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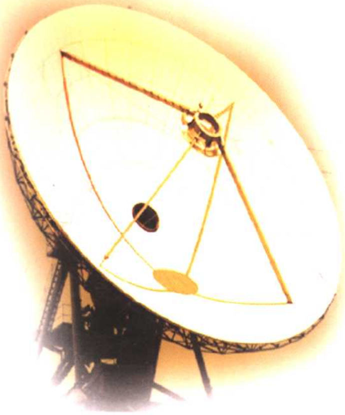
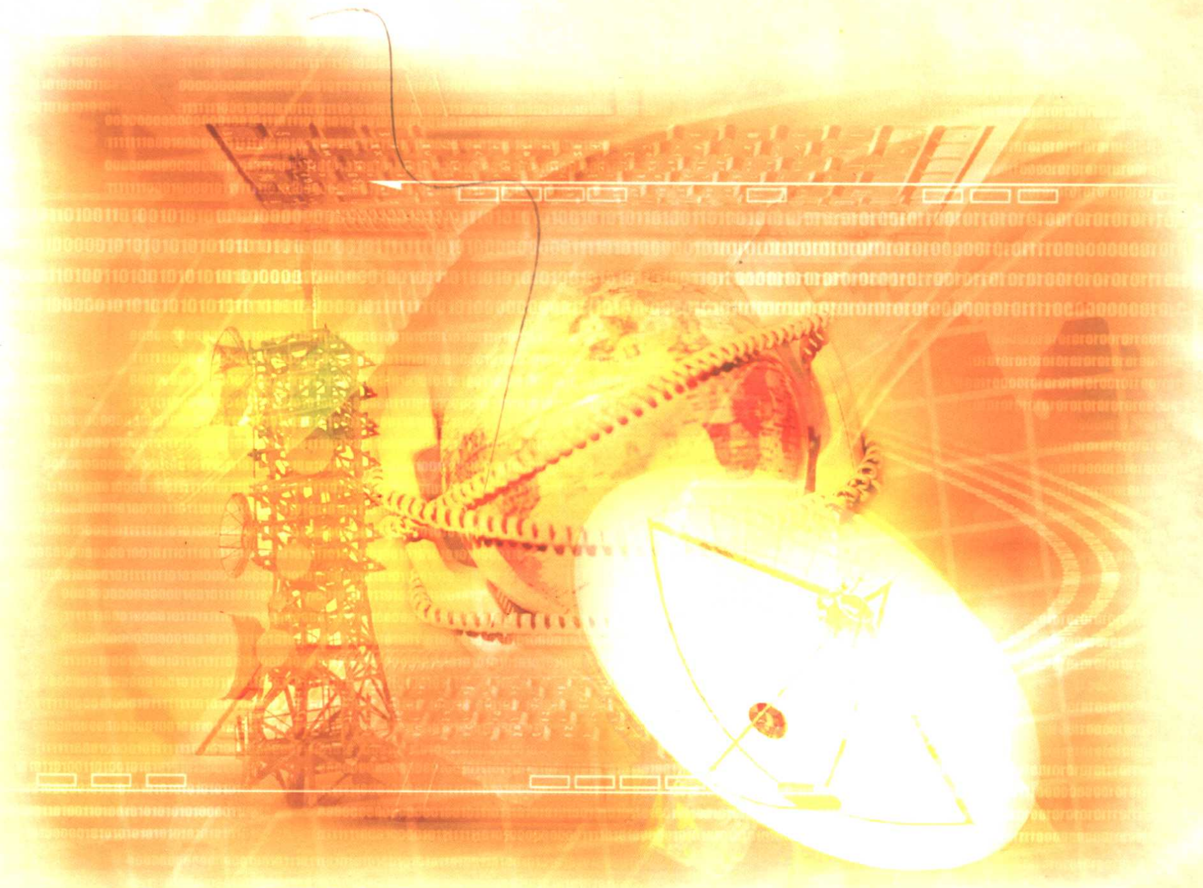


