电气专业英语

（第2版）

徐志成 郑见 主编

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前言 (Preface)

随着经济全球化的发展，国际技术交流也日益增强，工程技术人员迫切需要阅读和撰写大量的英文技术资料和文献，然而由于科技英语的表达方式，词汇范畴与公共日常英语存在较大差异，所以专业英语课程的开设对于提高专业学生阅读外文技术资料和撰写外文专业文献非常有必要。但是，目前电气专业的英语教材在内容的难易度、合适度上适合高等院校学生水平的尚不多。为此，编者从实际应用角度出发，结合电气专业所学课程，从国外原版教材、专著、相关网站及产品说明书等材料中精心挑选课文内容，并结合自己的教学体会给出了相关注释和练习。本书可作为高等院校电气专业及相近专业的专业外语教材，也可供电气专业的工程技术人员阅读参考。

本教材结合电气类专业的特点，将教材分为五章：第一章（第 1～5 单元）电工电子基础部分，即与电路元器件、电路网络分析、二极管、运算放大器等知识相关的外文材料；第二章（第 6～10 单元）电力电子及电机控制部分，即与电力电子及变频技术、直流电机、交流电机及其转速控制等知识相关的外文材料；第三章（第 11～16 单元）工业自动化部分，即与 PLC、单片机等知识相关的外文材料；第四章（第 17～21 单元）自动控制原理部分，即与传递函数、开环和闭环控制等知识相关的外文材料；第五章（第 22～26 单元）过程控制技术部分，即与先进控制方法、集散控制系统及传感器等知识相关的外文材料。

本书由徐志成、夏怡、王琳以及郑见联合编写，其中第一章由王琳副教授编写，第二～三章由张一沙、夏怡联合编写，第四～五章由徐志成、郑见联合编写。全书由徐志成、郑见统稿。由于编者经验和水平所限，书中存在不足和疏漏之处，敬请读者批评指正。

编　者

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Chapter 1 Electronic Components

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Chapter 4 Principles of Automatic Control

Chapter 5 Process Control Systems

Chapter 1
Electronic Components

Unit 1

Resistors

Resistors
翻译

Resistors are the most commonly used components in electronics, and their purpose is to create specified values of the current and voltage in a circuit. A number of different resistors are shown in the photos below (The resistors are put on the paper about a millimeter thick, which are spaced out 1 cm apart to give some idea of the dimensions). Fig. 1.1.1 shows some low-power resistors, while Fig. 1.1.2 shows some high-power resistors. Resistors with power dissipation below 5 watt (most commonly used types) are cylindrical in shape, with a wire protruding from each end for connecting to a circuit (Fig. 1.1.1). Resistors with power dissipation above 5 watt are shown below (Fig. 1.1.2).

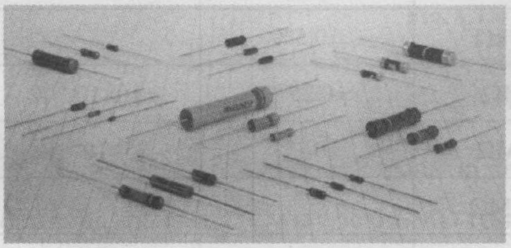

Fig. 1.1.1 Some low-power resistors

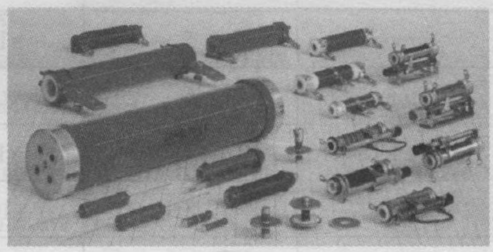

Fig. 1.1.2 High-power resistors and rheostats

The symbol for a resistor is shown in Fig. 1.1.3 (The upper: American symbol, and the lower: European symbol).

