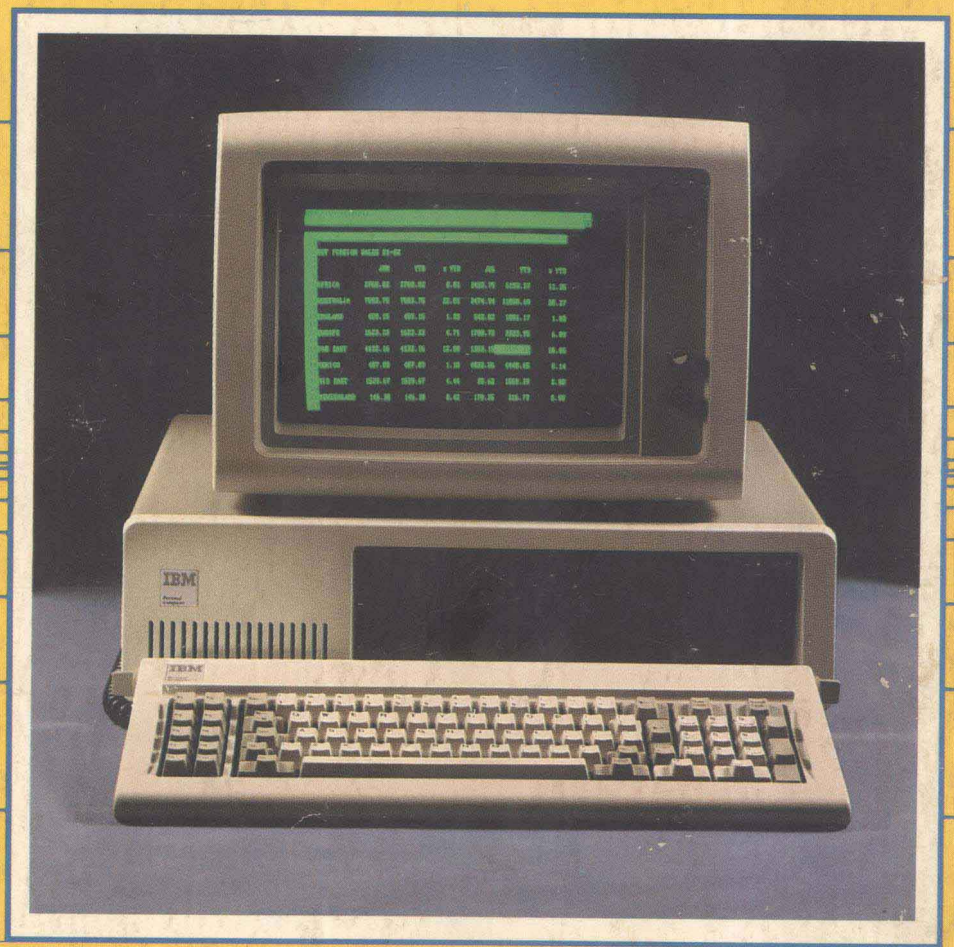
MICROPOWER SERIES

USER'S GUIDE WITH APPLICATIONS for the IBM Personal Computer

John P. Grillo / J. D. Robertson



Includes 34 easy to use programs plus an introduction to BASIC.

USER'S GUIDE WITH APPLICATIONS

for the IBM Personal Computer

Consulting Editor:
Edouard J. Desautels
University of Wisconsin-Madison

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John P. Grillo/J. D. Robertson
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To *Paul and Evans*

Preface

Level of Presentation

This book is written to serve as your guide and companion, to help you to better understand and use the microcomputer as a tool. Realizing that your degree of interest may vary from an inquisitive "I wonder how it works" to an intense "How can I maximize my micro's performance?", we have written this book in the hope of answering both of these questions. We have assumed that you, the reader, are somewhat familiar with microcomputers as a hobbyist, small business consultant or manager, student, teacher or professional programmer. However, we are confident that the material presented can be mastered by a novice who exerts a small amount of extra effort.

How to Use This Book

This microcomputer companion should accompany you whenever programming is done. The book provides you with up-to-date and efficient programming techniques and will help you to improve the performance and efficiency of your microcomputer. For example, the Shell-Metzner sort and the increasingly popular Binary Sequence Search Tree (BSST) are among the techniques you will learn to use, replacing more cumbersome and less efficient file management techniques. In addition, this publication's physical size and clarity of type ease the process of keying the included programs into your computer. You should strongly consider acquiring these programs on diskette through the publisher.

