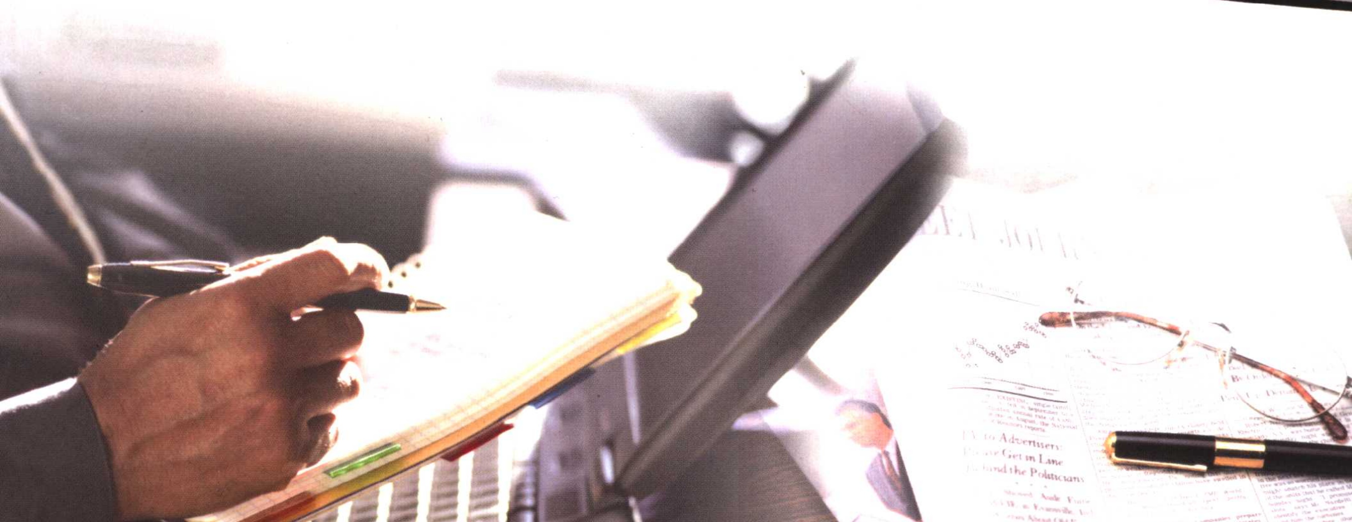
21世纪高职船舶系列教材
SHIJI GAOZHI CHUANBO XILIE JIAOCAI

船舶电气专业

船电专业英语

主编 余 华

CHUANDIAN ZHUANYE
YINGYU



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内容简介

本书介绍了与船舶电气自动化专业相关的主体内容，包括电子技术、电气传动技术、计算机控制技术和船舶电气四方面共16个单元，并且书后附有阅读材料，列举了船电工程师实用英语口语和常用的一些业务表格和文件，以及船电专业常用词汇表。整本书内容丰富，方便实用，具有较强的针对性和实用性。

本书既可作为高职高专船电类、自动化类及其他相关专业的教材，还可作为海员的培训教材，同时也可作为有关工程技术人员从事英文科技阅读和写作的参考书。

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高等职业教育系列教材编委会

（按姓氏笔画排序）

前言

近几年来，我国的船舶工业及远洋运输业得到了极大的发展，这使得对船电专业人才的需求急剧增加，大力培养高素质的船电专业人才迫在眉睫。但前几年，由于专业改革，各大专院校纷纷取消了船电专业，相关船电类的教材非常少而且内容陈旧。船电专业英语近几年来更是没有相关教材出版，而相关船厂及远洋运输企业又大多是制造出口船舶和进行远洋运输，因此对船电专业人才的英语水平要求较高，这就迫使我们急需编写一本内容新颖，适合船电专业所需的专业英语教材。武汉船舶职业技术学院自1985年开办船电专业以来，积累了丰富的教学经验和素材，此次在充分吸取以前船电专业英语相关教材、资料精髓的基础上，结合自动化专业英语教材的特点，突出船舶特色，大胆创新。本书主要有以下特点：(1) 充分涵盖电气自动化专业的主体内容，新颖、实用；(2) 彰显船电特色，注重吸收当前船电行业的新知识、新内容；(3) 融入船电工程师实用英语会话和常用业务表格及文件，充分体现现场实战特色。本书既可作为高职高专船电类、自动化类及其他相关专业的教材，还可作为海员的培训教材，同时也可作为有关工程技术人员从事英文科技阅读和写作的参考书。