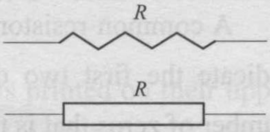

Fig. 1.1.3 Resistor symbols

The unit for measuring resistance is the OHM (the Greek letter Ω—called Omega). Higher resistance values are represented by "k" (kilo-ohms) and M (megohms). For example, 120,000 Ω is represented as 120 k, while 1,200,000 Ω is represented as 1.2 M. The dot is generally omitted as it can easily be lost in the printing process. In some circuit diagrams, a value such as 8 or 120 represents a resistance in ohms. Another common practice is to use the letter E for resistance in ohms. The letter R can also be used. For examples, 120 E (120 R) stands for 120 Ω, and 1E2 stands for 1R2, etc.

Resistor markings

Resistance value is marked on the resistor body. Most resistors have 4 bands. The first two bands provide the numbers for the resistance, and the third band provides the number of zeros. The fourth band indicates the tolerance. Tolerance values of 5%, 2%, and 1% are most commonly available.

Tab. 1.1.1 shows the colors used to identify resistor values.

Tab. 1.1.1 Resistor values

COLOR	DIGIT	MULTIPLIER	TOLERANCE	TC①
Silver		×0.01 Ω	±10%	
Gold		×0.1 Ω	±5%	
Black	0	×1 Ω		
Brown	1	×10 Ω	±1%	$\pm 100\times10^{-6}$/K
Red	2	×100 Ω	±2%	$\pm 50\times10^{-6}$/K
Orange	3	×1 kΩ		$\pm 15\times10^{-6}$/K
Yellow	4	×10 kΩ		$\pm 25\times10^{-6}$/K
Green	5	×100 kΩ	±0.5%	
Blue	6	×1 MΩ	±0.25%	$\pm 10\times10^{-6}$/K
Violet	7	×10 MΩ	±0.1%	$\pm 5\times10^{-6}$/K
Grey	8	×100 MΩ		
White	9	×1 GΩ		$\pm 1\times10^{-6}$/K

A common resistor has 4 bands. It is shown in Fig 1.1.4 (a). The first two bands indicate the first two digits of the resistance; the third band is the multiplier (the number of zeros that is to be added to the number derived from the first two bands); the fourth represents the tolerance.

Marking the resistance with five bands is used for resistors with tolerance values of 2%, 1% and other high-accuracy resistors. The first three bands determine the first three digits, and the fourth is the multiplier, and the fifth represents the tolerance (Fig. 1.1.4 (b)).

① TC — Temp. Coefficient, only for SMD devices.

For SMDs (Surface Mounted Devices), the available space on the resistor is very small. 5% of resistors use a 3-digit code, while 1% of resistors use a 4-digit code.

