



Low-impedance aluminum electrolytic capacitor 680μF/6.3V

Fig 5 -20°C (7pc)

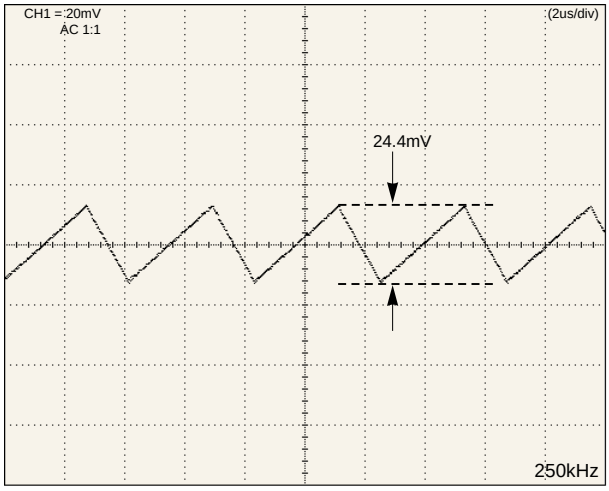
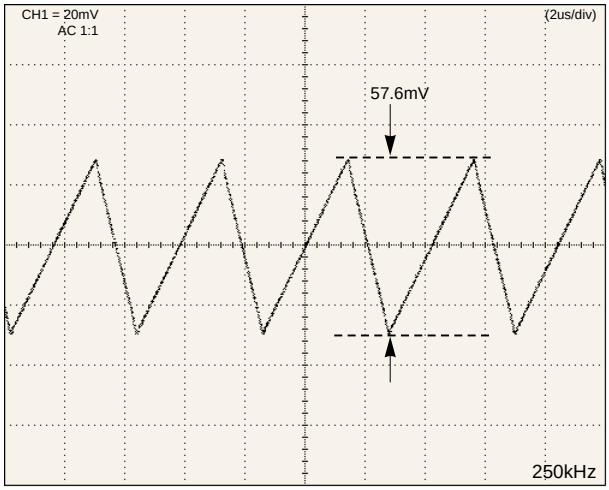
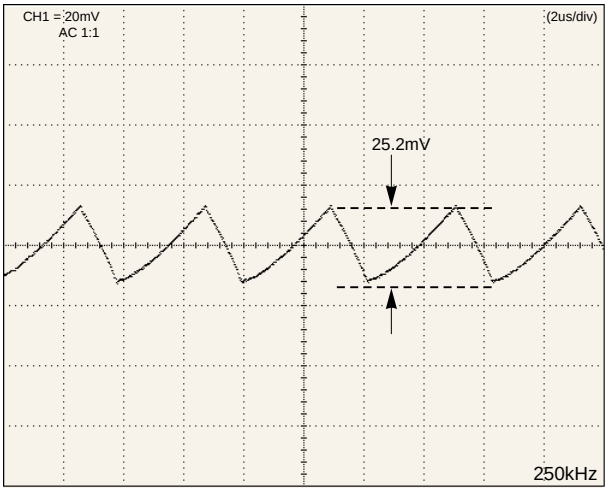


Fig 6 -20°C (3pc)



Low-ESR Tantalum capacitor 220μF/10V

Fig 7 -20°C (2pc)

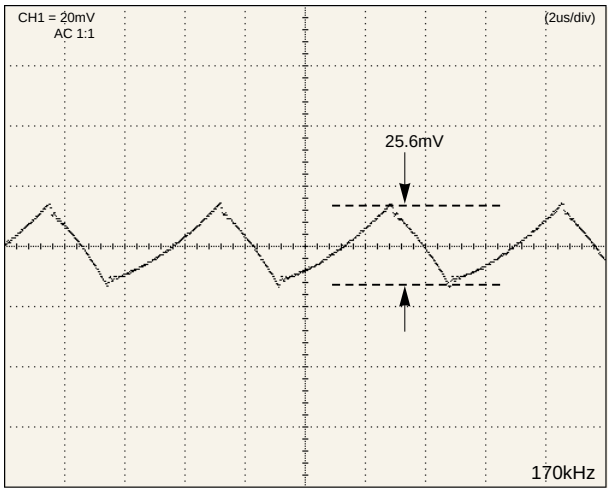


XI. Application

●Comparison at 70°C

OS-CON 100μF/6.3V

Fig 8 70°C (1pc)



Low-impedance aluminum electrolytic capacitor 680μF/6.3V

Fig 9 70°C (2pc)

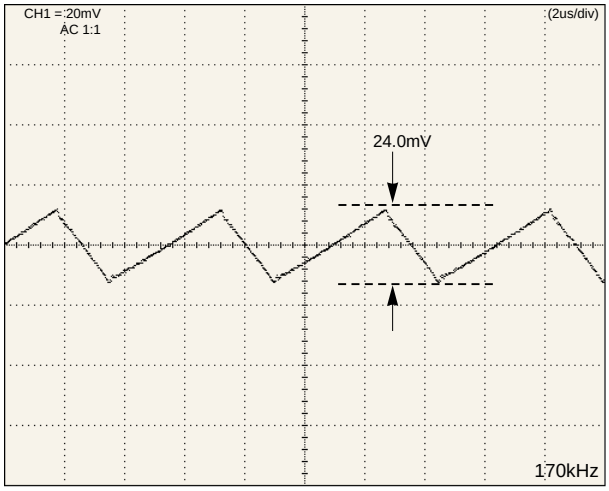
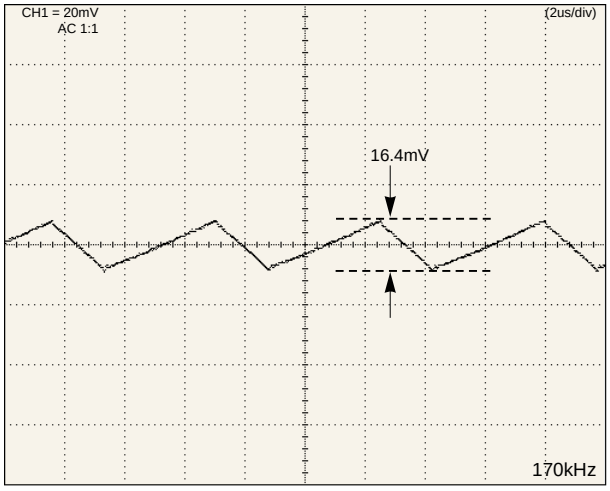
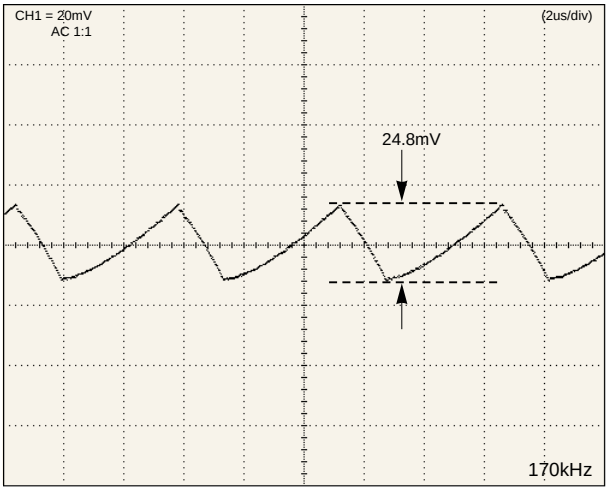


Fig 10 70°C (3pc)



Low-ESR Tantalum capacitor 220μF/10V

Fig 11 70°C (2pc)



OS-CON high speed back-up performance

(Back-up capacitor for variable load)

IC, especially MPU that are lately used in electronic devices operate at very high processing speed. PCB's are able to be more densely populated by reduction of operating voltage and getting narrow pattern space. Involved in changing to lower voltage, current load is increasing with a development of new MPU.

