普通高等教育"十一五"国家级规划教材

Specified English for Automation

自动化专业英语教程

第3版

◎ 王宏文 主编

机械工业出版社
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本书是普通高等教育“十一五”国家级规划教材，是针对高等工科院校自动化专业“科技英语阅读”课程的需要、在第2版的基础上修订而成，内容包括电气与电子工程基础、控制理论、计算机控制技术、过程控制系统、网络化与信息化控制及自动化技术的综合应用6部分，新增了智能控制综述、DSP、嵌入式系统、电力系统自动化、智能电网、大数据应用、知识自动化、云计算、智慧城市和智慧企业技术等诸多内容，涵盖了自动化专业各个发展方向，内容新颖、全面、系统、精炼。每篇文章后都附有词汇表和注解，并配有30篇英语翻译及应用文知识，专业、学科介绍，自动化学科相关的期刊、会议、科技前沿等诸多内容，使读者在学习并掌握专业词汇和翻译技能的同时开阔眼界。本书可作为自动化专业本科生及研究生专业英语课程的教材，也可供有关工程技术人员参考。

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序

随着我国经济发展逐渐被纳入全球经济发展轨道，特别是在我国加入 WTO 以后，我国与世界的政治、经济、文化交往越来越频繁，各行各业与国际接轨的步伐逐步加快，我国迫切需要既掌握专业知识又掌握专业外语的高素质、复合型人才。培养这种人才是现阶段中国高等教育发展的重要目标之一。教育部于2001 年 9 月颁布了 4 号文件《关于加强高等学校本科教学工作提高教学质量的若干意见》，要求全国各高等院校积极推广使用英语等外语进行专业课教学，实现我国高等教育的可持续发展。

在我国加入 WTO 的新形势下，教育现代化、国际化已成为高校办学水平的重要体现。双语教学在我国悄然兴起，并逐渐成为教育国际化的重要标志。英语教学作为一种全新的教学方式，承接了中西文化的碰撞与融合，涉及教学理念的更新、教学内容的重审、授课形式的改革、教学手段的改进、教材的创新。亟待探索的高校英语教学新模式，在实现英语教学提高学生英语语言素养和能力的同时，发挥各学科的学科育人功能，激发学生各方面的潜能，促进学生全方面的发展，培养国际型、复合型人才。

语言的本质是工具，但随着人类的进步、时代的发展、社会的前进，语言已从一种工具变为一种思想、一种知识库。从学习者的认知角度来看，语言是人类思维的工具、认识世界的工具，掌握一种语言也即掌握了一种观察和认识世界的方法和习惯，而学习另外一种语言就意味着学习另外一种观察和认识世界的方法和习惯。这不仅会增加学生浸入在外语中的机会，提高学生的第二语言能力，而且能从不同的侧面和角度，让学生接触世界最先进的文化成果，开发各方面的能力，从而促进他们的全面发展。

《自动化专业英语教程》一书是作者根据多年“专业英语”课程的教学实践，参照国家教育部制定的有关专业英语教学要求编写的。在选材上重视先进性，书中内容大部分选自欧美国家相关专业的教学参考书；在编排上力求系统性，较好地贯穿了自动化专业的全部专业课程。选编了许多新知识，使这门课程不仅是对专业课程的总结，而且是一种有益的补充。本书的另一特色是增加了专业英语知识，以加强对学生专业英语技能的培养，并选编和介绍了科技写作、广告、说明书、信函、合同与协议等内容，使得本书内容更加丰富。这有助于培养学生的综合能力，提高全面素质。该书出版后受到了广大师生的欢迎，被 100 余所高等院校所选用。这次修订除了保留原有的特色之外，又增加了许多最新学科知识，如智能控制、DSP、嵌入式系统、电力系统自动化、智能电网、大数据应用、知识自动化、云计算等诸多内容，使本书内容更加丰富。本书既是一本专业教材，又是一本专业参考书。

目前，许多高校自动化专业相继开设了“专业英语”课程，该教材是一本适应我国高校自动化专业教学的专业英语教材。再一次由衷地感谢本书的作者，对他们的努力和

杰出工作表示钦佩。同时感谢使用这本教材的学校和读者，你们的支持是这本教材再版的动力。专业英语教学作为一种手段，不仅着眼于它能够有效地提高学生的英语语言的工具作用，更为重要的是在实践中培养出全面发展的复合型、国际型人才，为全球化中开放的祖国建设服务。希望这次再版能够对此起到积极作用。

