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The ZX81™ TS1000™ Home Computer Book

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D.C.F.

Preface

This book is your introduction to the Timex Sinclair 1000 and Sinclair ZX81 personal computers. It describes the computers themselves and covers the common external devices and accessories, including the television display, cassette program storage, memory expansion, and printers.

The book has three main parts. Each part focuses on one kind of Timex Sinclair computer user. The first part addresses the person who plans to use commercially prepared programs but has little or no desire to program the computer. The second part teaches the programmer or prospective programmer how to use BASIC on these computers. The third part presents more advanced information about Sinclair BASIC and the Z80 microprocessor and explains how to take advantage of some of their special characteristics. These three parts are not mutually exclusive. Users of the first part may venture into the second part just to see what BASIC programming is all about. Users of the second and third parts are likely to find themselves referring to the first part from time to time.

The first two chapters answer two questions: "What is the TS1000 (or ZX81) computer?" and "How do you make it work?" The first chapter tells you what all the pieces of the computer system are and what they do. The second chapter describes the system in greater detail and tells you how to operate each component part. With this knowledge you are ready to use any of the ready-to-run programs that are available for text processing, financial analysis, bookkeeping, computer-aided instruction, and entertainment.

Chapters 3 through 6 teach you how to write your own BASIC programs. Chapter 3 begins with the fundamentals of Sinclair BASIC. Chapters 4, 5, and 6 describe the features of BASIC in greater detail, explaining what computer programming is all about and describing some of the things you can do with this knowledge.

Chapters 7 and 8 present more advanced aspects of the Timex Sinclair computers that will interest more experienced programmers and new users who have mastered the fundamentals.

The appendixes provides valuable reference information for each kind of user. Appendix A is a summary of Sinclair BASIC for readers who already understand BASIC and want to look up the details of particular commands or functions. Appendixes B through D contain general reference material for programmers, and Appendixes E through M describe more advanced aspects of these computers. Appendix N is a bibliography of other related books and magazines.

D.C.F.

Contents

Presenting the TS1000 and ZX81

Chapter One

This chapter introduces you to the TS1000 and ZX81 computers. In it you will learn about the basic functions of these computers' parts, from the microprocessor (the "brain" of the system) to the keyboard. The chapter also introduces you to the basic equipment that can be attached to your computer to make it more useful, for example, a cassette recorder (to save your programs) or more memory (to enable you to run longer and more complex programs).

THE COMPUTER

Figure 1-1 is a picture of the Timex-Sinclair 1000 computer (hereafter called the TS1000). Figure 1-2 shows the Sinclair ZX81. These two computers are essentially identical, except that the TS1000 has more memory. This book applies equally to both computers. Where it describes one, you can assume the other works exactly the same way.

The computer contains a Z80 microprocessor chip, two kinds of memory, a built-in keyboard, and circuitry that can control a television, cassette recorder, printer, and memory expansion pack. Figure 1-3 shows the inside of the computer. You don't have to understand how the electronic components work in order to be able to use the computer, but the sections that follow discuss each of the major components briefly so that you will know their names and functions.

You may be surprised to learn that your computer has so few internal components. As you can see from Figure 1-3, the computer's circuitry consists of only four integrated circuits: the microprocessor; a custom logic circuit (called a ULA); two memory chips; and a few small components. Each chip contains a large amount of internal circuitry, most of it so small that you could not see it without the aid of a microscope.

