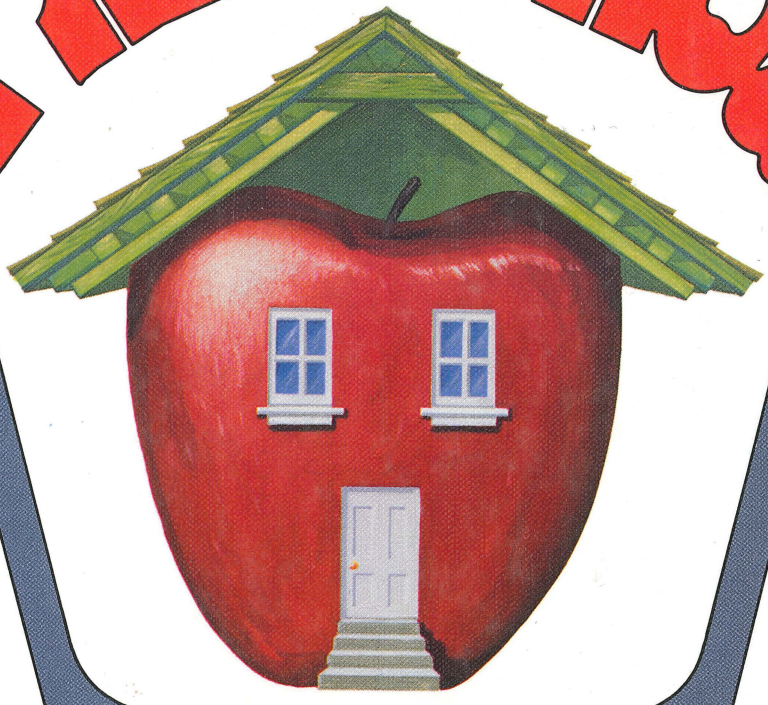
THE APPLE HOUSE



JOHN BLANKENSHIP

HOW TO COMPUTERIZE YOUR HOME USING YOUR APPLE COMPUTER

The Apple House

JOHN BLANKENSHIP
Senior Professor
DeVry Institute of Technology

PRENTICE-HALL, INC.
Englewood Cliffs, New Jersey 07632

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Preface

The computer age is no longer coming. Its here! The number of personal computers in the United States now numbers in the millions. Computer literacy is becoming commonplace. Even grade school students are learning to use and program computers.

But the really exciting news about computers is their steadily decreasing price and increasing performance. With some models selling for under $100, it is possible for anyone to own a computer. Unfortunately, getting a computer is the easy part. Once you have one you need to find ways of making it work for you.

Hundreds of programs are available to make your computer a useful appliance. It can become a friendly machine and play games with you. It can help organize your life by cataloging your record collection or personal library. You might even save some money by putting your budget and checkbook under the supervision of your computer.

These features are wonderful indeed, but if you are like me, you will find them a little less than exciting. I don't think a home computer is one that you use in the home. A home computer should control the home. It should handle security, supervise the lights, control the heat, answer the phone, and much much more.

The technology to computerize your home is available now. If the idea excites you, then prepare to enter the computer age and make your house the first APPLE HOUSE on the block.

JOHN BLANKENSHIP

1 What to Expect

Although computers are great for balancing checkbooks and formulating household budgets, this book was written for those persons that wish to extend the computer's power into far more exciting areas.

Imagine the convenience of having your "house" keep track of how many people are in each room and to turn off all the unnecessary lights. It does not take long till you take for granted that the lights should come on automatically when a room is entered.

Sometimes, of course, you will desire to take personal control and override such automation. Fantasize for a moment about the ability to just *talk* to your house to have your wishes carried out. And when you talk to the house, it will answer back—in its own voice.

I'm talking about a home that can also answer the phone, monitor security, and wake you up in the morning. And these are just a few of the capabilities you can expect.

All this is not some pie in the sky dream. Such computerization is a reality today in my home, and this book can make it a reality in yours.

The system described in this book is by no means the ultimate computerized home. It is, however, a complete and workable system that can have some very beneficial advantages. For example, you can expect to save a few dollars on your heating costs. Mine went down 30 percent.

You can save in other areas, too. Security systems and phone-answering devices are not cheap, and most will do far less for you than

your computerized home can. And my system is just the beginning. The only limit to your computerized home is your imagination.

I first started thinking about putting a computer in control of my home in 1976 when I bought my first Apple computer. It seemed so obvious to me that low-cost computing power would lead to residential automation.

Unfortunately, as the years passed it seemed that no one had both the motivation and the skill to tackle a project of such size and complexity. Finally, I gave up waiting and decided to do it myself.

I had five major goals in mind when I began the project. First, I wanted to use off-the-shelf equipment whenever possible. With the microcomputer becoming more of a consumer rather than a hobby item, I felt sure that many nontechnical people would like to duplicate my efforts.

The second goal was to devise a system that would be easy to install. I figured that even the most dedicated enthusiast would not want computerization enough to completely rewire a home in order to control the lights.

I also wanted the system to be easily expanded and customized. The same innovation and sense of adventure that would make a person want such a home would also make them want it his or her way. I decided to make the system as flexible as possible to ensure that subsystems could be added or deleted as necessary. Such a design would also make adapting the system to another brand of computer at least bearable.

Anytime that you add a lot of frills like voice recognition and speech synthesis to a computer project, you can expect the cost to increase. I wanted these frills though, and as my fourth goal I wanted to devise a system that would make such frills at least somewhat cost effective. The true value of some of the system's capabilities can only be measured in your desire to have them, but the increasing cost of energy has made any substantial reduction in the use of gas and electricity extremely exciting.

Finally, I wanted the system to be usable. Any system, no matter how cost effective, will not save anything if, because of the hassle of using it, it stays turned off. I wanted it to be friendly and helpful. I wanted a system that would be fondly missed the moment it broke down.

As you might guess, most people do not know what to expect from a computerized home, let alone what the requirements might be to build one. I would like to prepare you for what is to come and inform you of what knowledge and skills you will find useful if you decide to computerize your home.