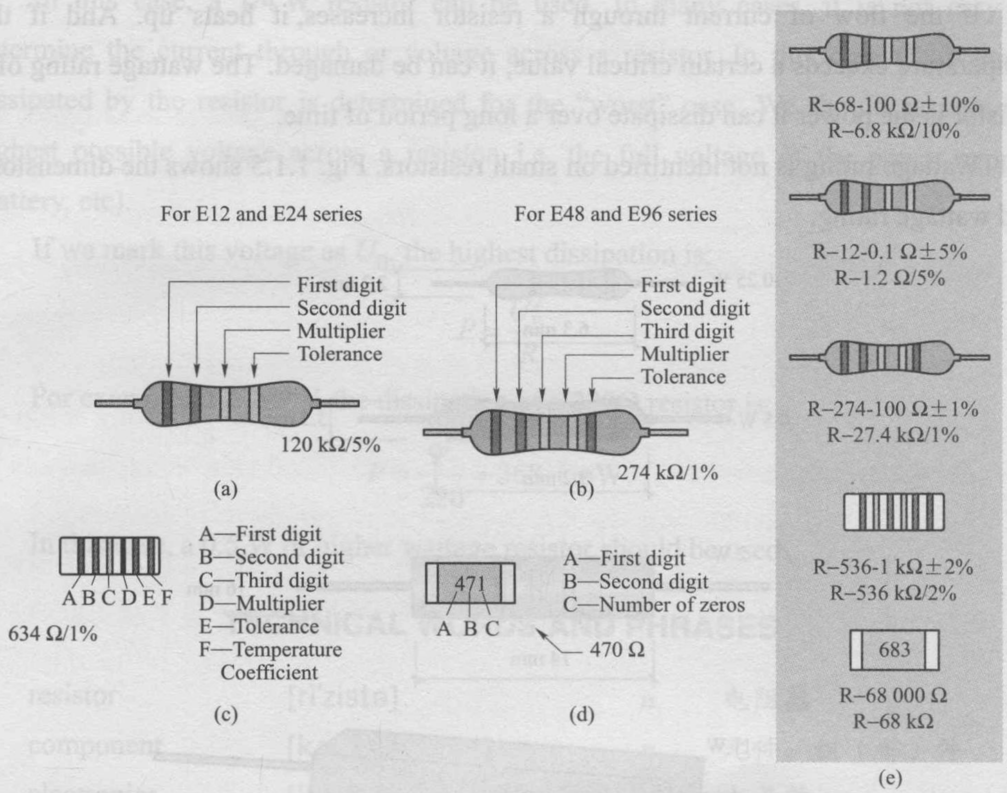

Fig. 1.1.4 Resistors

(a) A four-band resistor; (b) A five-band resistor; (c) A cylindrical SMD resistor; (d) A flat SMD resistor; (e) Examples

Some SMD resistors are made in the shape of small cylinder while the most common type is flat. Cylindrical SMD resistors are marked with six bands — The first five bands are "read" as with common five-band resistors, while the sixth band determines the Temperature Coefficient (TC), which gives us a value of resistance change upon 1-degree temperature change (Fig. 1.1.4 (c)).

The resistance of a flat SMD resistor is marked with digits printed on their upper side. The first two digits are resistance values, while the third digit represents the number of zeros (Fig. 1.1.4 (d)). For example, the printed number 683 stands for 68,000. That is 68 k.

For some electrical circuits, the resistor tolerance is not important, and it is not specified. In that case, resistors with 5% tolerance can be used. However, devices which require resistors to have a certain amount of accuracy need a specified tolerance.

Resistor dissipation

If the flow of current through a resistor increases, it heats up. And if the temperature exceeds a certain critical value, it can be damaged. The wattage rating of a resistor is the power it can dissipate over a long period of time.

Wattage rating is not identified on small resistors. Fig. 1.1.5 shows the dimensions and wattage rating.

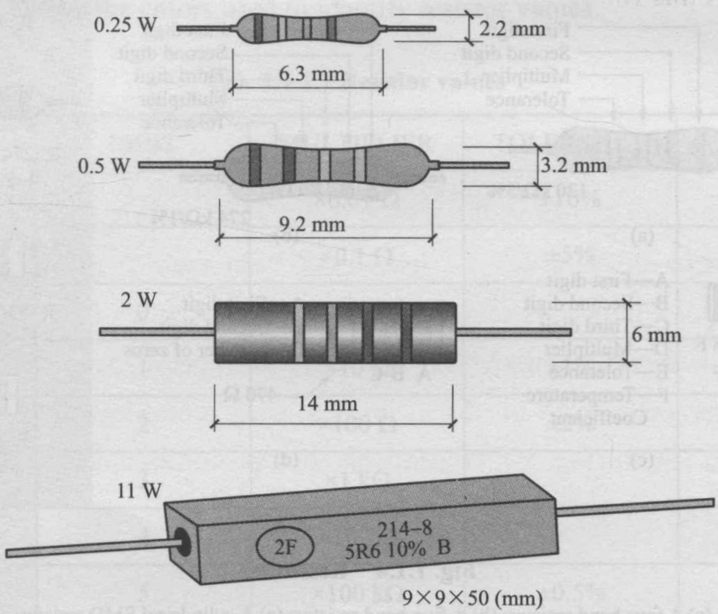

Fig. 1.1.5 Resistor dimensions

Most commonly used resistors in electronic circuits have a wattage rating of 1/2 W or 1/4 W. There are smaller resistors (1/8 W and 1/16 W) and higher ones (1 W, 2 W, 5 W, etc). In place of a single resistor with specified dissipation, another one with the same resistance and higher rating may be used, but its larger dimensions increase the space taken on a printed circuit board as well as the added cost.