What This Book Contains

Because you need more than the usual kind of guide that presents a multitude of choices with periodic pronouncements of "ABC is best" or "stay away from XYZ," this publication presents some timely and proven hints, programs, and techniques gleaned from our personal and consulting experiences with a broad range of microcomputer users. You are provided with complete systems in skeletal form and practical advice on how to flesh them out into whatever guise best suits your application. For example, the mailing list system described in the last three chapters can be modified easily to serve as an inventory, payroll, personnel, accounts receivable or payable, general ledger, grade book, information retrieval, word processing, or any other system that relies on many records spread out over a lot of files. So our method of guidance is to present a large variety of alternatives and show you how to select the best one for a particular application.

Self-Improvement—Our Ultimate Goal

To enhance your knowledge of the microcomputing field, we have included an up-to-date list of suggested readings at the end of the first chapter. These readings provide references to the latest literature in the field and will enable you to easily research areas of special interest and concern.

Thoroughly Tested Programs

The programs in this book have been carefully tested on an IBM Personal Computer system with 64K bytes of RAM and dual minifloppy disk drives. The language used is Microsoft's Advanced Disk BASIC adapted for the IBM PC. With a minimum of conversion all of the included programs should be easily transferable to other microcomputer systems. We have found that any program written for the IBM PC is easy to transfer to any other machine that uses Microsoft's BASIC, such as Radio Shack's TRS-80 and Apple Computer's Apple-II.

Waltham, Massachusetts
1983

JPG and JDR

Introduction

What are microcomputers? Why are they so popular? Aren't they only for games and microwave ovens? How can they be used for more general applications?

Some people have said that the electronic revolution will affect our society as deeply as did the industrial revolution that culminated in the 19th century. What is this phenomenon and how will it affect us? The microcomputer is one of the most significant physical manifestations of the electronic revolution, and its uses in many areas will determine our future life styles.

To those of you who suspect all computers of a corruption of life style away from some more humane or natural scheme, please read this book carefully. You will reduce your anxiety levels and increase your general knowledge of a real phenomenon. You will recognize the microcomputer (and all of its bigger kin) as a truly unintelligent tool. The potential hazard of this tool is its misuse by our fellow humans, so it benefits us all to know more about it. Microcomputers have the same computational power as full-sized computers that cost ten to a hundred times as much. This fact alone has forced people to consider them seriously in a wide number of applications that are normally relegated to those very expensive machines. Unfortunately the fit is rarely possible because the substitution is not one-for-one. Micros are supremely gifted, yet incredibly inarticulate. They compute very quickly, but they communicate with exceeding difficulty. The real secret of their proper use is to "get the word out," that is to make the device able to talk with us.

A microcomputer system is what makes this possible. It is an accumulation of equipment arrayed about the microcomputer with the purpose of easing the human-machine communication. This equipment's actions are governed entirely by the instructions that the microcomputer executes, and those instructions are written by a human. Therefore we humans are essential to the operation of the machinery, which is as it should be.

In this book we propose some methods of machine management. We assume only an introductory-level understanding of computers. We will introduce all of the essential areas that you must know in order to establish a microcomputer system into a working environment. We don't presume to know what that environment will be, so we have included three very common applications to microcomputer systems: small business, education, and individual use.

Go to it. Enjoy the satisfaction of being on the edge of a technology that promises much toward human well being. See what you can do to make the microcomputer work for you.

Contents

1

Microcomputers in Perspective

The importance of understanding what a computer is cannot be overemphasized. More and more computers are being put to use every day, and whether people are in the business of making them work or are just curious, they need to know more about these devices.

A typical dictionary definition of the word *computer* is "an electronic machine that performs rapid, complex calculations or compiles and correlates data according to an internally stored program of instructions." Introductory texts for computer science and data processing give a definition for a computer that emphasizes performance. A computer performs—

- complex computations;
- at high speed;
- without human intervention.

Even with precise meanings for high speed, complexity, and degree of human intervention, the notion of what a computer is remains nebulous.

In this chapter we will present some background material about computers so that the reader may formulate a realistic conception of what computers are.

Distorted View of Computers

It is easy for anyone who watches TV or goes to the movies these days to concoct a notion of what a computer is and does. Unfortunately, a rather distorted picture is presented to the viewer by the production staffs, and the basically dull computers are depicted as machines that flicker and flash. The following are images that TV and Hollywood provide their audiences.

