

# **www.mbsm.pro , Practical Electronics for Inventors, Fourth Edition**

written by mahdi miled | 23 November 2017

**Practical Electronics for Inventors, Fourth Edition**

by: Paul Scherz, Dr. Simon Monk

Abstract: A fully updated, no-nonsense guide to electronics. Advance your electronics knowledge and gain the skills necessary to develop and construct your own functioning gadgets. Written by a pair of experienced engineers and dedicated hobbyists, Practical Electronics for Inventors, Fourth Edition, lays out the essentials and provides step-by-step instructions, schematics, and illustrations. Discover how to select the right components, design and build circuits, use microcontrollers and ICs, work with the latest software tools, and test and tweak your creations. This easy-to-follow book features new instruction on programmable logic, semiconductors, operational amplifiers, voltage regulators, power supplies, digital electronics, and more. Coverage includes:

- Resistors, capacitors, inductors, and transformers
- Diodes, transistors, and integrated circuits
- Optoelectronics, solar cells, and phototransistors
- Sensors, GPS modules, and touch screens
- Op amps, regulators, and power supplies
- Digital electronics, LCDs, and logic gates
- Microcontrollers and prototyping platforms
- Combinational and sequential programmable logic
- DC motors, RC servos, and stepper motors
- Microphones, audio amps, and speakers
- Modular electronics and prototypes

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Authors:

Paul Scherz is a Systems Operation Manager who received his B.S. in physics from the University of Wisconsin. He is an inventor/hobbyist in electronics, an area he grew to appreciate through his experience at the University's Department of Nuclear Engineering and Engineering Physics and Department of Plasma Physics.

Dr. Simon Monk has a bachelor's degree in cybernetics and computer science and a Ph.D. in software engineering. He spent several years as an academic before he returned to industry, co-founding the mobile software company Momote Ltd. He has been an active electronics hobbyist since his early teens and is a full-time writer on hobby electronics and open-source hardware. Dr. Monk is author of numerous electronics books, including Programming Arduino, Hacking Electronics, and Programming the Raspberry Pi.

Description: A fully updated, no-nonsense guide to electronics. Advance your electronics knowledge and gain the skills necessary to develop and construct your own functioning gadgets. Written by a pair of experienced engineers and dedicated hobbyists, Practical Electronics for Inventors, Fourth Edition, lays out the essentials and provides step-by-step instructions, schematics, and illustrations. Discover how to select the right components, design and build circuits, use microcontrollers and ICs, work with the latest software tools, and test and tweak your creations. This easy-to-follow book

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1. <https://www.amazon.com/Practical-Electronics-Inventors-Fourth-Scherz/dp/1259587541> [back]

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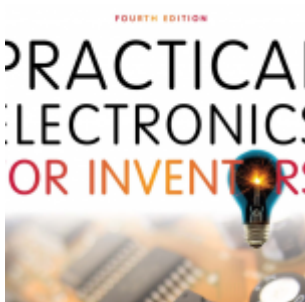
FOURTH EDITION