If you wish to have your home computer set up exactly like mine, you might be able to do so with a relatively small amount of knowledge. You

can buy or build everything described in this book and then type in the programs provided.

I suspect, however, that very few, if any, individuals are going to run out and buy a microcomputer system just to control their home. It is much more likely that this book is being read by someone that already has a computer and is looking for a new and novel way of using it. Thus, I will assume that you have read the literature that came with your system and that you are reasonably familiar with programming in BASIC.

At least some knowledge of assembly language programming would also be nice, but unless you wish to change my system considerably it is not absolutely necessary.

If you feel you need help in any of the areas mentioned, many books are available to help you. *Microprocessors and Microcomputers* (2nd ed.) by R. Tocci and Laskowski can give you an in-depth look at both the hardware and software associated with the 6502. *Interface Projects for the Apple II* by R. Hallgren offers several specific and interesting examples. Both of these books are published by Prentice-Hall, Inc., Englewood Cliffs, N.J.

Radio Shack sells the *Engineers Notebook* by Forest Mims III. For a very modest price it will provide you with a wide variety of electronic hobby information.

Don't feel limited to these suggestions. You can find a wide selection of suitable books at almost every computer store. In your search, don't overlook the traditional bookstores in your local mall or shopping center. Even they are now catering to the needs of the computer hobbyist.

Many of the pieces of equipment needed can be purchased from various sources. If you happen to like construction projects, you can save money by building some sections yourself. Complete schematics are given for some of the more appropriate areas. There are a few things that just cannot be purchased anywhere, and if you want them you will have to make them yourself. For that reason, I suggest that for maximum benefit of this book you have some general knowledge of electronics.

My home is controlled by an Apple II Plus from Apple Computer, Inc. I chose this system because of the wide range of peripheral devices that can be purchased for it and because of the ease of connecting these devices to it.

This does not mean that if you own some other type of computer that this book will not be of interest to you. The majority of the home control system is written in BASIC and is easily used on almost any computer system. This text is designed to not just show you what I did, but to

explain how it was accomplished and why a particular approach was chosen.

I also will explain in as much detail as space permits why what I have done works. With this information, an industrious person should be able to not only implement this system on other microprocessor systems, but to customize it to meet precisely his or her requirements.

If you have not purchased a computer yet and wish to do so, I would strongly urge that you wait until you have finished the book as you will be better prepared to determine if a given system can be easily adapted to computerizing your home.

The home control system will have five basic functions. Although the modules for each of these functions are described in detail later in this book, I would like to discuss them briefly here. They are as follows:

Voice request
Phone control
Security management
Event timing
Monitor movement

The *voice request* module allows you to talk to the computer using a microphone. I use wireless mikes and have them throughout the house in strategic places. There are numerous submodules for this module that allow you to control house lighting, ask what time it is, turn on the security system, have the system place a phone call for you, shut off the stereo, and much more.

The *phone control* module serves as an intelligent answering machine. Not only can the computer answer the phone and record a message from the caller, but it will tell you when you get home how many messages you have waiting. This module also allows you to call the computer and request status information about the house or to control the lights or the heating system from a remote location.

The module for *security management* can watch for movement outside the home as well as monitor entry at doors and windows. If an intruder is detected, appropriate action can be taken. Since the system is intelligent, it can react differently if you are home or away or if the intruder is outside or inside. It can even call a neighbor and inform them of the situation.

Event timing provides a means to establish a predetermined sequence of events that needs to be done on an ongoing basis. For example, the

house might wake you at seven o'clock on weekdays but let you sleep till ten on weekends. It should control the house lighting automatically to give a lived in look whenever no one is home. The heat should be turned off or down whenever no one is home and turned on again prior to your arrival.

The heart of the event timing module is an *event table*. Each entry in the table represents an action to be taken and the time and conditions for it to occur. For example, one entry might indicate that the heat should be cut off at midnight, and another entry turns the heat on at seven o'clock the next morning, but only if someone is home. If no one is home, a different set of times and events is automatically used.

There will be a separate event or time table for each day of the week. Once you have created the proper tables, the house can handle the functions without further direction. The tables can be edited when necessary to reflect changes in your life-style.

The *internal movement* module watches various sensors to allow the system to keep track of where people are in the house. This information is used to decide what lights should be on and off.

The overall organization of the program provides that you may use any of these systems alone, all of them together, or even add some of your own. This means that if you cannot afford the hardware for all the modules at first, you may still enjoy the same functions now and easily add to them later.

I don't propose that the system here is perfect for everyone. There are certainly many unexplored possibilities available to the imaginative person. My hope is to provide you with one complete system with all the whats, whys, and hows so that you can expand and customize until your particular wants and needs are met.

This book is divided into four parts. Part I is an introduction and overview of the entire system. It is very important because it prepares you for the details to come by showing you the big picture.

Part II covers all the hardware required by the system. Things that cannot be purchased are examined in much more detail than off-the-shelf items. I chose to build several sections because of the financial incentives and also I greatly enjoy the additional learning experience. If you do not enjoy such tinkering do not be discouraged by the number of schematics in Part II, because commercial substitutes can be purchased in most cases.

Part III covers the actual program coding used to implement each program module. You will find the code well structured and easy to follow. The explanations of each module's operations will make your customizing easy.

Part IV shows how to implement the hardware and software into a

complete system. It shows how to initialize the main program and explains the utility programs that are used to maintain the required tables. The last chapter discusses some ideas for additions and expansions.

The appendixes provide a complete listing of the entire home control program and its related maintenance programs. They are listed directly from my computer in order to ensure the absence of errors. There is also a partial list of vendors to assist you in locating some of the items used in the home control system.

I have tried to organize the book in a manner that will provide you with the best possible understanding of how the entire system actually works. This is especially important because, as I have mentioned, it is doubtful that you will wish to duplicate exactly my work. I expect you to improve on the system in every way you can. In fact, by the time you are reading this I probably will have added several improvements to my own computerized home.

Wherever applicable, I try to use novel approaches in my computerization, especially if it makes the system more cost effective. You may choose to use some of these approaches if you customize my system, although perhaps in different ways. I hope that I have provided stimulation in enough areas to ensure that you can create a system that meets your specific needs.

