

7. Major Applications

7-1 Power Supply Circuits

Stable DC power supplies are divided into intermittent control types (switching regulator) and continuous control types (Dropper).

Recent trends have shown an overwhelming growth in switching regulators, and so we will talk mainly about switching regulators below.

The capacitors used in switching regulators are selected depending on the circuit. A forward switching regulator is shown as an example in Fig.25. Another type is a flyback regulator.

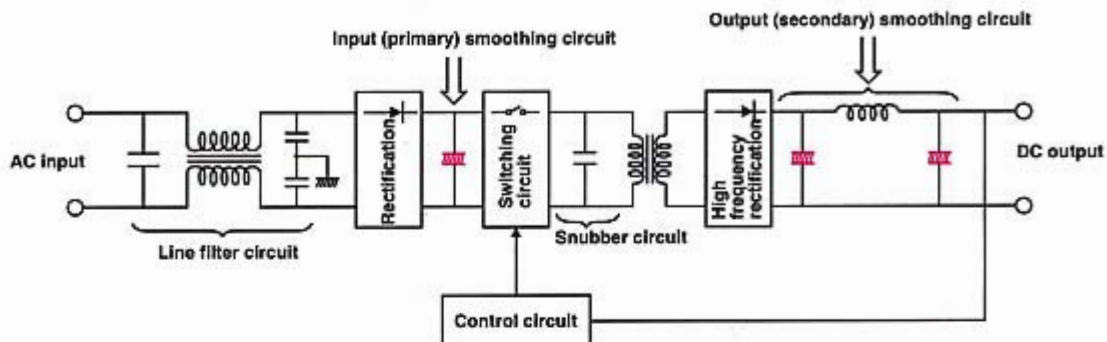


Fig.25 An Example of Capacitor Use

Examples of capacitor use

- ① Line filter circuits: ceramic capacitors, film capacitors
- ② Input smoothing circuits: aluminum electrolytic capacitors, (laminated ceramic capacitors)
- ③ Snubber circuits: ceramic capacitors
- ④ Output smoothing circuits: aluminum electrolytic capacitors, laminated ceramic capacitors, film capacitors, aluminum solid electrolytic capacitors, tantalum electrolytic capacitors.
- ⑤ Control circuit: ceramic capacitors, film capacitors, tantalum electrolytic capacitors, aluminum electro-

(1) Aluminum Electrolytic Capacitors for Input (Primary) Smoothing Circuits

The Aluminum electrolytic capacitors for input smoothing circuits used on commercial voltages (100 VAC, 200 VAC) and commercial frequencies (60 Hz, 50 Hz) must have a high withstand voltage and a ripple current resistance complying with twice the commercial frequency (normally full-wave current). These capacitors have large volumes (ground contact areas) compared to other components they are assembled with, and so the demand for more compact capacitors, as well as power supplies, is strong. Another problem is the need for longer aluminum electrolytic capacitor lives, but products guaranteed for 5000 hours at 105°C have recently been developed, thus realizing freedom from maintenance for 10 years.

Example of Aluminum Capacitor Series for JIS692 type Input Smoothing Circuits

Table-8

Category	85°C guaranteed products	105°C long life guaranteed products		
Features	General use product	General use product	Compact product	7000 hours guaranteed products
Series	TS-UP	TS-HA	TS-HB	TS-XB

(2) Aluminum Electrolytic Capacitors for Output Smoothing Circuits

the rated voltage of aluminum electrolytic capacitors used for smoothing at switching frequencies (20k-500kHz) is determined by the output voltage, and they must have low impedance (low ESR) at switching frequencies.

