SMT chip capacitor naming rules and methods

The naming of the chip capacitor:

The parameters included in the name of the chip capacitor include the size of the chip capacitor, the material used for this chip capacitor, the required accuracy, the required voltage, the required capacity, the requirements of the terminal and packaging requirements.
Generally, the parameters to be provided for ordering a chip capacitor should be the size, the required accuracy, the voltage requirement, the capacity value, and the required brand.

Example: 0805CG102J500NT

0805: refers to the small size of the chip capacitor, expressed in inches.
08 means the length is 0.08 inches, 05 means the width is 0.05 inches.

CG: It indicates the material required for making this kind of capacitor.
This material is generally suitable for making capacitors below 10000PF.

102: It refers to the capacitance, the first two digits are valid numbers,
and the last 2 indicates how many zeros there are 102 = 10×102 = 1000PF.

J: It is required that the error accuracy of the capacitance value of the capacitor is 5%,
and the dielectric material and the error accuracy are paired.

500: It is required that the withstand voltage of the capacitor is 50V. Also, the first two digits of 500 are valid numbers, and the latter refers to how many zeros there are.

N: refers to the terminal material, now the general terminal refers to the three-layer electrode (silver/copper layer), nickel, tin.

T: refers to the packaging method:
T represents the tape packaging, B represents the color of the chip capacitors in the bulk packaging of the plastic box, and the more common ones are yellow and blue-gray, which are lighter than the cardboard box, which will produce different differences in the specific production process of the chip capacitors. There is no printing on it, which is related to its production process (the chip capacitor is sintered at high temperature, so there is no way to print on its surface), while the chip resistor is silk-screened (marks can be printed).

The chip capacitors include medium and high voltage chip capacitors and ordinary chip capacitors. The series voltages include 6.3V, 10V, 16V, 25V, 50V, 100V, 200V, 500V, 1000V, 2000V, 3000V, and 4000V. The size representation of the chip capacitor is as follows There are two types, one is expressed in inches and the other is expressed in millimeters. The models of the chip capacitor series are 0201, 0402, 0603, 0805, 1206, 1210, 1812, 2010, 2225 and so on.

The materials of SMD capacitors are conventionally divided into three types, NPO, X7R, Y5V NPO. This material has the most stable electrical properties and hardly changes with the changes of temperature, voltage and time. It is suitable for high frequency circuits with low loss and stability requirements. . The capacity accuracy is about 5%, but this material can only be used for smaller capacity, conventional below 100PF, 100PF-1000PF can also be produced but the price is higher X7R This material is less stable than NPO, but the capacity is better than NPO. The material should be high, and the capacity accuracy should be around 10%.

Y5V capacitors of this type of medium have poor stability, the capacity deviation is about 20%, and they are more sensitive to temperature and voltage, but this material can achieve high capacity and low price, and is suitable for small temperature changes. in the circuit.

There are several packages of chip capacitors: they can be divided into two types: non-polar and polar.

The following two types of packages for non-polar capacitors are the most common.
That is, 0805, 0603; and polar capacitors are what we usually call electrolytic capacitors.

Generally, the most commonly used aluminum electrolytic capacitors are aluminum electrolytic capacitors. Since their electrolytes are aluminum, their temperature stability and accuracy are not very high. SMD components require high temperature stability because they are close to the circuit board. SMD capacitors are mostly tantalum capacitors.

According to their different withstand voltages, chip capacitors can be divided into four series: A, B, C, and D.