The rest of Part I will provide you with a complete overview of the system, both the hardware and the software. Read these chapters more than once if you really are planning to add a computer to your home. Make sure that you truly understand how the system is organized and what each module's responsibility is.

While you are reading, do not worry about the details of how a module accomplishes its task, but rather concentrate on how the combination of modules forms a means of intelligent control. As an example, let us assume we have a module that dials the phone. Do not be concerned with how the phone is actually dialed. That will come later. For now observe when and why the "dial phone" module is called to perform its task.

Not only will this approach provide you with a better understanding of the system, but it will make it easier to transfer this program to other computers or to implement it with other peripherals.

Let me cite one more example to help make my point. One of the modules in the system reads the electronic clock to find out what day it is and the time. Numerous clocks are available for the Apple, not to mention those for other computers. If you choose to buy a different clock from mine, you would only have to rewrite the "read clock" module, which is

very short. All the modules that use the ''read clock'' module could be used without modification.

Since low-level modules, such as the ''read clock'' module, have single specific objectives, they are generally easy to rewrite. In fact, the instruction manual for the peripheral involved should provide all the necessary information to do so.

2 System Overview: Hardware

Now that you have a good idea of where we are going, its time to get started. In this chapter I will present an overview of the system hardware. Remember, try not to worry about details. Later sections will discuss in detail the schematics and/or sources for purchasing the items mentioned here.

It is also important to mention that you are by no means limited to using the hardware described in this book. The system is set up in such a manner that you can very easily use alternative devices in almost every case.

Figure 2.1 shows a block diagram of the entire home control system. I realize this diagram is complicated, but I feel it is necessary to get a good overview of the system. Later in the book a whole chapter will be devoted to each item mentioned here.

Let us examine each part, starting from the top of the figure. The voice recognition unit provides us with the primary means of communicating our commands to the home. It consists primarily of an analog-to-digital (A/D) converter that transforms the amplitude variations of your voice into patterns of 1's and 0's that the computer can analyze. It will be from this analysis that the computer can determine what word or words are spoken.

As nice as it is to speak to a computer, you will probably find, as I did, that the novelty wears off very fast if you have to walk halfway through the house to get to the microphone to turn on a light. There are

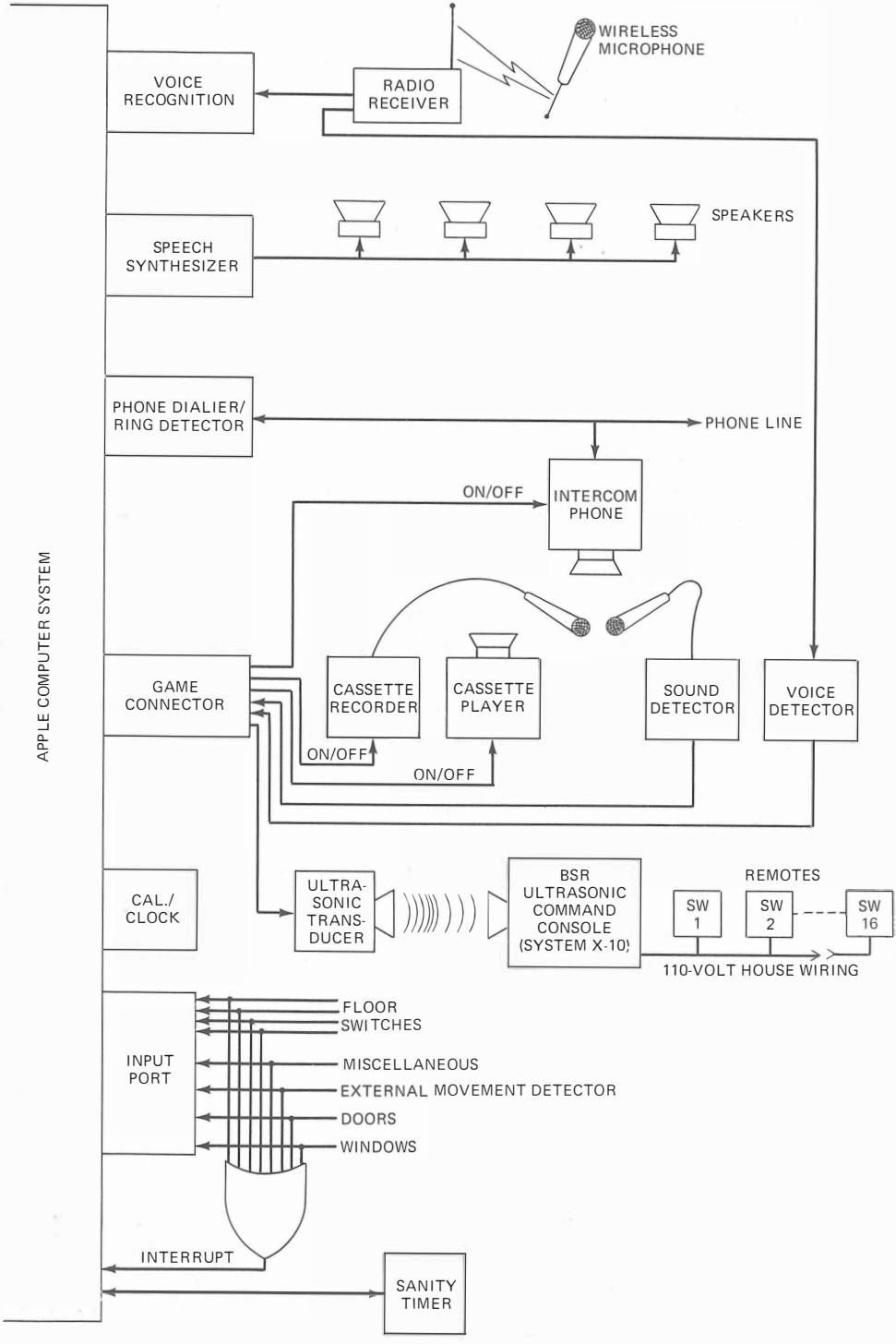


Figure 2.1 Detailed block diagram of the complete home control system.

many possible solutions to this problem, but I chose to use a wireless microphone, which is comprised of a small radio transmitter and receiver.