Therefore, aluminum electrolytic capacitors for output smoothing are designed to have low impedance at 20k-500kHz, and the recent development of a low resistance electrolyte using new materials has resulted in products with 1/3 to 1/4 the impedance of conventional products with the same volume. These low impedance products also have an extremely stable life, and they are expected to become

Example of Aluminum Capacitor Series for JIS04 type Output Smoothing Circuits

Table-9

Category	85°C guaranteed products		105°C long life guaranteed products		
Features	General use product	Compact product	General use product	Compact product	Low impedance products
Series	SU	M	GA	NHG	FB/FC

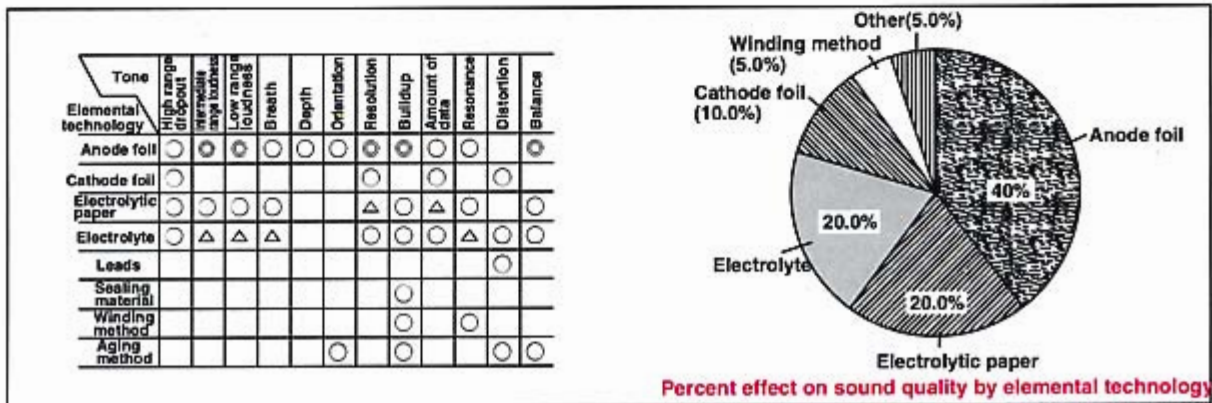
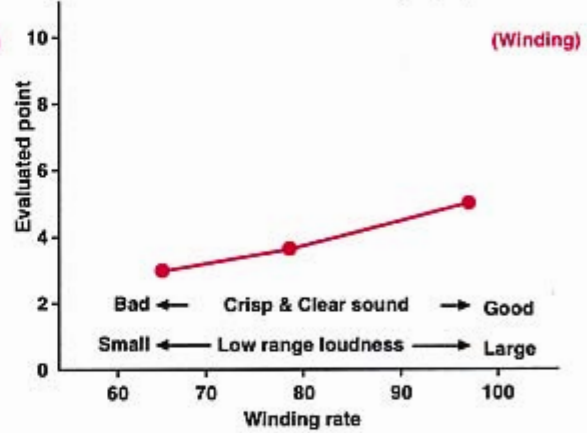
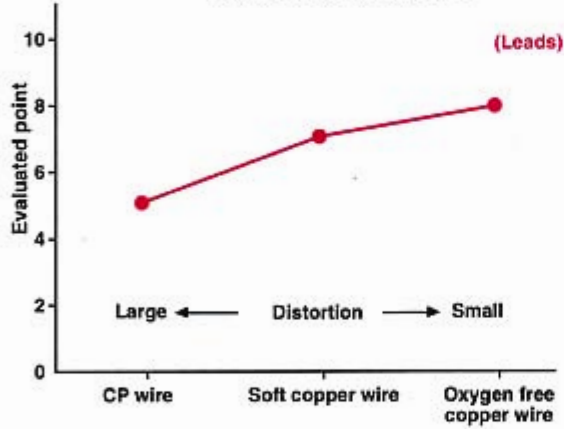
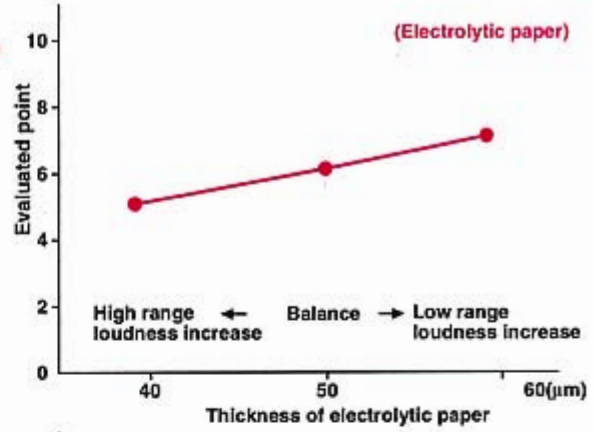
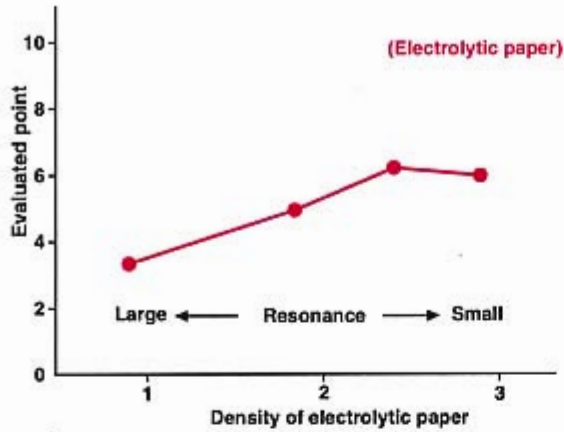
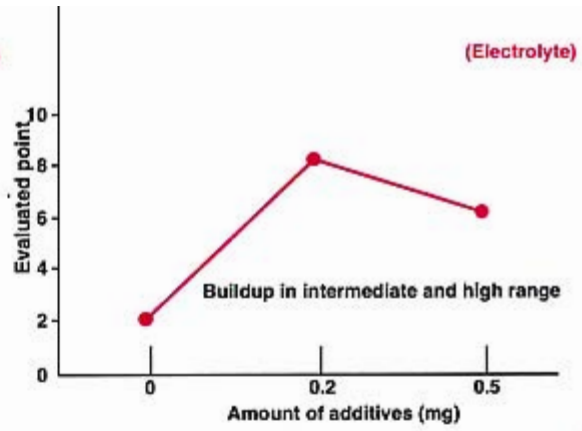
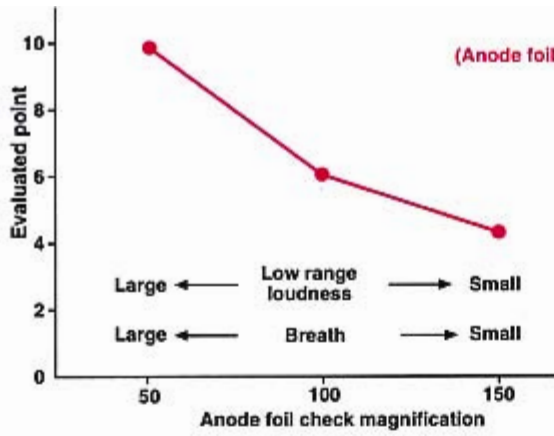
7 – 2 Audio Equipment