- The *TV Science Fiction Computer* consists of very fancy electronics hidden behind a facade of a multitude of switches and lights. The machine has an illusory name worthy of a Greek god, and its size dwarfs the puny humans—who scurry about while talking in hushed tones about data banks and readouts.
- The *Spy Movies Computer* is a whole room full of spinning tapes, chugging punched card readers, and the ubiquitous flashing lights. How does this computer communicate with its masters? It sorts cards! Put two or three trays of cards representing all known superspies and their characteristics into this card sorter, punch a few buttons, and somehow the machines seems to flush away all of the cards but one, and that one identifies Our Hero.
- The *Space Epic Computer* is a room full of electronics with a central component that communicates through a staccato, human-like voice. Speaking only when spoken to, the machine never volunteers information. This computer's circuitry is obviously fragile as it will spark and catch fire at the slightest turmoil, straining its usually affable relationship with the spaceship's engineering and navigation officers.

If these vignettes are not representative of what a computer is, then what is a computer? We have often heard the apologetic remark, "I wouldn't be able to tell a computer from a calculator." This is usually meant as a statement of ignorance, but it really is not. There is little difference between a computer and a calculator, particularly if the calculator is a programmable type.

Hierarchical View of Computers

In the following sections we consider the features of electronic tools and calculating aids, starting with the simplest hand-held machines and progressing to the most complex computers.

Four Function Calculator

At the present state of the art, the most primitive calculator is the four *function calculator* (which some people call the "four-banger") with its four functions: add, subtract, multiply, and divide. It can perform these operations in just a few *milliseconds* (thousandths of a second). The price is right, with the cheapest being under $5.. In figure 1.1, Erica is holding typical four function calculators.

Figure 1.1 Four Function Calculators

Scientific Calculator

The *scientific calculator* or "electronic slide rule" is the second level of sophistication in a hand-held calculator. It has memory and a number of functions in addition to the add-subtract-multiply-divide operations. It usually has square root, square, logarithm, and trigonometric function keys, and can display results in scientific notation. It costs between $8 and $40. Its speed can be sensed by pressing a button for a trig function. Most scientific calculators can provide the result in about 300 milliseconds (three tenths of a second). Figure 1.2 shows a typical scientific calculator.

Figure 1.2

Programmable Calculator

The programmable calculator has a feature that is common to all computers: the user can compose a set of instructions that can be saved for repeated use. On the calculator, keystrokes are made in sequence, which stores the program in a special memory; then, the user puts the calculator in "run" mode and the instruction steps in the memory are executed in order. These calculators cost between $40 and $300. Figure 1.3 shows a programmable calculator.