The specific classification is as follows: Type Package Withstand Voltage A 3216 10V B 3528 16V C 6032 25V D 7343 35V

There are two sizes of chip capacitors, one is expressed in inches, the other is expressed in millimeters,

The series models of chip capacitors are 0402, 0603, 0805, 1206, 1812, 2010, 2225, and 2512, which are in inches, 04 means the length is 0.04 inches, 02 means the width is 0.02 inches, and other similar models have dimensions (mm)

Inch Dimensions Metric Dimensions Length and Tolerance Width and Tolerance Thickness and Tolerance:

0402 1005 1.00 ±0.05 0.50 ±0.05 0.50 ±0.05

0603 1608 1.60 ±0.10 0.80 ±0.10 0.80 ±0.10

0805 2012 2.00 ±0.20 1.25 ±0.20 0.70 ±0.20 1.00 ±0.20 1.25 ±0.20

1206 3216 3.20 ±0.30 1.60 ±0.20 0.70 ±0.20 1.00 ±0.20 1.25 ±0.20

1210 3225 3.20 ±0.30 2.50 ±0.30 1.25 ±0.30 1.50 ±0.30

1808 4520 4.50 ±0.40 2.00 ±0.20 ≤2. 00 1812 4532 4.50 ±0.40 3.20 ±0.30 ≤2.50

2225 5763 5.70 ±0.50 6.30 ±0.50 ≤2.50

3035 7690 7.60 ±0.50 9.00 ±0.05 ≤3.00

Overview of chip capacitors: full name: multi-layer (multilayer, laminated) chip ceramic capacitors, also known as chip capacitors, chip capacity, English abbreviation: MLCC. The color of SMD capacitors is more commonly seen in yellow and blue-gray, which is lighter than the cardboard box. This will cause different differences in the specific production process. The conventional color of COG material is yellow, and the conventional color of X7R material is mainly gray.

The main specifications and sizes are divided into: 0201, 0402, 0603, 0805, 1206 according to the British standard.

Capacity range: 0.5pF ~ 100uF, among which, it is generally considered that the capacity above 1uF is a large-capacity capacitor. Rated voltage: From 4V to 4KV (DC), when the rated voltage is 100V and above, it is classified as medium and high voltage products.

There is a corresponding relationship between the stability and capacity accuracy of chip capacitors and the dielectric materials used, which are mainly divided into three categories:

1. It is a high-frequency capacitor with COG/NPO as the class I medium, its temperature coefficient is ±30ppm/℃, the capacitance is very stable, and it hardly changes with the changes of temperature, voltage and time, mainly used in high-frequency electronic circuits, Such as oscillation, timing circuit, etc.; its capacity accuracy is mainly ±5, and when the capacity is lower than 10pF, B gear (±0.1pF), C gear (±0.25pF), D gear (±0.5pF) can be selected precision.

2. It is an intermediate frequency capacitor with X7R as the class II medium, its temperature coefficient is ±15, and its capacitance is relatively stable. Under special circumstances, products with J-level (±5) accuracy can be provided.

3. It is a low-frequency capacitor with Y5V as class II medium, its temperature coefficient is: +30 ~ -80, the capacitance is greatly changed by temperature, voltage and time, and it is generally only suitable for various filter circuits. Its capacity accuracy is mainly Z file (+80 ~ -20), and products with ±20 accuracy can also be selected.

When choosing a chip capacitor correctly, in addition to providing its size and capacity, special attention must be paid to the circuit's requirements for parameters such as temperature coefficient and rated voltage of the chip capacitor.

Standard naming method and definition of chip capacitors: The naming of chip capacitors. There may be differences in different countries, but the parameters included are the same.

Parameters included in the naming of chip capacitors:

1. Size of chip capacitors (0201, 0402, 0603, 0805, 1206, 1210, 1808, 1812, 2220, 2225)

2. The material of the chip capacitor (COG, X7R, Y5V, Z5U, RH, SH)

3. The required accuracy (±0.1PF, ±0.25PF, ±0.5PF, 5, 10%, 20%)

4. Voltage (4V, 6.3V, 10V, 16V, 25V, 50V, 100V, 250V, 500V, 1000V, 2000V, 3000V)

5. Capacity 0PF-47UF

6. Requirements for the terminal N means three-layer electrode

7. Packaging requirements T means tape packaging, P means bulk packaging

Example: 0805CG102J500NT

0805: refers to the size of the chip capacitor, which is expressed in inches. 08 means the length is 0.08 inches (converted to mm=0.08*24.50=1.96mm), 05 means the width is 0.05 inches, converted to mm=0.05* 24.50=1.225ccm
CG: is the material required to produce capacitors
102: It refers to the capacitance, the first two digits are valid numbers, and the last 2 indicates