# PRACTICAL ELECTRONICS FOR INVENTORS

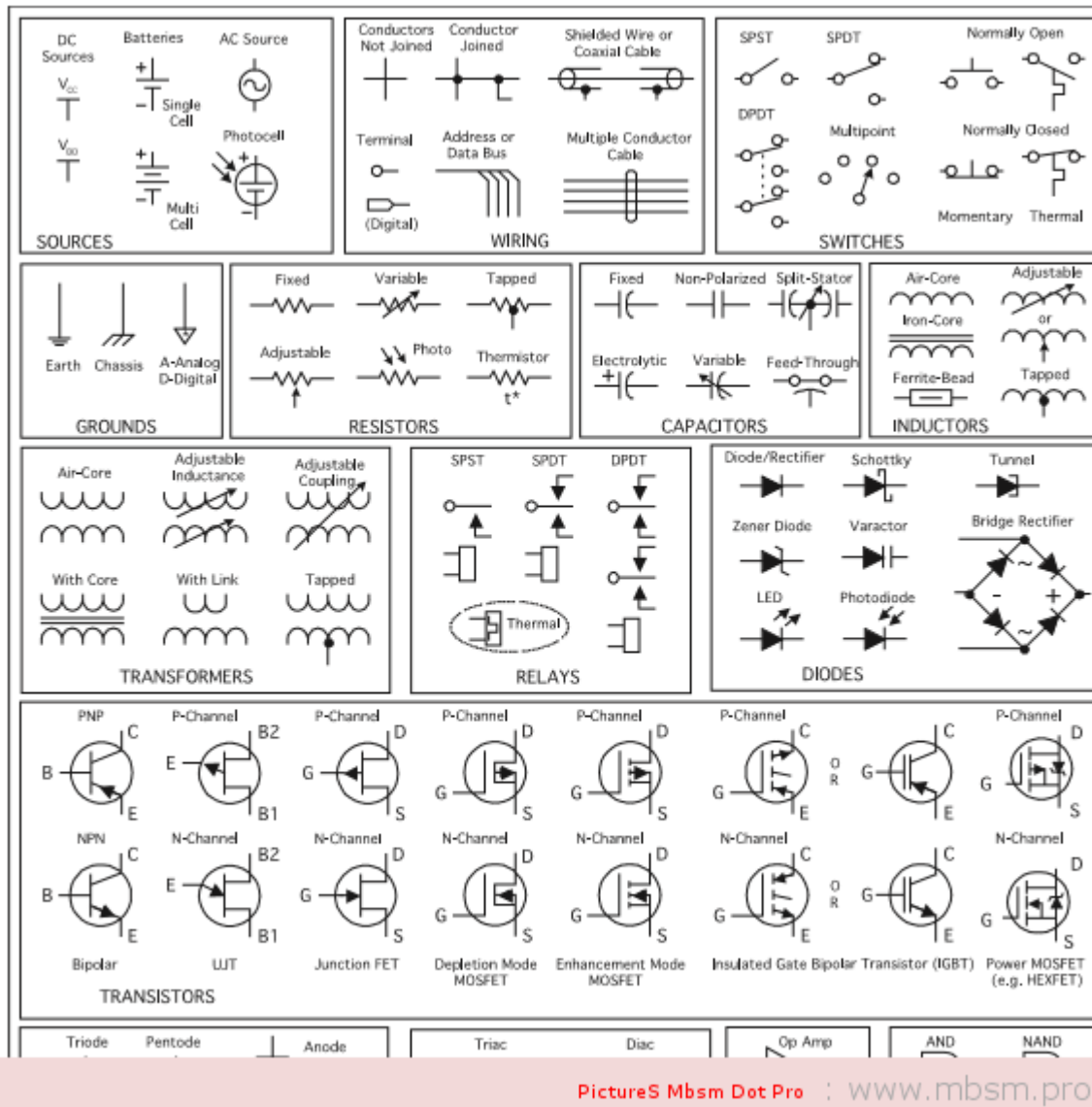


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### Resistor Labels

#### Conversion Calculator

k = 1,000 ; M = 1,000,000

1MΩ = 1,000,000 Ω = 1 x 10<sup>6</sup>Ω

1kΩ = 1,000 Ω = 1 x 10<sup>3</sup>Ω

**Examples:**

3.3 kΩ = 3,300 Ω = 3.3 x 10<sup>3</sup>Ω

22 kΩ = 22,000 Ω = 22 x 10<sup>3</sup>Ω

2 MΩ = 2,000,000 Ω = 2 x 10<sup>6</sup>Ω

1.68 MΩ = 1,680,000 Ω = 1.68 x 10<sup>6</sup>Ω

#### Resistor Color Code

Color	Sig. Fig.	Decimal Multiplier	Tolerance (%)
Black	0	1	-
Brown	1	10	1
Red	2	100	2
Orange	3	1,000	-
Yellow	4	10,000	-
Green	5	100,000	0.5
Blue	6	1,000,000	0.25
Purple	7	10,000,000	0.1
Gray	8	100,000,000	-
White	9	1,000,000,000	-
Gold	-	0.1	5
Silver	-	0.01	10
No Color	-	-	20

#### Body Color

The body color of a resistor typically doesn't carry meaning, except in some instances where it may specify temperature coefficient. However, if you find resistors within a circuit that are white/gray or blue in color, they may be non-flammable or fusible resistors. Care must be taken when entering such resistors.

### 4-Band Resistor Code (Most Common)

**Label Meaning**

Red Black Orange Gold  
20 x 1,000 = 20k Ω ± 5%

First Digit Second Digit Multiplier (#of zeros) % Tolerance

### 5-Band Resistor Code (3-digit)

**Label Meaning**

Purple Blue Green Brown Brown  
675 x 10 = 6750 Ω ± 1%

First Digit Second Digit Third Digit Multiplier (#of zeros) % Tolerance

### 5-Band Resistor Code (Reliability)

**Label Meaning**

Yellow Purple Green Silver Brown  
47 x 100,000 = 4.7 MΩ ± 10%

1% Reliability/1000 Hr — Brown

Color	Reliability (%/1000 Hr)
Brown	1
Red	0.1
Orange	0.01
Yellow	0.001

First Digit Second Digit Multiplier (#of zeros) Reliability % Tolerance

### 6-Band Resistor Code

**Label Meaning**

Purple Red Black Blue Brown Red  
276 x 1 = 276Ω ± 1%

TC of 50 ppm — Red

Color	Temp. Coeff
Brown	100 ppm
Red	50 ppm

First Digit Second Digit Third Digit Multiplier (#of zeros) Temp. Coeff. % Tolerance