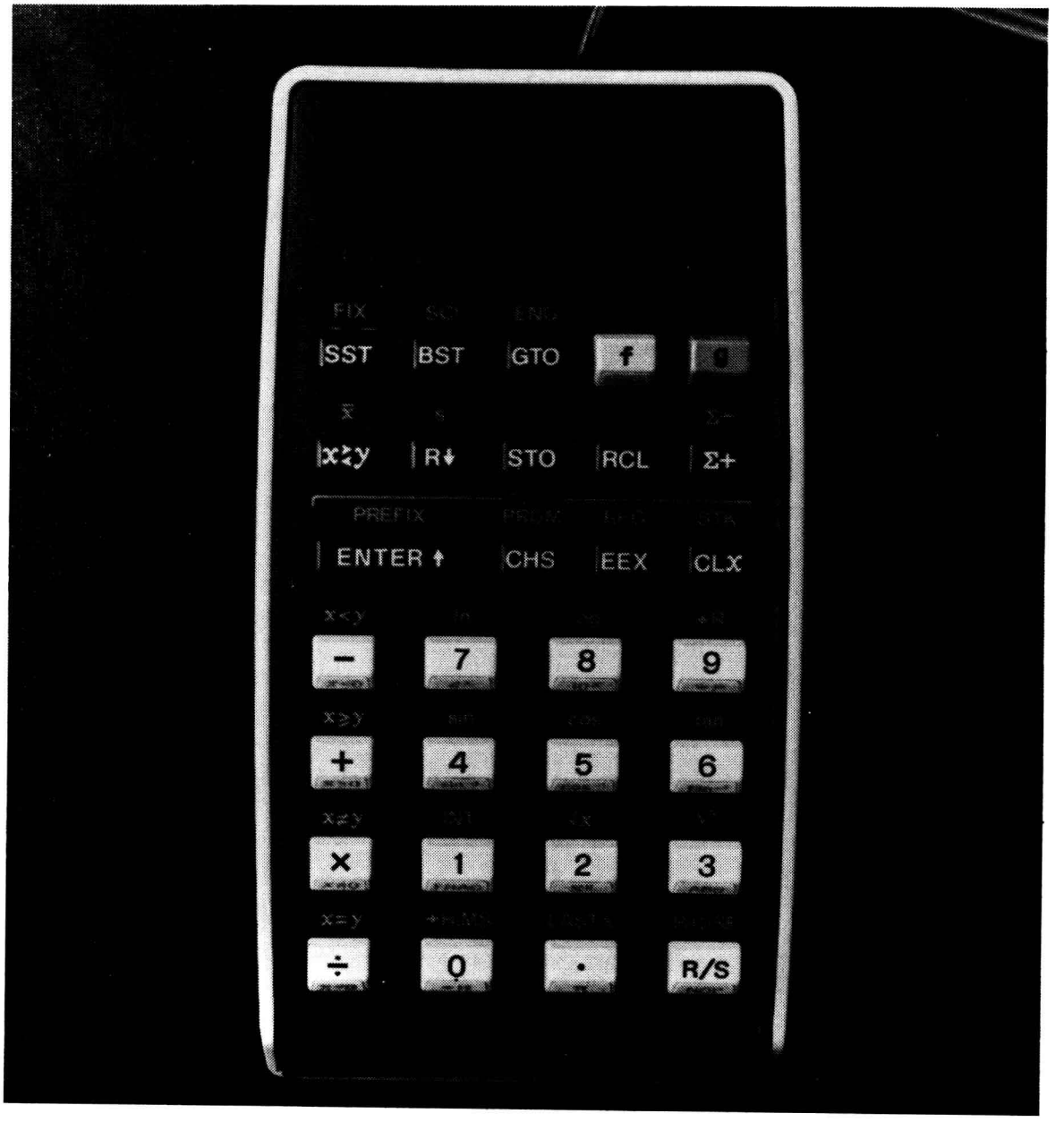

Figure 1.3 Programmable Calculator

At this level in the hierarchy of hand-held calculators and computers, the distinction between the two devices is cloudy. It is like trying to define the phrase "far away" by quoting distances. There is a vague area that is neither near nor far. However, calculators have one common characteristic that is different from all computers. This difference is in the way individual characters are stored in the display or in the memory. All calculators, even the most sophisticated programmable models with printer output, store the characters as four-bit groups; that is, four binary digits (*bits*) are used to store each of the decimal digits or special symbols. When a character or a number is stored electronically, it is coded into *binary digits* (1 or 0).

binary digits	decimal equivalent	stored and displayed character
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	- (minus)
1011	11	. (decimal point)
1100	12	F (overflow indicator)
1101	13	E (error indicator)
1110	14	(not used)
1111	15	(blank or space)

Table 1.1 Representation of Typical Calculator Symbols

Information is stored as binary digits in the memory of both calculators and computers. Since a human perceives information as characters, for storage purposes the information must be encoded into patterns of bits. For presentation to the human, these bits in memory must be decoded into characters. Different machines use different length sequences of bits to represent characters. For example, calculators use four binary digits to encode a character, and computers use six to eight bits.

Aside from the characteristic of being able to manage more bits at a time, computers are also much faster than calculators. The speed of an addition in a calculator is typically in the range between one tenth and one millisecond, while most microcomputers can add two numbers in one to ten *microseconds* (millionths of a second). This high speed is especially useful when calculations are repeated many times, as in a loop, which is a common feature of many computer programs. In general, one can say that computers are at least 100 times faster than calculators.

number of bits	number of arrangements (number of characters)	comments
4	16	calculators
6	64	BCD[1] code: allows upper case, digits, 28 special characters.
7	128	ASCII[2] code: allows lower case.
8	256	EBCDIC[3] and 8-bit ASCII code: allows all characters plus many special characters.

[1]BCD (Binary Coded Decimal) has been used to code computer information in many systems, from the IBM 1620 in 1960 to some current CDC Cyber 176 systems.
[2]ASCII (American Standard Code for Information Interchange) is almost universally used in computer terminal communication. See Appendix for a complete description of the ASCII code.
[3]EBCDIC (Extended Binary Coded Decimal Interchange Code) was developed by IBM for its 360-series computers, and is rarely used outside that company.

Table 1.2 Characters Representable with Binary Digits

Another way to distinguish calculators from computers is in terms of *function*. A calculator's function is to solve a problem on the spot and display numeric results sequentially.

A computer, however, has several more sophisticated functions:

- It *manages information*. That is, it can be programmed to accept and store new data files, and to retrieve, modify, rearrange, and purge old data files.
- It can, and usually does, *produce more than one result*, and it can print or display its output in a preselected layout or format on paper, video screen, or other medium.

After this minor diversion to discuss an important characteristic of computers, let us return to the hierarchy of calculating aids.