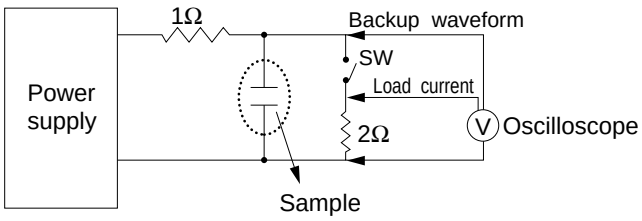
A sudden change of current load with larger variable load at high speed causes the voltage variation of supply line, and it makes MPU work wrong.

Let us evaluate the excellent back-up performance of **OS-CON** compared to that of other electrolytic capacitors.

Capacitors with low ESR and large capacitance are necessary for high-speed load fluctuations. The **OS-CON** can provide the largest capacitance among low ESR capacitors, and in this regard, the **OS-CON** is a suitable back-up capacitor.

1. Test condition

Test circuit

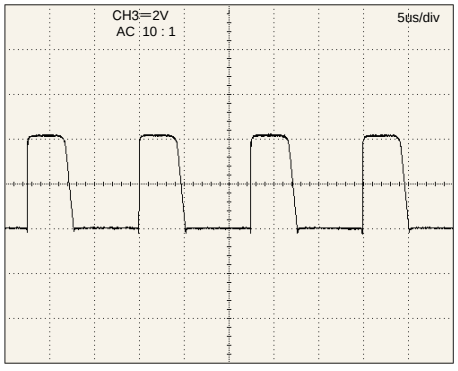


Load condition

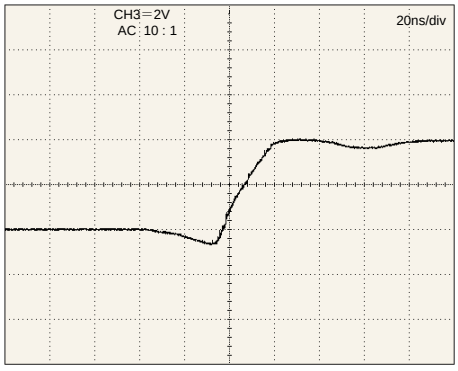
Item	Condition
Load width	5μs
Cycle	12.5μs
Rising time	20ns
Current load	2A
Voltage	4V
Power supply impedance	1Ω

Switching wave form

Whole wave form



Rising wave form



The value of capacitance for back-up will be:

$$C=\frac{\Delta I \times \Delta t}{\Delta V - \Delta I \times ESR}$$

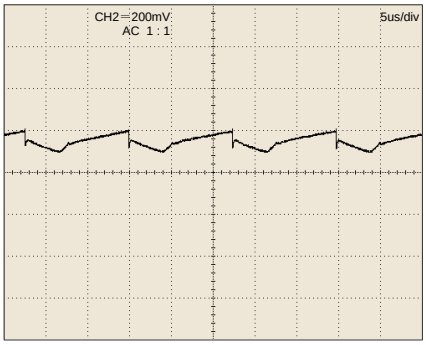
C : Capacitance (F)
ESR : ESR (Ω)
ΔV : AC Volt tolerance (V)
Δt : reaction time (second)
ΔI : load current change (A)

2. Result

2-1 Comparison between OS-CON and other capacitors with same capacitance

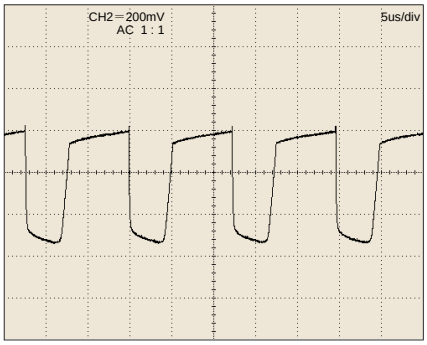
Compared with same capacitance, OS-CON's voltage drop of supply line is 104mV, but low-impedance Aluminum electrolytic capacitor indicates 548mV (5.3times of OS-CON), and low ESR Tantalum electrolytic capacitor indicates 212mV (2times of OS-CON).

OS-CON
10SP100M, ESR : 21mΩ



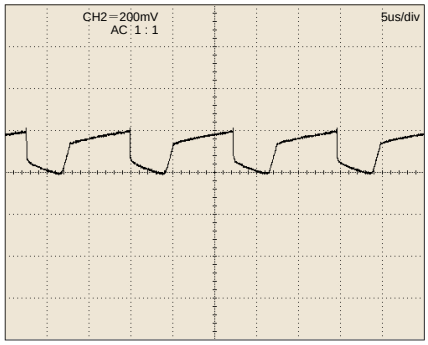
ΔV=104mV 200mV/div 5μs/div

Low Z Aluminum capacitor
10V100μF, ESR : 425mΩ



ΔV=548mV 200mV/div 5μs/div

Low ESR Tantalum capacitor
10V100μF, ESR : 85mΩ



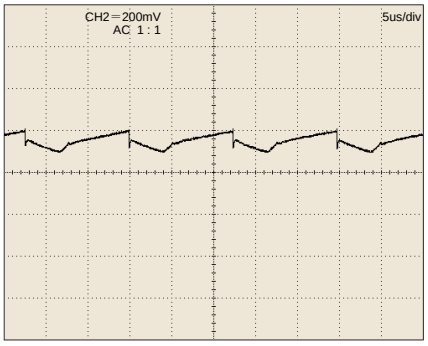
ΔV=212mV 200mV/div 5μs/div

2-2

A : Examination of same level variable load

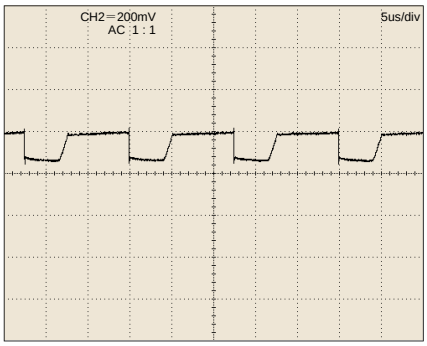
To obtain similar level of voltage drop to 10SP100M, Low Z Aluminum electrolytic capacitor needs 1,500μF or more. Low ESR Tantalum electrolytic capacitor needs 220μF X 2pcs or more.

OS-CON
10SP100M



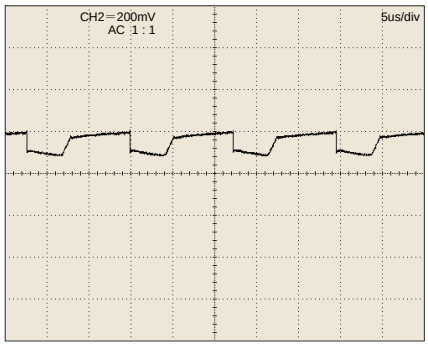
ΔV=104mV 200mV/div 5μs/div

Low Z Aluminum capacitor
10V1,500μF



ΔV=128mV 200mV/div 5μs/div

Low ESR Tantalum capacitor
10V220μF×2

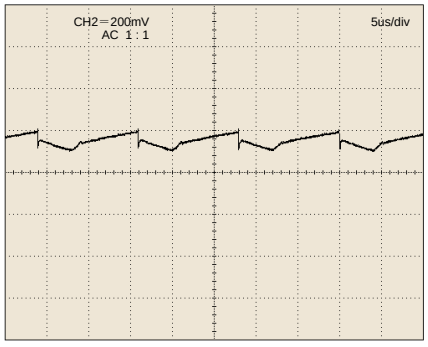


ΔV=116mV 200mV/div 5μs/div

B : In case of lower temperature (-20°C)

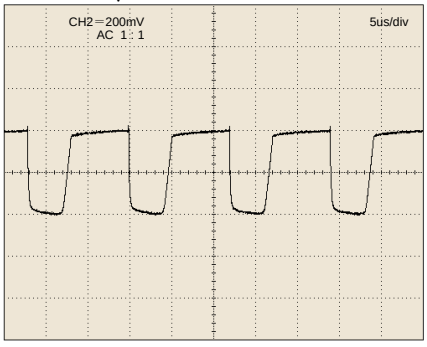
Compared them under the lower temperature, OS-CON is able to keep stable, while the low Z aluminum capacitor has 3.2 times larger drop of the voltage and the low ESR tantalum capacitor has 1.2 times larger drop of the voltage.