本书由武汉船舶职业技术学院余华任主编并统审全书，李汉玲、周民任副主编。编写过程中，该书参考了王天序老师主编的《船电专业英语》(1993年)和张晋莒老师主编的《船员实用英语会话》(1998年)中的部分内容，在此深表感谢。

由于编者水平和经验有限，书中难免存在不足和疏漏之处，敬请读者批评指正，我们将不胜感激。

编　者

2006年4月

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目录

21世纪高职船舶系列教材 SHIJI GAOZHI CHUANBO XILIE JIAOCAI

船电专业英语

CHAPTER 1 Electronics Technology

电 子 技 术

Unit 1 Semiconductor Devices

半导体器件

1.1 The Diode 半导体二极管

Although diodes rarely occur directly in the schematic of present digital gates, they are still omnipresent. For instance, each MOS transistor implicitly contains a number of reverse-biased diodes. Diodes are used to protect the input devices and integrated circuit (IC) against static charges. A number of bipolar gates also use diodes as a means to adjust voltage levels. Therefore, a brief review of the basic properties and device equations of the diode is appropriate.

The PN-junction diode is the simplest of the semiconductor devices. The circuit symbol of the diode, as used in schematic diagrams, is introduced in Fig. 1.1. The reader is most probably familiar with the ideal diode equation, which relates the current through the diode I_D to the diode bias voltage V_D.

$$I_D = I_S(e^{V_D/\Phi_T} - 1) \tag{1}$$

I_S represents a constant value, called the saturation current of the diode. Under reverse bias conditions, where $V_D \ll 0$, $I_D \approx I_S$ and equals the reverse-biased leakage current. Φ_T is the thermal voltage of equation above and is equal to 26 mV at room temperature.

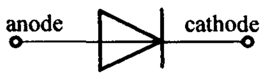

Fig.1.1 The diode

When the diode is forward-biased, it begins to conduct with only a small forward voltage across it, which is on the order of one volt. When the diode is reverse-biased, only a negligibly small leakage current flows through the device until the reverse breakdown voltage is reached.

In normal operation, the reverse-biased voltage should not reach the breakdown rating.

In view of the very small leakage currents in the blocking (reverse bias) state and the small voltage in the conducting (forward bias) state as compared to the operating voltages and currents of the circuit in which the diode is used, the I-V characteristics for the diode can be idealized. This idealized characteristic can be used for analyzing the converter topology, but should not be used for the actual design, for example, heat sink requirements for the device are being estimated.

At turn-on, the diode can be considered an ideal switch because it turns on rapidly compared to the transients in the power circuit. However at turn-off, the diode current reverses for a reverse recovery time t_{on} before falling to zero. This can lead to overvoltage in inductive circuits. In many circuits, this reverse current does not affect the converter characteristic and so the diode can also be considered as ideal during the turn-off transient.

1.2 Bipolar Junction Transistor 半导体三极管

Today, industrial electronic systems employ several devices that is described by the term transistor. Each type of transistor has different characteristics and operational conditions that is used to distinguish from others. In the first part of this discussion, we are concerned with the bipolar junction transistor. Structurally, this transistor is described as bipolar because it has two different current-carrier polarities. Holes are positive current carriers, whereas electrons are negative current carriers. Two distinct kinds of semiconductor crystals are connected together by a common element. The structure of this device is similar to that of two diodes connected back to back, with one crystal being common to both junctions. The center material is usually made thinner than the two outside pieces. Fig. 1.2 shows the crystal structure, element names, and schematic symbols of two distinct types of bipolar transistors.

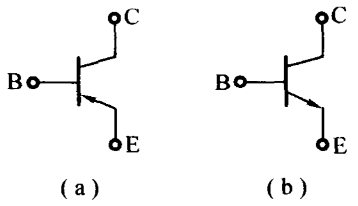

Fig. 1.2 PNP and NPN transistors
(a) PNP transistor; (b) NPN transistor

A bipolar transistor is primarily used as an amplifying device that regulates the amount of current that passes through it[1]. Current from the energy source enters the emitter, flows through the base region, and exits through the collector. Variations in collector current are usually identified as the output of a transistor. Collector current is controlled by a small change in base current. This relationship is described as current gain of beta (β). Expressed mathematically,

$$\beta = \Delta I_C / \Delta I_B \quad \text{or} \quad \beta \approx \Delta I_E / \Delta I_B$$

The Greek letter delta (Δ) of this formula indicates a change value. This is used to denote the response of transistor when AC values are applied. Conditions of this type are called dynamic characteristics. Omission of the delta sign in formula denotes DC or static operating conditions.