Personal Computer

The *personal computer* costs between $100 and $2000, and is a computer in the truest sense. Its memory stores not only the program, but also stores significantly more information. The arrangement of the memory is somewhat different also. It is divided into *words* of equal length, with each word being a single 8-bit character, often called a *byte*. Personal computers are the least expensive microcomputers, but their calculating speed is no less than any other microcomputer of a like magnitude. Figure 1.4 shows Kristine at the keyboard of a personal computer.

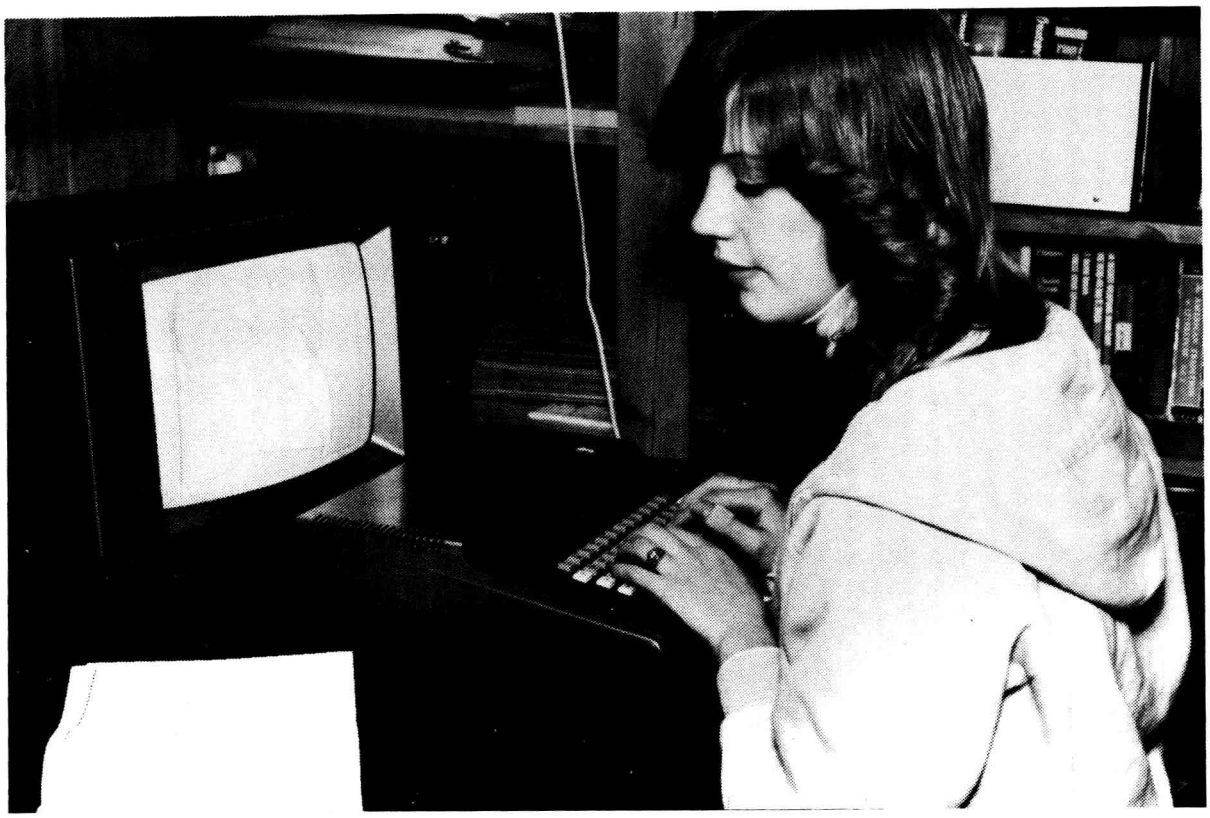

Figure 1.4 Personal Computer

Whereas calculator input is usually performed by keystroke on a numeric keyboard and output by digital display, most personal computers use typewriter-like keyboards for input and TV-like screens for output. Also, the programs are no longer composed of keystrokes, but are usually written in BASIC—a high-level language that allows much more programming flexibility.

Microcomputer System

The microcomputer system is made up of the previously discussed microcomputer along with additional hardware and software. Although its computing electronics are identical to the personal computer, it can be distinguished by what is called *peripheral equipment*, or devices hooked up to the central computer. The word *system* implies the coordinated operation of the *central processing unit*, or CPU, memory, and its associated peripheral devices. The usual system includes a floppy disk drive, which is an extension of memory, but cheaper per byte of storage, although it is slower and larger; and a printer, which serves to provide paper output. A feature of the floppy disk is its ability to serve as an archival storage device. That is, files of programs and data can be kept for extended periods of time. Figure 1.5 shows a typical microcomputer system.