OS-CON
10SP100M



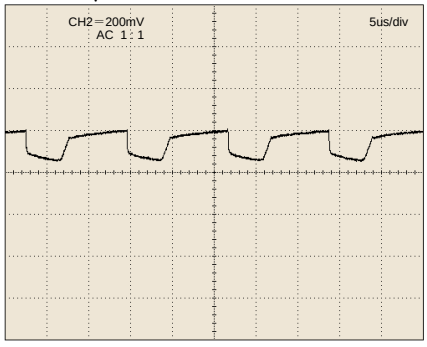
ΔV=104mV 200mV/div 5μs/div

Low Z Aluminum capacitor
10V1,500μF



ΔV=404mV 200mV/div 5μs/div

Low ESR Tantalum capacitor
10V220μF X 2



ΔV=144mV 200mV/div 5μs/div

Application to low-pass filter circuits

As a means of removing noise from power supply lines, a low-pass filter such as shown below may be used.

In recent years, switching power supplies have been referred to as power sources, which are compact and highly efficient, but must be large noise sources in not a few cases. Also, digital circuits are various types of noise sources, and in most of the devices with mixed noise-sensitive analog circuits, entry of high-frequency noise into the analog circuits is prevented by connecting these low-pass filters to the power supply lines of the analog circuits.

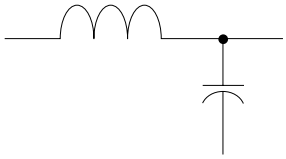


Fig.1 LC Filter

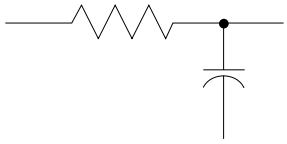


Fig.2 RC Filter

Then, the ESR of capacitors in use affects the damping factor of filters, and an ideal damping effect can be expected with decrease in the ESR. This is because the capacitor's capacitance and ESR make a zero, which is a first order phase lead network, grow, so that the damping factor effect is cancelled by +20dB/dec at frequencies higher than zero. In other words, the damping factor effect is lost from -40dB/dec to -20dB/dec in the LC filter, and from -20dB/dec to 0 in the RC filter.

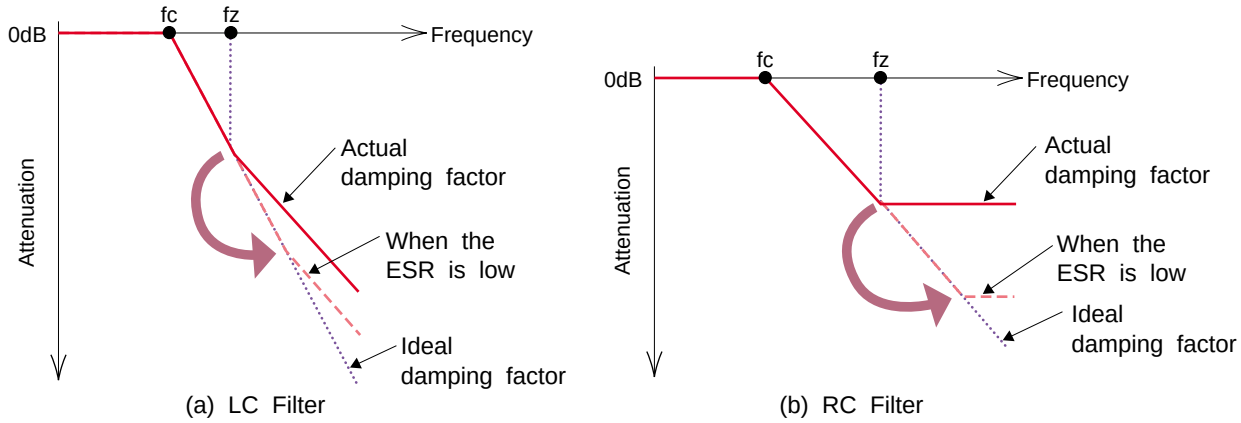
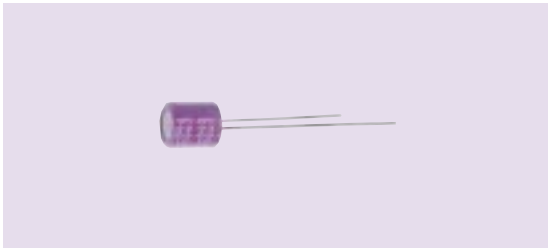


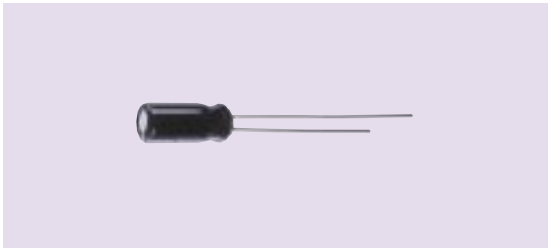
Fig.3 Actual damping factor

Therefore, there are not a few cases where this zero phenomenon affects such problems that the noise-cutting effect cannot be produced in spite of an increase in the capacitance of the capacitor in use.
Due to its small ESR, the **OS-CON** is most effective with this low-pass filter.

Next, comparisons of actual damping factor effects are made with an aluminum electrolytic capacitor.
The capacitors used for comparisons are as follows:

- **OS-CON** : 16V/33uF, ESR=37mΩ (16SA33M) ※ESR is an actual measurement.
- Aluminum electrolytic capacitor : 10V/33uF, ESR=1410mΩ

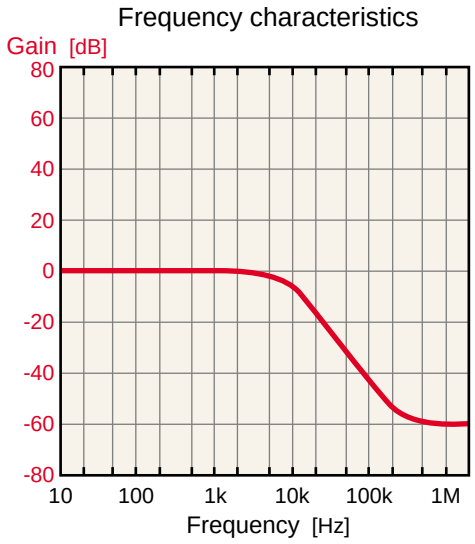




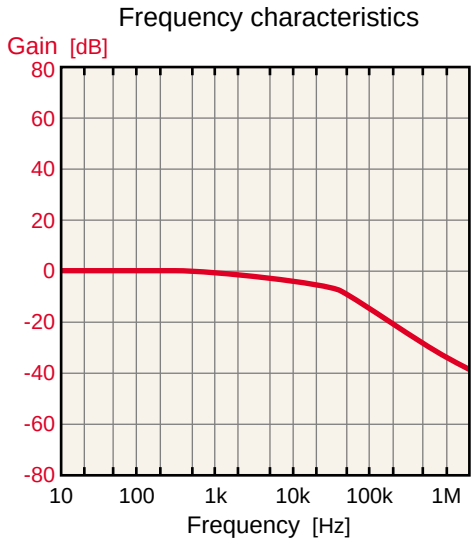
XI. Application

① LC Filter (L=10uH)

