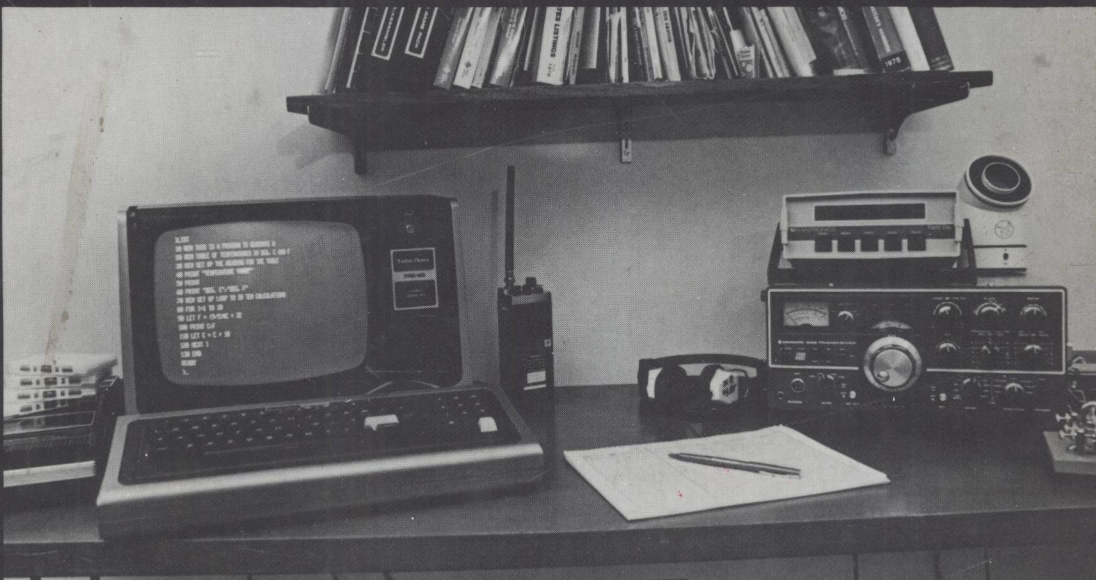
COMPUTERS AND THE RADIO AMATEUR

Phil Anderson



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COMPUTERS AND THE RADIO AMATEUR

To Pat, Becca, Ken, and Merry

PREFACE

The book is written for radio amateurs who have had little or no exposure to computers—how they function and how one programs them and attaches them to other equipment.

The introductory material in Chapter 1 explores current and future uses for computers in amateur radio, and Chapter 2 discusses the history and background of the computer. Chapters 3 through 7 examine how the computer does what it does and describe programming.

Chapter 3 presents details on how computers work. An analogy is made with how human beings solve mathematical problems; the point being that once a procedure is programmed as to how to solve a problem, the computer can follow the steps as laid out. From this point of view, the building blocks of the computer are introduced and how they function together to follow a stored program in memory is explained. This leads naturally to programming procedures, introduced in Chapters 4 and 5.

Chapter 4 introduces the basics of BASIC programming; this is the programming language used most often by home computer hobbyists. Many examples are included and no prior experience is necessary.

Chapter 5 introduces assembly language programming; this is programming right at the computer's language level. The 6502 microprocessor is used as an example, and several straightforward programs are presented.

After the fundamentals of logic circuits are described in Chapter 6, Chapter 7 introduces computer interfacing. Memory-mapped interfacing is presented as a general way to interface amateur or other equipment to the processor of any computer. A coffeepot interface is presented as a first example, and it serves as an introduction to the remaining five chapters, which all involve application projects.

If you are familiar with BASIC programming or assembly language programming, we suggest that you read Chapters 1 through 3 and 7 through 12. If your experience is primarily with logic, you might consider the software sequence, Chapters 1 through 5. If you are versed in both software and hardware and are interested in further applications, we suggest the sequence Chapters 1 and 2 and 7 through 12.

In any event, share with us the futuristic possibilities for computer use in amateur radio as described in Chapter 1. In case you are not a radio enthusiast but are just interested in joining in on the computer fun, Chapters 2 through 7 and Chapter 12, should prove interesting. Happy computing.