### Surface Mount Resistor Code

#### 3-digit Label

**Label Meaning**

101 10 and 1 zero = 100 Ω

105 10 and 5 zero = 1,000,000 Ω

224 22 and 4 zeros = 220,000 Ω

1R0 1.0 and no zeros = 1 Ω

22R 22.0 and no zeros = 22 Ω

R10 0.1 and no zeros = 0.1 Ω

The first two digits represent significant figures; the last digit specifies the multiplier. For values under 100 Ω, the letter R is substituted for one of the significant digits and represents a decimal point.

#### 4-digit Label

**Label Meaning**

1001 100 and 1 zero = 1000 Ω

22R0 22.0 and no zeros = 22 Ω

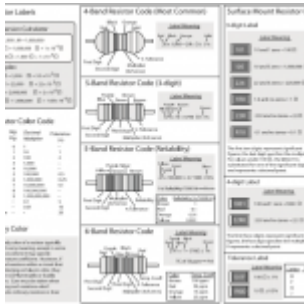
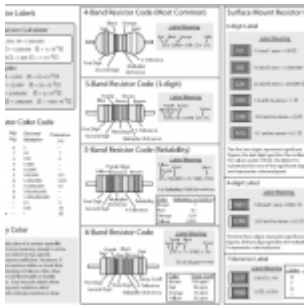
The first three digits represent significant figures; the last digit specifies the multiplier. R represents a decimal point.

#### Tolerance Label

Label Meaning	Letter	Tolerance
101F	D	±0.5 %
	F	±1.0 %

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# Capacitor Markings

**Capacitance Conversion Calculator**

$1 \text{ F} = 1 \times 10^6 \mu\text{F} = 1 \times 10^9 \text{ nF} = 1 \times 10^{12} \text{ pF}$   
 $1 \mu\text{F} = 1 \times 10^{-6} \text{ F} = 1 \times 10^3 \text{ nF} = 1 \times 10^6 \text{ pF}$   
 $1 \text{ nF} = 1 \times 10^{-9} \text{ F} = 1 \times 10^{-3} \mu\text{F} = 1 \times 10^3 \text{ pF}$   
 $1 \text{ pF} = 1 \times 10^{-12} \text{ F} = 1 \times 10^{-6} \mu\text{F} = 1 \times 10^{-3} \text{ nF}$   
 $\text{F} = \text{Farad}, \mu = \text{micro}, \text{n} = \text{nano}, \text{p} = \text{pico}$

$1000 \mu\text{F} = 1,000,000 \text{ nF} = 10 \times 10^8 \text{ pF}$   
 $100 \mu\text{F} = 100,000 \text{ nF} = 10 \times 10^7 \text{ pF}$   
 $10 \mu\text{F} = 10,000 \text{ nF} = 10 \times 10^6 \text{ pF}$   
 $1 \mu\text{F} = 1,000 \text{ nF} = 10 \times 10^5 \text{ pF}$   
 $0.1 \mu\text{F} = 100 \text{ nF} = 10 \times 10^4 \text{ pF}$   
 $0.01 \mu\text{F} = 10 \text{ nF} = 10 \times 10^3 \text{ pF}$   
 $0.001 \mu\text{F} = 1 \text{ nF} = 10 \times 10^2 \text{ pF}$

**Tantalum**

**Label meaning 1**

1st significant figure in  $\mu\text{F}$   
 2nd significant figure in  $\mu\text{F}$   
 Multiplier (See table)  
 Voltage

Color	S.F.	Multiple	Voltage
Black	0	1	10V
Brown	1	10	
Red	2	100	
Orange	3	1000	
Yellow	4		6.3V
Green	5		16V
Blue	6		20V
Violet	7		
Gray	8	0.01	25V
White	9	0.1	3V
Pink			35V

