

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

Book Details

Title: Practical Electronics for Inventors, Fourth Edition

Publisher: McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto

Copyright / Pub. Date: 2016 McGraw-Hill Education

ISBN: 9781259587542

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

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

Table of Contents

A. ABOUT THE AUTHORS

B. PREFACE

C. ACKNOWLEDGMENTS

1. Introduction to Electronics
2. Theory
3. Basic Electronic Circuit Components
4. Semiconductors
5. Optoelectronics
6. Sensors
7. Hands-on Electronics
8. Operational Amplifiers
9. Filters
10. Oscillators and Timers
11. Voltage Regulators and Power Supplies
12. Digital Electronics
13. Microcontrollers
14. Programmable Logic
15. Motors
16. Audio Electronics
17. Modular Electronics
- A. Power Distribution and Home Wiring
- B. Error Analysis

C. Useful Facts and Formulas

Tools & Media

figure (1 036)

table (64)

Expanded Table of Contents

A. ABOUT THE AUTHORS

PREFACE PRELIMINARIES

ABOUT THE TECHNICAL EDITORS

B. PREFACE

PREFACE PRELIMINARIES

Notes about the Fourth Edition

C. ACKNOWLEDGMENTS

1. Introduction to Electronics

CHAPTER PRELIMINARIES

2. Theory

CHAPTER PRELIMINARIES

Theory of Electronics

Electric Current

Voltage

A Microscopic View of Conduction (for Those Who Are Interested)

Resistance, Resistivity, Conductivity

Insulators, Conductors, and Semiconductors

Heat and Power

Thermal Heat Conduction and Thermal Resistance

Wire Gauges

Grounds

Electric Circuits

Ohm's Law and Resistors

Voltage and Current Sources

Measuring Voltage, Current, and Resistance

Combining Batteries

Open and Short Circuits

Kirchhoff's Laws

Superposition Theorem

Thevenin's and Norton's Theorems

AC Circuits

AC and Resistors, RMS Voltage, and Current

Mains Power

Capacitors

Inductors

Modeling Complex Circuits

Complex Numbers

Circuit with Sinusoidal Sources

Power in AC Circuits (Apparent Power, Real Power, Reactive Power)

Thevenin's Theorem in AC Form

Resonant Circuits

Lecture on Decibels

Input and Output Impedance

Two-Port Networks and Filters

Transient Circuits

Circuits with Periodic Nonsinusoidal Sources

Nonperiodic Sources

SPICE

3. Basic Electronic Circuit Components

CHAPTER PRELIMINARIES

Wires, Cables, and Connectors

Batteries

Switches

Relays

Resistors

Capacitors

Inductors

Transformers

Fuses and Circuit Breakers

4. Semiconductors

CHAPTER PRELIMINARIES

Semiconductor Technology

Diodes

Transistors

Thyristors

Transient Voltage Suppressors

Integrated Circuits

5. Optoelectronics

CHAPTER PRELIMINARIES

A Little Lecture on Photons

Lamps

Light-Emitting Diodes

Photoresistors

Photodiodes

Solar Cells

Phototransistors

Photothyristors

Optoisolators

Optical Fiber

6. Sensors

CHAPTER PRELIMINARIES

General Principles

Temperature

Proximity and Touch

Movement, Force, and Pressure

Chemical

Light, Radiation, Magnetism, and Sound

GPS

7. Hands-on Electronics

CHAPTER PRELIMINARIES

Safety

Constructing Circuits

Multimeters

Oscilloscopes

The Electronics Laboratory

8. Operational Amplifiers

CHAPTER PRELIMINARIES

Operational Amplifier Water Analogy

How Op Amps Work (The “Cop-Out” Explanation)

Theory

Negative Feedback

Positive Feedback

Real Kinds of Op Amps

Op Amp Specifications

Powering Op Amps

Some Practical Notes

Voltage and Current Offset Compensation

Frequency Compensation

Comparators

Comparators with Hysteresis

Using Single-Supply Comparators

Window Comparator

Voltage-Level Indicator

Instrumentation Amplifiers

Applications

9. Filters

CHAPTER PRELIMINARIES

Things to Know Before You Start Designing Filters

Basic Filters

Passive Low-Pass Filter Design

A Note on Filter Types

Passive High-Pass Filter Design

Passive Bandpass Filter Design

Passive Notch Filter Design

Active Filter Design

Integrated Filter Circuits

10. Oscillators and Timers

CHAPTER PRELIMINARIES

RC Relaxation Oscillators

The 555 Timer IC

Voltage-Controlled Oscillators

Wien-Bridge and Twin-T Oscillators

LC Oscillators (Sinusoidal Oscillators)