1) OS-CON

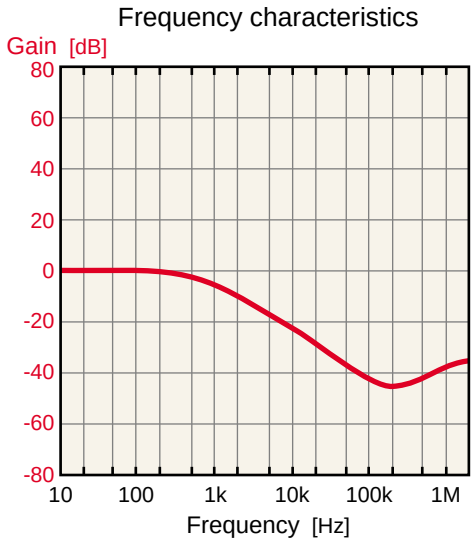


2) Aluminum electrolytic capacitor

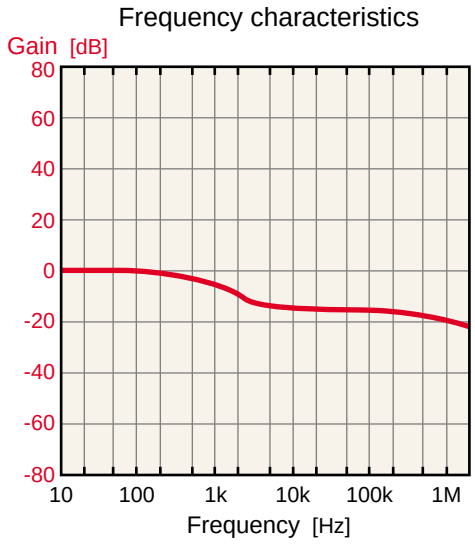


② RC Filter (R=5.6Ω)

1) OS-CON



2) Aluminum electrolytic capacitor



In any of these instances, it can be seen that the OS-CON shows an damping effect in higher frequency regions.

These measurements were made only at room temperature. It is, however, needless to say that the difference will be more obvious at low temperatures (especially 0°C or less). This is because the ESR of the aluminum electrolytic capacitor increases extremely at low temperatures, while the ESR of the OS-CON hardly changes at low temperatures, which does not affect the damping effect of the filter.

Application of switching power supply for smoothing capacitor

It is said that to restrain output ripple current, the output smoothing capacitor of the switching power supply is suitable to use the smaller ESR capacitor. However when the low ESR capacitor is used, the phenomenon sometimes occurs that is called the abnomal oscillation of output voltage.
The occurrence degree of the abnormal oscillation of output voltage changes even if it depends on the topology such as the control system, and Boost and Buck style. We explain the mechanism and the treatment method of output voltage oscillation with the example of the Buck style switching regulator under the voltage control mode.

1. Abnormal oscillation of output voltage

The switching power supply usually has the negative feed-back circuit to stabilize output voltage. The outline control block is shown in Figure 1. The difference between output voltage and standard voltage Vref are amplified with the error amplifier and convert to the digital signal with the PWM comparator and flip on and flip off switch Q1. Input voltage Vin becomes a square wave form by Q1, and you obtain DC output voltage Vout by make it smooth with coil L and capacitor Cout. Therefore, L and also Cout assumed that they form the second low pass filters.

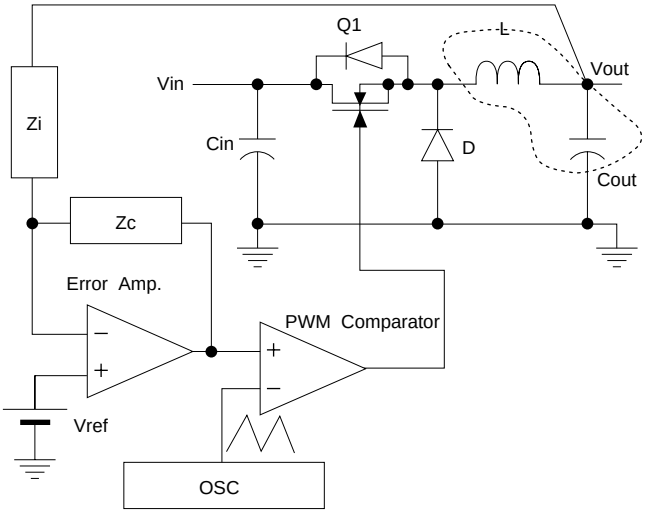


Fig.1 Control block of switching power supply

The frequency characteristic of the output LC filter is expressed with the Bode diagram like Figure 2. On the other hand, the phase is delayed 180 degrees originally, because the error amplifier is a negative feedback circuit. Therefore, the phase delay of the output LC filter and the error amplifier occur at the same time, and when 360 degrees delay occur, the output voltage oscillates.

Let's think about an ideal LC filter. The damping rate of the LC filter is -40dB/dec and the cut-off frequency becomes $\frac{1}{2\pi\sqrt{LC}}$, and become Gain and Phase like the dotted line of Figure 2.
With an ideal filter the output voltage oscillates because it is delayed 180 degrees. But more than some frequency that is called zero frequency, damping rate of Gain becomes -40dB/dec to -20dB/dec. Furthemore the Phase returns to delay 90 degrees from delay 180 degrees. This is because the first

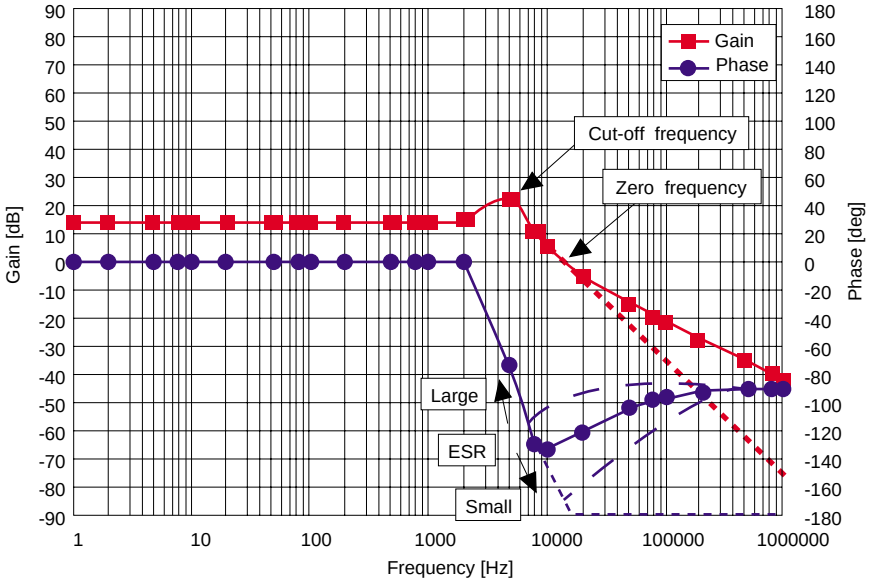


Fig.2 Frequency characteristic of LC filter

order Phase lead network is formed by the capacitance value and ESR of Cout. Because, after the zero frequency $\frac{1}{2\pi \text{ Cout ESR}}$, the Gain damping rate goes on the Phase of +20 dB, +90 degrees. However, when the small ESR capacitor is used, it works as a LC filter up to high frequency band, and the Phase delay to nearly 180 degrees and it becomes easy to oscillate.
30 degrees to 40 degrees or more of Phase margin is thought as a necessity to inhibit the oscillation of output voltage with a general negative feed-back circuit. The Phase margin is numerical value how much the minimum value of the Phase is distant from-180 degrees. The smaller the Phase margin gets, the higher the possibility to oscillate by the characteristic dispersion and temperature change of the component will be.