All the current entering a transistor at the emitter is identified as emitter current, or I_E. The collector current, or I_C, is always somewhat less than I_E. The difference between I_E and I_C is due to base current[2]. Mathematically, this is base current (I_B) = emitter current − collector current

$$I_B = I_E - I_C$$

Example 1 − 1: Determine the base current of a bipolar transistor with an I_E of 11 mA and an I_C of 10.95 mA.

Solution:

$$I_B = I_E - I_C = 11 \text{ mA} - 10.95 \text{ mA} = 0.05 \text{ mA}$$

Fig. 1.3 shows the circuit connections of a simple NPN silicon transistor. Operation of this circuit is based on a forward-biased emitter-base junction and a reverse-biased collector. Forward biasing of the emitter-base junction is accomplished by connecting the negative side of the DC source to the emitter and the positive side through R_B to the base. Reverse biasing of the collector occurs when it is connected to the positive side of source through resistor R_C. Collector current through R_C is controlled by the forward-biased voltage of the emitter-base junction.

In the operation of a single PN diode junction, forward biasing causes conduction and reverse biasing causes nonconduction. In a transistor, this rule does not apply directly because two PN-junctions are involved[3]. For example, when the emitter-base junction is forward-biased, it causes a large amount of I_E to enter the base region. Reverse biasing of the base-collector junction would ordinarily restrict this current. But due to the thin base structure, I_E will immediately enter into the collector when it reaches the base area. Ultimately, this current passes through the collector and appears as collector current I_C or output current. Forward biasing of the emitter-base junction therefore alters or reduces the reverse biasing effect of the base-collector junction in normal transistor operation.

A transistor is primarily classified as a current-operating device. This means that the output or collector I_C will occur only when the emitter-base junction is forward-biased and producing base current. When the base current ceases, collector current stops and the transistor become nonconductive. This condition is called cut off. On the other hand, if an excessive amount of base current occurs, the transistor is driven into saturation. When this condition occurs, a further increase in I_B will not cause a corresponding change in I_C. When amplitude control is being achieved, a transistor is rarely operated in the saturation region; when a transistor is used as a switch, it usually operates in the saturation region[4].

The transistor amplifier circuit of Fig. 1.4 is a PNP counterpart of the previous NPN circuit. The battery of this circuit is connected in a reverse direction in order to achieve proper biasing. Performance is basically the same as that of the NPN circuit. Currents I_B, I_C, and I_E are represented in this diagram by arrows. The emitter current of this circuit still provides the largest current value. The composite of I_C plus I_B also equals I_E in this circuit.

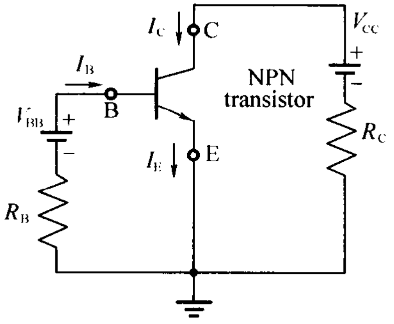

Fig. 1.3 NPN transistor circuit

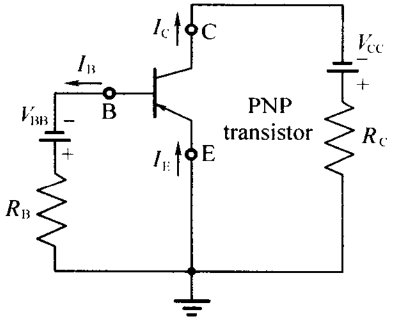

Fig. 1.4 PNP transistor circuit

1.3 The MOSFET MOS 场效应管

The metal-oxide-semiconductor field-effect transistor (MOSFET or MOS, for short) is certainly the workhorse of contemporary digital design. Its major assets are its integration density and a relatively simple manufacturing process, which make it possible to produce large and complex circuits in an economical way.

At the most superficial level, the NMOS transistor can be considered to act as switch. When a voltage is applied to the gate that is larger than a given value called the threshold voltage V_T, a conducting channel is formed between drain and source. In the presence of a voltage difference between drain and source, current flows between the two. The conductivity of the channel is modulated by the gate voltage—the larger the voltage difference between gate and source, the smaller the channel resistance and the larger the current. When the gate voltage is lower than the threshold, no such channel exists, and the switch is considered open.

In an NMOS transistor, current is carried by electrons moving through an n-type channel between source and drain. This is in contrast with the PN-junction diode, where current is carried by both holes and electrons. MOS devices can also be made by using an n-type substrate and p^+ drain and source regions. In such a transistor, current is carried by holes moving through a p-type channel. Such a device is called a p-channel MOS, or PMOS transistor. In a complementary MOS technology (CMOS), both devices are present. In a pure NMOS or PMOS technology, the substrate is common to all devices and invariably connected to DC power supply voltage. In CMOS technology, PMOS and NMOS devices are fabricated in separate isolated regions called wells that are connected to different power supplies.