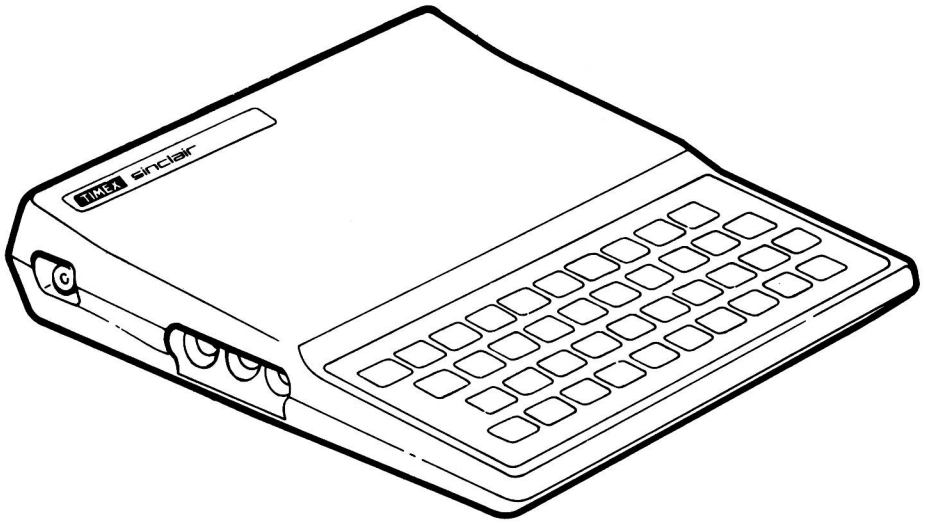


Figure 1-1. TS1000

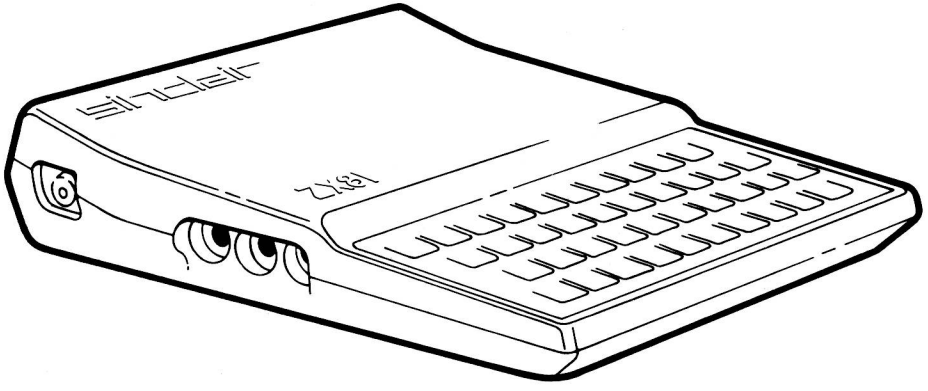
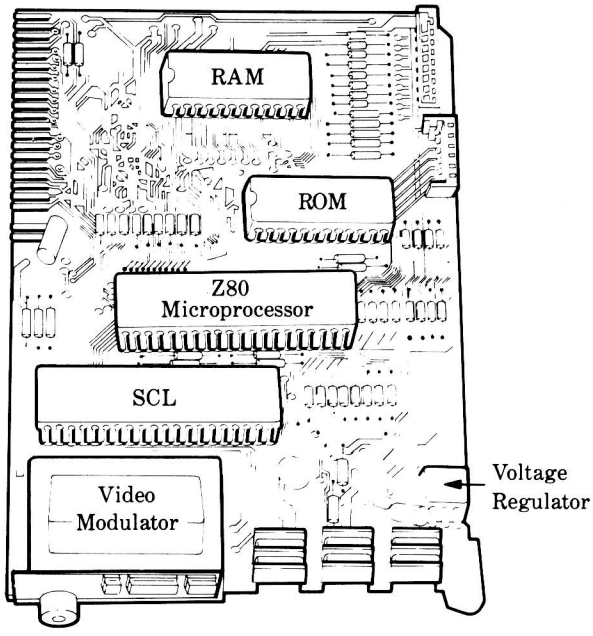


Figure 1-2. ZX81



Adapted from *Timex User Manual* by Steven Vickers, © 1982 Timex Corporation

Figure 1-3. Inside the computer

The Microprocessor

The *microprocessor* or CPU (Figure 1-3) is the "brain" of the computer. It executes the instructions of your program one at a time by performing arithmetic functions, comparing and manipulating numbers, and transferring data from one location to another in memory. It also creates the television display and communicates with the cassette unit.