电子信息工程专业英语

Special English for Electronic Information Engineering

主　编　曹玲芝
副主编　胡智宏



华中科技大学出版社

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内 容 简 介

本书是按照学生熟悉的知识体系结构形式编写的，使读者感到不是单纯在学习英语，而是在学习相关的专业知识，只是知识的表现形式是英语。书中主要内容包括电子元器件、传感器、信号调理、数字信号处理、嵌入式系统、通信等内容。每章内容相对独立，而每章中各节内容又互相连贯，构成一个完整的内容体系，不仅使读者掌握常用的专业英语词汇和翻译技巧，而且可以用英语的形式熟悉相关专业知识，培养和提高读者阅读和翻译专业英语资料的能力。该书内容的覆盖面宽，实用性强，既可作为电子信息类专业本科生、研究生的教材，又可供从事相关专业技术人员参考。

前　言

我国国力日益增强，在国际上的交流日益广泛；为提高电子信息类专业的本科生、研究生及工程技术人员的专业英语水平，使他们能熟练地阅读和翻译有关英文文献、资料和书籍，提高英语写作能力，扩展、深化对本学科关键技术的认识，及时了解电子信息产业的最新动态，增强与国外专家、学者的交流能力，特编写了《电子信息工程专业英语》这本书。

全书由7个部分组成，涵盖电子信息领域常用的技术，涉及电子元器件、传感器、信号调理、数字信号处理、嵌入式系统、通信等内容。每章内容相对独立，而每章中各节的内容又互相连贯，构成一个完整的内容体系，不仅使读者掌握常用的专业英语词汇、翻译技巧，而且可以以英语的形式熟悉相关专业知识，培养和提高读者阅读和翻译专业英语资料的能力。

本书由郑州轻工业学院的曹玲芝担任主编，胡智宏担任副主编。书中第一章、第二章、第三章由曹玲芝编写，第四章、第五章、第六章由胡智宏编写，第七章由廖旎焕编写。

在收集资料的过程中得到了澳大利亚卧龙岗大学的 Parviz Doulai 博士的支持；在编写过程中，研究生石军、张恒、陈华英参与了部分插图的绘制、单词注解及文字校对工作，在此，向他们表示衷心的感谢。同时，也对引用的国内外高等院校的教科书和专业技术刊物的作者表示感谢。

由于水平所限，在内容难易程度的把握上会有不尽人意的地方，编写过程中可能有纰漏和欠妥之处，请各位读者不吝赐教，以便改正。

曹玲芝

2006年5月

Contents

1 Electric Devices

1.1 Resistors

Resistors restrict the flow of electric current[1], for example, a resistor is placed in series with a light-emitting diode (LED) to limit the current passing through the LED.

1.1.1 Resistor Values

The Resistor Colour Code Resistance is measured in ohms, the symbol for ohm is an omega Ω. 1 Ω is quite small so resistor values are often given in kΩ and MΩ. 1 kΩ=1 000 Ω; 1 MΩ=1 000 000 Ω.

Resistor values are normally shown using coloured bands.[2] Each colour represents a number as shown in the Table 1.1.

Table 1.1 The Resistor Colour Code

Colour	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Number	0	1	2	3	4	5	6	7	8	9

Most resistors have 4 bands:

- The **first band** gives the **first digit**.
- The **second band** gives the **second digit**.
- The **third band** indicates the **number of zeros**.
- The fourth band is used to show the tolerance (precision) of the resistor, this may be ignored for almost all circuits but further details are given below.

The resistor in Figure 1.1 has red (2), violet (7), yellow (4 zeros) and gold bands.[3] So its value is 270 000 Ω=270 kΩ. On circuit diagrams the Ω is usually omitted and the value is written 270k.

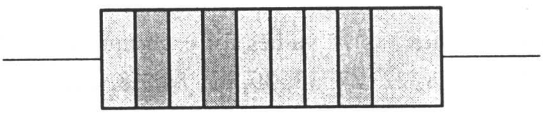

Figure 1.1 Resistor with colour code

The standard colour code cannot show values of less than 10 Ω. To show these small values two special colours are used for the third band: gold which means × 0.1 and silver which means ×0.01. The first and second bands represent the digits as normal.

For example:

Red, violet, gold bands represent 27×0.1=2.7 Ω.

Blue, green, silver bands represent 56×0.01=0.56 Ω.

