

# Parts Information (2)

## Capacitors

Like resistors, capacitors have a wide application in electronic circuit design. Selection is made according to where they are to be located in the circuit and depends on many factors. Such things as working voltage, capacitance tolerance, high-frequency characteristics, loss of thermal characteristics, high/low temperature characteristics; their form and capacitance must all be taken into consideration.

It is important to note that one capacitor cannot always replace another of the same capacitance and/or size, therefore, a knowledge of capacitor characteristics is essential when replacing or reordering them.

### 1. Principle of the Capacitor (Condenser)

Basically, a capacitor consists of two parallel metal plates (electrodes), separated by an expanse of air. When a DC voltage is supplied across the electrodes,

an electric charge proportional to the DC voltage supplied is stored between them. The polarity of the charge depends on that of the voltage supplied (positive to electrode A or B). The larger the area of the electrodes, and the closer the distance between them, the larger the electric charge (capacitance) becomes. And if a piece of insulation material is placed between the electrodes, the capacitance becomes even higher.

Now, supposing the capacitance, or more precisely, the electrostatic capacitance of a capacitor without an insulation insert (with a vacuum) is  $C$ , then the capacitance with an insulation insert would be  $\epsilon_s$  times  $C$  ( $\epsilon_s$  being larger than 1). The multiplier  $\epsilon_s$  is known as the specific inductive capacity.

The value of  $\epsilon_s$  differs with the kind of insulation material used. Material which gives a particularly high  $\epsilon_s$  value is called dielectric.

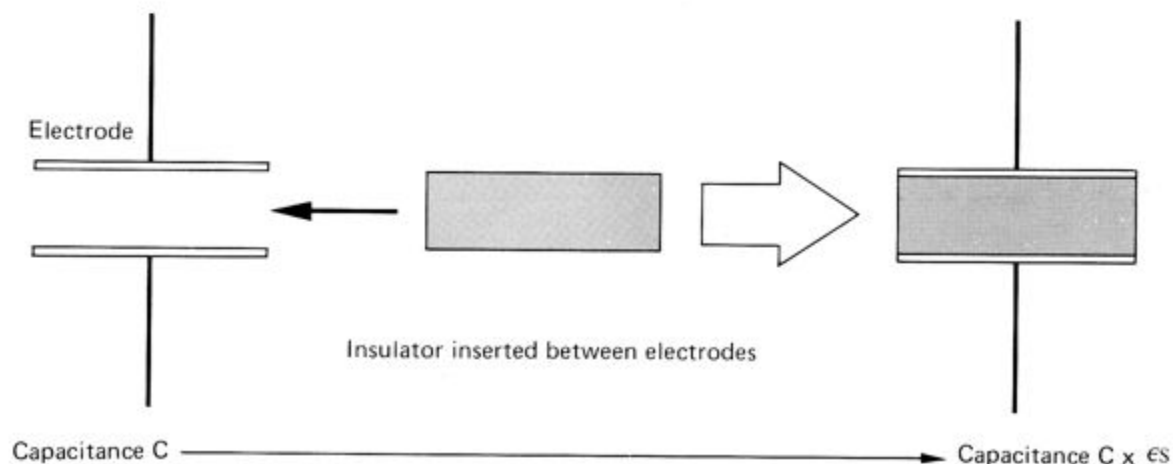


Fig. 1 Capacitance increased by dielectric

Although there are many kinds of capacitors available, most of them are of the dielectric type. The basic unit of capacitance is the Farad (unit F). One Farad is defined as a capacitance which can store a charge of 1 Coulomb (C) when a voltage of 1 volt (V) is supplied across the terminals. However, since the Farad is too large for practical application, smaller units of capacitance like micro-Farad ( $\mu\text{F}$ ) and pico-Farad (pF) are used. Their relationship to the Farad are as follows:

$$1\mu\text{F} = 10^{-6}\text{ F}$$

$$1\text{pF} = 10^{-12}\text{ F}$$

Therefore  $0.001\mu\text{F}$  equals 1,000pF. Capacitance values of less than  $0.001\mu\text{F}$  are usually expressed in pico-Farads.