Memory

The *memory* chips are used for storing information. Your computer has two different kinds of memory, called *read-only memory* (ROM) and *read/write memory* (RAM, which means random-access memory). These chips contain thousands of storage units called *bytes* where programs, data, text, and other kinds of information are stored.

The SCL

Besides the microprocessor and memory chips, your computer contains a custom-made chip called the SCL, which provides special circuitry for connecting other chips and generating the cassette, video, and keyboard signals.

The letters SCL stand for "Sinclair Computer Logic." The chip used is called a ULA (Universal Logic Array). It is programmed at the factory to perform the SCL functions.

The computer also contains a voltage regulator and a video modulator. The voltage regulator controls the power to the computer and the video modulator converts the computer display data into a standard broadcast signal so you can use your television set for the video display.

PUTTING THE SYSTEM TOGETHER

Figure 1-4 is a picture of a typical TS1000 computer system. The system configuration of a ZX81 is identical. Your system may differ from the one pictured because some of the components shown are optional. Your television set and cassette recorder/player may also be different from the ones shown since neither Sinclair nor Timex markets their own televisions or recorders.

Only two of the components shown in Figure 1-4 are necessary for a

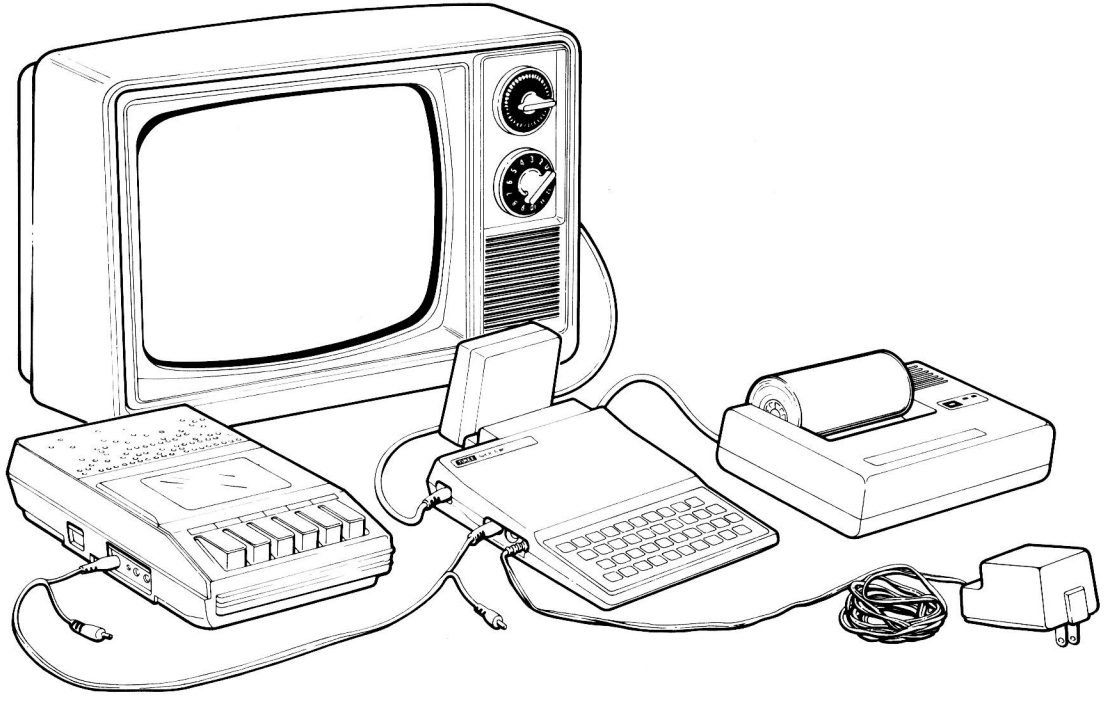


Figure 1-4. The TS1000 computer, memory expansion pack, cassette recorder/player, printer, and television screen

working computer system: the computer itself (including the built-in keyboard) and the television set. The cassette unit is used to save programs and load them into the computer from tape. The Timex 2040 printer shown prints both programs and the results of calculations onto paper.