Sound quality characteristics of aluminum electrolytic capacitors

As the sound quality of audio equipment has improved due to digitalization, there has been a strong demand for aluminum electrolytic capacitors with enhanced sound performance. The relationship between sound quality and elemental technology of capacitors is described as follows.

Relationship of sound characteristics to materials and methods

Elemental technology		Factors	Affect on sound quality
Anode foil	Etching magnification	<ul style="list-style-type: none"> Etching conditions (temperature, fluid, current) 	<ul style="list-style-type: none"> The lower the magnification The greater the loudness and resonance in the low range The more enhanced depth and breadth are
	Etching shape	<ul style="list-style-type: none"> Etching conditions (temperature, fluid, current) Impressed current (AC/DC, waveform, frequency) Core thickness, foil thickness 	<ul style="list-style-type: none"> Affects loudness in intermediate and low ranges Determines sound tendency, balance and orientation Affects buildup and resolution
	Forming method	<ul style="list-style-type: none"> Forming conditions (temperature, fluid) 	<ul style="list-style-type: none"> Improves resolution in intermediate and high ranges Affects amount of data Improves dropout in high ranges
	Forming voltage		<ul style="list-style-type: none"> Affects loudness in intermediate range Affects lingering of sound
Electrolyte	<ul style="list-style-type: none"> Solute Solvent Additives 	<ul style="list-style-type: none"> Type Composition ratio 	<ul style="list-style-type: none"> Affects dropout in the high range and distortion Affects buildup, resolution and amount of data Determines sound tendency, balance and loudness
Electrolytic paper	Density		<ul style="list-style-type: none"> Affects dropout in high range Affects lingering and resonance of sound
	Thickness		<ul style="list-style-type: none"> Determines sound tendency, balance and loudness
	Material	<ul style="list-style-type: none"> Manila paper Kraft paper 	<ul style="list-style-type: none"> Improves depth and breadth Improves buildup in low range
Leads	Material	<ul style="list-style-type: none"> CP wire 	<ul style="list-style-type: none"> Affects distortion
	Sealing material, Outer sleeves, Case		<ul style="list-style-type: none"> Affects buildup in low range Affects dropout
Winding method	Winding tension	<ul style="list-style-type: none"> Method 	<ul style="list-style-type: none"> Affects buildup, resonance and loudness in the low range