孙鹤旭

前　言

本书自2007年第2版问世以来，得到了许多学校师生的喜爱。经过8年多的教学实践，在广泛采纳兄弟院校师生建议的基础上，并遵循教育部“自动化专业教学指导委员会”的教改精神，在第2版的基础上对本书进行了修订，增加了目前国内外自动化技术研究的热点问题等内容。

编写本书的指导思想是：“内容新颖、全面、系统、精炼，既重视学科基础知识又反映学科发展前沿动态”。同时新增了专业介绍、学科相关科技文献网站、自动化专业的科技前沿、学术会议等辅助内容。“见多才能识广”，希望本书对培养有开拓精神、综合素质强的科技创新型人才有所帮助。

全书包括电气与电子工程基础、控制理论、计算机控制技术、过程控制系统、网络化与信息化控制、自动化技术的综合应用6部分共30个单元。新增了智能控制综述、DSP、嵌入式系统、电力系统自动化、智能电网、大数据应用、知识自动化、云计算、智慧城市和智慧企业技术等诸多内容，覆盖9万余字的专业词汇量。

本书由河北工业大学王宏文教授担任主编，河北工业大学李练兵教授、刘作军教授担任副主编。书中Part 1的Unit 1由天津工业大学綦建副教授编写；Part 1的Unit 2、Unit 3和Part 2的Unit 6由天津工业大学王萍教授编写；Part 2的Unit 1－5由河北工业大学李练兵教授编写；Part 3的Unit 1A、Unit 2A由李练兵教授和河北科技大学陈志军副教授编写；Part 3的Unit 1B、Unit 2B、Unit 4A由陈志军副教授和河北科技大学薛忠辉副教授编写；Part 1的Unit 5B、Unit 6B由河北理工大学孙进生教授编写；Part 1的Unit 4、Unit 5A、Unit 6A由河北工业大学江春冬讲师编写；Part 2的Unit 7由河北工业大学孙昊博士编写；Part 3的Unit 3、Unit 5由河北工业大学岳大为博士编写；此次修订，岳大为博士对附录C中的19处内容做了更新和修改；Part 3的Unit 4B由河北工业大学孙曙光副教授编写；Part 4由河北工业大学耿昕硕士编写；Part 5的Unit 1、Unit 2由河北工业大学梁涛教授编写；Part 5的Unit 3、Unit 4由河北工业大学雷兆明博士编写；Part 6的Unit 1、Unit 2、Unit 3由河北工业大学王宏文教授编写；Part 4的Unit 4C由河北工业大学林燕研究馆员、刘作军教授编写；Part 5的Unit 1C、Unit 2C由林燕研究馆员编写；Part 4的Unit 1C、Unit 3C由河北工业大学暴永辉硕士编写；其余章节的C部分均由刘作军副教授编写。王宏文教授对全书进行总编和修改更正，河北工业大学杨鹏教授、沈阳大学李彦平教授担任主审。

在此对参加本书第1版编写工作的天津理工大学陈在平教授，以及为本书第1版的出版提供大力帮助的孙鹤旭教授、杨鹏教授表示由衷的感谢！河北工业大学2013级硕士研究生吴红星、曹泽华、侯美杰、孟立新，2014级硕士研究生郭章亮、雷盼云、宁乐

参加了本书部分章节的计算机绘图与文字校对工作，在此一并表示感谢。

本书有完备的参考译文供任课教师使用，欢迎大家对本书提出宝贵意见。通信地址：天津河北工业大学东院358信箱（300130），联系人：王宏文、李练兵、刘作军。E-mail：wanghongwen@ hebut. edu. cn

编　者

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PART 1

Electrical and Electronic Engineering Basics

UNIT 1

A Electrical Networks

An *electrical circuit or network* is composed of elements such as resistors, inductors, and capacitors connected together in some manner. If the network contains no energy sources, such as batteries or electrical generators, it is known as a *passive network*. On the other hand, if one or more energy sources are present, the resultant combination is an *active network*. In studying the behavior of an electrical network, we are interested in determining the voltages and currents that exist within the circuit. Since a network is composed of passive circuit elements, we must first define the electrical characteristics of these elements.

In the case of a resistor, the voltage-current relationship is given by Ohm's law, which states that the voltage across the resistor is equal to the current through the resistor multiplied by the value of the resistance.[1] Mathematically, this is expressed as

$$u = iR \tag{1-1A-1}$$

where u = voltage, V; i = current, A; R = resistance, Ω.