Fig. 2 Farad too large as a unit of capacitance

### Classification of Capacitors

Listed below are the fifteen types of capacitors that are used in Pioneer audio products.

CE	Aluminum Electrolytic Capacitors
CSY	Solid Aluminum Electrolytic Capacitors
CSS	Solid Aluminum Electrolytic Capacitors for Coupling
CSZ	Solid Tantalum Electrolytic Capacitors
CK	Ceramic Capacitors with High Dielectric Constant
CC	Ceramic Capacitors for Thermal Compensation
CM	Mica Capacitors
CQM	Mylar Capacitors
CQS	Polystyrene Film Capacitors
CQC	Polycarbonate Film Capacitors
CP	Oil-filled Paper Capacitors
CG	Ceramic Capacitors
CQE	Metalized Mylar Film Capacitors
CQP	Polypropylene Film Capacitors
CH	Metalized Paper Capacitors

The codes in the lefthand column are used in the Parts List.

### Parts Numbers of Capacitors

The parts numbers of Pioneer capacitors are broken down into seven codes.

For example:

CE	A	NL	101	M	50	NP	1. Type of capacitor
1	2	3	4	5	6	7	2. Form
							3. Characteristics
							4. Nominal capacitance
							5. Tolerance
							6. Maximum working voltage
							7. Miscellaneous

The miscellaneous code 7 (NP) is used exclusively to indicate a non-polar electrolytic capacitor.

2. Type of Capacitors  
2.1 Aluminum Electrolytic Capacitors

This is represented by the code CE in the previous example.

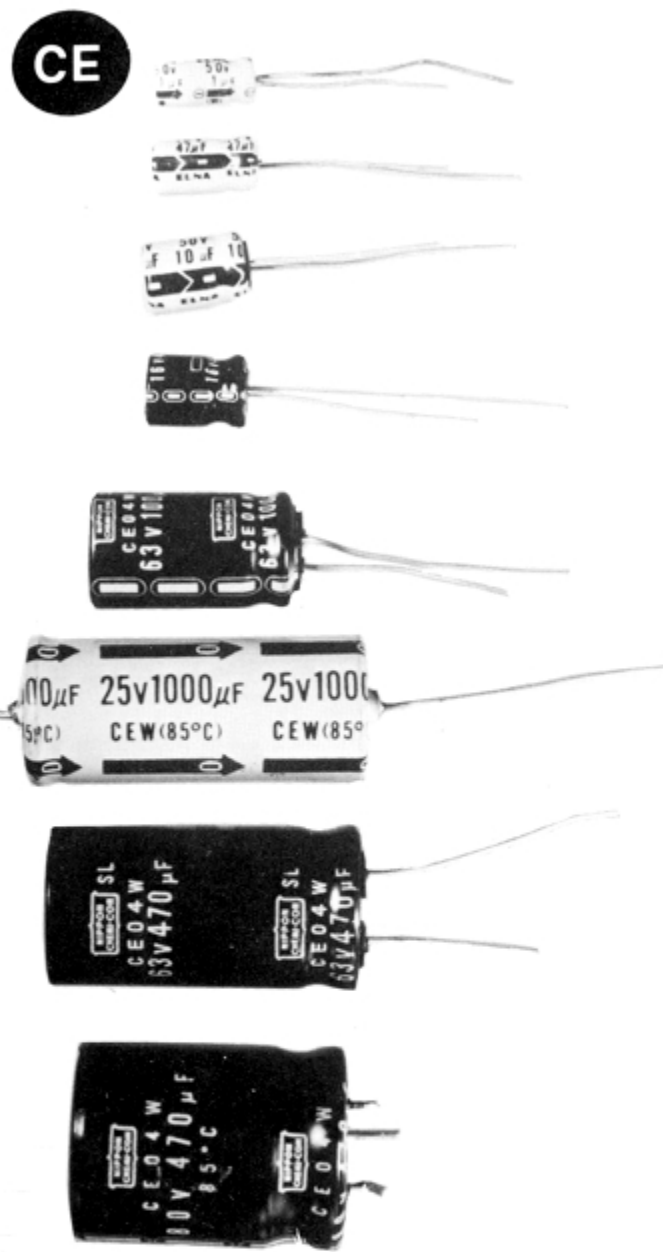


Fig. 3 Aluminum electrolytic capacitors for printed circuit boards



Fig. 4 Block electrolytic capacitors  
Note that the Part No. differs from CR coding.