The memory expansion pack increases the memory to 16,384 bytes (called 16K bytes in the number system used in computers). With this added memory, the computer can handle longer programs and more data.

The Keyboard

The built-in keyboard is your main way of giving instructions to the computer. The TS1000 and ZX81 accept commands in a language called BASIC, which uses a small number of English words, along with numbers and a few other symbols, in a fairly simple and systematic way. Much of this book will explain how to use the language BASIC. For now, notice that the keyboard has all of the special words and other symbols of BASIC printed on the keys. This can make the TS1000 and ZX81 much easier to use than many other personal computers that require you to remember all the special words and type them in yourself, letter by letter.

The Video Display

The television screen displays the interaction between you and the computer. It displays each command or keyboard character as you type it in. It also displays a special symbol called a *cursor*, which tells you what kind of information the computer expects you to enter next and where it will appear.

The screen is divided into 24 lines of 32 characters each. Although you can use just about any kind of television, a small black and white set will probably give the best picture.

Expansion Interface

At the rear of the computer is a long, flat connector. This connector is the *expansion interface*. It is used to connect various devices to the TS1000 and ZX81 computers.

Two of the devices that connect to this interface are the 16K memory pack and the Timex 2040 or Sinclair ZX printer.

Memory and Memory Expansion

In any computer system, the microprocessor (also called the *Central Processing Unit*, or CPU) performs all of the logical functions of the computer.

But in order for it to perform these functions, it is necessary to have a controlling program. This program can be stored in memory as either a permanent (or *nonvolatile*) program, such as the BASIC programming language, or in temporary memory, such as programs you enter.

THE MASTER PROGRAM

The TS1000 and ZX81 computers have two different kinds of memory. *Read-only memory* (ROM) contains the master program that controls every aspect of the computer's operation. When you plug in the computer, this master program automatically takes over. When you enter commands or programs for the computer to execute (in BASIC), it is this master program in ROM that instructs the microprocessor to interpret your commands and carry them out. The ROM contains permanently stored information that was placed there at the factory, and you cannot change it.

DATA AND PROGRAM STORAGE

The other kind of memory in your computer is called *read/write memory* (RAM), because you can change (write) its contents as well as read what was previously written into it. The letters R.A.M. are an acronym for *random-access memory*. Although both ROM and RAM can be accessed randomly, only read/write memory is called RAM. When you enter and run a program of your own, the microprocessor stores your program and the data it needs in RAM. It also keeps track of where these things are stored, so that you can find them easily when you need them.

When you turn off the power, everything stored in RAM disappears. If you saved the program on cassette before turning off the power, you can recall it by loading it into RAM; otherwise you will have to retype it.

Both ROM and RAM are made up of individual storage units called *bytes*. Each byte can contain one character, such as a letter, a punctuation mark, or a graphic symbol. The more bytes you have, the more information (programs, numbers, or text) you can store in your computer.

Memory capacity is usually described in units of Kbytes (sometimes simply called K). One Kbyte means 1024 bytes. The TS1000 and ZX81 have 8K bytes (that's 8192 bytes) of ROM. Additionally, the TS1000 has 2K bytes (2048 bytes) of RAM, while the ZX81 has 1K byte (1024 bytes) of RAM. With the optional memory expansion pack, each computer has a total of 16K, or 16,384 bytes of RAM.

How To Operate the TS1000 or ZX81

Chapter Two

This chapter begins by telling you how to hook up your computer and make sure it is working correctly. It also describes different parts of the computer system and how to use them. These are the television display, the keyboard, the cassette recorder, the printer, and the 16K memory pack.

SETTING UP THE SYSTEM

Find the video cable that came with the computer and plug it into the socket marked "TV" on the left side of the computer (Figure 2-1). Make sure the plug goes all the way in, so that the metal flange on the outside of the plug makes good contact with the outer surface of the socket.