Crystal Oscillators

Microcontroller Oscillators

11. Voltage Regulators and Power Supplies

CHAPTER PRELIMINARIES

Voltage-Regulator ICs

A Quick Look at a Few Regulator Applications

The Transformer

Rectifier Packages

A Few Simple Power Supplies

Technical Points about Ripple Reduction

Loose Ends

Switching Regulator Supplies (Switchers)

Switch-Mode Power Supplies (SMPS)

Kinds of Commercial Power Supply Packages

Power Supply Construction

12. Digital Electronics

CHAPTER PRELIMINARIES

The Basics of Digital Electronics

Logic Gates

Combinational Devices

Logic Families

Powering and Testing Logic ICs

Sequential Logic

Counter ICs

Shift Registers

Analog/Digital Interfacing

Displays

Memory Devices

13. Microcontrollers

CHAPTER PRELIMINARIES

Basic Structure of a Microcontroller

Example Microcontrollers

Evaluation/Development Boards

Arduino

Interfacing with Microcontrollers

14. Programmable Logic

CHAPTER PRELIMINARIES

Programmable Logic

FPGAs

ISE and the Elbert V2

The Elbert 2 Board

Downloads

Drawing Your FPGA Logic Design

Verilog

Describing Your FPGA Design in Verilog

Modular Design

Simulation

VHDL

15. Motors

CHAPTER PRELIMINARIES

DC Continuous Motors

Speed Control of DC Motors

Directional Control of DC Motors

RC Servos

Stepper Motors

Kinds of Stepper Motors

Driving Stepper Motors

Controlling the Driver with a Translator

A Final Word on Identifying Stepper Motors

16. Audio Electronics

CHAPTER PRELIMINARIES

A Little Lecture on Sound

Microphones

Microphone Specifications

Audio Amplifiers

Preamplifiers

Mixer Circuits

A Note on Impedance Matching

Speakers

Crossover Networks

Simple ICs Used to Drive Speakers

Audible-Signal Devices

Miscellaneous Audio Circuits

17. Modular Electronics

CHAPTER PRELIMINARIES

There's an IC for It

Breakout Boards and Modules

Plug-and-Play Prototyping

Open Source Hardware

A. Power Distribution and Home Wiring

APPENDIX PRELIMINARIES

Power Distribution

A Closer Look at Three-Phase Electricity

Home Wiring

Electricity in Other Countries

B. Error Analysis

APPENDIX PRELIMINARIES

Absolute Error, Relative Error, and Percent Error

Uncertainty Estimates

C. Useful Facts and Formulas

APPENDIX PRELIMINARIES

Greek Alphabet

Powers of 10 Unit Prefixes

Linear Functions ($y = mx + b$)

Quadratic Equation ($y = ax^2 + bx + c$)

Exponents and Logarithms

Trigonometry

Complex Numbers

Differential Calculus

Integral Calculus

1

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

www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition1.png (273 KB)