Power (in watts) can be calculated according to one of the following formulae, where U is the symbol for Voltage across the resistor (and is in Volts), and I is the symbol for Current in Amps, and R is the resistance in ohms:

$$P = UI$$

$$P = RI^2$$

$$P = \frac{U^2}{R}$$

For example, if the voltage across an 820 Ω resistor is 12 V, the wattage dissipated by the resistors is:

$$P=\frac{U^2}{R}=\frac{12^2}{820}=0.176\text{（W）}=176\text{ mW}$$

In this case, a 1/4 W resistor can be used. In many cases, it is not easy to determine the current through or voltage across a resistor. In this case the wattage dissipated by the resistor is determined for the "worst" case. We should assume the highest possible voltage across a resistor, i.e. the full voltage of the power supply (battery, etc).

If we mark this voltage as U_B, the highest dissipation is:

$$P=\frac{U_B^2}{R}$$

For example, if U_B=9 V, the dissipation of a 220Ω resistor is:

$$P=\frac{9^2}{220}=368\text{（mW）}$$

In this case, a 0.5 W or higher wattage resistor should be used.

TECHNICAL WORDS AND PHRASES

resistor	[ri'zistə]	*n.*	电阻器
component	[kəm'pəunənt]	*n.*	元件，组（部）件
electronics	[ilek'trɔniks]	*n.*	电子学
current	['kʌrənt]	*n.*	电流
voltage	['vəultidʒ]	*n.*	[电工]电压，伏特数
circuit	['səːkit]	*n.*	电路
power	['pauə]	*n.*	[物]功率
dissipation	[ˌdisi'peiʃən]	*n.*	损耗
resistance	[ri'zistəns]	*n.*	电阻，阻抗
ohm	[əum]	*n.*	[物]欧姆
tolerance	['tɔlərəns]	*n.*	偏差，公差
cylindrical	[si'lindrik(ə)l]	*adj.*	圆柱的
multiplier	['mʌltiplaiə]	*n.*	乘数
formula	['fɔːmjulə]	*n.*	公式
wattage	['wɔtidʒ]	*n.*	瓦特，瓦特数
battery	['bætəri]	*n.*	电池
wattage rating			额定功率
power supply			电源
four-band resistor			四色环电阻

SMD (Surface Mounted Device)	表面贴装器件
printed circuit board	印刷电路板

NOTES

1. Resistors with power dissipation below 5 watt (most commonly used types) are cylindrical in shape, with a wire protruding from each end for connecting to a circuit.

   译文：功耗低于5瓦的电阻（最常使用的类型）为圆柱形，两端伸出的导线用来连接电路。

   句中"with a wire protruding from"为伴随状语。

2. Power (in watts) can be calculated according to one of the following formulae, where U is the symbol for Voltage across the resistor (and is in Volts), and I is the symbol for Current in Amps, and R is the resistance in ohms.

   译文：功率（单位为瓦）可以用下面公式中的一个来计算，其中U是电阻两端电压的符号（单位为伏），I是单位为安培的电流的符号，R是单位为欧姆的电阻的符号。

   句中"where"引导非限制性定语从句。

EXERCISES

Ⅰ. Translate the following words into English.

1. 电压　　2. 电流
3. 功率损耗　　4. 滑动变阻器
5. 四色环电阻　　6. 温度系数
7. 额定功率　　8. 电源

Ⅱ. Complete the following sentences.