Tolerance of Resistors (fourth band of colour code) The tolerance of a resistor is shown by the fourth band of the colour code. Tolerance is the precision of the resistor and it is given as a percentage. For example a 390 Ω resistor with a tolerance of ±10% will have a value within 10% of 390 Ω, between 390 − 39=351 Ω and 390+39=429 Ω (39 is 10% of 390).

A special colour code is used for the fourth band tolerance:

silver ±10%, gold ±5%, red ±2%, brown ±1%.

If no fourth band is shown the tolerance is ±20%.

Tolerance may be ignored for almost all circuits because precise resistor values are rarely required.

Resistor Shorthand Resistor values are often written on circuit diagrams using a code system which avoids using a decimal point because it is easy to miss the small dot. Instead the letters R, K and M are used in place of the decimal point. To read the code: replace the letter with a decimal point, then multiply the value by 1 000 if the letter was K, or 1 000 000 if the letter was M. The letter R means multiply by 1.[4]

For example:

560R means 560 Ω

2K7 means 2.7 kΩ=2 700 Ω

39K means 39 kΩ

1M0 means 1.0 MΩ=1 000 kΩ

1.1.2 Real Resistor Values

You may have noticed that resistors are not available with every possible value, for example, 22 kΩ and 47 kΩ are readily available, but 25 kΩ and 50 kΩ are not.

Why so? Imagine that you have decided to make resistors every 10 Ω giving 10, 20, 30, 40, 50 and so on. That seems fine, but what happens when you reach 1 000? It would be pointless to make 1 000, 1 010, 1 020, 1 030 and so on because for these values 10 is a very small difference, too small to be noticeable in most circuits. In fact it would be difficult to make resistors sufficiently accurate.

To produce a sensible range of resistor values you need to increase the size of the "step" as the value increases. The standard resistor values are based on this idea and they form a series which follows the same pattern for every multiple of ten.

The E6 Series The E6 series has 6 values for each multiple of ten[5] or resistors with 20% tolerance.For example: 10, 15, 22, 33, 47, 68, then it continues 100, 150, 220, 330, 470, 680, 1 000 etc.

Notice how the step size increases as the value increases. For this series the step (to the next value) is roughly half the value.

The E12 Series The E12 series has 12 values for each multiple of ten, for resistors with 10% tolerance.For example:10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, then it continues 100, 120, 150 etc.

The E12 series is the one most frequently used for resistors. It allows you to choose a value within 10% of the precise value you need. This is sufficiently accurate for almost all projects and it is sensible because most resistors are only accurate to ±10% (called their 'tolerance'). For example a resistor marked 390 Ω could vary by ±10%×390 Ω=±39 Ω, so it could be any value between 351 Ω and 429 Ω.

1.1.3 Power Ratings of Resistors

Electrical energy is converted to heat when current flows through a resistor. Usually the effect is negligible, but if the resistance is low (or the voltage across the resistor is high) a large current may pass making the resistor become noticeably warm. The resistor must be able to withstand the heating effect and resistors have power ratings to show this.

Power ratings of resistors are rarely quoted in parts lists because for most circuits the standard power ratings of 0.25W or 0.5W are suitable.[6] For the rare cases where a higher power is required it should be clearly specified in the parts list, these will be circuits using **low value resistors** (less than about 300 Ω) or **high voltages** (more than 15V).

Notes

1. Resistors restrict the flow of electric current.
   电阻限制电流的流动。
2. Resistor values are normally shown using coloured bands.
   电阻值常常用色码带表示。 coloured bands 的意思是色码带，也称色环。
3. The resistor in Figure 1.1 has red（2）, violet（7）, yellow（4 zeros）and gold bands.
   图 1.1 中的电阻有红色环、紫色环、黄色环和金色环。这里的 red（2）指红色代表有效数字第一位数，数值为 2；violet（7）指紫色代表有效数字第二位数，数值为 7；yellow（4 zeros）指黄色代表倍乘数 10^4。
4. To read the code: replace the letter with a decimal point, then multiply the value by 1 000 if the letter was K, or 1 000 000 if the letter was M. The letter R means multiply by 1.
   为了读取电阻值，用小数点代替字母，如果字母是 K，就用电阻上标示的值乘以 1000，如果字母是 M，就用电阻上标示的值乘以 1 000 000。如果字母是 R，就用电阻上标示的值乘以 1。
5. each multiple of ten 意思是“每个 10 的倍乘”，如 100、1000 等。
6. Power ratings of resistors are rarely quoted in parts lists because for most circuits the standard power ratings of 0.25W or 0.5W are suitable.
   因为额定功率为 0.25W 或 0.5W 的电阻适合大多数电路，所以电阻的功率额定值很少在器件列表中给出。