The voltage across a pure inductor is defined by Faraday's law, which states that the voltage across the inductor is proportional to the rate of change with time of the current through the inductor. Thus we have

$$u = L\frac{\mathrm{d}i}{\mathrm{d}t} \tag{1-1A-2}$$

where $\mathrm{d}i/\mathrm{d}t$ = rate of change of current, A/s; L = inductance, H.

The voltage developed across a capacitor is proportional to the electric charge q accumulating on the plates of the capacitor. Since the accumulation of charge may be expressed as the summation, or integral, of the charge increments $\mathrm{d}q$, we have the equation

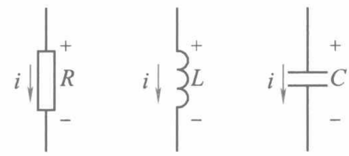
$$u = \frac{1}{C}\int \mathrm{d}q \tag{1-1A-3}$$

where the capacitance C is the proportionality constant relating voltage and charge. By definition, current equals the rate of change of charge with time and is expressed as $i = \mathrm{d}q/\mathrm{d}t$. Thus an increment of charge $\mathrm{d}q$ is equal to the current multiplied by the corresponding time increment, or $\mathrm{d}q = i\ \mathrm{d}t$. Eq. (1-1A-3) may then be written as

$$u = \frac{1}{C}\int i\mathrm{d}t \qquad (1\text{-}1\text{A}\text{-}4)$$

where C = capacitance, F.

A summary of Eqs. (1-1A-1), (1-1A-2) and (1-1A-4) for the three forms of passive circuit elements is given in Fig. 1-1A-1. Note that conventional current flow is used; hence the current in each element is shown in the direction of decreasing voltage.



$u_R = iR$ $\quad u_L = L\mathrm{d}i/\mathrm{d}t$ $\quad u_C = (1/C)\int i\mathrm{d}t$

$i = u_R/R$ $\quad i = (1/L)\int u_L\mathrm{d}t$ $\quad i = C\mathrm{d}u/\mathrm{d}t$

a) b) c)

Fig. 1-1A-1 Passive circuit elements
a) Resistor b) Inductor c) Capacitor

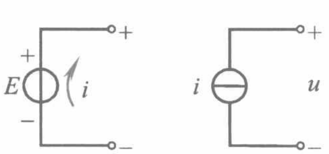
Active electrical devices involve the conversion of energy to electrical form. For example, the electrical energy in a battery is derived from its stored chemical energy. The electrical energy of a generator is a result of the mechanical energy of the rotating armature.

Active electrical elements occur in two basic forms: *voltage sources* and *current sources*. In their ideal form, voltage sources generate a constant voltage independent of the current drawn from the source. The aforementioned battery and generator are regarded as voltage sources since their voltage is essentially constant with load. On the other hand, current sources produce a current whose magnitude is independent of the load connected to the source. Although current sources are not as familiar in practice, the concept does find wide use in representing an amplifying device, such as the transistor, by means of an equivalent electrical circuit. Symbolic representations of voltage source and current source are shown in Fig. 1-1A-2.

A common method of analyzing an electrical network is mesh or loop analysis. The fundamental law that is applied in this method is Kirchhoff's first law, which states that the algebraic sum of the voltages around a closed loop is 0, or, in any closed loop, the sum of the voltage rises must equal the sum of the voltage drops. Mesh analysis consists of assuming that currents—termed loop currents—flow in each loop of a network, algebraically summing the voltage drops around each loop, and setting each sum equal to 0.

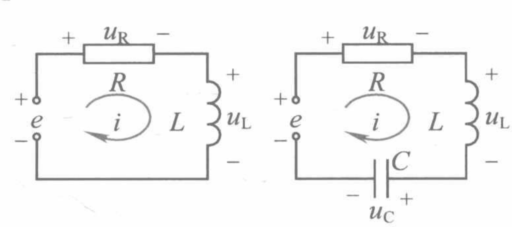
Consider the circuit shown in Fig. 1-1A-3a, which consists of an inductor and resistor connected in series to a voltage source e. Assuming a loop current i, the voltage drops summed around the loop are

$$-e + u_R + u_L = 0 \qquad (1\text{-}1\text{A}\text{-}5)$$



a) b)

Fig. 1-1A-2 Voltage source and current source
a) Voltage source b) Current source



a) b)

Fig. 1-1A-3 Series circuits containing R, L and C

The input voltage is summed negatively since, in the direction of assumed current, it represents an increase in voltage. The drop across each passive element is positive since the current is in the direction of the developed voltage.