The wireless system must be of high quality or it will be difficult, if not impossible, for the computer to understand your commands. Fortunately, such systems are not as expensive as you might imagine. You may even decide to have several microphones throughout the house at strategic locations.

Naturally, if you are going to talk to the house, you will expect it to talk back. You will notice that I sometimes refer to the house rather than the computer. This transition may seem a bit harsh at the moment, but you will find it to be a very natural adjustment.

The speech synthesizer will produce a voice that can easily be sent to every room in the house. The speakers can be mounted in the ceiling or placed in any convenient location. I prefer to have mine behind a plant or otherwise camouflaged so that the illusion that the house is speaking is further enhanced.

As you will see in later sections, the house will take on a personality. The personality chosen for this book is meant to be somewhat neutral, but you will be able to tailor yours to suit yourself. It will be a combination of the personality and the fact that you can communicate with the house as you would with a person (with speech) that will soon convince you that the house and the computer have become one.

Some people might find such thoughts a bit disconcerting. I suspect, however, that the idea of machine intelligence is somewhat intriguing to you or you would not be reading this book to begin with.

Continuing down Figure 2.1, we come to the telephone portion of the system. The major element is an intercom telephone. The phone itself, as well as many of the associated controls, is interfaced to the computer through the Apple game connector.

The game connector provides an easy means to connect external devices to an Apple computer. It has three primary capabilities. They are paddle inputs, switch inputs, and annunciator outputs.

Game paddles and joysticks are the most common items plugged into the connector. For such devices, the paddle inputs convert the value of a variable resistance into a number between 0 and 255. The switch inputs are used to read the on/off condition of a switch, which usually controls a game function in some manner.

The annunciator outputs are seldom used by the commercial devices for the game connector. Since they are output pins, they can be used to turn on or off a transistor, relay, or almost anything you desire.

The switch inputs and annunciator outputs are nothing more than

one-bit input/output (I/O) ports. The home control system will use them to read from or to control external devices. If you are not using an Apple to computerize your house, you can easily substitute a standard bidirectional port for these pins. Chapter 12 discusses input/output ports in detail and will provide you with additional information.

The paddle inputs would be a little more difficult to simulate on another computer. For this reason, I have chosen not to make use of them in the home control system. Let's look specifically now at the I/O pins of the game connector and how they will be used.

The Apple's game connector has four output pins that can be used to control external devices, and it has three input pins for reading the status of external data. One of the output pins is used to turn the intercom phone on and off. This allows the computer to answer the phone for you and permits you to talk over the intercom from anywhere in the room. The phone dialer provides a means for the computer to call a requested party. Proper control of these functions can mean that you never again have to touch the phone.

A ring detector informs the computer when incoming phone calls require processing. One of the computer's responsibilities will be to act as a phone-answering machine if you are not available to get to the phone. Rather than have an electrical connection directly to the phone lines, which requires special equipment and a notification to the phone company, I decided to let the computer communicate with callers just as you would—by speaking on the intercom phone.

The computer already has a voice, and it could easily be used to inform the caller of your message. Unfortunately, most voice synthesizers presently affordable by the average hobbyist take a little getting used to. This should not imply that they are extremely difficult to understand; on the contrary, after only a few minutes of practice most synthesizers become reasonably clear.

A person calling on the phone, however, does not expect to be greeted by an electronic voice and does not have time to get used to the computer's peculiar accent. Add to this any distortion added by the intercom phone and you might have many of your callers simply hanging up rather than leaving messages.

However, I just happened to have a couple of cheap cassette recorders laying around from the days before disks and arrived at my final phone answering system as follows.

One of these recorders is set in the playback mode using a 30-second endless loop cassette. The other has a regular tape and is left in the record state. Two more of the game connector output pins are used to control the

on/off condition of the two tape recorders. When the phone rings, the computer can turn on the intercom, play the 30-second message, and then record any reply from the caller.

A sound detector is used to allow the computer to determine if there are sound changes or voices present. Using this capability, the system can record only as long as the caller is actually talking. This permits messages of any length and also keeps you from having a 30-second tape of a dial tone if someone hangs up.

For most calls, all you will want the computer to do is record the message. If it is you that is calling, however, you might want to communicate with the computer to issue special requests. The computer could then give you a status report for the house, this time in its own voice. You might wish to tell the house to turn on the heat, turn off a light, or anything else that the system is capable of handling.

Naturally, you will not want just anyone to be able to communicate directly with the system, so a way must be devised to inform the house that it is you calling. My method is simple. While the message is being recorded, the computer will continue to monitor the sound detector, watching for a particular sequence of sound. You can indicate it is you calling by playing the proper sequence into the phone, using a small hand-sized tone generator. As long as you have this generator, you can gain access to the computer anytime you call the house.

Another detector is used by the system to determine when you are trying to get the computer to respond to voice commands through the wireless mike. The process of understanding speech is very difficult and time consuming and will not be invoked unless it is required. Normally, the computer will not bother to analyze sounds present at the A/D converter. It will, however, watch the input from the voice detector, which is very easy. If you should pick up a wireless mike and say "computer" (or anything else for that matter), the computer will see the voice detect pin change and respond by saying something like "Yes sir, what can I do for you?" and then monitor the A/D converter for your response.

The last output pin on the game connector is connected to an ultrasonic transducer. This device is much like a loudspeaker for your stereo except that it is much smaller and can produce ultrasonic waves, which are sound waves above the range of human hearing.

To see the importance of such a capability, let's discuss a commercial device called the BSR System X-10 Ultrasonic Command Consol. This device can be purchased in many department stores. Sears Roebuck even markets the same device under their own name.

The console plugs into any 110-volt outlet and generates coded pulses for each button pressed on the console. These pulses travel throughout your house on the existing house wiring. You can buy remote switches from BSR that can replace wall switches and receptacles at appropriate places in your house.

These remote switches contain electronic circuits that constantly monitor the power lines for pulse codes from the command console that can inform them to turn on or off. This allows you to control lights throughout the house simply by pressing buttons on the command console.