1. Most resistors have ________ bands. The first two bands provide the numbers for the ________ and the third band provides the number of ________.
2. Some SMD resistors are made in the shape of small ________ while the most common type is ________.
3. If the flow of current ________ a resistor increases, it heats up. And if the temperature ________ a certain critical value, it can be damaged.
4. Power (in watts) can be calculated according to one of the following formulae, where U is the symbol for Voltage ________ the resistor (and is in Volts), and I is the symbol for ________ in Amps, and R is the resistance in ________.

Supplementary Reading

Reading 1 Capacitors

Capacitors are the common components of electronic circuits, used almost as frequently as resistors. The basic difference between the two is the fact that capacitor resistance (called reactance) depends on the frequency of the signal passing through the item. The symbol for reactance is X_C, and it can be calculated using the following formula:

$$X_C = \frac{1}{2\pi fC}$$

in which f represents the frequency in Hz, and C represents the capacitance in Farad.

For example, 5 nF-capacitor's reactance at f=125 kHz equals:

$$X_C = \frac{1}{2\times 3.14\times 125\,000\times 5\times 10^{-9}} = 255\ (\Omega)$$

while it is at f=1.25 MHz, it equals:

$$X_C = \frac{1}{2\times 3.14\times 1\,250\,000\times 5\times 10^{-9}} = 25.5\ (\Omega)$$

A capacitor has an infinitely high reactance for direct current, because f=0.

Capacitors are used in circuits for many different purposes. They are common components of filters, oscillators, power supplies, amplifiers, etc.

The basic characteristic of a capacitor is its capacity — the higher the capacity is, the higher the amount of electricity it can hold will be. Capacity is measured in farads (F). As one farad represents fairly high capacity, smaller values such as microfarad (μF), nanofarad (nF) and picofarad (pF) are commonly used. As a reminder, relations between the units are:

$$1\ \text{F}=10^6\ \mu\text{F}=10^9\ \text{nF}=10^{12}\ \text{pF}$$

That is, 1 μF=1,000 nF and 1 nF=1,000 pF. It is essential to remember this notation, as same values may be marked differently in some circuits. For example, 1,500 pF is the same as 1.5 nF, and 100 nF is 0.1 μF. A simpler notation system is used with resistors. If the mark on the capacitor is 120, the value is 120 pF. 1n2 stands for 1.2 nF. n22 stands for 0.22 nF, while .1 μ (or .1 u) stands for 0.1 μF.

Capacitors come in various shapes and sizes, depending on their capacity, working voltage, type of insulation, temperature coefficient and other factors. All capacitors can be divided into two groups: one with changeable capacity values and the other with fixed capacity values. These will be covered in the following chapters.

Block-capacitors

Capacitors with fixed values (the so-called block-capacitors) consist of two thin metal plates (these are called "electrodes" or sometimes called the "foil"), separated by a thin insulating material such as plastic. The most commonly used material for the "plates" is aluminum, while the common materials used for insulator include paper, ceramic, mica, etc. after which the capacitors get named. A number of different block-capacitors are shown in Fig. 1.1.6. A symbol for a capacitor is in the upper right corner of the figure.

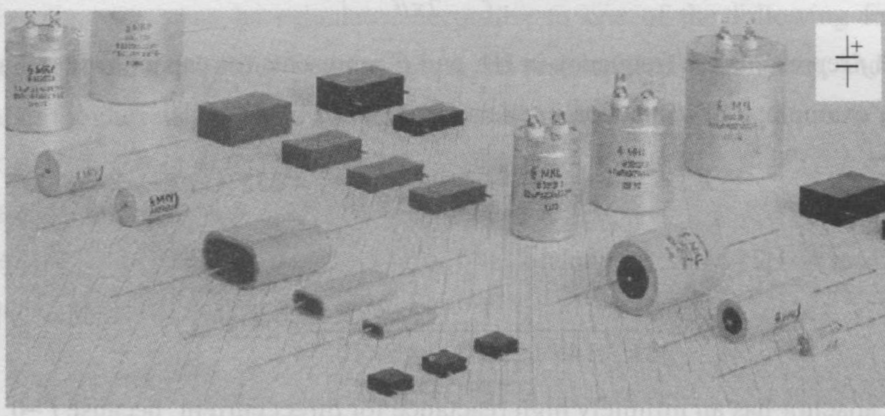

Fig. 1.1.6 Block capacitors

Most of the capacitors, block-capacitors included, are non-polarized components, meaning that their leads are equivalent in respect of the way the capacitor can be placed in a circuit. Electrolytic capacitors represent the exception as their polarity is important.