2.2 Solid Aluminum Electrolytic Capacitors for Coupling

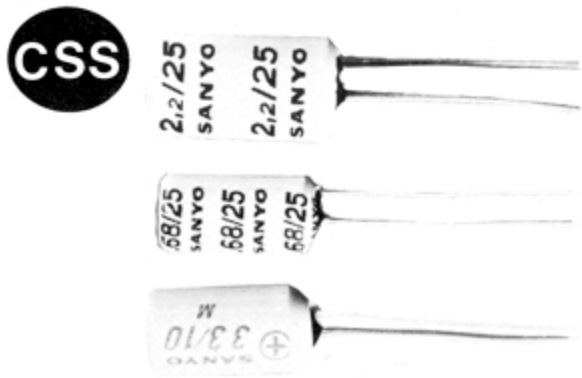


Fig. 5 Solid aluminum electrolytic capacitors

## 2.3 Solid Tantalum Electrolytic Capacitors

**CSZ**

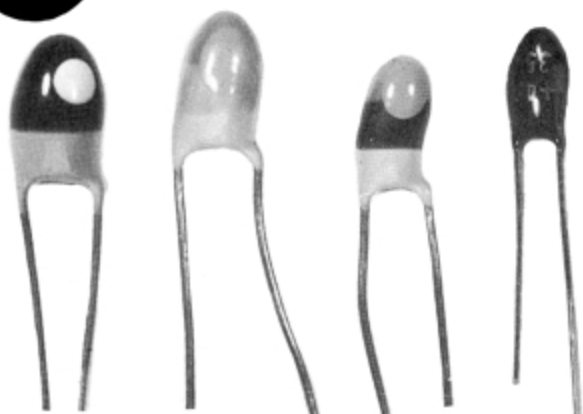


Fig. 6 Solid tantalum capacitors

## 2.4 Ceramic Capacitors

**CK/CC**



Fig. 7 Ceramic capacitors

## 2.5 Mylar\* Capacitors (Polyester Film Capacitors)

**CQM**

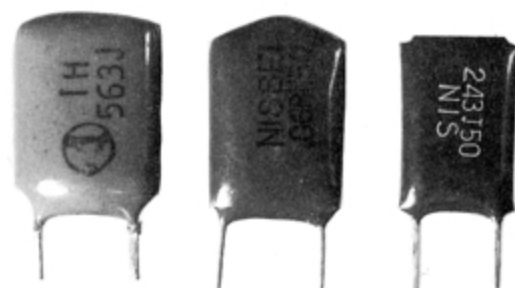


Fig. 8 Mylar capacitors

Mylar is a registered brand name of Dupont Co. Ltd.