We produce sound qualities and sound design to satisfy the demands of various users by combinations of above elemental technologies in our aluminum electrolytic capacitors for audio equipment.

7-3 Inverters

With the advancement of power devices for high electric power, semiconductor devices for controlling power supplies with capacitors from 1W to 10kW have come into practical application.

With the application of these devices, the use of electronic devices incorporating inverter circuits has rapidly increased for everything from communications, data processing and industrial use to home appliances, the most common of which is the inverter air conditioner.

The smoothing circuits of the input sections of these inverter circuits also use aluminum electrolytic capacitors. The capacitors used in conventional series power supplies have to have a high ripple current resistance and a long life. Here we describe an example of an inverter application and the necessity of using an aluminum electrolytic capacitor in the inverter circuit and in smoothing.

○ General Use Inverter

Electric motors are widely used in all types of machine equipment, building ventilator fans, and factory manufacturing equipment, and the use of general use inverters for the rotational control of these motors is increasing rapidly because they permit variable speed control and improve total efficiency. The input section of these general-use inverters smooths a 200-VAC, three-phase current and employs a

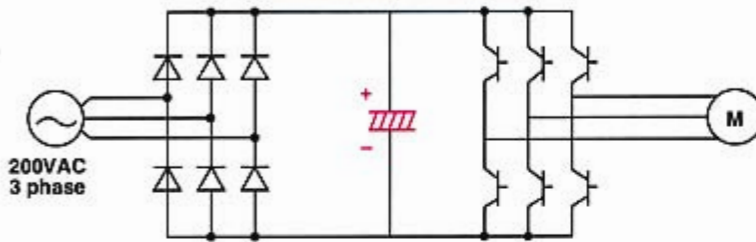


Fig.26

power transistor to make an alternating current for driving the motor. The principal type of circuit used is shown in Fig.26. The electrolytic capacitor used in the smoothing section must normally be rated for 350-450V and have excellent ripple current resistance.

The type of capacitor used depends on the output capacity. In the case of a large output capacity, a single screw terminal type aluminum capacitor or two or more in parallel are used, and in the case of a small output, printed circuit board types are used in parallel.

One point to be careful of when selecting a capacitor is the rated voltage since the voltages at both

○ Inverter Air Conditioners

(Since inverter air conditioners for home use came on the market in 1983 because of their efficiency and low power consumption, their production volume has skyrocketed.)

Aluminum electrolytic capacitors are also used for input smoothing in these products, and depending on the AC power input, they can generally be classified by the following circuit types.

Input	Typical circuit	Electrolytic capacitor					
		C ₁ , C ₂			C ₃		
		Rated voltage	Rated capacitance	Ripple current	Rated voltage	Rated capacitance	Ripple current
1 phase 100V		250V	330 680μF	3A 8A at 60Hz	330V	1300μF 2200μF	3A 6A at 120Hz
1 phase 200V		350V	70 220μF	3A 6A at 60Hz	350V	1300μF 2200μF	3A 6A at 120Hz
3 phase 200V					350V	470μF 1000μF	2.1A 4.5A at 120Hz

The capacitors C₁ and C₂, in particular, in the initial stage of single phase 100 VAC and 200 VAC circuits must have a low capacitance and an extremely high ripple current resistance in order to raise the power factor, and compared to capacitors for general power supply circuits, they must have high heat resistance and low loss.