The BSR system provides a relatively inexpensive means to control many of your lights and appliances from a single location. The ultrasonic model of the command console has an additional feature that makes it especially attractive for our purposes.

Just as some TV sets can be controlled by aiming an ultrasonic unit at them, the BSR ultrasonic console can be manipulated using a cordless controller that generates ultrasonic pulses that can be received and interpreted by the command console.

Under program control, the house computer will generate the appropriate ultrasonic pulses using the game connector and the transducer previously mentioned. In this manner, the computer may control any device in the house that is equipped with a BSR remote switch.

Naturally, we will want the computer to control lights and appliances when verbally commanded to do so. In many cases, though, we will not wish to be bothered with trivial matters and will wish the house to handle them on its own.

Some examples of trivial actions would be turning off the heat every night at midnight and then back on at seven the next morning. Since these two actions occur on a regular basis, they should be handled automatically.

To provide a means for the house to handle such actions, a special clock will be interfaced to the computer. It will tell the house what time and what day it is. Using this clock, the house will be able to handle routine tasks without any human intervention at all.

There is another type of action that the house should handle for you automatically. As mentioned earlier, the system should monitor the movement of people throughout the house and control the lights accordingly. To provide the movement information, pressure-sensitive switches are placed at strategic positions under the carpet. These switches are connected to an input port so they may be read by the system.

This same port will monitor other switches and detectors that will provide the information required by the house to monitor security matters.

The closure of any switch will trigger an interrupt to get the computer's attention. The computer's reaction to interrupts is discussed in more detail in the next chapter.

The last piece of hardware to be mentioned now is the system sanity timer. It will ensure that the system software cannot fail even if unpredictable errors occur. A complete explanation of this subsystem will come later, but for now just accept the fact that if the system ever fails due to software faults the entire system will be reinitialized from disk and proper control resumed.

Now that you have had your first glimpse of what the home control computer will look like, let us start examining an overview of the software required to give the house its intelligence.

3

System Overview: Software

Now that we have an overall picture of the hardware needed to computerize your house, its time to begin looking at how the programs will be organized. The importance of understanding the software cannot be overemphasized. Although the home control system presented in this book is complete and usable as described, it can be enlarged and customized in many different directions with very little if any additions to the hardware. To do so, however, will require an in-depth knowledge of the present program.

As with the overview on hardware, do not worry about details when reading this section. Later in the book we will find out exactly how to accomplish each function described here. At this point, however, you should be striving to see how each module relates to the overall operation of the program.

The flow chart in Figure 3.1 shows the primary organization of the home control program. The system is organized into five major modules. We will look at each separately.

The *initialization* module is only run when the system is powered up. It checks to see what day it is and sets up the appropriate files. It can adjust to the present status of events without human intervention. This is particularly important if you are out of town and the system has to restart itself after a temporary power failure.

Once initialization is complete, control passes to the four modules

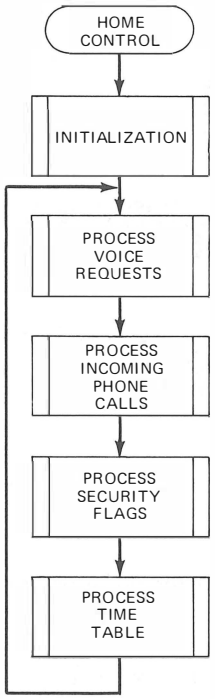


Figure 3.1 Flow chart showing the primary modules in the home control software.

that handle the primary actions. The functions of these four modules were described in Chapter 1.

Usually, there is nothing happening that would require the attention of any of these modules. Control is continually passed from one to another, waiting, or if you prefer, watching for a situation to occur that requires attention. For example, if the voice detector does not show that someone is requesting to talk with the system, then control passes on to the *phone* module.

If the phone is not presently ringing, then the *security* module takes over. If conditions show that all is well, the *time* module processes the next item in the present time table. Afterward, the entire process starts over.

In this manner, the loop normally completes very quickly so that the system appears to be watching all the potential situations simultaneously. If, while the system is looping, any of the modules find that a task needs to be done, the system will spend the time necessary in that module to complete it. Once that task is completed, the looping will continue.

Let's briefly look at lines 10 to 60 in Appendix A. As odd as it may seem, these lines represent the main home control program. Of course,

each of the subroutines called will have to be expanded and coded. I will discuss each in detail as we move through the book.

Although the system can only process one thing at a time, usually it will only take a second or so to respond to an external stimuli, such as an intruder or the phone ringing. Such a small delay obviously presents no real problem. If the system is busy in one of the modules though, it might take much longer to respond.

At first glance, this possibility of lengthy delays appears to present a real problem. Fortunately, there is very seldom a situation in which one module needs to take immediate priority over another module. Furthermore, in almost every instance that a valid conflict occurs, there is a human present to decide on which module should get control.

Perhaps some examples of such conflict can make this clearer. Assume for a moment that you are talking with the computer, thus making the voice module busy. If the phone should ring and you want the house to process it, you may simply say "goodbye." This would cause the voice module to terminate, and the system would continue through the loop and process the phone call.

If you were not home to tell the computer "goodbye," there would be no problem to begin with, because you would not have been talking to the computer and it would have answered the phone automatically.

For a second example, assume that the computer is answering the phone during the time an event, such as turning off the heat, is scheduled in the time table. The event timing module is designed so that, even if the scheduled time has passed, the event will occur the next time the module is run.

Thus even in the worst case an event would be processed within a minute or two of its scheduled time. Furthermore, remember that such a delay will only occur if the phone just happens to ring when you are not at home and just when an event is to be processed. The infrequent occurrence of such situations does not, at least for me, deserve enough attention to increase considerably the complexity of the system.

If we go through a similar process for each possible situation it can be shown that there are two situations that truly represent a potential problem. One problem is that the security system is inactive while the computer is acting as a phone-answering system. In this case, even a one-minute delay might determine if an intruder could be easily scared away by turning on appropriate lights and the radio. As before, no problem exists unless just the proper set of events happens at just the right times. Even so, I value security enough to see this as a major concern.

