ELECTRONICS · E-SERIES · COLOR CODES · DIELECTRICS · REFERENCE DOCUMENT · PUBLIC

Resistor & capacitor values & codes

Reading and choosing passives — the E-series preferred values, resistor colour and SMD codes, capacitor codes and dielectrics, and the derating that keeps them in spec.

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ABSTRACT

Passives only come in standard (E-series) values, and they're marked with compact codes. This reference decodes resistor colour bands and SMD codes, capacitor codes and dielectric types, and gives the derating rules that keep a chosen part actually meeting its number in circuit.

Section 1 is the E-series. Section 2 is resistor codes. Section 3 is capacitor codes and dielectrics. Section 4 is tolerance and selection. Section 5 is power and voltage derating. Section 6 is a quick reference.

RESISTOR COLOR CODE — 4-BAND

4 yellow · 7 violet · ×100 red · ±5% gold

47 × 100 = 4.7 kΩ ±5%

band 1·2 = digits · band 3 = multiplier · band 4 = tolerance

SMD R: 472 = 4.7 kΩ
SMD C: 104 = 100 nF

A 4-BAND RESISTOR: TWO DIGIT BANDS, A MULTIPLIER, A TOLERANCE BAND — YELLOW-VIOLET-RED-GOLD = 4.7 KΩ ±5%. SMD PARTS USE A 3-DIGIT SHORTHAND (472 = 4.7 KΩ, 104 = 100 NF).

CONTENTS

1. The E-series (preferred values)

Components are made only in **preferred values** spaced logarithmically so each value's tolerance band just meets the next. Pick the nearest E-series value to your calculated one:

SERIES	TOLERANCE	VALUES PER DECADE
E6	±20%	6
E12	±10%	12
E24	±5%	24
E48	±2%	48
E96	±1%	96

E12 (the everyday set): 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 (× any decade). For tight dividers/filters use E96 (1%).

`Preferred value`	A standard E-series value — design to these, not arbitrary numbers
`Tolerance`	± band on the value; tighter = more series values and more cost
`Multiplier`	Power-of-ten band (resistor) or implied pF exponent (cap code)
`Dielectric`	The capacitor's insulator — sets stability, temp range and DC-bias behaviour

2. Resistor codes

4-band colour: digit · digit · multiplier · tolerance. **5-band** adds a third digit (for 1%).

COLOUR	DIGIT	MULTIPLIER	TOLERANCE
Black	0	×1	—
Brown	1	×10	±1%
Red	2	×100	±2%
Orange	3	×1k	—
Yellow	4	×10k	—
Green	5	×100k	±0.5%
Blue	6	×1M	±0.25%
Violet	7	×10M	—
Grey / White	8 / 9	—	—
Gold / Silver	—	×0.1 / ×0.01	±5% / ±10%

SMD codes: 3-digit `472` = 47 × 10² = 4.7 kΩ; 4-digit `4702` = 470 × 10² = 47 kΩ; `R` marks the decimal: `4R7` = 4.7 Ω. **EIA-96** uses 2 digits (a value lookup) + a letter (multiplier) for 1% parts.

3. Capacitor codes and dielectrics

Code is in **pF**: 3 digits = first two digits × 10^(third). `104` = 10 × 10^4 pF = 100 000 pF = **100 nF**. `220` = 22 pF. An `R` marks a decimal (`4R7` = 4.7 pF). A trailing letter is tolerance.

Always note the **voltage rating** and the **dielectric** — the dielectric dominates real-world behaviour:

DIELECTRIC	STABILITY	USE
C0G / NP0 (class 1)	excellent, no DC-bias loss	timing, filters, RF; small values only
X7R (class 2)	±15% over −55…+125 °C; loses C with DC bias	general decoupling, bulk
X5R	like X7R but to +85 °C	space-constrained decoupling
Y5V / Z5U	huge capacitance, terrible stability	last resort bulk only
Film	very stable, low loss	audio, snubbers, timing (bulky)
Aluminium electrolytic	high bulk C, polarised	power-rail bulk, low cost
Tantalum / polymer	high C small size, polarised	compact bulk — derate voltage hard

4. Tolerance and selection

- **Pick the nearest E-series value for the tolerance you need; don't specify a value that isn't made.**
- **MLCC DC bias: class-2 ceramics (X7R/X5R) lose capacitance under applied voltage**
  sometimes 50–80% at rated volts. Choose a higher-voltage / larger case part and verify the effective
  capacitance at your operating voltage.
- **Temperature coefficient: use C0G/NP0 where the value must be stable (oscillators, filters).**

5. Power and voltage derating

Resistor power by SMD size (rated; derate to ~50%):

SIZE	RATED POWER
0201	1/20 W
0402	1/16 W
0603	1/10 W
0805	1/8 W
1206	1/4 W
2010 / 2512	3/4 W / 1 W

Capacitor voltage derating: MLCC to ~50–70% of rated (and watch DC bias); aluminium electrolytic to ~80%; **tantalum to ~50%** (lower in high-inrush rails) — tantalum fails short and can ignite if not derated.

6. Quick reference

- E12: 10 12 15 18 22 27 33 39 47 56 68 82.
- Resistor SMD: `472` =4.7 k · `4702` =47 k · `4R7` =4.7 Ω.
- Cap code (pF): `104` =100 nF · `103` =10 nF · `102` =1 nF · `220` =22 pF.
- Defaults: 0603/0402 for general SMD; 100 nF X7R decoupling per IC power pin; C0G for timing.