2. Inhibition method of oscillation

By doing Phase compensation with the feed-back circuit of the error amplifier the oscillation of output voltage can be inhibited.
There are various kinds in Phase compensation. It is most effective to use the Phase compensation circuit like the following in the switch power supply of the voltage control mode.

Figure 3 shows that ② and ④ form first order Phase lead network and ① and ③ form first order Phase lag network. By adjusting these values, it dose the Phase compensation by which Phase will occur and improve Phase delay of the whole negative feed-back circuit by the frequency characteristic of output LC filter at the frequency band which the Phase indicates the lowest. Figure 4 is the example. As the Phase of the output LC filter of Figure 2 becomes a lowest point at around 10kHz, it has about 30 degrees of Phase lead around that frequency. Because of this, it can secure the Phase margin of 30 degrees even if the Phase delay of LC filter becomes 180 degree nearly, the oscillation of output voltage can be inhibited.
Related in detail, please inquire it to us.

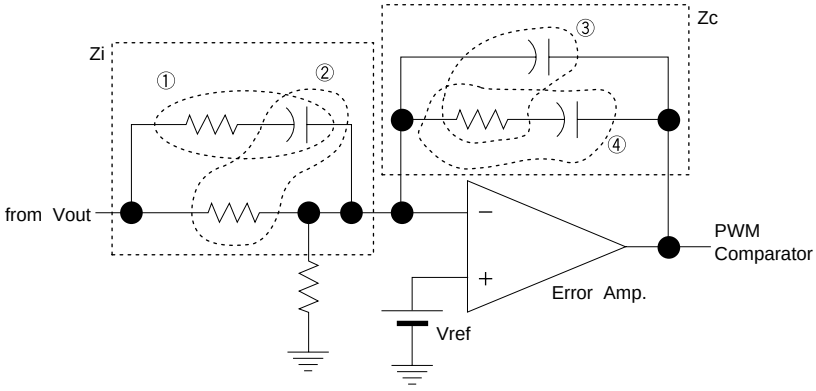


Fig.3 Phase compensation network of Voltage Control Mode

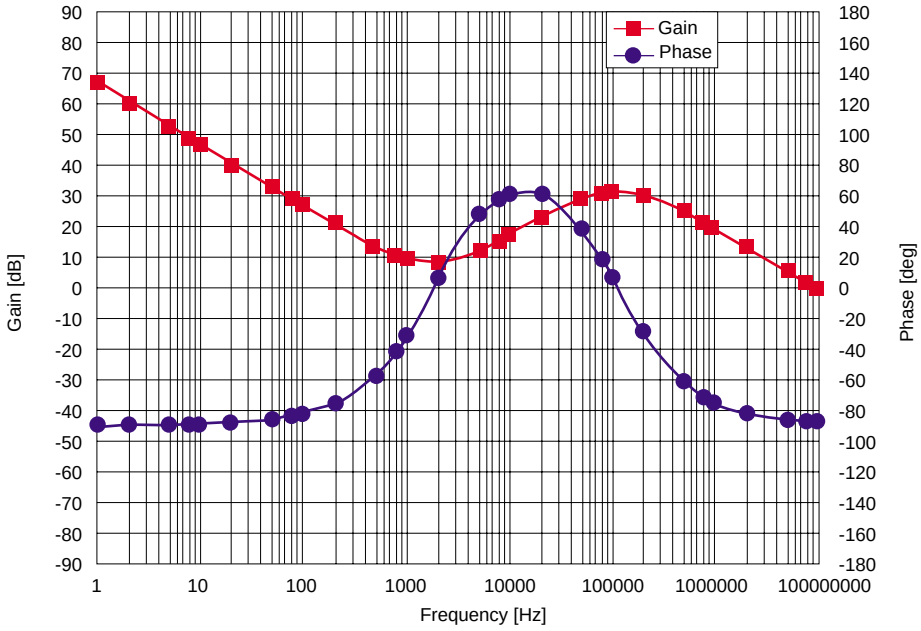
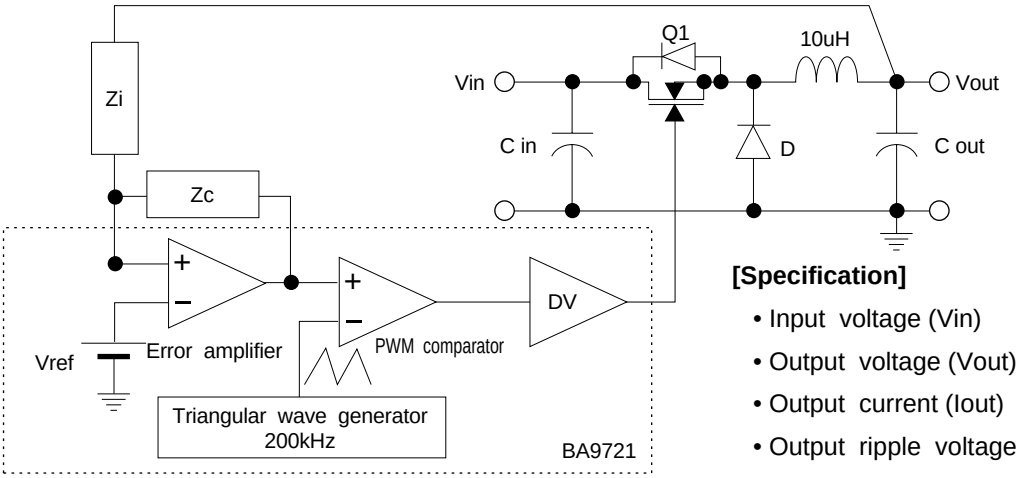


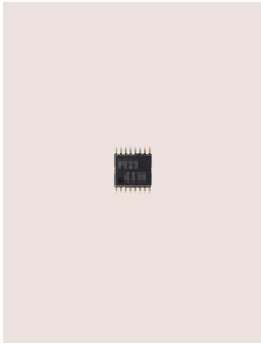
Fig.4 Frequency characteristic of Phase Compensation Network

XI. Application

3. Concrete examples of prevention oscillation

Now, concrete examples of design are introduced.
Fig. 5 shows an example of the design of a step-down DC-DC converter using a ROHM-made power supply control IC.





[Specification]

- Input voltage (Vin) : 5V
- Output voltage (Vout) : 3.3V
- Output current (Iout) : 3.2A
- Output ripple voltage (Vripple) : 20mVp-p

Fig.5 A concrete example of design

The ESR of the output capacitor necessary to make an output ripple voltage of 20mVp-p can be obtained as follows:
ESR < Vripple / ((Vin-Vout) / L*Vout / Vin / fosc) = 35.7mΩ
Consequently, the following capacitors have been selected.

1) **OS-CON**
   6SVP100M 1-parallel φ6.3×L6mm ESR = 32mΩ ※ESR is an actual measurement.
2) Aluminum electrolytic capacitor
   6V/680uF 3-parallel φ10×L8mm ESR = 128mΩ/p. Total ESR = 43mΩ

Photograph 1 (a) and (b) show measuring circuits using the above capacitors. Following, it will be verified just how much we can downsize by using the **OS-CON** compared with aluminum electrolytic capacitors if the most favorable phase compensating circuit is provided.