As with any activity of any size, no one person is responsible for all the work or all the content. An author's experience is made by those he comes into contact with and the many ideas he has received over a period of time from many sources. In that vein, I wish to thank all who have contributed, directly or indirectly, to this book. In addition, I especially thank the following: Rockwell-Collins, Radio Shack, Apple Inc., Worldradio, Kantronics Inc., and the American Radio Relay League.

PHIL ANDERSON

CONTENTS

1

OUR CHANGING HOBBY: COMPUTER USES IN THE HAMSHACK

Automatic code for the automatic op,
Slick and smooth and it never stops,
Automatic messages for all to hear,
That we can copy with a precision ear,
Automatic tuning fast and slick,
Really accurate and quick as a lick,
Automatic QSOs one like another,
It's really true; can you hear them, brother?

—WØXI, Worldradio

Each technological innovation brings change and the microprocessor is no exception for amateur radio (Figure 1–1). In fact, the microprocessor will change all aspects of electronics to a degree perhaps nobody can quite measure yet. Vacuum tubes brought amplification to radio, transistors brought minimization and cost reductions, and now the computer in the form of an inexpensive integrated-circuit (IC) chip will bring automatic features and improved performance.

In addition, the computer innovation has brought with it a peculiar twist; unlike each piece of vacuum-tube or transistor equipment, it can be reused, reconfigured, or reprogrammed to be used as different pieces of equipment. In addition, it can often be used as several pieces of equipment simultaneously. It is like the

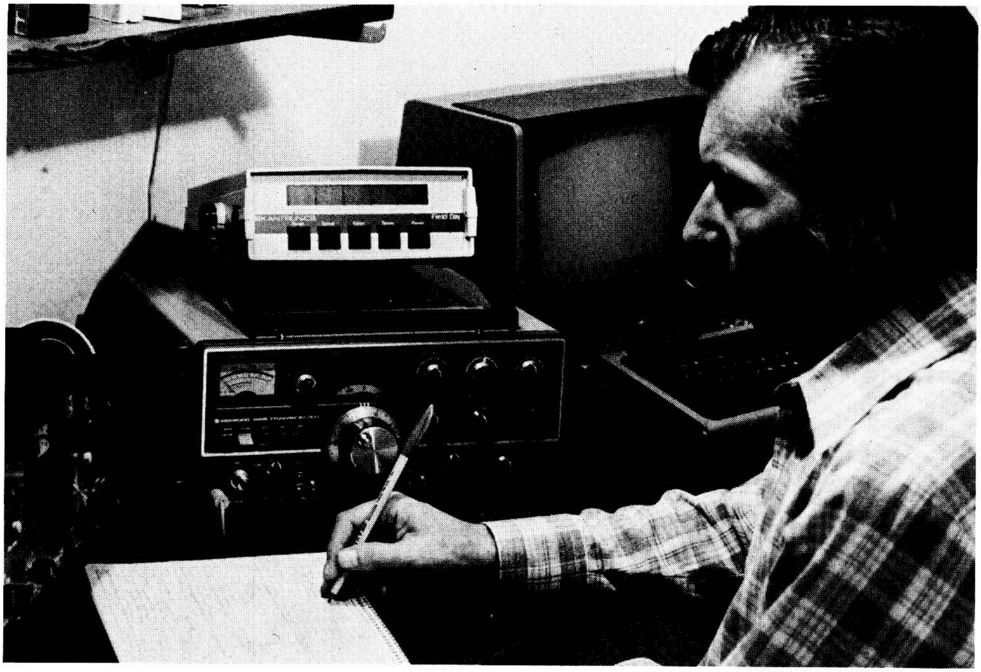

Figure 1-1. Our Changing Hobby: Computers in the Hamshack. (Courtesy WBØKDE.)

salamander—adaptable and flexible. This aspect makes its application unpredictable, and for this reason most experts think that we have just scratched the surface for uses.

In many ways the technology of the microcomputer is already in use: IC technology in the form of logic chips and operational amplifiers can be found in many transceivers and pieces of peripheral equipment. Some transceivers have memory for recalling a number of variable-frequency-oscillator (VFO) frequencies and others have several forms of digital frequency readout. Still further, some units have outboard keyboards to assist the operator in efficient usage.