To meet these needs, we are developing and manufacturing low loss anode foils and high conductivity,

○ Other

The use of devices employing inverter circuits is also increasing in uninterrupted power supplies, inverter power supplies for train air conditioners and other purely industrial applications.

To obtain large capacitance, multiple aluminum electrolytic capacitors are often connected in series and parallel, thus increasing the importance of capacitance balance and leakage current balance.

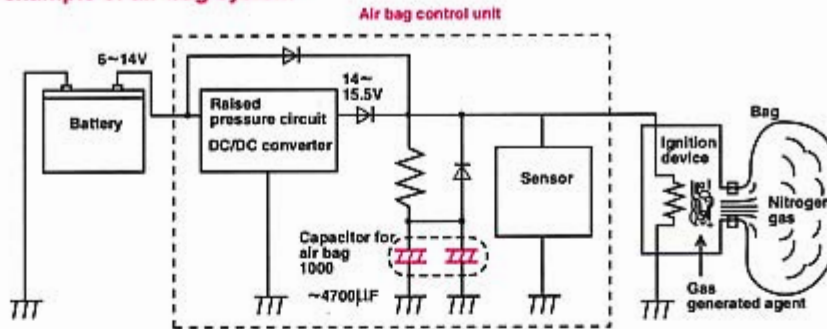
7-4 Air bag

In the U.S., air-back or automatic seat belt have been obliged from 1990 style car. Adopting air bag system is also expanding in domestic automobile manufacturers in order to enforce the safety measure.

This air bag system uses large capacitance aluminum electrolytic capacitor as back-up battery for redundant design. We have a variety of aluminum electrolytic capacitors for air bag system with high reliability.

Here, the circuit of air bag system, requirements and features of aluminum electrolytic capacitors for

(1) Circuit example of air-bag system



1000~4700 μ F aluminum electrolytic capacitors are used for back-up power supply.

(2) Requirements of air bag capacitors

- High reliability (105°C 5000h guarantee)
- Miniature and large capacitance
- Small electrostatic capacitance change (temperature and life change)
- Small DC resistance

(If DC resistance is high, voltage will fall by IR drop at the moment of discharge.)

(3) Features of air bag capacitor

Initial capacitance is large. Capacitance tolerance:0~+30% (General products 20%)

Superior temperature characteristics. (Capacitance change, DC resistance change)

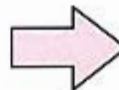
Long life (105 °C 500h guarantee), high reliability.

Superior excessive voltage characteristics. (can endure JASO excessive voltage performance)

(4) Comparison with general products

	For air bag	SU series
Capacitance	2700 μ F	2200 μ F
Capacitance tolerance	0~30%	\pm 20%
Life assurance (capacitance change)	105°C3000h(\pm 10%) 105°C5000h(\pm 20%)	85°C2000h(\pm 20%)
Capacitance change at -40°C	-5~-10%	-20~-30%

For air bag, initial capacitance is always more than official.
Long life and small capacitance change.
The changes at low temperature is very small.



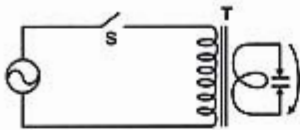
Contributes to total cost performance.

7-5 Welders

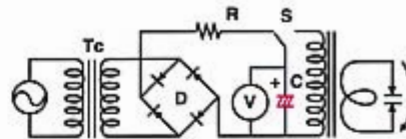
Spot welders are divided into the following four types according to their power supply.

1. AC welding power supply
2. Capacitor welding
3. Transistor welding power supply
4. Inverter welding power supply

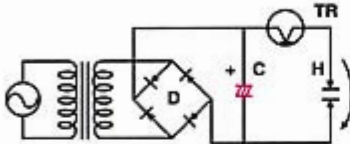
1) AC welding power supply



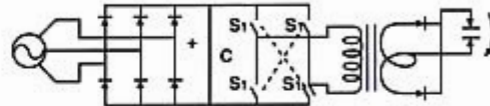
2) Capacitor welding



3) Transistor welding power supply



4) Inverter welding power supply



Of the above systems, the AC system does not require an aluminum electrolytic capacitor, but 2), 3) and 4) all require capacitors for their input, and the properties of those capacitors all differ.