(a) **OS-CON**

(b) Aluminum electrolytic capacitor

Photo 1 Evaluated circuit boards

4. Examples of design with aluminum electrolytic capacitors

When the aluminum electrolytic capacitors are used, the frequency characteristics of the output LC filter are as shown in Fig.6, and there is a sufficient phase margin to such an extent that there is no need to make phase compensation. Therefore, the phase compensating circuit in Fig.7 is sufficient.

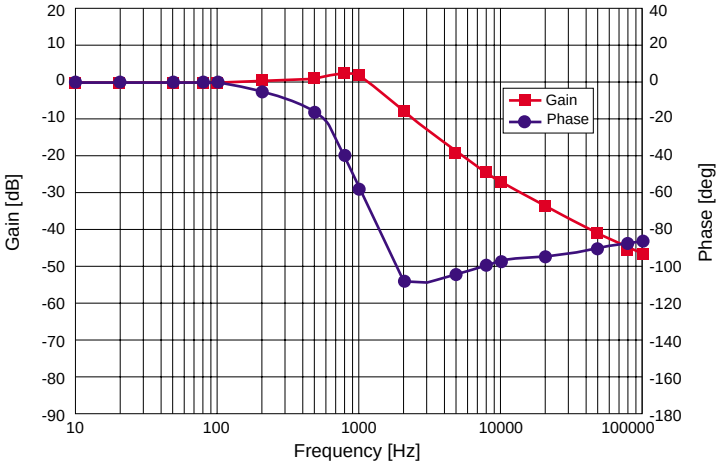


Fig.6 Frequency characteristics of the LC filter with the AL-E

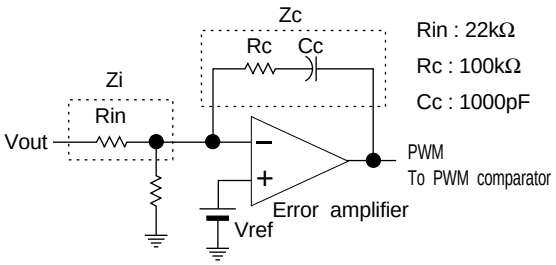


Fig.7 Phase compensating circuit with the AL-E

With the phase compensation network in Fig.7 (properly speaking, phase compensation is not made), the total frequency characteristics are as shown in Fig.8, and it can be said that there is a sufficient phase margin. The output ripple voltage waveform is shown in Fig.9.

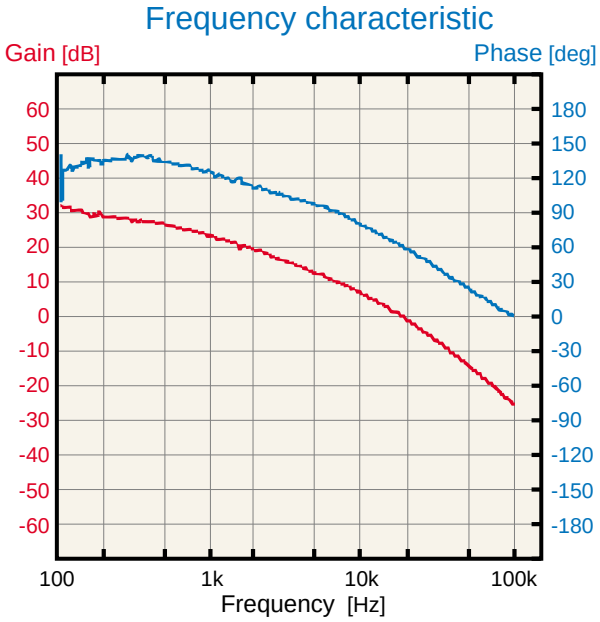


Fig8 Total frequency characteristics with the AL-E

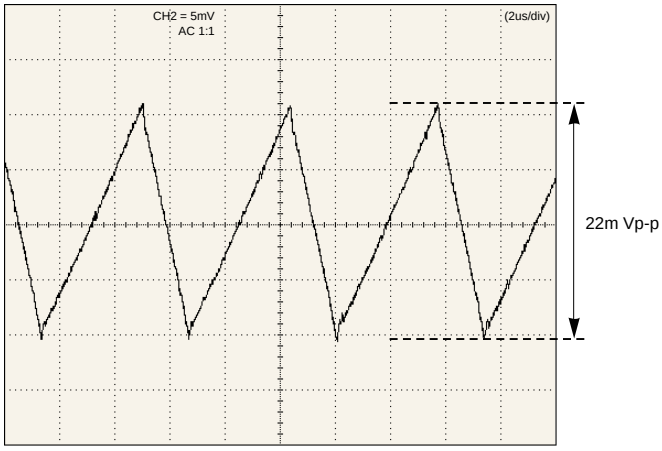


Fig.9 Output ripple voltage waveform with the AL-E

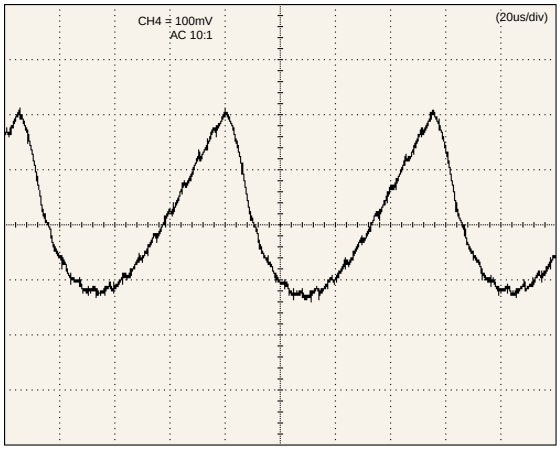


Fig.10 Oscillating output voltage waveform

5. Examples of design with the OS-CON

When the aluminum electrolytic capacitors used in power supply circuits are replaced with the **OS-CON** without changing the phase compensation network, the output voltage oscillates. (Fig.10)

As a reason, we can say that the phase margin is lost because the phase compensation network is not changed despite the fact that the frequency characteristics of the output LC filter change as shown in Fig.6, where the aluminum electrolytic capacitors are used, to Fig.11, where they are replaced with the low ESR **OS-CON**.

When the LC filter has little phase margin as shown in Fig.11, appropriate phase compensation can be made by using such a phase compensation network as shown in Fig.12.

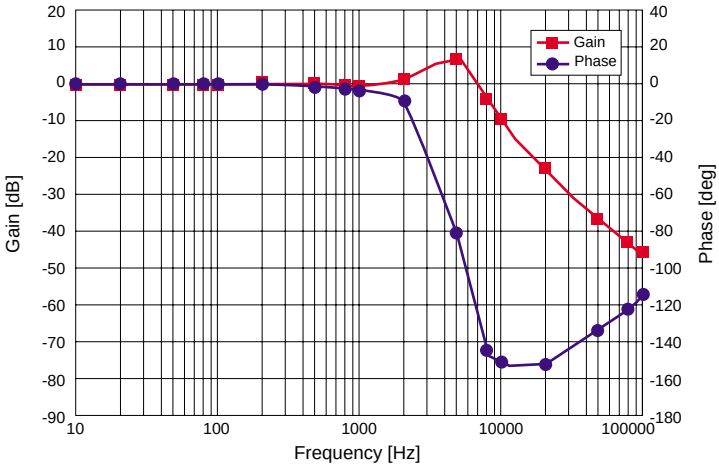


Fig.11 Frequency characteristics of the LC filter with the OS-CON

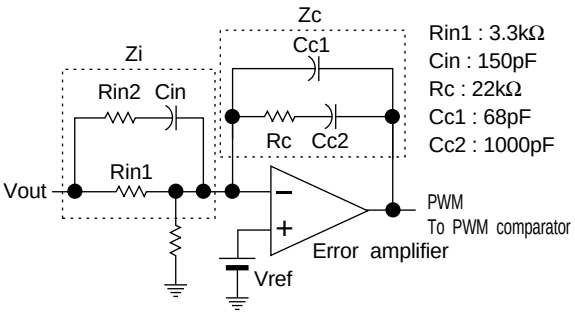


Fig.12 Phase compensating circuit with the OS-CON

This is to cancel the deepened phase lag by forming phase leads at Zi and Zc in Fig.12. Because of this, the total frequency characteristics are as shown in Fig.13; the phase margin is sufficient; and the output ripple voltage waveform (Fig.14) is almost the same as is the case with the aluminum electrolytic capacitors.