To solve this dilemma, the phone module will also monitor a security flag (which indicates some kind of security problem exists) and, if necessary, end the phone call and continue looping. The security module would then react appropriately to whatever situation had occurred.

As you can see, because it is seldom that two tasks are required at exactly the same time, the entire system can appear to be handling all the tasks simultaneously even though the program is sequential in nature. It is this sequential format that makes the system so easy to program.

The second problem is one that cannot be handled on the first come, first served priority arrangement that I have shown so far. You may have noticed that, although I mentioned earlier that the house would monitor the movement of people, there is no module in the main loop to provide this function. For this function the system needs the ability to respond immediately, no matter what it is doing. After all, if you have to wait even a few seconds for the lights to come on when entering a room, this module looses its usability.

To provide this immediate action, all the floor switches as well as

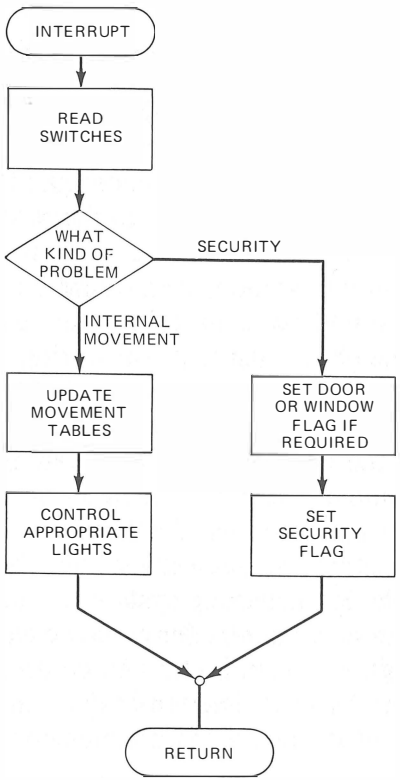


Figure 3.2 An interrupt system handles problems that cannot wait.

security detectors will cause a computer interrupt to be generated. An interrupt simply tells the computer to abandon what it is presently doing and process some other program. When this second program is completed, control is passed back to the original program at the point where the interrupt occurred.

A functional flow chart of the interrupt program is shown in Figure 3.2. When an interrupt occurs, the computer will read the switches to determine if it is a security problem or if residents are moving inside the house. If it is a security situation, certain flags will be set (including the security flag) to convey that information to the main program.

If it was internal movement of the residents that caused the interrupt, the appropriate lights will be turned on and/or off. Since this interrupt program always requires less than two seconds to run, it is unlikely that any module presently active will even notice the interruption.

If you should feel unsure of how all this is going to be accomplished, please don't be discouraged. So far we have only touched the surface. Rest assured that the details are coming.

By now you should, however, have a better idea of what the computerized house can be expected to do. You should know what general types of hardware will be necessary to allow the computer to gather information and to communicate with the outside world.

You should also be starting to see how the program will handle the many different types of tasks that will be required. If you are unsure of any of these areas, you may wish to reread some parts of this section. Otherwise, let's move on to Part II and start examining the hardware in detail.

4 The Voice Recognition System

In this and the following chapters in this section, we will be looking at the hardware required to automate your home. There are several things that should be emphasized before we begin.

First, all the hardware discussed in this section is only a suggestion. True, I have tested this particular combination of hardware and have solved the problems related to it. In doing so though, I also tried to develop a system that was very modular.

Each section of the hardware is interfaced to the system only through its function. This means that any equipment that can provide the correct function should be easily adaptable for use in the home control system.

As you read this section, you should also realize that the intelligence in the home control system is found in the software and not the hardware. This section is not intended to explain how the system works. What it will do is to provide a thorough understanding of the environment that the software must run in. With this in mind, let's look first at the system that processes voice requests.

Giving a computer the power to recognize speech is far from an easy task. Fortunately, several companies have done a great deal of research in this area and have produced commercial products for personal computers that can aid us tremendously.

One such company was Heuristics. They produced two low-cost voice recognition systems. Their Speech Lab could recognize 32 words

and their Speech Link was capable of 64. Unfortunately, Heuristics went out of business just after I had completed the computerizing of my home using a Speech Link.

Some dealers may have Speech Links still in stock. If you cannot find one, there is no need to worry. It will be very easy to interface virtually any speech recognition system made for your computer to my software. I will discuss equipment substitution in detail later.

The Speech Link is a user-trainable, isolated word recognition system with a maximum standard vocabulary of 64 words. User-trainable means that the prospective user must initially "say" each word for the system so that it can create a template in memory of what each word looks like. Each time a sound or word is to be recognized, a new template will be formed and it will be compared against the templates in memory to find the best match.

Isolated word recognition simply means that the system can only recognize a word by itself. This is opposed to being able to pick a word out of a sentence. If you were to read this paragraph out loud, it would become quickly apparent that in normal speech there are very few pauses between words. This lack of pauses is one of the major obstacles to be overcome if a machine is to effectively understand human speech. To stay cost effective, we will have to settle, at least for the present, for isolated word recognition. You will see later that the proper software can make this restriction much less binding.

The Speech Link is very easy to use. It effectively allows the Apple command "INPUT A$" to wait, not for a keyboard entry, but for a word to be spoken. This word may actually be a phrase of several words as long as there is no significant pause between the words.

The software explained in Chapter 16 will utilize the contents of the string variable (in this example A$) to determine the action required. For now, however, we need to examine the special hardware requirements of the system.

We will not examine the Speech Link itself in any detail. For such information you should consult a Speech Link manual. Instead we will be looking at some hardware that will make the Speech Link much more usable for our application.

There are two major problems with most commercial speech recognition units. First, once the system is directed to recognize something, it will, as you would suspect, wait until some sound has occurred and then analyze it. On the surface, this appears very usable.

To see the problem, consider the structure of our home control system. It normally loops from one module to another. If there is no verbal

input, we want the system to continue on through the loop to perform the next task. If, during each loop, we ask the Speech Link to check for a sound, it becomes quickly apparent that if no sound occurs the system will "hang" in that module.