Regarding the capacitor type welder in 2), since a charged voltage is directly discharged to the capacitor when the welder is turned on, a rapid charge-discharge capacitor designed to withstand sudden discharge is required since reverse voltage is also applied by the L part of the coil.

Regarding the transistor and inverter type welders in 3) and 4), a rapid charge-discharge type is not required since the capacitor is used for smoothing, but a capacitor with superior ripple current resistance is required. Consult us regarding more detailed technical specifications.

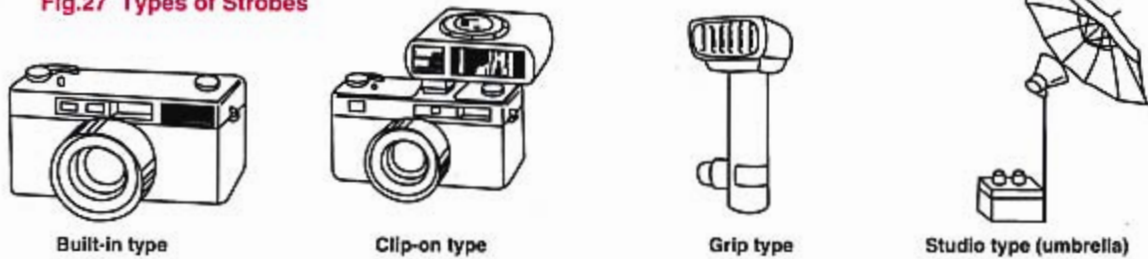
7-6 Strobes

○ Types of strobes

Based on type, strobes can be classified as follows.

1. Built-in type
2. Clip-on type
3. Grip type
4. Studio type

Fig.27 Types of Strobes

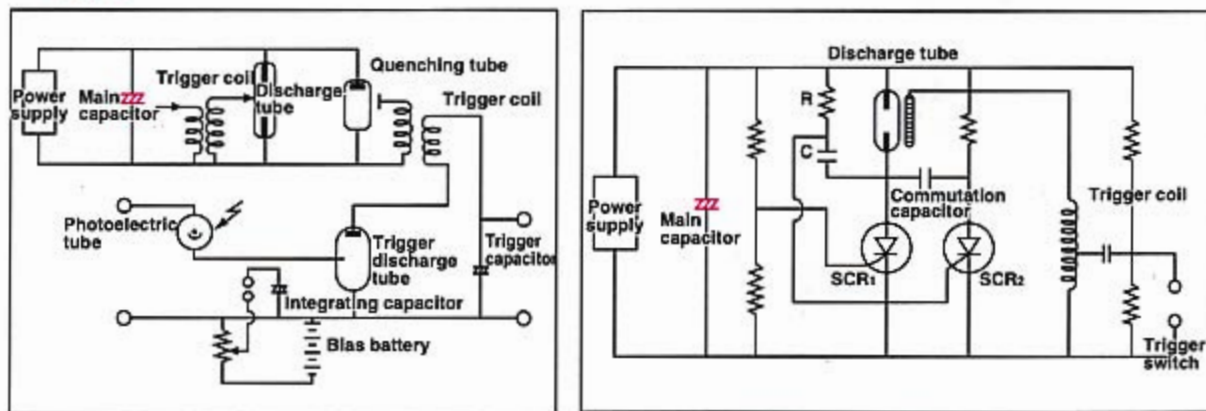


Of these, the studio type requires an electrolytic capacitors with unique characteristics for the photographic flash, so please consult us separately regarding this type of capacitor.