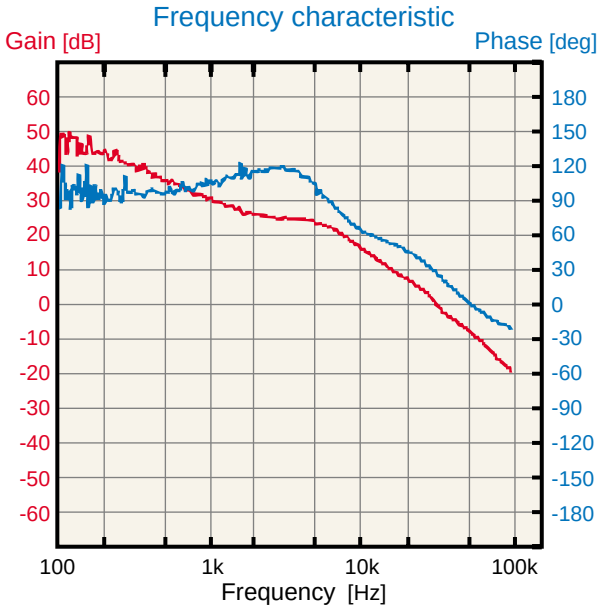


Fig.13 Total frequency characteristics with the OS-CON

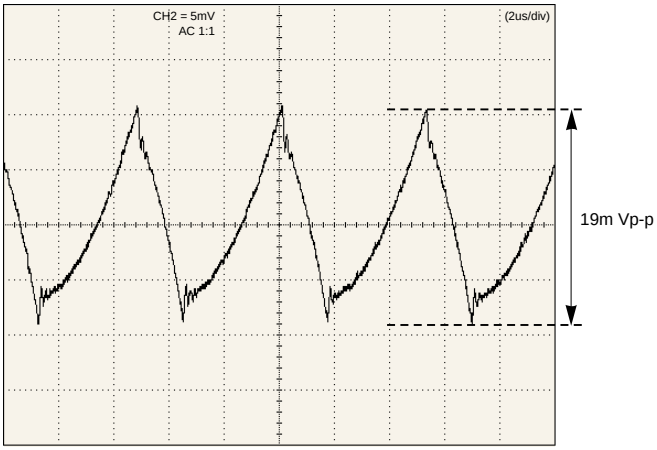


Fig.14 Output ripple voltage waveform with the OS-CON

Influence of output ripples from switching power supply on actual images

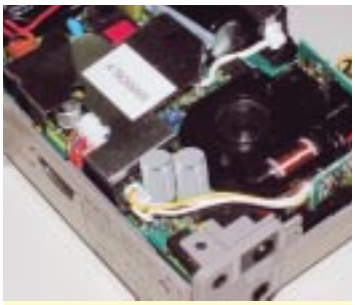
As shown on page 70 through to page 75, an OS-CON, aluminum electrolytic capacitor, and a tantalum capacitor were connected as the output capacitor of a switching power supply to compare the remaining output ripples. The result showed that the OS-CON provided an excellent filter effect, superior to those of other capacitors. This section discusses the influence of such remaining ripples on images. You may understand how digital noise affects analog signals.

Influence on images by a digital camera

An OS-CON with rating of 10V / 47μF X 2p. (SL series, size: φ6.3 X L5.0) and a low impedance aluminum electrolytic capacitor with rating of 10V / 330μF (size: φ6.3 X L11.0) were connected as the smoothing capacitor on the output side of the DC-DC converter in a digital camera to compare their influence on actual images when the temperature was changed between 25°C, 0°C and -20°C .

Parts mounting circuit

OS-CON is used



AI-E is used

☆OS-CON

10V / 47μF X 2p. (SL series ; size : φ6.3 X L5.0)

☆Low impedance Aluminum electrolytic capacitor

10V / 330μF X 2p. (size : φ6.3 X L11.0)

Photo I at 25°C

Photo 2 at 25°C

Photo 3 at 0°C

Photo 4 at 0°C

Photo 5 at -20°C

Photo 6 at -20°C

As shown above, images were quite normal down to −20°C when the OS-CON was used, while images started to become white, like misting, around 0°C as a whole, and images hardly appeared at all at −20°C as shown in Photo 6 when the low impedance aluminum electrolytic capacitor was used.

Ⅻ. Information and wish

①Since the following models of the SC, SA, SL, SH and SVP series have been integrated into models with a higher voltage rating, please consider these higher voltage rating models for new adoption or model changes.

Series	Size Code	Applicable model	Alternative model
SC	A	16SC1M	25SC1M
		16SC1R5M	25SC1R5M
	B	6SC10M	10SC10M
	C	16SC10M	25SC10M
		6SC22M	10SC22M
	D	6SC47M	10SC47M
SA	C	10SA33M	16SA33M
	E	10SA100M	16SA100M
SL	B'	6SL10M	10SL10M
	C'	6SL22M	10SL22M
		6SL33M	10SL33M
		6SL47M	10SL47M
SH	A	16SH1M	25SH1M
		16SH1R5M	25SH1R5M
	C	16SH10M	25SH10M
SVP	A5	6SVP15M	10SVP15M
		4SVP22M	6SVP22M
	B6	10SVP22M	16SVP22M
		6SVP33M	10SVP33M
	C6	6SVP56M	10SVP56M
		4SVP82M	6SVP82M
	E7	10SVP82M	16SVP82M
		6SVP120M	10SVP120M
		6SVP150M	10SVP150MX
		4SVP220M	6SVP220MX
	F8	4SVP470M	6SVP470MX

②Production of the SG and SV series has been discontinued. Therefore, customers using these series at present are kindly requested to substitute the SP series for the SG series, and the SVP series for the SV series.

③Production of the SM and SN series is scheduled to be discontinued upon receipt of customer approval. Please use the SVP series for new board designs.