**Label meaning 2**

Marking	Actual
22	22 $\mu\text{F}$ , 16 V

**Mylar (Polyester Film)**  
**Polypropylene**  
**Dipped Mica**

**Label meaning**

Marking	Actual
.001K*	0.001 $\mu\text{F}$ , $\pm 10\%$
104K	0.1 $\mu\text{F}$ , $\pm 10\%$
22J*	0.22 $\mu\text{F}$ , $\pm 5\%$
472K	0.0047 $\mu\text{F}$ , $\pm 10\%$
221J	220 pF, $\pm 5\%$
470J	47 pF, $\pm 5\%$
102J	1000 pF, $\pm 5\%$
103F	0.01 $\mu\text{F}$ , $\pm 1\%$
223F	0.022 $\mu\text{F}$ , $\pm 1\%$

**Ceramic Disc Capacitors**

**Multiplier Code**

Numeric Character	Decimal Multiplier (pF)
0	None
1	10
2	100
3	1000
4	10,000

**EIA Capacitor Tolerance Codes**

Letter	$\leq 10 \text{ pF}$	$\geq 10 \text{ pF}$
B	$\pm 0.1 \text{ pF}$	-
C	$\pm 0.25 \text{ pF}$	-
D	$\pm 0.5 \text{ pF}$	-
E	-	$\pm 25\%$
F	-	$\pm 1\%$
G	-	$\pm 2\%$
H	-	$\pm 2.5\%$
J	-	$\pm 5\%$
K	-	$\pm 10\%$
M	-	$\pm 20\%$
P	-	$-0 + 100\%$
S	-	$-20 + 50\%$
W	-	$-0 + 200\%$
X	-	$-20 + 40\%$
Z	-	$-20 + 80\%$

**Ceramic Disc (European Markings)**

**Label Meaning**

Marking	Actual	Marking	Actual
p68	0.68 pF	22p	22 pF
1p0	1.0 pF	n10	0.1 nF
4p7	4.7 pF	n27	0.27 nF

Label: p = picofarads, n = nanofarads; location of p or n signifies decimal point.

**Fixed Ceramic Color Code**

Color	S.F.	Tolerance	Temp. Coeff. ppm/°C
Black	0	$\pm 20\%$	2.0 pF
Brown	1	$\pm 3\%$	-3.0
Red	2	$\pm 10\%$	-4.0
Orange	3	$\pm 20\%$	-5.0
Yellow	4	$\pm 20\%$	-10.0
Green	5	$\pm 5\%$	-15.0
Blue	6	$\pm 5\%$	-20.0
Violet	7	$\pm 5\%$	-25.0
Gray	8	$\pm 10\%$	-30.0
White	9	$\pm 10\%$	-50.0

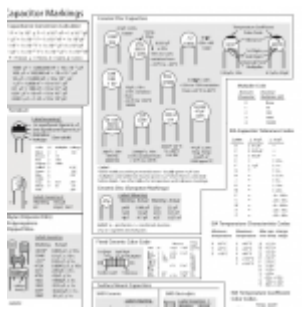
**Surface Mount Capacitors**

**EIA Temperature Characteristic Codes**

Minimum temperature	Maximum temperature	Max. cap. change over temp. range
X -55°C	2 +45°C	A $\pm 1.0\%$
Y -35°C	4 +65°C	B $\pm 1.5\%$
Z +10°C	5 +85°C	C $\pm 2.2\%$
	6 +105°C	D $\pm 3.3\%$
	7 +125°C	E $\pm 4.7\%$
		F $\pm 7.5\%$
		P $\pm 10\%$
		R $\pm 15\%$
		S $\pm 22\%$
		T -33%, +22%
		U -56%, +22%
		V -82%, +22%

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**Capacitor Markings**

Capacitor markings are used to identify the value, tolerance, and other characteristics of a capacitor. The markings are usually printed on the capacitor's body or on a label.

The most common marking system is the three-digit code. The first two digits represent the significant figures, and the third digit represents the multiplier. For example, 104 represents 10 x 10<sup>4</sup> pF = 0.1 μF.

Another common marking system is the four-digit code. The first three digits represent the significant figures, and the fourth digit represents the multiplier. For example, 1004 represents 100 x 10<sup>4</sup> pF = 1 μF.

Capacitors are also marked with their tolerance. A tolerance of ±5% is indicated by a letter 'D', and a tolerance of ±10% is indicated by a letter 'F'.

The diagram illustrates various capacitor markings and their corresponding values. It includes:

- Examples of three-digit and four-digit codes: 104, 1004, 105, 1005.
- Examples of tolerance markings: D (±5%), F (±10%).
- Examples of capacitor types: electrolytic, ceramic, and film.
- Examples of capacitor values: 0.1 μF, 1 μF, 10 μF, 100 μF, 1000 μF.
- Examples of capacitor ratings: 50V, 100V, 250V, 500V, 1000V.