how many zeros there are 102 = 10×102, that is, = 1000PF

J : It is required that the error accuracy of the capacitance value of the capacitor is 5%, and the dielectric material and the error accuracy are paired.
500: It is required that the withstand voltage of the capacitor is 50V. Similarly, the first two digits of 500 are valid numbers, and the latter refers to how many zeros there are.
N: refers to the terminal material, and now the general terminal refers to the three-layer electrode (silver/copper layer), nickel, tin.
T: refers to the packaging method, T means tape packaging, B means bulk packaging in plastic boxes SMD capacitors currently use different material specifications such as NPO, X7R, Z5U, Y5V, and different specifications have different uses.

Below, we only introduce the commonly used NPO, X7R, Z5U and Y5V to introduce their performance and application, as well as the ordering items that should be paid attention to in order to attract everyone's attention. Different companies may have different naming methods for the above capacitors with different performances. Here we refer to the naming method of our company . For other companies' products, please refer to the company's product manual.

The main difference between NPO, X7R, Z5U and Y5V is their filling medium. Under the same volume, the capacity of the capacitor formed by the different filling medium is different, and the subsequent dielectric loss and capacity stability of the capacitor are also different. Therefore, when using capacitors, different capacitors should be selected according to their different functions in the circuit.

1. NPO capacitor NPO is one of the most commonly used monolithic ceramic capacitors with temperature compensation. Its filling medium is composed of rubidium, samarium and some other rare oxides. NPO capacitors are one of the most stable capacitors in terms of capacitance and dielectric loss. The capacitance change is 0±30ppm/°C from -55°C to +125°C, and the capacitance change with frequency is less than ±0.3 ΔC. The drift or hysteresis of NPO capacitors is less than ±0.05%, which is negligible compared to film capacitors greater than ±2%. Its typical capacity versus lifetime variation is less than ±0.1%. NPO capacitors have different characteristics of capacitance and dielectric loss with frequency depending on the package form, and the frequency characteristics of large package size are better than those of small package size. NPO capacitors are suitable for tank capacitors in oscillators, resonators, and coupling capacitors in high frequency circuits.

2. X7R Capacitors X7R capacitors are called temperature-stable ceramic capacitors. When the temperature is from -55 ℃ to +125 ℃, the capacitance change is 15%. It should be noted that the capacitance change of the capacitor is non-linear at this time. The capacity of the X7R capacitor is different under different voltage and frequency conditions, and it also changes with time, about 1% ΔC every 10 years, which shows a change of about 5% in 10 years. X7R capacitors are mainly used in less demanding industrial applications where the change in capacitance when the voltage changes is acceptable. Its main feature is that the capacitance can be relatively large under the same volume.

3. Z5U Capacitors Z5U capacitors are known as "universal" ceramic monolithic capacitors. The first thing to consider here is the operating temperature range, the main thing for the Z5U capacitor is its small size and low cost. For the above three ceramic monolithic capacitors, the Z5U capacitor has the largest capacitance under the same volume. However, its capacitance is greatly affected by environmental and working conditions, and its aging rate can decrease by up to 5% every 10 years. Despite its unstable capacity, it has a wide range of applications due to its small size, low equivalent series inductance (ESL) and equivalent series resistance (ESR), and good frequency response. Especially in decoupling circuit applications.

