# SMT MLCC&SMD resistance parameters and detailed explanation

**I. Chip capacitors(MLCC)**

The full name of chip capacitors: multilayer (multilayer, laminated) chip ceramic capacitors, also known as chip capacitors, chip capacitance.

**1. Brands:** Japanese: TDK, Murata, Kyocera, TAIYO YUDEN, Panasonic, ROHM, KOA (KOA Speer Electronics.Inc) Taiwan: Yageo (YAGEO), Huake (WALSIN) Korean: Samsung (Samsung) Domestic: Fenghua (FH), Yuyang (E YANG)

**2. Main parameters:** Capacitance Voltage Error Material (Accuracy) Size

**3.Detailed explanation of each parameter:**

**a.Capacitance**

**Capacitance Algorithm Common Capacitance Units:** UF, NF, PF (Microfarads, Nanofarads, Picofarads) Capacitance values are all in kilograms (the former is 1000 times the latter)

**For example:** 1,000PF =1NF =102 =0.001UF 10,000PF =10NF =103 =0.01UF 100,000PF =100NF =104 =0.1UF

**Note:** 5PF = 509 uses two digits to indicate significant figures and a letter to indicate the magnitude of the value. For example: 1p2 means 1.2pF, 220n means 0.22uF, 3u3 means 3.3uF, 2m2 means 2200uF. Another notation is to use three digits for the capacitance and a letter for the error at the end. The first two digits of the three-digit number represent the effective value, the third digit represents the nth power of 10, and n is generally 1-8.

**The special case is:** when n=9, it does not represent the 9th power of 10,
but the -1th power of 10.

**For example:** "102" means 10*100=1000pF "223" means 22*1000=22000pF=0.022uF "474" means 47*10000=0.47uF "159" means 15*0.1=1.5pF

**b. Voltage**

Different brands of capacitors have different voltage representation methods. Series voltages are 6.3V, 10V, 16V, 25V, 50V, 100V, 200V, 500V, 1000V, edited word 2000V, 3000V, 4000V.

**c.Error**

**The capacitance value error of the capacitor is usually expressed in characters:** The first type, the absolute error, is usually expressed as the absolute error of the capacitance value, in PF, that is: B represents ± 0.1PF C, represents ± 0.25PF D, represents ± 0.5PF Y, represents ± 1PF, A represents ± 1.5PF, V represents ± 5PF. This expression is often used for small capacitors.

The second is relative error, expressed as the percentage of deviation of the nominal value of capacitance, namely: D represents ± 0.5%, P represents ± 0.625% F, represents ± 1%, R represents ± 1.25% G, represents ± 2%, U stands for ± 3.5%, J for ± 5%, K for ± 10%, M for ± 20%, S for ± 50%/-20%, Z for ± 80%/-20%.

**d.Material**

**The materials of chip capacitors are generally divided into four types: NPO, X7R, X5R, Y5V**

1. NPO has the most stable electrical properties and hardly changes with temperature, voltage and time. It is suitable for high frequency circuits with low loss and high stability requirements.

The capacity accuracy is about 5%, but this material can only be used for smaller capacity, usually below 100PF. 100PF-1000PF can also be produced but at a higher price 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. When the temperature is from -55℃ to 125℃, the capacitance change is 0±30ppm/℃, 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. Larger package size has better frequency characteristics than small package size.

**The capacity range of NPO capacitors can be selected**

Package 500T=50V; 101T=100V
020110—100P
08050.5—1000pF0.5—820pF
12060.5—1200pF0.5—1800pF
1210560—5600pF560—2700pF

NPO capacitors are suitable for tank capacitors in oscillators, resonators, and coupling capacitors in high frequency circuits.

2. The material of X7R is less stable than NPO, but its capacity is higher than that of NPO, and the capacity accuracy is about 10%. Edited word 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 about a 5% change 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.

**The capacity range of NPO capacitors can be selected**

package 500T=50V;101T=100V
0201 120pF—820pF
0805 1200pF—0.056 μ F 330pF —0.012 μF
1206 1000pF—0.15 μ F 1000pF —0.047 μF
1210 1000pF—0.22 μ F 1000pF —0.1 μF

3. X5R X5R means that the normal operating temperature of the capacitor is -55° C~+85° C, and the corresponding capacitance change is ± 15%.

4. 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 the price is low, suitable for temperature changes. Y5V capacitors in large circuits are general-purpose capacitors with a certain temperature limit, and their capacity changes can reach +80% to -20% in the range of -30° C to 85° C.
The high dielectric constant of Y5V allows the fabrication of capacitors up to 4.7 μF in a small physical size.

**The value range of the Y5V capacitor is as follows:**

**package** 250T=25V;500T=50V
02010.01 μF—0.39 μ F0.01 μF
08050.01 μF—0.39 μ F0.01— μF0.1 μF
12060.01 μF—1 μ F0.01 — μF0.33 μF
12100.1 μF—1.5 μ F0.01— μF0.47 μF

Other technical indicators of Y5V capacitors are as follows: Operating temperature range -30° C — 85 ° C Temperature characteristics +22% — - 82% Maximum dielectric loss 5% General accuracy is corresponding to the material, such as: 5% is represented by J, corresponding to NPO Material; 10% is represented by K, corresponding to X7R material, and the accuracy of X5R material is generally between ± 10%—± 20%; Z file corresponds to Y5V material generally.