## 2.6 Polyestylene Film Capacitors

**CQS**

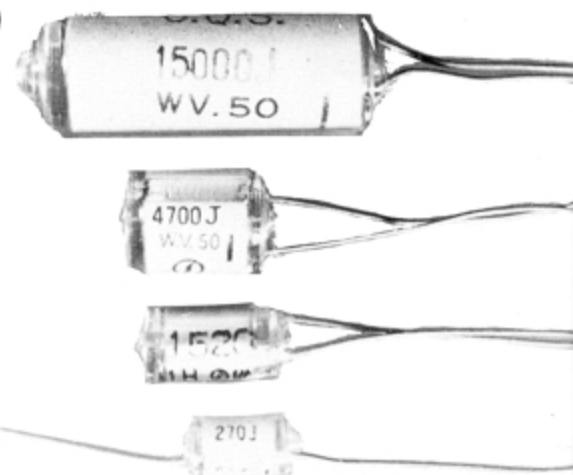


Fig. 9 Polyestylene film capacitors

## 2.7 Ceramic Capacitors

**CG**



Fig. 10 Ceramic capacitors

## 2.8 Polyester Film Capacitors

**CQE**

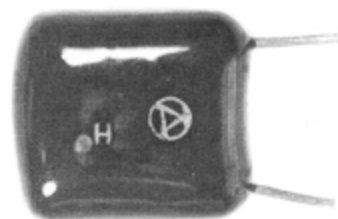


Fig. 11 Polyester film capacitors

## 2.9 Solid Aluminum Electrolytic Capacitors

This type of capacitor is not used today. Instead, the CSS type is used.

## 2.10 Mica Capacitors

Used before, but few of them are used today.

CM

## 2.11 Polycarbonate Capacitors

Not used.

CQC

## 2.12 Oil-filled Paper Capacitors

Scarcely used for the products which utilize semi-conductors such as transistors. Parts No. for this is indicated by codes other than CR coding.

CP



Fig. 12 Oil-filled paper capacitors

## 2.13 Polypropylene Film Capacitors

This is the most precise type of capacitor in current use and has a tolerance as low as  $\pm 1\%$ . For this reason, it is used in precision circuits.

CQP

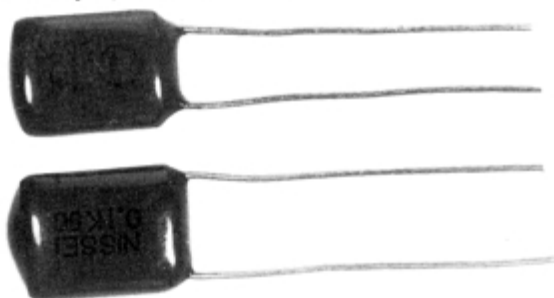


Fig. 13 Polypropylene film capacitors

## 2.14 Other Capacitors

### 2.14.1 MP Capacitors

Used in crossover networks of speaker systems and as condensive capacitors in tape decks. The Part No. differs from the CR code.



Fig. 14 MP capacitors used for crossover networks in speaker systems

### 2.14.2 Bipolar (BP) Electrolytic Capacitors

Used in crossover networks of speaker systems, this type of capacitor has been included in Pioneer's parts list from October, 1975.



Fig. 15 Bipolar electrolytic capacitors

### 2.14.3 Metalized Film Capacitors

This is usually called an MF capacitor and is used in crossover networks of speaker systems. It is made by vapor deposition of aluminum on a polyester film and is similar to the CQE type. As from October, 1975, this type of capacitor has been included in Pioneer's parts list.

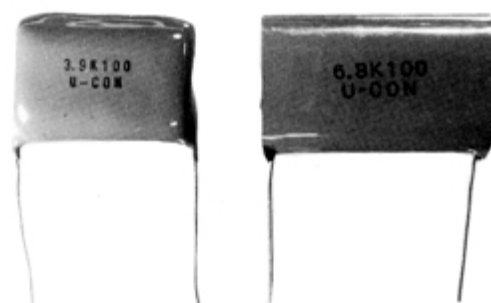


Fig. 16 Metalized film capacitors

### 3. Form

This is represented by one of the following letters of the alphabet:

- A: Terminals or leads on one end only
- B: Terminals or leads on both ends
- D: Disc type (ceramic, etc.)
- H: Terminals or leads on one end with insulator mount

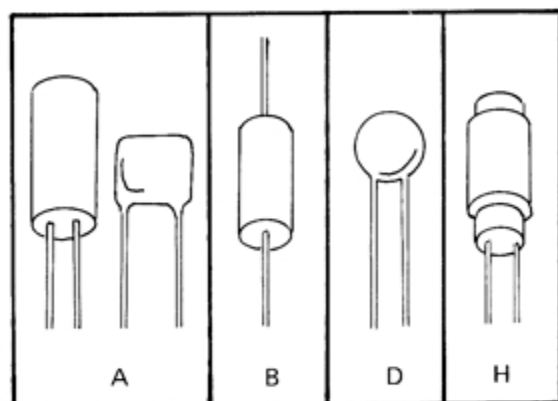


Fig. 17 Capacitors forms

### 4. Characteristics

The characteristics are represented by two letters of the alphabet, but only apply to ceramic (CK or CC) and electrolytic (CE) type capacitors.