Other technical indicators of Z5U capacitors are as follows: Operating temperature range +10 ℃ - +85 ℃ Temperature characteristics +22% - -56% Dielectric loss max. 4% Four Y5V capacitors Y5V capacitors are general-purpose capacitors with a certain temperature limit. The capacity change can reach +22% to -82% in the range of -30 ℃ to 85 ℃. The high dielectric constant of Y5V allows the fabrication of capacitors up to 4.7 μF in a small physical size.

Other technical indicators of Y5V capacitors are as follows: Operating temperature range -30 ℃ - +85 ℃ Temperature characteristics +22% - - -82% Dielectric loss maximum 5% The main characteristic parameters of the capacitor:

(1) **Capacity and error:** the maximum allowable deviation range between the actual capacitance and the nominal capacitance.

The capacity errors generally used are: J-level ±5%, K-level ±10%, M-level ±20%. Precision

capacitors have smaller allowable errors, while electrolytic capacitors have larger errors, and they use different error levels. Commonly used capacitors have the same accuracy class as resistors.

Indicated by letters: Class D——±0.5%; Class F——±1%; Class G——±2%; Class J——±5%; Class

K——±10%; Class M——±20%.

(2) **Rated working voltage:** Capacitor can work stably and reliably for a long time in the circuit, and the maximum DC voltage it can withstand is also called withstand voltage. For devices with the same structure, medium and capacity, the higher the withstand voltage, the larger the volume.

(3) **Temperature coefficient:** within a certain temperature range, the relative change value of the

capacitance when the temperature changes by 1°C. The smaller the temperature coefficient, the

better.

(4) **Insulation resistance:** used to indicate the size of leakage. Generally, small-capacity capacitors have a large insulation resistance, in the hundreds of megohms or several gigaohms. The insulation resistance of electrolytic capacitors is generally small. Relatively speaking, the larger the insulation resistance, the better, and the leakage current is also small.

(5) **Loss:** Under the action of the electric field, the energy consumed by the capacitor heats up in unit time. These losses are mainly from dielectric loss and metal loss. Usually expressed in terms of loss tangent.

(6) **Frequency characteristic:** The property that the electrical parameters of a capacitor vary with the frequency of the electric field. Capacitors that work under high frequency conditions have a corresponding reduction in capacitance because the dielectric constant is smaller at high frequencies than at low frequencies. Losses also increase with frequency.

In addition, when working at high frequency, the distributed parameters of the capacitor, such as the resistance of the pole piece, the resistance between the lead and the pole piece, the self inductance of the pole piece, the lead inductance, etc., will affect the performance of the capacitor. All of these limit the frequency at which the capacitor can be used. Different types of capacitors have different maximum usage frequencies.

Small mica capacitors are within 250MHZ; disc type ceramic capacitors are 300MHZ; tubular ceramic capacitors are 200MHZ; disc type ceramic capacitors can reach 3000MHZ; small paper dielectric capacitors are 80MHZ; medium paper capacitors are only 8MHZ.

The performance of chip capacitors is evaluated from three aspects. The first is the four conventional electrical properties of chip capacitors, namely capacity Cap. loss DF, insulation resistance IR and withstand voltage DBV. Generally, the loss value of X7R products DF<= 2.5%, the smaller the better, IR*Cap>500 ohm*farad, BDV>2.5Ur. The second is the accelerated life performance of the chip capacitor, under the ambient temperature of 125deg.c and the DC load of 2.5Ur, the chip should be able to withstand 100 Hours without breakdown, good quality can withstand 1000 hours without breakdown.

Then it is the thermal shock resistance of the product. Immerse the capacitor in a 300deg.c tin furnace for 10 seconds, make a few more chips, and observe whether there are surface cracks under the microscope. Then, the capacity loss can be tested and compared with that before the thermal shock to determine whether the chip has internal cracks.

Chip capacitors have problems on the circuit. It may be that the quality of the chip capacitor itself is poor, or it may be due to the poor selection of specifications during design or the mechanical and thermal shock of surface mounting, which causes certain damage to the chip capacitor.
cause.