To solve this problem, we simply need some means for the main program to know when someone wants to speak to the computer. We might do this by simply connecting a switch to an input pin. Depending on the position of the switch, the computer would get either a 1 or a 0 when reading that pin. The computer could use this information to decide whether or not to turn control over to the Speech Link.

We will return to the first problem in just a moment. Another problem with using voice control of a house is that you may not be beside the computer, or more specifically beside the microphone, when you wish to issue a command. This problem can be solved in a variety of ways.

If you only have a couple of places in the house that you wish to issue verbal commands from, you might actually run microphone cables to those spots. A mixer could then be used to combine the signals before sending them to the Speech Link.

Although this method can be very acceptable, I decided to add more flexibility by using a radio transmitter and receiver. In this way, the microphones are completely wireless and permit use anywhere in the home.

The method chosen to solve the first problem will effect the solution to the second. If, for example, you run cables to each mike, you could also run wires for switches to tell the program when to turn control over to the Speech Link. If you are using wireless mikes, though, you lose all their flexibility if you must go to a specific place to press a switch in order to get the computer's attention.

Since I wanted to use wireless mikes, I solved this problem by having a special circuit watch for sound changes at the receiver and place the appropriate 1 or 0 on one of the Apple's game connector input pins. There are three of these pins on the Apple game connector, two of which are normally connected to switches on the game paddles.

Figure 4.1 shows the schematic for the sound detection circuitry. Note that the output of the circuit is connected to the game connector so that a program could decide if there was any sound present by reading the status of the appropriate address. This would be done in BASIC with the PEEK command.

The operation of the circuit is straightforward. The output of the receiver is sent to the first operational amplifier, which is used as a buffer to prevent loading. The gain of the second amplifier is controlled by the

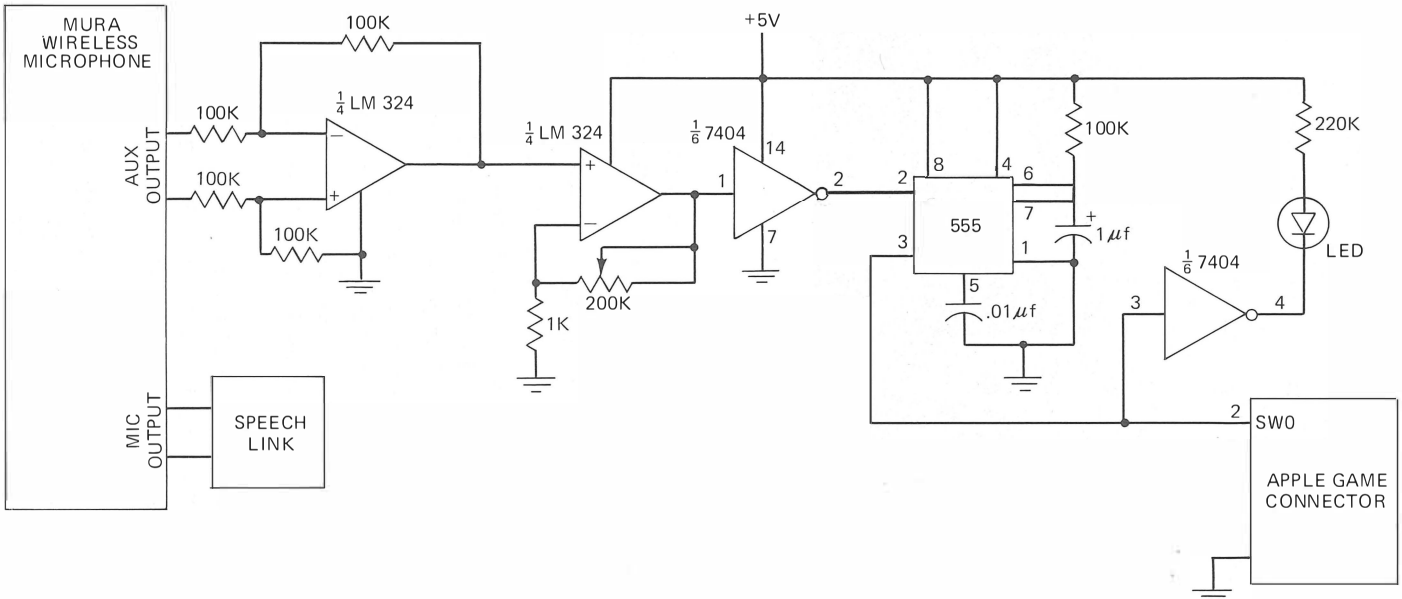


Figure 4.1 This circuit serves as a voice detector so that the computer can quickly determine if someone wants to issue verbal commands to the system.

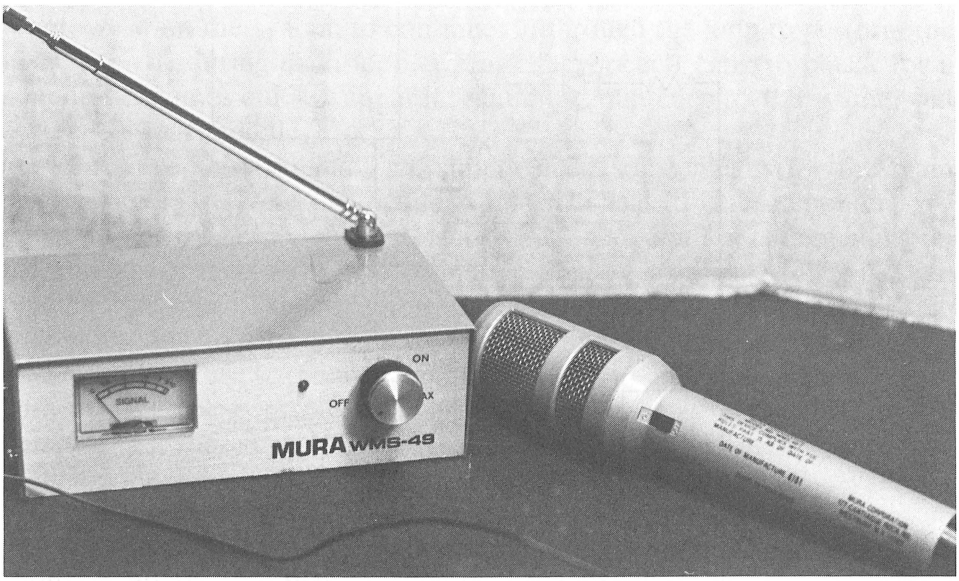


Figure 4.2 A wireless microphone allows you to talk to the computer from anywhere in the house.