Using the equations for the voltage drops in a resistor and inductor, we have

$$L\frac{\mathrm{d}i}{\mathrm{d}t} + Ri = e \tag{1-1A-6}$$

Eq. (1-1A-6) is the differential equation for the current in the circuit.

It may be that the inductor voltage rather than the current is the variable of interest in the circuit.[2] As noted in Fig. 1-1A-1, $i = \frac{1}{L}\int u_L \mathrm{d}t$. Substituting this integral for i in Eq. (1-1A-6) gives

$$u_L + \frac{R}{L}\int u_L \mathrm{d}t = e \tag{1-1A-7}$$

After differentiation with respect to time, Eq. (1-1A-7) becomes

$$\frac{\mathrm{d}u_L}{\mathrm{d}t} + \frac{R}{L}u_L = \frac{\mathrm{d}e}{\mathrm{d}t} \tag{1-1A-8}$$

which is the differential equation for the inductor voltage.

Fig. 1-1A-3b shows a series circuit containing a resistor, inductor, and capacitor. Following the mesh-analysis method outlined above, the circuit equation is

$$L\frac{\mathrm{d}i}{\mathrm{d}t} + Ri + \frac{1}{C}\int i\mathrm{d}t = e \tag{1-1A-9}$$

Recalling that current $i = \mathrm{d}q/\mathrm{d}t$, a substitution of this variable may be made to eliminate the integral from the equation. The result is the second-order differential equation

$$L\frac{\mathrm{d}^2 q}{\mathrm{d}t^2} + R\frac{\mathrm{d}q}{\mathrm{d}t} + \frac{q}{C} = e$$

WORDS AND TERMS

network *n.* 网络，电路
resistor *n.* 电阻器
inductor *n.* 电感器
capacitor *n.* 电容器
passive network 无源网络
active network 有源网络
characteristic *adj.* 特性（的）；*n.* 特性曲线
Ohm *n.* 欧姆
Faraday *n.* 法拉第
electric charge 电荷
integral *n.* 积分
increment *n.* 增量
armature *n.* 电枢，衔铁，加固
aforementioned *adj.* 上述的，前面提到的
represent *v.* 代表，表示，阐明
amplify *v.* 放大
symbolic *adj.* 符号的，记号的
mesh *n.* 网孔
Kirchhoff's first law 基尔霍夫第一定律
loop current 回路电流
voltage drop 电压降
in series 串联
differential *adj.* 微分的；*n.* 微分
variable *n.* 变量
outline *n.* 轮廓；*v.* 提出……的要点
eliminate *v.* 消除，对消

NOTES

[1] In the case of a resistor, the voltage-current relationship is given by Ohm's law, which states that the voltage across the resistor is equal to the current through the resistor multiplied by the value of the resistance.

就电阻来说，电压－电流的关系由欧姆定律决定。欧姆定律指出：电阻两端的电压等于电阻上流过的电流乘以电阻值。

in the case of：就……来说，就……而论

in case (of)：假如；万一；在……的情况下

in that case：那么，既然是那样

in this case：既然是这样

in any case：无论如何，总之

in all case：就一切情况而论

[2] It may be that the inductor voltage rather than the current is the variable of interest in the circuit.

或许在电路中，人们感兴趣的变量是电感电压而不是电感电流。

M rather than N：是 M 而不是 N

of interest：有价值的；使人感兴趣的；有意义的

B Three-Phase Circuits

A three-phase circuit is merely a combination of three single-phase circuits. Because of this fact, current, voltage, and power relations of balanced three-phase circuits may be studied by the application of single-phae rules to the component parts of the three-phase circuit. Viewed in this light, it will be found that the analysis of three-phase circuits is little more difficult than that of single-phase circuits. [1]

Reasons for Use of Three-Phase Circuits

In a single-phase circuit, the power is of a pulsating nature. At unity power factor, the power in a single-phase circuit is zero twice each cycle. [2] When the power factor is less than unity, the power is negative during parts of each cycle. Although the power supplied to each of the three phases of a three-phase circuit is pulsating, it may be proved that the total three-phase power supplied a balanced three-phase circuit is constant. Because of this, the characteristics of three-phase apparatus, in general, are superior to those of similar single-phase apparatus.