**e. Size Capacitor size is generally expressed by two size codes**.

A size code is an EIA (Electronic Industries Association) code represented by a 4-digit number, with the first two digits and the last two digits representing the length and width of the capacitor, in inches. The other is the metric code, also represented by a 4-digit number, whose units are millimeters.

**The following is the relationship between the imperial and metric notation of capacitance:**

| Imperial (mil) | Metric (mm) | Length (L) (mm) | Width (W) (mm) | Height (t) (mm) | a(mm) | b(mm) |
|---|---|---|---|---|---|---|
| 0201 | 0603 | 0.60±0.05 | 0.30±0.05 | 0.23±0.05 | 0.10±0.05 | 0.15±0.05 |
| 0402 | 1005 | 1.00±0.10 | 0.50±0.10 | 0.30±0.10 | 0.20±0.10 | 0.25±0.10 |
| 0603 | 1608 | 1.60±0.15 | 0.80±0.15 | 0.40±0.10 | 0.30±0.20 | 0.30±0.20 |
| 0805 | 2012 | 2.00±0.20 | 1.25±0.15 | 0.50±0.10 | 0.40±0.20 | 0.40±0.20 |
| 1206 | 3216 | 3.20±0.20 | 1.60±0.15 | 0.55±0.10 | 0.50±0.20 | 0.50±0.20 |
| 1210 | 3225 | 3.20±0.20 | 2.50±0.20 | 0.55±0.10 | 0.50±0.20 | 0.50±0.20 |
| 1812 | 4832 | 4.50±0.20 | 3.20±0.20 | 0.55±0.10 | 0.50±0.20 | 0.50±0.20 |
| 2010 | 5025 | 5.00±0.20 | 2.50±0.20 | 0.55±0.10 | 0.60±0.20 | 0.60±0.20 |
| 2512 | 6432 | 6.40±0.20 | 3.20±0.20 | 0.55±0.10 | 0.60±0.20 | 0.60±0.20 |

**II. SMD Resistors**

SMD Resistor, is a kind of metal glass uranium resistor. It is a resistor made by mixing metal powder and glass uranium powder and printing it on the substrate by screen printing. Resistant to humidity, high temperature and small temperature coefficient. 1. Brand Japanese: KOA Taiwan: YAGEO, WALSIN Domestic: Fenghua (FH), Housheng, Wangquan

**a. Main parameters:** resistance value precision size

**b. Detailed explanation of each parameter:**
**(1). Resistance**

The basic unit of resistance is Ω 1000Ω=1K Ω The resistance error accuracy of chip resistors is ± 1%, ± 2%, ± 5%, ± 10% accuracy, the most commonly used are ± 1% and ± 5%, The routine of ±5% accuracy is to use three digits to represent Example 512, the first two digits are significant digits, and the third digit 2 represents how many zeros there are. =1M Ω In order to distinguish the resistance of ± 5% and ± 1%, the resistance of ± 1% is usually represented by 4 digits, so that the first three digits represent significant digits, and the fourth digit represents how many zeros 4531 are. 4530Ω, which is equal to 4.53KΩ

**(2).Accuracy**

It is generally expressed by the deviation percentage of the nominal resistance value, namely: D represents ± 0.5%P, represents ± 0.625%, F represents ± 1%, R represents ± 1.25%, G represents ± 2%, and U represents ± 3.5% , J stands for ± 5%, K stands for ± 10%, M stands for ± 20%, S stands for ± 50%/-20%, Z stands for ± 80%/-20%.

**(3). Dimensions**

It is basically the same as the capacitor size specification, please refer to the capacitor size specification. Resistor sizes are generally represented by two size codes. One size code is the EIA (Electronic Industries Association) code represented by a 4-digit number, with the first and last two digits representing the length and width of the resistor, in inches. The other is the metric code, also represented by a 4-digit number, and its unit is millimeters.

**The following is the relationship between the imperial and metric notation of resistance:**

**Imperial (mil) Metric (mm) Length (L) (mm) Width (W) (mm) Height (t) (mm) a(mm) b(mm)**

0201 0603 0.60±0.05 0.30±0.05 0.23± 0.05 0.10±0.05 0.15±0.05

0402 1005 1.00±0.10 0.50±0.10 0.30± 0.10 0.20±0.10 0.25±0.10

0603 1608 1.60±0.15 0.80±0.15 0.40± 0.10 0.30±0.20 0.30±0.20

0805 2012 2.00±0.20 1.25±0.15 0.50± 0.10 0.40±0.20 0.40±0.20

1206 3216 3.20±0.20 1.60±0.15 0.55± 0.10 0.50±0.20 0.50±0.20

1210 3225 3.20±0.20 2.50±0.20 0.55± 0.10 0.50±0.20 0.50±0.20

1812 4832 4.50±0.20 3.20±0.20 0.55± 0.10 0.50±0.20 0.50±0.20

2010 5025 5.00±0.20 2.50±0.20 0.55± 0.10 0.60±0.20 0.60±0.20

2512 6432 6.40±0.20 3.20±0.20 0.55± 0.10 0.60±0.20 0.60±0.20