FOURTH EDITION

PRACTICAL ELECTRONICS FOR INVENTORS

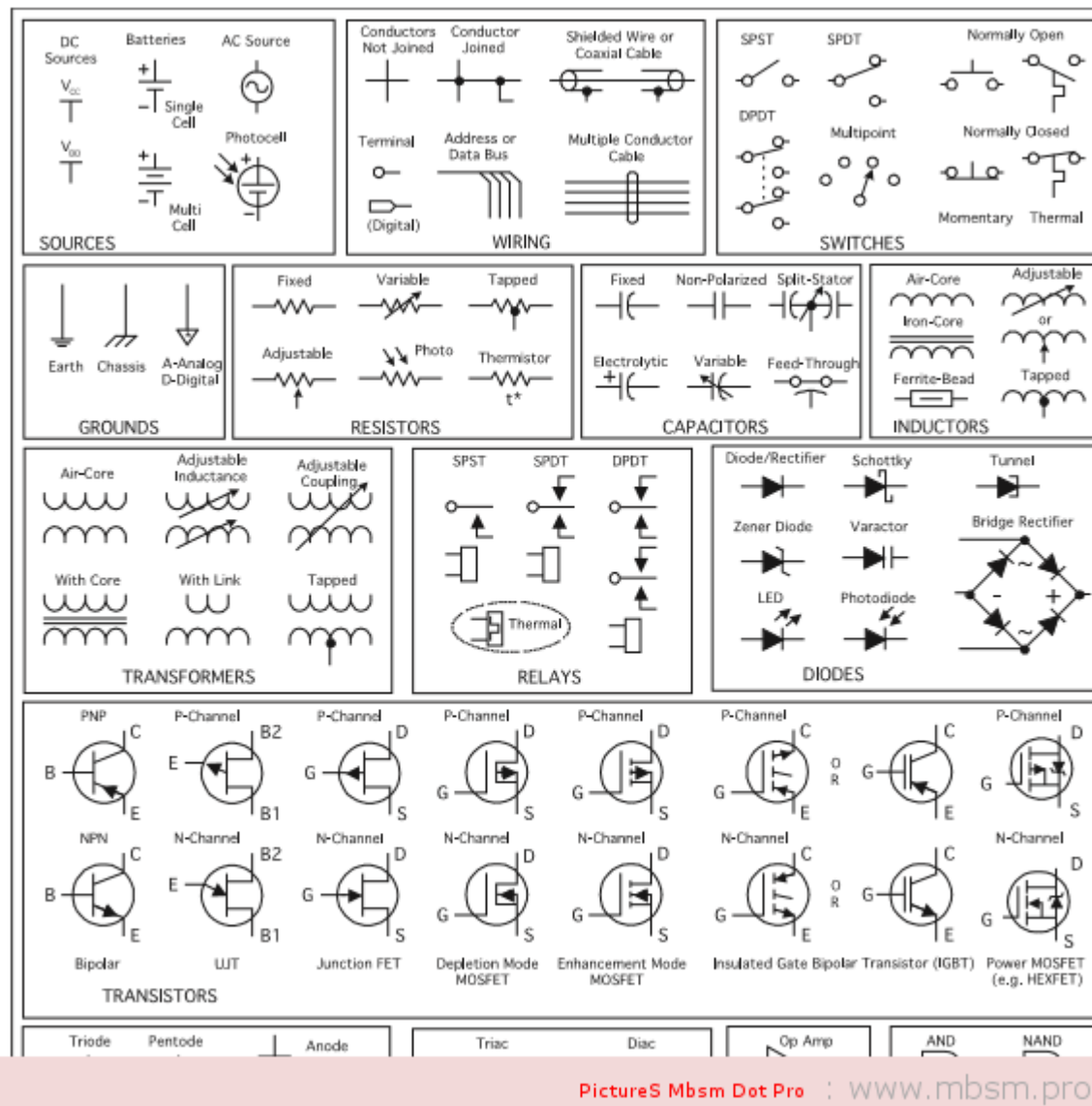


PictureS Mbsm Dot Pro : www.mbsm.pro

www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition1.png (239 KB)



www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition2.png (121 KB)



www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition2.png (111 KB)





www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition3.png (146 KB)

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

Red Black Orange Gold
 $20 \times 1,000 = 20k\ \Omega \pm 5\%$

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

5-Band Resistor Code (3-digit)

Label Meaning

Purple Blue Green Brown Brown
 $675 \times 10 = 6750\ \Omega \pm 1\%$

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

5-Band Resistor Code (Reliability)

Label Meaning

Yellow Purple Green Silver Brown
 $47 \times 100,000 = 4.7\ M\Omega \pm 10\%$

First Digit Second Digit Third Digit Multiplier (# of zeros) Reliability

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

6-Band Resistor Code

Label Meaning

Purple Red Black Blue Brown Red
 $276 \times 1 = 276\ \Omega \pm 1\%$

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

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

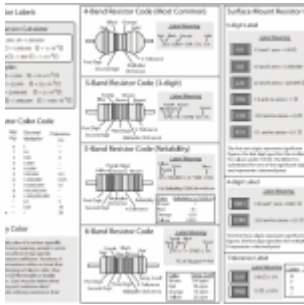
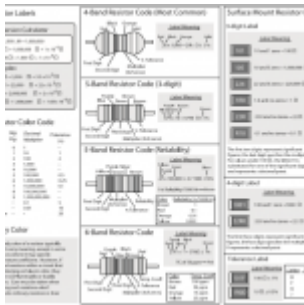
Label Meaning

101F 100 $\Omega \pm 1\%$

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

PictureS Mbsm Dot Pro : www.mbsm.pro

www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition3.png (134 KB)



www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition4.png (193 KB)

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
47p			
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	$\pm 9\%$	500

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

PictureS Mbsm Dot Pro : www.mbsm.pro

www-mbsm-pro-Practical-Electronics-for-Inventors-Fourth-Edition4.png (178 KB)