Three-phase machinery and control equipment are smaller, lighter in weight, and more efficient than single-phase equipment of the same rated capacity. In addition to the above-mentioned advantages offered by a three-phase system, the distribution of three-phase power requires only three fourths as much line copper as does the single-phase distribution of the same amount of power.

Generation of Three-Phase Voltages

A three-phase electric circuit is energized by three alternating emfs of the same frequency and differing in time phase by 120 electrical degrees. Three such sine-wave emfs are shown in Fig. 1-1B-1. These emfs are generated in three separate sets of armature coils in an AC generator. These three sets of coils are mounted 120 electrical degrees apart on the generator armature. The coil ends may all be brought out of the generator to form three separate single-phase circuits. However, the coils are ordinarily interconnected either internally or externally to form a three-wire or four-wire three-phase system.

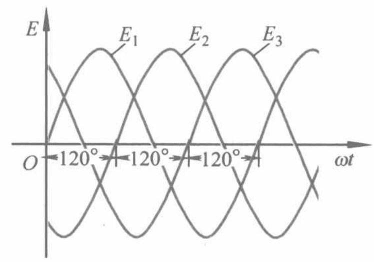


Fig. 1-1B-1 Three sine-wave emfs differing in phase by 120 electrical degrees are used for energizing a three-phase circuit

There are two ways of connecting the coils of three-phase generators, and in general, there are two ways of connecting devices of any sort to a three-phase circuit. These are the *wye-connection* and the *delta-connection*. Most generators are wye-connected, but loads may be either wye-connected or delta-Connected.

Voltage Relations in a Wye-Connected Generator

Fig. 1-1B-2a represents the three coils or phase windings of a generator. These windings are so spaced on the armature surface that the emfs generated in them are 120° apart in time phase. Each coil ends lettered S and F (start and finish). In Fig. 1-1B-2a, all the coil ends marked S are connected to a common point N, called the neutral, and the three coil ends marked F are brought out to the line terminals A, B, and C to form a three-wire three-phase supply. This type of connection is called the wye-connection. Often the neutral connection is brought out to the terminal board, as shown by the dotted line in Fig. 1-1B-2a, to form a four-wire three-phase system.

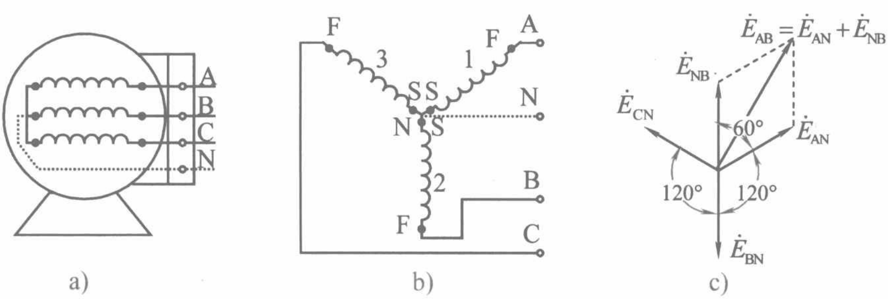


Fig. 1-1B-2 a) Connection of the phase windings in a wye-connection generator
b) Conventional diagram of a wye-connection
c) Phasor diagram showing the relation between phase and line voltages

The voltages generated in each phase of an AC generator are called the *phase voltages* (symbol E_p). If the neutral connection is brought out of the generator, the voltage from any one of the line terminals A, B, or C to the neutral connection N is a phase voltage. The voltage between any two of the three line terminals A, B, or C is called line-to-line voltage or, simply, a *line voltage* (symbol E_L).

The order in which the three voltages of a three-phase system succeed one another is called the phase sequence or the phase rotation of the voltages. This is determined by the direction of rotation of the generator but maybe reversed outside the generator by interchanging any two of the three line wires (not a line wire and a neutral wire).

It is helpful when drawing circuit diagrams of wye connection to arrange the three phases in the shape of a Y as shown in Fig. 1-1B-2b. Note that the circuit of Fig. 1-1B-2b is exactly the same as that of Fig. 1-1B-2a, with the S end of each coil connected to the neutral point and the F end brought out to the terminal in each case. After a circuit diagram has been drawn with all intersections lettered, a phasor diagram may be drawn as in Fig. 1-1B-2c. The phasor diagram shows the three phase voltages $\dot{E}_{AN}$, $\dot{E}_{BN}$, and $\dot{E}_{CN}$ which are 120° apart.