Marking the block-capacitors

Commonly, capacitors are marked by a set of numbers representing the capacity. Beside this value is another number representing the maximal working voltage, and sometimes tolerance, temperature coefficient and some other values are printed as well. But on the smallest capacitors (such as surface-mount) there are not markings at all, and you must not remove them from their protective strips until they are needed. The size of a capacitor is never an indication of its value as the dielectric and the number of layers or "plates" can vary from manufacturer to manufacturer. The value of a capacitor on a circuit diagram, marked as 4n7/40 V, means the capacitor is 4,700 pF, and its maximal working voltage is 40 V. Any other 4n7 capacitor with higher maximal working voltage can be used, but they are larger and more expensive.

Sometimes, capacitors are identified with colors, similar to the 4-band system used for resistors (Fig. 1.1.7 and Tab. 1.1.2). The first two colors (A and B) represent the first two digits, and the third color (C) is the multiplier, and the fourth color (D) is the tolerance, and the fifth color (E) is the working voltage.

With disk-ceramic capacitors (Fig. 1.1.7 (b)) and tubular capacitors (Fig. 1.1.7 (c)) working voltage is not specified, because these are used in circuits with low DC voltage. If a tubular capacitor has five color bands on it, the first color represents the temperature coefficient, while the other four specify the capacity in the previously described way.

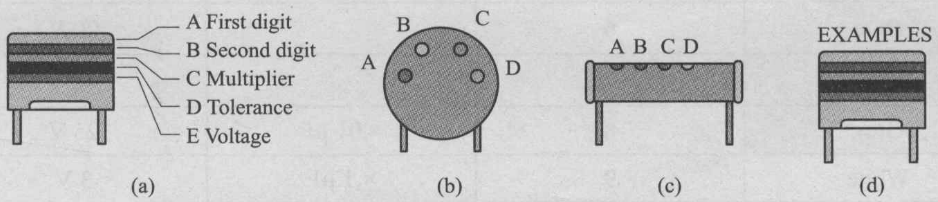

Fig. 1.1.7 Marking the capacity using colors

Tab. 1.1.2 Capacitor values

COLOR	DIGIT	MULTIPLIER	TOLERANCE	VOLTAGE
Black	0	×1 pF	±20%	
Brown	1	×10 pF	±1%	
Red	2	×100 pF	±2%	250 V
Orange	3	×1 nF	±2.5%	
Yellow	4	×10 nF		400 V
Green	5	×100 nF	±5%	
Blue	6	×1 μF		
Violet	7	×10 μF		
Grey	8	×100 μF		
White	9	×1,000 μF	±10%	

Fig. 1.1.8 and Tab. 1.1.3 show how the capacity of miniature tantalum electrolytic capacitors is marked by colors. The first two colors represent the first two digits and have the same values as with resistors. The third color represents the multiplier, to get the capacity expressed in μF. The fourth color represents the maximal working voltage.

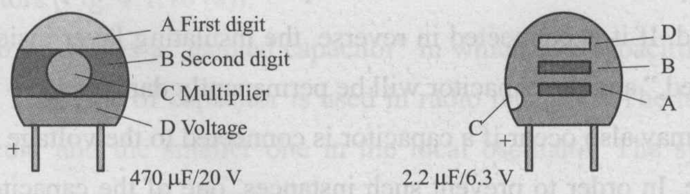

Fig. 1.1.8 Marking tantalum electrolytic capacitors