#### 4.1 Ceramic Capacitors with High Dielectric Constant (CK)

CK-type capacitors are divided into the following five groups according to their capacitance variations within the operating temperature range of  $-25 \sim +85^{\circ}\text{C}$  for Y and  $-30 \sim +85^{\circ}\text{C}$  for B, using the capacitance at  $+20^{\circ}\text{C}$  as a reference.

Temp. range	Code	Capacitance variation range	Tolerance code
Y	A	Within $-5$ to $+5\%$	J, K
Y	B	Within $-10$ to $+10\%$	K
Y	D	Within $-30$ to $+20\%$	M
Y	F	Within $-80$ to $+30\%$	Z
B	C	Within $-30$ to $+30\%$	M, Z

Table 1 Characteristic code for CK-type capacitors

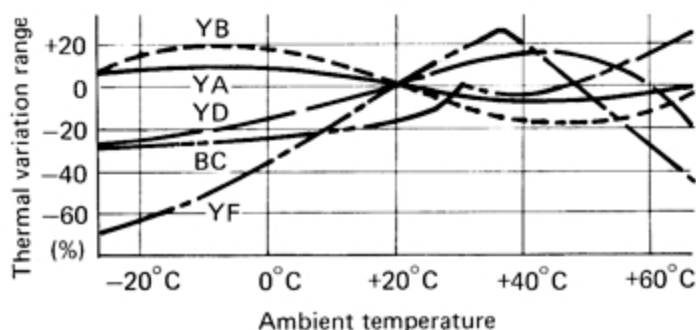


Fig. 18 Typical thermal characteristics curve for CK-type capacitors

### 4.2 Ceramic Capacitors for Thermal Compensation (CC)

The first letter of the code gives the temperature coefficient of the nominal capacitance, while the second indicates the capacitance tolerance. The codes for various sized CC-type capacitors are as follows:

2pF or less	CK, HK, LK, PK, RK, SK, TK, UK, SL
3pF	CJ, HK, LJ, PJ, RJ, SJ, TJ, UJ, SL
4 to 9pF	CH, HH, LH, PH, RH, SH, TH, UJ, SL
Above 10 to approx. 330pF	CG, HG, LG, PG, RG, VK, WK, LX, CH, HH, LH, PH, RH, SH, TH, UJ, SL

First code			Second code	
Code	Thermal coefficient PPM/ $^{\circ}\text{C}$	Color code	Code	Thermal coefficient tolerance PPM/ $^{\circ}\text{C}$
C	$\pm 0$	Black	G	$\pm 30$
H	$-30$	Brown	H	$\pm 60$
L	$-80$	Red	J	$\pm 120$
P	$-150$	Orange	K	$\pm 250$
R	$-220$	Yellow	L	$\pm 500$
S	$-330$	Green		
T	$-470$	Blue		
U	$-750$	Violet		
V	$-1,000$	V		
W	$-1,500$	W		
X	$-2,200$	X		
SL	$-1,000 \sim +350$	No color		

Table 2 Characteristics of CC-type capacitors

Note: 1. PPM represents  $10^{-6}$

2. Code SL indicates an ordinary capacitor for which no thermal coefficient is rated (capacitance variation range  $+4.5$  to  $-5\%$  at  $-25$  to  $+85^{\circ}\text{C}$ ).

3. Example UJ is for  $-750 \pm 120\text{PPM}/^{\circ}\text{C}$

### 4.3 Aluminum Electrolytic Capacitors (CE)

This type of capacitor, designed for very low leakage currents, is given an NL code and is covered by an orange tube.