○ Basic strobe Circuit

A strobe is composed of a light emitting section, a charging section, a power supply section, and an automatic exposure adjustment section, and the main capacitor used in the charging section is an electrolytic capacitor. The basic circuit is shown in Fig.28

Fig.28

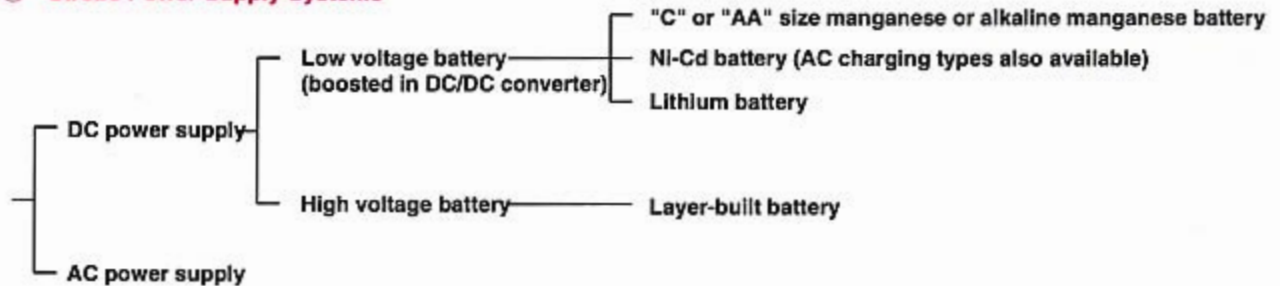


Parallel Control System

Series Control System

Compared to the parallel control system, the series control system is slightly more expensive, but it does have such advantages as low battery loss and a short recycle time under normal use conditions, thus making it the most commonly used capacitor in strobes today.

○ Strobe Power Supply Systems



Characteristic Required of Photographic Flash Electrolytic Capacitors

These capacitors, of course, must be compact and lightweight.

They are arranged in the table below according to type and power supply system.

	DC power supply, low voltage	DC power supply, high voltage	AC power supply	Characteristics		
				W.V	Cap.	Other
Built-in	○			280V.DC } 330V.DC	150 μ F } 300 μ F	Low $\tan\delta$ to obtain a high quantity of light. Low leakage current (voltage retention characteristic) necessary for short recycle time and low battery
Clip-on	○			Mainly 330V.DC	400 μ F } 900 μ F	Low leakage current necessary for short recycle time and low battery
Grip	○	○	○	330V.DC } 380V.DC	1000 μ F } 3000 μ F	Must have long life (charge-discharge 10,000 times) for professional use. Safety valve must be considered for AC power supply types.

7-7 Time Constant Circuit

All varieties of electronic devices are changing from conventional mechanical timers to electronic timers which have superior reliability and can be built in. One type of electronic timer is the CR timer. It has a simple circuit construction, uses aluminum electrolytic capacitors and is made in large numbers.

[Required Characteristic of a Capacitor]

- 1) Leakage current must be small and stable.
- 2) Leakage current degradation after letting stand with no load must be nothing.
- 3) Leakage current increase must be small with increase in ambient temperature.
- 4) Capacitance allowance must be small.
- 5) Decrease in capacitance must be small after life test.
- 6) Capacitance increase must be small with increase in ambient temperature.

These are absolutely necessary requirements to assure the required accuracy and reliability. Panasonic offers the general type MT series and high performance type TH series for use in CR timers.

[Time Constant Resistance]

In practice, the time constant resistance has correlation to the leakage current of the aluminum electrolytic capacitor and using an unnecessarily large resistance can adversely affect accuracy and even prevent operation in some cases. Panasonic recommends the following resistance values as a guideline.

Series	Time constant resistance
TH	Less than 1M Ω
MT	Less than 500k Ω
85°C general use SU	Less than 100k Ω

The above values are upper limits, and if greater accuracy is required or if the capacitor is being used in a charging timer circuit, a smaller resistance must be selected. If a capacitor other than one designed specifically for a time constant circuit is employed, keep the resistance below 100k Ω .

Technical Guide of Aluminium Electrolytic Capacitors

The first edition:October 1st 1994

The fourth edition:March 2nd 2000

**Issued by Panasonic Electronic Devices Co., Ltd.
Capacitor Business Unit**

Tel : 81-774-32-1111

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