1-1. COMPUTER EQUIPMENT APPLICATIONS

Table 1–1 lists some current and potential uses for computer systems and microprocessors in the hamshack. Computer-based units have been used as keyers, keyboards for CW, RTTY, or ACII terminals, station loggers, message takers, and so on. Many stations have replaced the old Teletype with the so-called silent terminal, the cathode-ray-tube (CRT) screen. Integrated-circuit technology has brought the keyer, the ran-

Table 1-1: COMPUTER USES IN THE HAMSHACK

Some equipment uses	*Some operational aids*	*Some futuristic uses*
Memory keyer for code paddles	Station logger	CW voice, synthetic voice
CW keyboard	Contest secretary	Automatic antenna tuning
24-hour clock	QSL generator and filer	CQ search scanning
RTTY or ASCII terminal	Message taker	Automatic QSO machine
Morse reader	CW net controller	For automatic preselection and equipment adjustment
Random code generator		The computer as the transceiver
Part of the station transceiver		

dom code generator, and the 24-hour clock, and the microprocessor has made possible the automatic reading of Morse code. Let us take a closer look at these.

Memory Keyer

A memory keyer is an electronic keyer that can also remember one or several messages that can be recalled on command. The electronic keyer is a device that regulates the spacing of the dots and dashes that an operator sends to it with a two-contact code paddle. A properly operating keyer will not allow the operator to shorten the duration between dots and dashes within a Morse character and it will take the paddle contacts and form the dots and dashes to exact Morse specifications. Keyers appeared on the market in quantity once integrated circuits became readily available.

It is a fairly simple matter to program a computer to act as a keyer, and generally a great deal of memory is left over to store many messages for recall at any time. The basics of a computer keyer are described in Chapter 8.

RTTY or ASCII Terminal

Probably the most common use of the home computer for our hobby has been as a radioteletype (RTTY) terminal. As shown in Figure 1-2, an RTTY send/receive system consists of a station transceiver, a demodulator, a computer or a teletype terminal, and the frequency-shift-keying (FSK) modulator for transmission.

The demodulator takes the 5-bit baudot code from the audio output of the transceiver that is in the form of two audio tones and converts it to an on–off logic signal for the terminal to follow. The FSK modulator takes the on–off signal from the keyboard and converts it back to an audio tone for insertion at the phone input of the single-sideband (SSB) transmitter portion of the transceiver. Such a scheme has been in use for many years.

The computer terminal, of course, replaces the Teletype in this system and makes the system a good deal less noisy. In fact, many amateurs can now copy RTTY

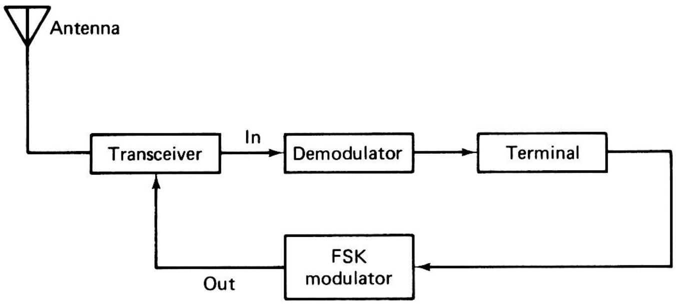

Figure 1–2. Radioteletype System.

this way without objection to the clank and clatter from the XYL or XOM. The computer must be programmed to receive RTTY and place it on its screen, but fortunately this is not a difficult task.

CW Keyboard

The use of a computer terminal for RTTY has generated another obvious use, Morse send and receive.

Programming and outfitting a computer to act as a CW keyboard is straightforward. The computer must be programmed to convert the letters typed on the keyboard into dots and dashes. These codes must then be transferred to the transmitter via a transistor or relay circuit. The only thing that the amateur must do to attach his or her computer to the transmitter is to design a very small and inexpensive interface and load the program in the computer. As a result, many keyboards exist on the market. Most of these, however, include only enough logic with them to be used as a keyboard. Some computer-based systems are offered also, and they usually include Morse-reading capability.