Circuit symbols for the various MOS transistors are shown in Fig. 1.5(a). In general, the device is considered to be a three-terminal one with gate, drain, and source ports. In reality, the MOS transistor has a fourth terminal, the substrate. Since the substrate is generally connected to a DC supply that is identical for all devices of the same type (GND for NMOS, VDD for PMOS), it is most often not shown on the schematics. In case a design deviates from that concept, a four-terminal symbol is also available as shown in Fig. 1.5(b). If the fourth terminal is not shown, it is assumed that the substrate is connected to the appropriate supply.

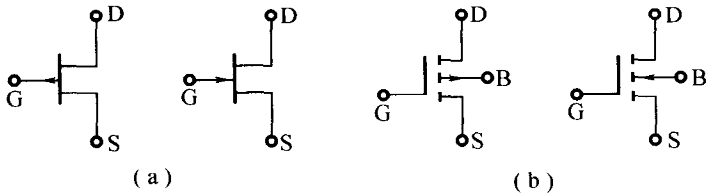

Fig. 1.5 The MOS transistor

(a) three-terminal MOS transistors; (b) four-terminal MOS transistors

1.4 The Types of Solid-state Power Device 其他功率器件

We focus on solid-state power devices, or power semiconductors, only as they are being used in the power leads or power circuits to three-phase 460 V AC squirrel cage induction motors for either phase (voltage) control or frequency (speed) control. The five major types of power semiconductors used in solid-state AC motor control are:

①Diodes

②Thyristors [e.g. silicon-controlled rectifiers (SCRs)]

③Transistors

④Gate-turn-off thyristors

⑤Triacs

SCRs and triacs are commonly used for phase controls. Various combinations of diodes, SCRs, transistors, and GTOs are used for speed controls. The commonality of these devices is the use of crystals of silicon in the form of wafers that are layered so as to form various combinations of PN-junction. The P-junction is usually called the anode and N-junction is usually called the cathode for diodes, SCRs, and GTOs; the corresponding terms for transistors are collector and emitter. The differences among these devices relate to how they go into and out of conduction and in their available ampere and voltage capabilities.

New Words and Expressions

bipolar *adj*.	双极的;双向的	carrier *n*.	载流子
polarity *n*.	极性	positive *adj*.	正的;(电)阳性的
negative *adj*.	负的;(电)阴极的	semiconductor *n*.	半导体
crystal *n*.	结晶;晶体	emitter *n*.	发射极
collector *n*.	集电极	base *n*.	基极
denote *v*.	意味着	forward-biased *adj*.	正偏置的;正偏压的
reverse-biased *adj*.	反偏置的;反偏压的		

Notes to the Text

1. A bipolar transistor is primarily used as an amplifying device that regulates the amount of current that passes through it.

双极型晶体管主要通过调节流过它的电流来作为放大器件。

2. All the current entering a transistor at the emitter is identified as emitter current, or I_E. The collector current, or I_C, is always somewhat less than I_E. The difference between I_E and I_C is due to base current.

所有流进晶体管发射极的电流定义为发射极电流(I_E)。集电极电流(I_C),总是略微小于I_E。I_E 和 I_C 的差值即为基极电流。

3. In the operation of a single PN diode junction, forward biasing causes conduction and reverse biasing causes non-conduction. In a transistor, this rule does not apply directly because two PN-junctions are involved.

对单个 PN 结而言,正向偏压导通,反向偏压截止。由于晶体管是由两个 PN 结组成,这个特性不再适用。

4. When amplitude control is being achieved, a transistor is rarely operated in the saturation region; when a transistor is used as a switch, it usually operates in the saturation region.

当作为放大管使用时,晶体管很少工作在饱和区域;当晶体管作为开关使用时,它通常在饱和区域中工作。

Unit 2 Integrated Circuit

集 成 电 路

The integrated circuit is sometimes called IC. It is called an integrated circuit because all the elements are bombed together or integrated. A non-integrated circuit would have several separate units wire together. The IC was invented in 1958, and already it is being called one of the marvels of electronics industry. It is being used in dozens of industries, and it is also being used many consumer products. The IC has many potential uses including elements of many different functions, such as diodes, transistors, capacities and resistors.

Many consumer products use integrated circuits. For example, electronic calculators, digital clocks and wrist watches use integrated circuits. The IC is used to control the electric range and oven, the clothes dryer and the electronic organ. These applications of the chip are possible because the costs of manufacturing the integrated circuit have declined.