Connect the television switch box terminals (marked "TV") to the VHF antenna terminals on the back of your television set (Figure 2-2). Connect the switch terminals marked "ANTENNA" to the antenna, and plug the free end of the video cable into the connector marked "COMPUTER." Set the switch to the "COMPUTER" position.

Caution: Always make sure the computer is disconnected from power before plugging in the memory expansion pack, the printer, or any other device that plugs into the edge connector at the back of the computer. You can do serious damage to the computer and device if you forget this.

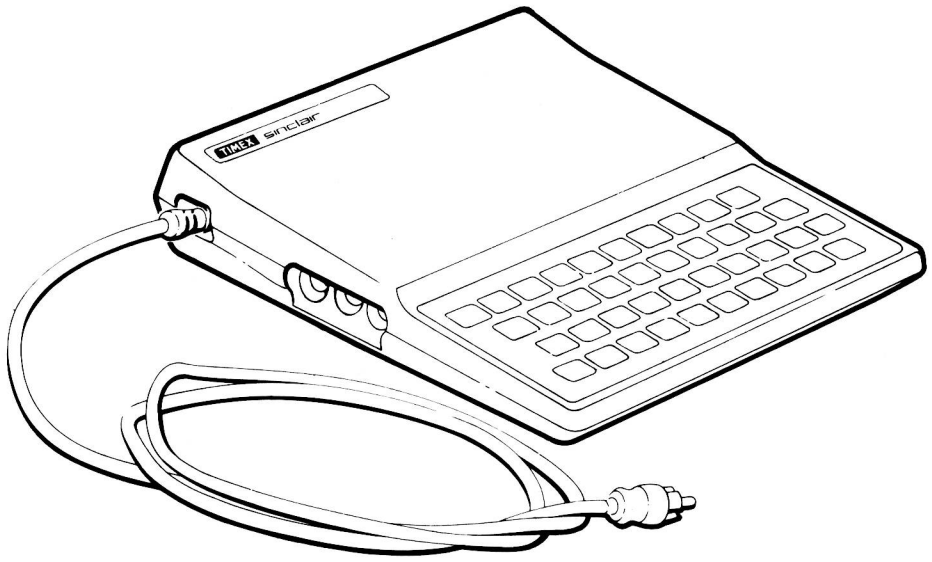


Figure 2-1. The video cable plugs into the left side of the TS1000

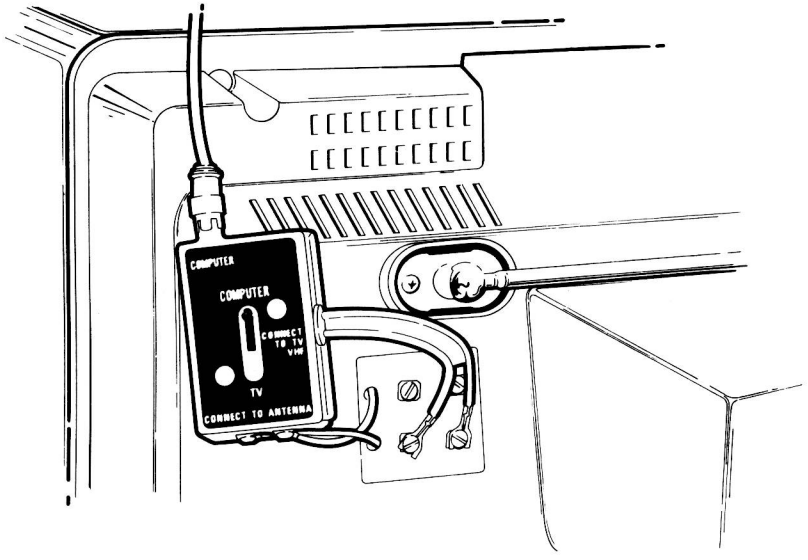


Figure 2-2. The television switch box connects to VHF antenna terminals