Key Words & Expressions

resistor [ri'zistə] *n.*电阻
restrict [ris'trikt] *v.*限制
diode ['daiəud] *n.*二极管
ohm [əum] *n.*欧姆
omega ['əumigə] *n.* 希腊字母的最后一个字 Ω
tolerance ['tɔlərəns] *n.*容限，公差，允许误差
circuit ['sə:kit] *n.*电路
shorthand ['ʃɔ:thænd] *n.*速记
decimal ['desiməl] *a.* 十进位的，小数的
multiply ['mʌltiplai] *v.*乘，增加
pointless ['pɔintlis] *a.*无意义的
range [reindʒ] *n.*幅度，范围
negligible ['neglidʒəbl] *a.* 可以忽略的，微不足道的
quote [kwəut] *n.* 引用；*v.* 引述，举证，报价
ratings ['reitiŋz] *n.* 额定值

Feedback and Review

1. Fill in the blanks using the sentences and definitions found in the texts.
   (1) Tolerance is the（　）of the resistor and it is given as a percentage.
   (2) The resistor must be able to withstand the heating effect and resistors have power（　）to show this.
   (3) 2K7 means（　）Ω.

(4) 1M0 means (　) Ω.

(5) The E6 series for resistors has (　) values for each multiple of ten.

2. True /False.

(1) A 25 kΩ resistor is not readily available.

(2) Tolerance of resistors may be ignored for all circuits .

(3) Electrical energy is converted to heat when current flows through a resistor.

(4) When you choose a resistor, you do not need to consider the power ratings of the resistor.

1.2 Capacitor

A capacitor consists of two parallel conducting plates separated by an insulating material such as air.[1] Capacitors store electric charge. The insulating material is called the dielectric of the capacitor. Addition of certain insulating material between the plates changes capacitor-characteristics.

Things about capacitors which can be changed include:

the area of overlap of the plates,

the distance between the plates, and

the material used as an insulator.

1.2.1 Capacitance

The ideal capacitor does not dissipate any of the energy supplied to it.[2] It stores the energy in the form of an "electric field" between the conducting surfaces.

CAPACITANCE is a measure of capacitor's ability to store electric charge (and hence energy) .The more stored charge per unit of voltage, the greater capacitance and the greater energy stored.

A capacitor has a capacitance of 1 farad (F) if 1 coulomb (C) of charge is deposited on the plates by a potential difference of 1 volt (V) across the plates.

The farad is generally too large for most practical applications, so prefixes are used to show the smaller values.

Three prefixes (multipliers) are used, μ (micro) , n (nano) and p (pico) :

- μ means 10^{-6} (millionth) , so 1 000 000 μF=1F,
- n means 10^{-9} (thousand-millionth) , so 1 000 nF=1μF,
- p means 10^{-12} (million-millionth) , so 1 000 pF=1nF.

Capacitor values can be very difficult to find because there are many types of capacitor with different labelling systems!

1.2.2 The Polarised Capacitors and Unpolarised Capacitors

There are many types of capacitor but they can be split into two groups, Polarised and unpolarised. Each group has its own circuit symbol.

Polarised Capacitors (large values, 1μF+)　Electrolytic capacitors are Polarised and they must be connected the correct way round[3], at least one of their leads will be marked＋or－. They are not damaged by heat when soldering.

There are two designs of electrolytic capacitors; axial where the leads are attached to each end (220μF in picture) and radial where both leads are at the same end (10μF in picture) . Radial capacitors tend to be a little smaller and they stand upright on the circuit board.