The micro-chip has reduced the size of another well-known instrument—the computer, light weight, portable, minicomputer using integrated circuits can be moved easily, and placed in locations where they are needed. The integrated circuit is a revolutionary invention.

2.1 Design Methodologies Based on Hardware Description Languages 基于硬件描述语言的设计方法

The complexity of electronic systems is constantly growing. This is well known by both designers and users. Some facts have been of great importance in allowing this growth: the improvement of the manufacturing processes, the diversity of applications, and the quantity of elements in the market being some of the crucial points. However, this development could not have been possible if the design processes and computer-aided design (CAD) tools had not developed, as well. Besides the system complexity, the market has evolved with very rapid changes, where quality and cost are as important as the time to market of the electronic equipment. The result is that development time and costs are decreasing, while design complexities are increasing. With these factors in mind, a lot of effort has been and is being made to improve what are usually called design methodologies. A design methodology defines a set of procedures, rules, and tools to optimize the electronic systems' design. The optimization criteria could come from different sources, depending in the system nature, application, and complexity. The following are some of the most important factors.

①development time and effort;

②final product cost;

③reusability of the design;

④customer and quality control during the whole design cycle;

⑤first-attempt success guarantee.

To make the design of complex systems manageable, the design team has to be coordinated throughout the whole development period. This is not an easy task, when arranging different departments and people with diverse skills (from the systems engineer, through the components designer, to the test team). Communication among them should be made using a common format or language, which makes possible understanding. Hardware description languages (HDLs) have come to solve some of the problems previously posed. Some of the previewed advantage are as follows.

①HDLs allow shorter development phases in the projects.

②HDLs provide continuous checking and verification of the system performance and behavior.

③HDLs make the system independent of the target technology and the final implementation details, in the early stages of the project.

④HDLs are a common language throughout most design phases, so CAD tools and users benefit from it.

⑤HDLs supply a common interface between different people involved in the project and between designers and CAD tools.

An important step ahead in design methodologies based on HDLs is the acceptance of a standard language by the IEEE. This language is VHSIC HDLs (VHDLs), balloted as a standard for the first time in 1987, and reballoted in 1993[1]. The existence of a standard has spread the use of the language because its use is accepted by different designers (systems, application-specific integrated circuits (ASIC's), test, etc.) and several CAD tools from different venders. Other languages, such as Verilog, are also widely used for hardware design.

In the case of ASIC's, HDLs have been widely used in recent years (actually, from the moment VHDLs was standardized), and the growth of ASIC's designers using HDLs is foreseen to be constant. The design methodologies based on HDLs include the following stages.

①Specification and Documentation

The first stage of a project is the specification phase. In this phase, all functional features of the system have to be clearly defined before the design starts. Practice shows that most of the problems during the design phase come from in consistencies and vagueness in the specification.

②Simulation

Using a simulation tool, it is possible to know the response of a system, given a set of input stimuli. In this way, it is possible to preview the system performance before it is manufactured. Simulators are very useful in the design of systems based on components, when previous prototypes can be built to estimate the system performance and to debug the design.

③Synthesis

Synthesis is the transformation of a description of a high abstraction level into another with lower abstraction level. Depending on the level of the stating description, two different syntheses can be considered.

(a) one is behavioral synthesis, which translates and algorithmic description into a RTL model.

(b) the other is RTL synthesis, which translates a register transfer description into a logic level model.

④Test

The next step is the test procedures which will be used to verify its performance and functionality, once the system is manufactured. The more complex the system is, the more difficult the generation of the test is. For most electronic systems, when complexity grows, the observability and controllability of signals decreases, because, generally speaking, internal complexity is increased but the number of access points (primary inputs and outputs) is not increased by the same factor[2]. The testability problem is even greater when talking about integrated circuits (where no internal net can be directly accessed), but is also important for multilayer PCB's surface mounted boards, or multichip modules (MCM's).

2.2 Conclusions 结论

In spite of the drawbacks that are found in the method, the HDLs-based design is a good solution to deal with the complexity of current electronic systems. So far, it is restricted to digital systems, but some effort is being made to extend some of these concepts to analog electronics. Besides, some of the problems related to testing are being studied to obtain a test methodology similar to the design method.

The forecast for the use of this process is very promising. A large group of designers is seeking from old methodologies to those based on HDLs. Some companies and institutions are starting to demand HDLs documentation for all their designed systems. The method, that was only used by ASIC designers, is beginning to get into the systems, and this implies that new design tools, there is a very important issue, which is the possibility of hardware-software codesign based on HDLs.