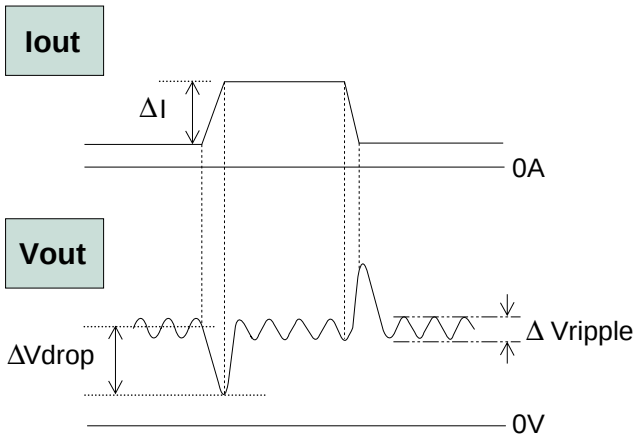
XIII. Capacitors Selection Sheet

Company			
Dept.			
Name			
TEL		FAX	
E-mail			

Application	Power Supply / Filter / By-pass Capacitor / Coupling Circuits / Others ( )		
Equipment	PC / PC Peripheral Unit / Audio / Communication / Automobile / Other ( )		
Height limit	mm	Mount type	Radial SMD

Indispensable item

Item	Symbol	Value	Unit
Switching Frequency	fosc		kHz
Input Voltage	Vin		V
Output Voltage	Vout		V
Output Current	Iout		A
Ripple Voltage	ΔVripple		mVp-p
Ambient Temperature	Ta		°C
Primary Inductance	L1		μH
Inductance	L		μH
Winding ratio	n1 : n2	:	

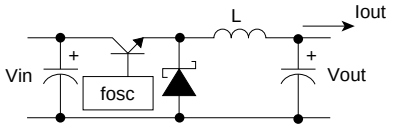


Option

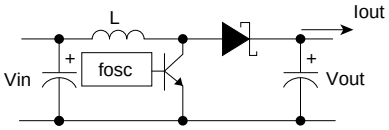
Current Change	ΔI		A
Voltage Drop	ΔVdrop		mV
Control IC			

◆Please enclose the use circuit in a circle.

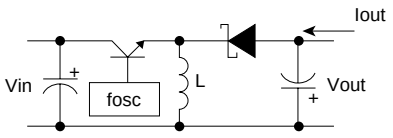
①BUCK
Vin > Vout



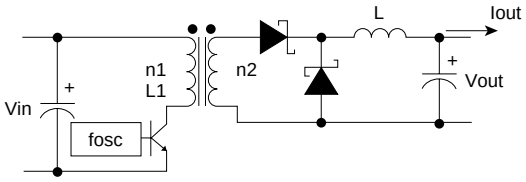
②BOOST
Vin < Vout



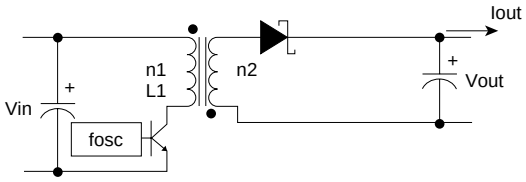
③BUCK-BOOST
0 > Vout



④FORWARD



⑤FLYBACK



Memo

SANYO

Application to OS-CON

Portable Navigation System

DVD PORTABLE NAVIGATION SYSTEM GORILLA DX

NV-DX851

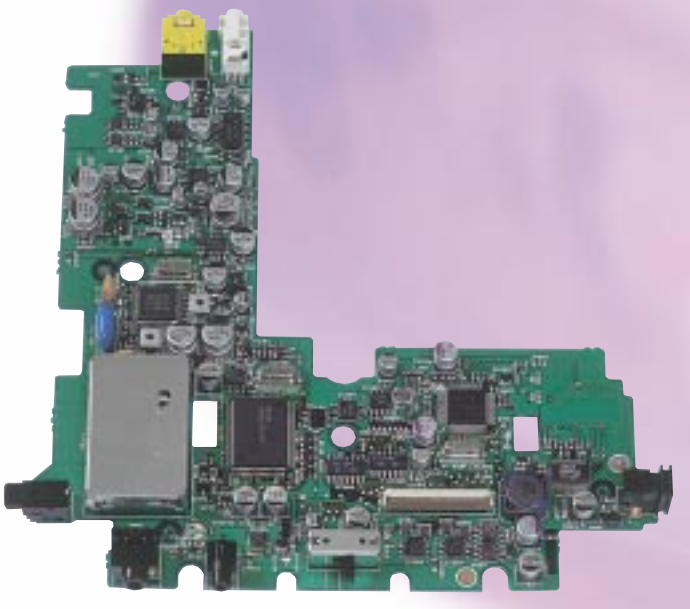
●The image of monitor is an inlaid composite photograph.

OS-CON™

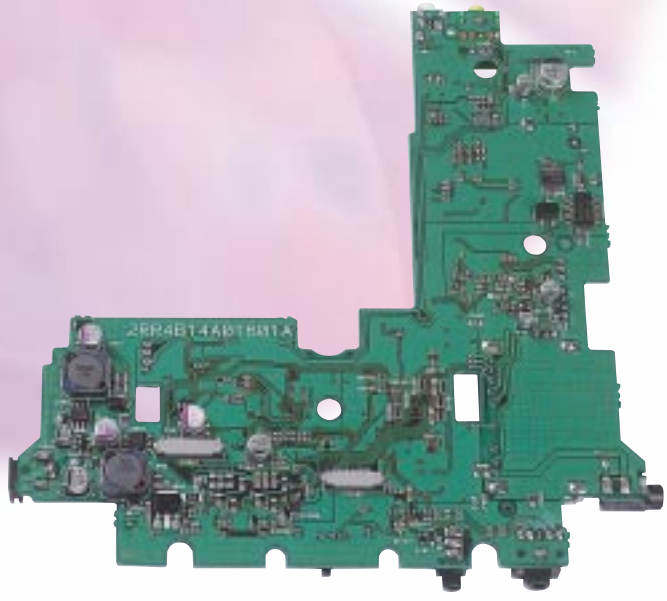
Adopted model × Quantity

20SVP22M × 2

6SVP82M × 4



(Front)



(Back)

OS-CON is used for the DC-DC converter part.

SANYO Electric Co., Ltd.
Electronic Device Company

Sales division(Japan)
1-1 SANYO-cho, Daito, Osaka, 574-8534
Phone:(072)870-6375/6377
FAX: (072)870-6456 **http://www.secc.co.jp**
SANYO Component Europe GmbH
Stahlgruberring 81829 Munich Germany
Phone:＋49-(0)89-460095-284
FAX: ＋49-(0)89-460095-275
Taiwan Branch(Taiwan)
4 Fl., No.146, Sungjiang Rd., Taipei, Taiwan104, R.O.C.
Phone:886-2-2536-1855
FAX: 886-2-2536-6168
Korea office
7th Floor, Han-Wha Building 110, Sogong-Dong, Chung-ku, Seoul, Korea
Phone:02-777-5860
FAX: 02-777-6053

SANYO Electronic Device (U.S.A.) Corporation

San Diego Headquarter
2055 SANYO Ave., San Diego, CA. 92154, U.S.A.
Phone:1-619-661-4134
FAX: 1-619-661-1055 **http://www.sanyodevice.com**
San Jose sales office
1230 Oakmead Parkway, Ste. #314, Sunnyvale, CA 94085, U.S.A.
Phone:1-408-749-9714
FAX: 1-408-749-0212
Boston sales office
100 Cummings Center, Ste. #218C, Beverly, MA 01915, U.S.A.
Phone:1-978-922-6573
FAX: 1-978-922-7428
Dallas sales office
2007 North Collins Blvd., Ste. 407, Richardson, TX 75080, U.S.A.
Phone:1-972-238-7450
FAX: 1-972-238-7321
Forrest City sales Representative
P.O.Box 2604-Forrest City, AR 72336, U.S.A.
Phone:1-870-494-3793
FAX: 1-870-633-6720

SANYO Electronic Components (Singapore) Pte., Ltd.

70 Anson Road #19-01 To 08, Apex Tower Singapore/079905/Singapore
Phone:65-6223-0225
FAX: 65-6223-0986

SANYO Electronic Components (HK) Limited

Suite 3601-06, 36/F, Tower 6, The Gateway, Harbour City, 9 Canton Road, T.S.T., Kowloon, Hong Kong.
Phone:852-2301-0529
FAX: 852-2301-2255