It is easy to find the value of electrolytic capacitors because they are clearly printed with their capacitance and voltage rating. The voltage rating can be quite low (6 V for example) and it should always be checked when selecting an electrolytic capacitor. If the project parts list does not specify a voltage, choose a capacitor with a rating which is greater than the project's power supply voltage.[4] 25V is a sensible minimum for most battery circuits.

Tantalum bead capacitors are polarised and have low voltage ratings like electrolytic capacitors. They are expensive but very small, so they are used where a large capacitance is needed in a small size.

Modern tantalum bead capacitors are printed with their capacitance and voltage in full. However older ones use a colour-code system which has two stripes (for the two digits) and a spot of colour for the number of zeros to give the value in μF. [5] The standard colour code is used, but for the spot, grey is used to mean ×0.01 and white means ×0.1 so that values of less than 10μF can be shown. A third colour stripe near the leads shows the voltage(yellow 6.3V, black 10V, green 16V, blue 20V, grey 25V, white 30V, pink 35V).

For example: **blue, grey, black spot** means 68μF

For example: **blue, grey, white spot** means 6.8μF

For example: **blue, grey, grey spot** means 0.68μF

Unpolarised Capacitors (small values, up to 1μF) Small value capacitors are unpolarised and may be connected either way round. They are not damaged by heat when soldering, except for one unusual type (polystyrene). They have high voltage ratings of at least 50V, usually 250V or so. It can be difficult to find the values of these small capacitors because there are many types of them and several different labelling systems!

Many small value capacitors have their value printed but without a multiplier, so you need to use experience to work out what the multiplier should be!

For example: 0.1 means 0.1μF=100nF.

Sometimes the multiplier is used in place of the decimal point.

For example: 4n7 means 4.7nF.

1.2.3 Capacitor Number Code and Colour Code

A number code is often used on small capacitors where printing is difficult:

- the 1st number is the 1st digit
- the 2nd number is the 2nd digit
- the 3rd number is the number of zeros to give the capacitance in pF
- ignore any letters - they just indicate tolerance and voltage rating

For example: 102 means 1 000pF=1nF (not 102pF!).

For example: 472J means 4 700pF=4.7nF (J means 5% tolerance).

A colour code has been used on polyester capacitors for many years. Each colour represents a number as shown in the Table 1.2. The colour code is now obsolete, but of course there are many still around. The colours should be read like the resistor code, the top three colour bands giving the value in pF. Ignore the 4th band (tolerance) and 5th band (voltage rating).

Table1.2 Capacitor Colour Code

Colour	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Number	0	1	2	3	4	5	6	7	8	9

For example: **brown, black, orange** means 10 000pF=10nF=0.01μF.

Note that there are no gaps between the colour bands, so 2 identical bands actually appear as a wide band.

For example: **wide red, yellow** means 220 nF=0.22μF.

1.2.4 Capacitor Values

You may have noticed that capacitors are not available with every possible value, for example 22μF and 47μF are readily available, but 25μF and 50μF are not!

Why so? Imagine that you have decided to make capacitors every 10μF giving 10, 20, 30, 40, 50 and so on. That seems fine, but what happens when you reach 1 000? It would be pointless to make 1 000, 1 010, 1 020, 1 030 and so on because for these values 10 is a very small difference, too small to be noticeable in most circuits and capacitors cannot be made with that accuracy.

To produce a sensible range of capacitor values you need to increase the size of the "step" as the value increases. The standard capacitor values are based on this idea and they form a series which follows the same pattern for every multiple of ten.

The E3 Series The E3 series has 3 values for each multiple of ten. For example:10, 22, 47, then it continues 100, 220, 470, 1 000, 2 200, 4 700, 10 000 etc.

Notice how the step size increases as the value increases (values roughly double each time) .

The E6 Series The E6 series has 6 values for each multiple of ten. For example:10, 15, 22, 33, 47, 68, then it continues 100, 150, 220, 330, 470, 680, 1 000 etc.

The E3 series is the one most frequently used for capacitors because many types cannot be made with very accurate values.

1.2.5 The Main Characters of Capacitor

Voltage Rating Every capacitor has a limit on the amount of voltage that it can withstand across its plates: The "VOLTAGE RATING" specifies the maximum dc voltage that can be safely applied. This is also called the BREAKDOWN VOLTAGE. Breakdown permanently damages the capacitor.