It should be noted in Fig. 1-1B-2 that each phasor is lettered with two subscripts. The two letters indicate the two points between which the voltage exists, and the order of the letters indicates the relative polarity of the voltage during its positive half-cycle. For example, the symbol $\dot{E}_{AN}$ indicates a voltage between the points A and N with the point A being positive with respect to point N during its positive half-cycle. In the phasor diagram shown, it has been assumed that the generator terminals were positive with respect to the neutral during the positive half-cycle. Since the voltage reverses every half-cycle, either polarity may be assumed if this polarity is assumed consistently for all three phases. It should be noted that if the polarity of point A with respect to N ($\dot{E}_{AN}$) is assumed for the positive half-cycle, then $\dot{E}_{NA}$ when used in the same phasor diagram should be drawn opposite to, or 180° out of phase with, $\dot{E}_{AN}$.[3]

The voltage between any two line terminals of wye-connected generator is the difference between the potentials of these two terminals with respect to the neutral. For example, the line voltage $\dot{E}_{AB}$ is equal to the voltage A with respect to neutral ($\dot{E}_{AN}$) minus the voltage B with respect to neutral ($\dot{E}_{BN}$). To subtract $\dot{E}_{BN}$ from $\dot{E}_{AN}$, it is necessary to reverse $\dot{E}_{BN}$ and add this phase to $\dot{E}_{AN}$. The two phasors $\dot{E}_{AN}$ and $\dot{E}_{NB}$ are equal in length and are 60°apart, as shown in Fig. 1-1B-2c. It may be shown graphically or proved by geometry that $\dot{E}_{AB}$ is equal to 1.73, multiplied by the value of either $\dot{E}_{AN}$ or $\dot{E}_{NB}$. The graphical construction is shown in the phasor diagram. Therefore, in a balanced wye connection

$$E_L = 1.73E_P$$

Current Relations in a Wye-Connected Generator

The current flowing out to the line wires from the generator terminals A, B, and C (Fig. 1-1B-2) must flow from the neutral point N, out through the generator coils. Thus, the current each line wire (I_L) must equal the current in the phase (I_P) to which it is connected. In a wye connection

$$I_L = I_P$$

WORDS AND TERMS

pulsate *v.* 脉动，跳动，振动
apparatus *n.* 一套仪器，装置
rated *adj.* 额定的，设计的，适用的
coil *n.* 绕组，线圈；*v.* 盘绕
distribution *n.* 分配，分布，配电
generator *n.* 发生器，发电机
emf（electromotive force） 电动势
interconnect *v.* 互相连接
wye *n.* Y 形联结，星形联结，三通
delta *n.* 希腊字母 Δ（δ），三角形（物）
geometry *n.* 几何学，几何形状
winding *adj.* 缠绕的；*n.* 线圈，绕组
polarity *n.* 极性
neutral *adj.* 中性的；*n.* 中性线
subscript *n.* 下标，脚注，索引
succeed *v.* 继……之后，接替
intersection *n.* 相交，逻辑乘法
phase sequence 相序
reverse *v.*，*n.* 反转；*adj.* 变换极性的

NOTES

[1] Viewed in this light, it will be found that the analysis of three-phase circuits is little more difficult than that of single-phase circuits.

这样看来，三相电路的分析比单相电路的分析难不了多少。

viewed in this light：从这个意义上来看

that：指代 analysis

[2] At unity power factor, the power in a single-phase circuit is zero twice each cycle.

在功率因数为 1 时，单相电路里的功率值每个周波有两次为零。

twice each cycle：每个周波有两次（为零）。twice 和 each cycle 都做状语。

[3] It should be noted that if the polarity of point A with respect to N ($\dot{E}_{AN}$) is assumed for the positive half-cycle, then $\dot{E}_{NA}$ when used in the same phasor diagram should be drawn opposite to, or 180° out of phase with, $\dot{E}_{AN}$.

应该注意，如果是在电压的正半周定义 A 点相对于 N 的极性（$\dot{E}_{AN}$），那么 $\dot{E}_{NA}$ 在用于同一相量图中时就应该画得同 $\dot{E}_{AN}$ 相反，即相位差为 180°。

with respect to：相对于；关于

C 专业英语（Specified English）概述

大学生在经过基础英语的学习后，基本上已掌握了英语的常用语法，并具有 4000 以上的词汇量，具备了较扎实的英语基础。进入三年级后，随着专业课的进一步学习，学生的专