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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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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

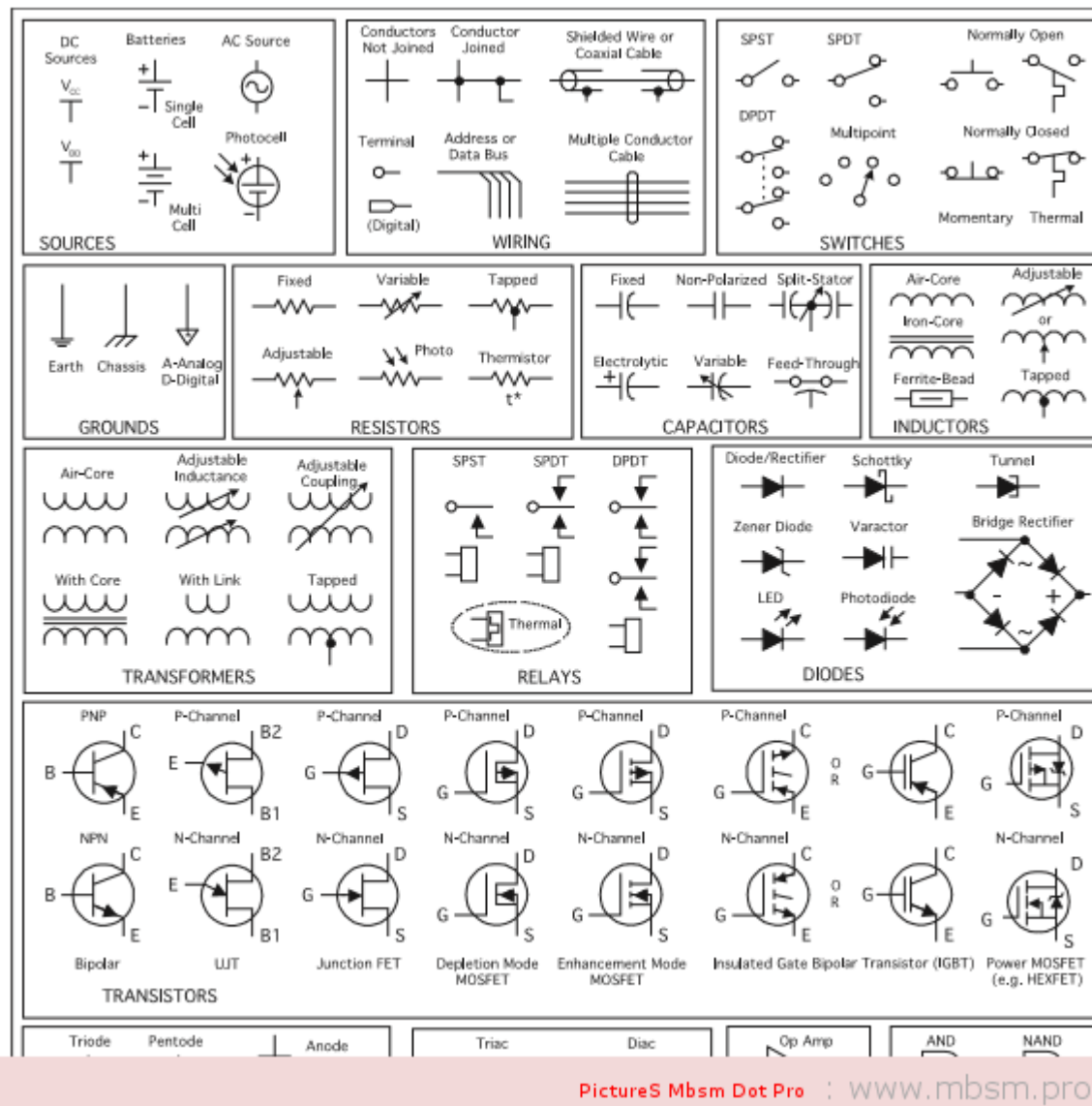


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Resistor Labels

Conversion Calculator

$k = 1,000$; $M = 1,000,000$
 $1M\Omega = 1,000,000\ \Omega = 1 \times 10^6\ \Omega$
 $1k\Omega = 1,000\ \Omega = 1 \times 10^3\ \Omega$

Examples:

$3.3\ k\Omega = 3,300\ \Omega = 3.3 \times 10^3\ \Omega$
 $22\ k\Omega = 22,000\ \Omega = 22 \times 10^3\ \Omega$
 $2\ M\Omega = 2,000,000\ \Omega = 2 \times 10^6\ \Omega$
 $1.68\ M\Omega = 1,680,000\ \Omega = 1.68 \times 10^6\ \Omega$

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 replacing such resistors. don't

4-Band Resistor Code (Most Common)

Label Meaning
 $20 \times 1,000 = 20k\ \Omega \pm 5\%$

5-Band Resistor Code (3-digit)

Label Meaning
 $675 \times 10 = 6750\ \Omega \pm 1\%$

5-Band Resistor Code (Reliability)

Label Meaning
 $47 \times 100,000 = 4.7\ M\Omega \pm 10\%$
 1% Reliability/1000 Hr — Brown

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

6-Band Resistor Code

Label Meaning
 $276 \times 1 = 276\Omega \pm 1\%$
 TC of 50 ppm — Red

Color	Temp. Coeff.
Brown	100 ppm
Red	50 ppm

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

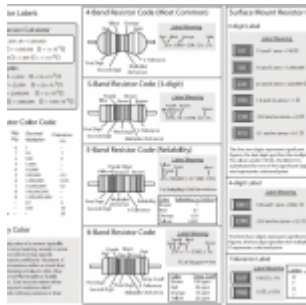
Tolerance Label

Label Meaning

Letter	Tolerance
D	$\pm 0.5\%$
F	$\pm 1.0\%$

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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 μF
2nd significant figure in μF
Multiplier
Voltage (See table)

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 μF , 16 V

Mylar (Polyester Film)

Polypropylene

Dipped Mica

Label meaning

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

Voltage Rating

Ceramic Disc Capacitors

22 pF $\pm 20\%$
1000V

Temp. Char.
Z5U
.0033 $\pm 20\%$
-56% to +22% variation from +10°C to +85°C

1Z
100V
0.1 μF
-20% to +80%
100V

Temperature Coefficient
Color Code
Tolerance
1st Digit
2nd Digit
Decimal Point
Multiplier

121K
120 pF $\pm 10\%$

4R7D
4.7 pF $\pm 0.5\text{pF}$

X7R
10K
1 kV
10 pF $\pm 10\%$
 $\pm 15\%$ variation from -55°C to +125°C
1000V

K5U
474M
0.47 μF $\pm 20\%$
+22% to -70% variation from +25°C to +85°C

20 $\pm 20\%$
50V AC
400V DC
20 pF $\pm 20\%$
50V AC
400V DC

Z5P
2200 K
2200 pF $\pm 10\%$
 $\pm 10\%$ variation from +10°C to +85°C

200 nZ
12V
200 nF -20°C to +80°C
12V DC

N2200
47 pF $\pm 20\%$
Neg. Temp. Coeff. of 2200 ppm/°C

Label:
Varies widely according to manufacturer. Usually given in pF (see multiplier code table) but may be given in μF when there is a decimal before digits. See other tables for temperature and tolerance markings.

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

1st Digit 2nd Digit Multiplier

Color	S.F.	Tolerance	Temp. Coeff. ppm/°C
Black	0	$\pm 20\%$	<10
Brown	1	$\pm 1\%$	-10
Red	2	$\pm 2\%$	+10
Orange	3	$\pm 3\%$	-100
Yellow	4	$\pm 4\%$	-150
Green	5	$\pm 5\%$	-200
Blue	6	$\pm 6\%$	-300
Violet	7	$\pm 7\%$	-400
Gray	8	$\pm 8\%$	-500
White	9	$\pm 9\%$	+100

Temp. Coeff. Tolerance

Surface Mount 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	$\pm 1 \text{ pF}$	$\pm 1\%$
G	-	$\pm 2\%$
H	-	$\pm 2.5\%$
J	-	$\pm 5\%$
K	-	$\pm 10\%$
M	-	$\pm 20\%$
P	-	-0 to +100%
S	-	-20 to +50%
W	-	-0 to +200%
X	-	-20 to +40%
Z	-	-20 to +80%

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% to +22%
		U -56% to +22%
		V -82% to +22%

EIA Temperature Coefficient

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