The capacitor behaves as a conductor when breakdown occurs. Lightning is a typical example of breakdown.

The breakdown voltage of a capacitor is determined by the "dielectric strength" of the material used.

Leakage Current No insulating material is perfect. Ideally, the flow of electrons will occur in a dielectric only when the breakdown voltage is reached. Practically, there are free electrons in every dielectric due in part to impurities in the dielectric.[6] The dielectric of any capacitor will conduct some very small amount of current. Thus, the charge on a practical capacitor will eventually leak off.

This effect is represented(MODELED)by a resistor in parallel with the capacitor. Typical values for this resistance is around 100 megohms. This in fact is the resistance of dielectric material through which leakage current flows. [7]

Some capacitors, however, have an extremely high resistance, as high as 1 000 MΩ.Some types of capacitors, such as the "electrolytic type", have higher leakages than the others. Electrolytic capacitors lose their charge in a matter of seconds because of the flow of charge from one plate to the other.

Temperature Coefficient The temperature coefficient indicates the amount and direction of a change in capacitance value with temperature. A positive (negative) temperature coefficient means that the capacitance increases (decreases) with an increase (decrease) in temperature.

Temperature coefficient is typically specified in "part per million (ppm)" per degree Celsius (ppm/C).

A negative temperature coefficient of 150 ppm/C for a 1F capacitor means that for every Celsius degree rise in temperature the capacitance decreases by 150 pF.

The temperature coefficient constitutes part of the capacitor labeling. For example;

N150: Negative temperature coefficient of 150.

P330: Positive temperature coefficient of 330.

NOTE: Other data such as capacitance and working voltage are also printed on the outer wrapping if the capacitor is large enough.

1.2.6 First Order Systems & Transients

This section explores the solution of circuits that contain a single energy storage element (capacitor) and a combination of voltage/current sources and resistors (and possibly switches). An electric circuit with only one energy storage element is referred to as a "first order system". The response of a circuit to sudden application of a voltage or current is called "transient response".[8]

The most common instance of a transient response in a circuit occurs when a switch is turned "ON" or "OFF". This is a common event in electrical circuits. Although there are many possible types of transients that can be introduced in a circuit, in this note we shall focus exclusively on the transient response of circuits in which a switch activates or deactivates a dc source. Also, the analysis in this section is restricted to "first-order systems". This is a circuit that contains resistors but only one energy storage element. To analyse transient response of first order systems, the following quantities are to be determined: initial condition, steady state solution and time constant.

Time Constant in *RC* Circuits Before detailed analysis of capacitor charging and discharging processes in first-order systems, it will be useful to consider the time constant in circuits containing capacitors. In the circuit shown in Figure 1.2 there are two switches and one switch is "ON" at a time.

Charging Process: SW1 "ON" and SW2 "OFF"

Discharging Process: SW2 "ON" and SW1 "OFF"

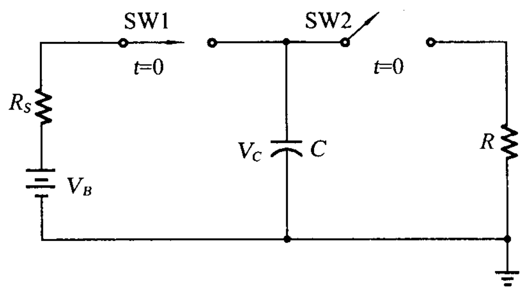

Figure1.2 First order system

The capacitor in this circuit has been connected to a battery (SW1 "ON") for a long time so that it is fully charged. The capacitor voltage is therefore equal to the battery voltage (V_C=V_B).

Suppose at t=0 the capacitor is disconnected from the battery and connected to a resistor. The capacitor voltage would decay exponentially. Note that the existence of a closed circuit path drains the capacitor of its stored charge[9] (being dissipated in the resistor).

Physically, the exponential decay shown in Figure 1.3 signifies that the energy stored in the capacitor at t=0 is dissipated by the resistor at a rate determined by the product of the circuit equivalent resistance (viewed from the capacitor) and the capacitance ($R \times C$).[10] This product is called the capacitor circuit time constant.