As we discuss in Chapter 10, designing a demodulator and programming a computer to receive Morse code well is not an easy task.

Morse Reader

As shown in Figure 1–3, a Morse-reading system consists of a receiver, a CW demodulator, a computer or microcomputer, and a screen or other form of readout for letters and numbers. The demodulator serves the same purpose as the RTTY demodulator; it must convert the CW tones from the audio output of the receiver to logic signals that the computer can accept. The computer must then convert them into letters for presentation.

A number of complications must be overcome to copy code well: varying code speed, variations in hand-sent Morse, variations in incoming signal strength, and interference from adjacent transmitting stations. It is easy to see that a non-

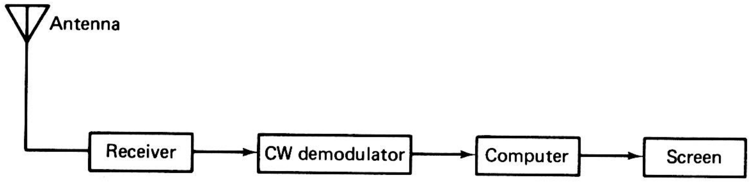

Figure 1–3. CW Reader System.

computer-based instrument or system would find it difficult to accomplish such a task. The computer can do it because it is adaptable and can be programmed to follow complicated rules for reading the code.

Because of the abilities of the computer, a number of computer-based instruments have arrived on the market, and these are probably just the tip of the iceberg of offerings from the manufacturers. An excellent example of a sophisticated microprocessor-based piece of amateur gear is Kantronics' Field Day 2, which reads Morse, RTTY, ASCII, and includes a 24-hour clock. The power of the microprocessor is evident in its many features in a small package.

As shown in Figure 1–4, the unit includes a 10-character alphanumeric display for code presentation, a number of control switches, and a very portable case.

When the speed switch is pushed, the left two digits on the readout indicate the speed of the code that is being received. When editor is pressed, the reader will correct to some extent errors in spacing and dot-and-dash duration from hand-sent code. A feature not evident from the panel is the unit's ability to adapt to varying code speeds; it tracks the speed of the code on the fly.

Figure 1–4. Kantronics Field Day 2 Morse and RTTY Reader (a microcomputer-based product). (Courtesy Kantronics.)

1-2. STATION OPERATIONAL AIDS

The computer has been used and will be used to an even greater extent as an aid to the station operator. Table 1-1 suggests its use as a station logger, contest secretary, QSL card manager, message taker, and CW net controller. This list could be much larger, of course.

My favorite is the contest secretary. If you have ever worked a contest, you know that the duplicate contact sheets get crowded very quickly, and often you cannot read them after a while. In addition, if you are working the contest yourself, it is sometimes hard to keep up. With a computer, all contacts could be recorded, and then when you hear a new station and wonder if you have worked it, all you have to do is type the call into your trusty computer. It will come back with a yes or no on duplication. Another plus is that you could program the machine to record all contact data such as RST, zone if required, and contact number, and these could be printed out at the end of the contest, including your score. That permits pure enjoyment of the contest without the hassle of the paperwork to deal with.

But these examples of current uses of the computer are probably just the beginning. Let us peek into the future, which is always a bit dangerous, and guess where computers might take us as regards new equipment and new applications. Then, we search the past to see where the computer concept came from.

1-3. FUTURE USES

Who can guess what the computer's future uses will be? Probably nobody, to any degree of accuracy. A few that seem plausible are listed on the right in Table 1-1. Let's take a look.

1-3-1. CW Voice

CW voice is artificial voice generated by computer from a CW transmission. It is the kind of voice you would expect to hear from a robot in a movie or from a computer-speaking toy. It is not available yet, but there is no reason why equipment cannot be built to bring your station synthetic voice right now. Of course, the expense would be a bit hard on the budget, but perhaps this will not be true for very long.

First of all, we might say why bother? Single-sideband (SSB) is excellent and an improvement over amplitude modulation (AM), and the voice quality would be better than any artificial voice signal we might receive. In addition, SSB takes only half the space that AM does. That's right, of course, but it may be possible to use even less bandwidth for the transmission of CW voice signals, and the voice quality might just be reasonably acceptable.