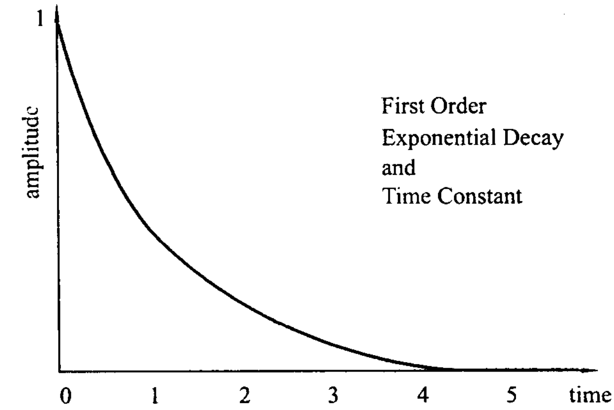

Figure 1.3 First order exponential decay

Time constant for a series R-C circuit:

$$\tau = RC$$

where τ is in seconds when "C" is in farads and "R" is in ohms.

The time constant is a relative measure of the rate at which the voltages and currents are changing in a transient phase. The time constant for a single capacitor circuit is $R_{TH}C$ where R_{TH} is the Thevenin equivalent resistance as seen by the capacitor. Note that to calculate R_{TH} all sources should be turned off first.

The transient in R-C circuits is essentially zero after 5 time constants (5τ). This means that the transient analysis in first-order circuits involves circuit solution from the instant transient starts to the time equal to about five time constants.

After 5 time constants the capacitor current and voltage become equal to **"dc steady state"** conditions in which the capacitor is modeled as an **"open-circuit"**.

Charging a Capacitor A capacitor charges when it is connected to a dc source. See Figure 1.4, when the switch is closed, electrons are drawn from one plate and deposited on the other; resulting in net positive and negative charges on plates. The transfer of electrons is very rapid at first. It slows down as the V_C approaches E. It ceases when V_C=E, where the net charge of $Q = CV_C$ stays on plates.

When a capacitor is connected to a dc supply of voltage E via R, it will be charged up to the supply voltage.

Voltage equation is

$$V_C = E(1 - \mathrm{e}^{-t/RC})$$

Current equation is

$$i_C = \frac{E}{R}\mathrm{e}^{-t/RC}$$

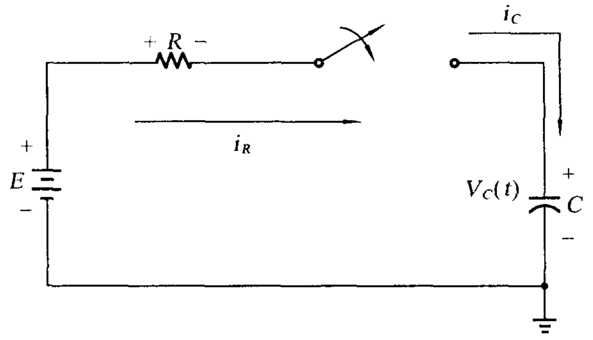

Figure 1.4 Charging a capacitor

• Since $e^{-t/\tau}$ is a decaying exponential function, the factor $(1 - e^{-t/\tau})$ will grow towards its maximum value of 1 with time.

• Since E is the multiplying factor, the capacitor voltage essentially becomes equal to E volts after five time constants of the charging phase.

Keeping R constant and reducing C will result in smaller RC, and faster charging time. RC will always have some numerical value, even though it may be small.

Capacitor voltage cannot change instantaneously. Note that at t=0+ the voltage across the capacitor is still zero due to the capacitor voltage continuity principle. At that instant, the capacitor can be treated as a voltage source of strength zero (ie. a short circuit) . However, the current through the capacitor can change instantaneously (or relatively so) from zero to a new value. Here the voltage source E drive s the current through R.

$$V_C(0^+) = V_C(0^-) = 0$$

Capacitor Discharge In Figure 1.5, when the switch is placed in position "1", the capacitor will charge toward the supply voltage E through R. At any point in the charging process, if the switch is moved to "2", the capacitor will begin to discharge. Discharge circuit includes C and R, therefore $\tau = RC$. As explained before, the time constant for a series R-C circuit is equal to $\tau=RC$ where τ is in seconds when "C" is in farads and "R" is in ohms.

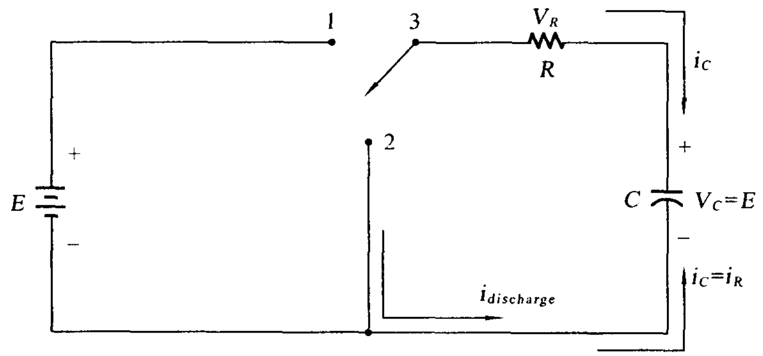

Figure 1.5 Capacitor discharge

If the capacitor has a voltage of E across its plates, the equation for decaying V_C is

$$V_C = Ee^{-t/RC}$$

V_C has the same shape as i_C during the charging phase. During the discharge phase, i_C will also decrease. The equation for decaying i_C is

$$i_C = \frac{E}{R} e^{-t/RC}$$

For practical purposes, the complete discharge occurs in 5τ. Also note that where more sources and/or more resistors are involved, E_{Th} and R_{Th}, external to the capacitor, should be used in capacitor charging/discharging equations.[11]

Notes

1. A capacitor consists of two parallel conducting plates separated by an insulating material such as air.
   电容器由被诸如空气这样的绝缘材料隔离的两个并行的导体组成。
2. The ideal capacitor does not dissipate any of the energy supplied to it.
   理想的电容器不消耗任何供给它的能量。
   supplied to it 是省略了 that is 的定语从句,修饰 energy。
3. Electrolytic capacitors are Polarised and they must be connected the correct way round,...
   电解电容是有极性的,它们必须以正确的方式连接，……
4. If the project parts list does not specify a voltage, choose a capacitor with a rating which is greater than the project's power supply voltage.
   工程列表中没有说明电容额定电压大小，选择电容时，要选择额定电压大于供电电压的电容。
5. However older ones use a colour-code system which has two stripes (for the two digits) and a spot of colour for the number of zeros to give the value in μF.
   然而，过去的钽电容是利用色码系统表示电容值大小的，这种色码系统由两个色带（代表两个数字）和表示零的数量的点组成，电容的单位是μF。
   ones 表示前句中的 tantalum bead capacitors。
6. Practically, there are free electrons in every dielectric due in part to impurities in the dielectric.
   实际上，由于电介质中存在杂质，使得每种电介质中都有自由电子存在。
7. This in fact is the resistance of dielectric material through which leakage current flows.
   电介质材料中有漏电流流过。Which 指句子中的 dielectric material。
8. The response of a circuit to sudden application of a voltage or current is called "transient response"。
   突然施加电压或电流的电路响应称为"暂态响应"。
9. Note that the existence of a closed circuit path drains the capacitor of its stored charge.
   闭合电路消耗了电容中存储的能量。
10. Physically, the exponential decay shown in Figure 1.3 signifies that the energy stored in the capacitor at t=0 is dissipated by the resistor at a rate determined by the product of the circuit equivalent resistance (viewed from the capacitor) and the capacitance ($R \times C$).
    实际上，图 1.3 中的衰减指数表示从 t=0 时刻开始，电容存储的能量以一定的速率被电阻消耗，能量消耗的速率由电路的等效电阻和电容值决定。
    句子中 determined by the product of the circuit equivalent resistance (viewed from the capacitor) and the capacitance ($R \times C$) 修饰 rate。
11. Also note that where more sources and/or more resistors are involved, E_{Th} and R_{Th}, external to the capacitor, should be used in capacitor charging/discharging equations.
    同时注意有的电路包含多个电源和电阻，此时在电容充电和放电等式中应使用 E_{Th} 和 R_{Th}。
    句中 E_{Th} 和 R_{Th} 分别表示戴维南等效电压和等效电阻。