200K potentiometer. The amplifier output is turned upside down by the 7404 inverter. The pulse from the inverter is stretched by the 555 in order to make it easier to recognize.

Whenever a sound is present at the wireless mike, the game connector pin will be held high. The main program can monitor this pin to determine if it should stop and carry out verbal commands.

The wireless mike must be of a fairly high quality or the Speech Link will not operate satisfactorily. I tried several units with very limited success. Finally, I found one that seems to be perfect. It is a model WMS-49 wireless microphone system by Mura. It is pictured in Figure 4.2 and comes with a microphone and a receiver, both operated from 9-volt batteries. Since the receiver needs to be left on continuously, I use a battery eliminator.

Another nice feature of the Mura unit is that it has two outputs on the receiver. The microphone output connects to the microphone input on the Speech Link while I use the auxiliary output to drive the voice detection circuitry as shown in Figure 4.1.

If you use some other wireless microphone system, you should consider having the following features. The receiver and transmitter should be crystal controlled to ensure drift-free reception. The frequency response should be as wide as possible. The Mura unit is 30 to 18,000 hertz

(Hz). A microphone output (in addition to an auxiliary output) is really necessary to ensure a proper impedance match to the Speech Link.

The gain of the receiver should be adjusted to give the best results with the Speech Link. The only way to make this adjustment is through trial and error. Once that is done, you will need to adjust the 200K potentiometer (Figure 4.1) so that the LED glows only when you speak into the mike.

This completes the description of the hardware required to allow voice command of the house computer. Even though I am using the Speech Link, almost any voice recognition unit may be used. In later chapters we will see how the proper software can give intelligence to the recognition capability discussed here.

5 The Voice Synthesizer System

Being able to talk to your computer is very nice. If the "conversation" is to be complete though, we will have to give the house the power to talk for itself. With today's technology, we have many methods to choose from.

We could utilize an A/D (analog-to-digital) converter to sample an actual voice. These samples could be stored in the computer's memory and then played back at any time by using a D/A converter. Using this method, you can get excellent quality speech, but at a very high cost. What you must give up is memory. It is not unreasonable to use well in excess of 4000 bytes of memory for each second of speech using this method.

Linear predictive coding (LPC) is another method for reproducing speech. This technique is used in the Texas Instruments' Speak & Spell. The data compression technology used permits a second of speech to be stored using only a few hundred bytes of memory, and the quality of speech is still very good.

The problem with LPC is that the data used to generate the speech are very complex and are provided to the user in the form of read-only memory (ROM). There are many words and phrases offered, but you are, for the most part, limited to a severely restricted vocabulary.

As I designed the home control system, it became quickly apparent

that I needed a nearly unlimited vocabulary if the system was to communicate in the manner I was planning. I also needed a method for storing speech that was extremely efficient if my home was to say more than a few sentences.

A company called Votrax has been utilizing a technology that differs distinctly from the two methods just discussed. First, they do not copy or reproduce a human voice. Instead they have developed a set of filters that can simulate the human vocal track.

By sending codes to their system, you can instruct it to produce any of the basic sounds used in the English language. These sounds are called phonemes. Since each phoneme requested requires only one byte of memory, and since most words require less than ten phonemes, the amount of memory used is almost trivial.

In addition, you can have the computer say anything you wish, as long as you can decide on the basic phonemes required for each word. As you would expect, you do have to give up something in exchange for all these pluses. The quality of the speech is somewhat less than with the other methods.

At first it may be difficult to understand. My experience has been that after only a little practice you get used to the peculiar "accent" found in the Votrax synthesizers. Recently, Votrax introduced a single integrated circuit that has all the filters on it. This has spurred the release of a new type of product from several companies.

The new products not only have the capability to produce phonemes on command, but they have a built-in microprocessor with the software to convert standard English text into its appropriate phonemes. Some of these products also add inflection to the speech, which makes it much easier to understand. Any of these devices satisfy all the major requirements I had for giving a voice to my home.

I own two such voice synthesizers, a Votrax Type 'N Talk and a Microvox from Micromint. They are shown in Figure 5.1. Either can perform satisfactorily for your computerized home.

Although I have not done any scientific studies, I think the Type 'N Talk makes fewer errors when it translates text to speech, although there is not really much difference.

The Microvox is much faster and has less pause between the words spoken. It also offers you the ability to control the pitch on individual words or even syllables so that the quality of the speech can be greatly improved. With a little work, you can even have it waking you each morning to a song.

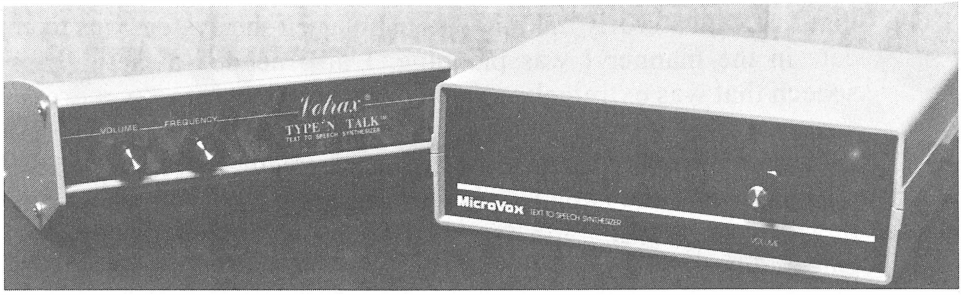


Figure 5.1 There are many speech synthesizers suitable for giving your home a voice.

The Type 'N Talk requires a serial port to connect it to a computer. You may use either serial or parallel with the Microvox. If you really enjoy construction projects, as I do, you will appreciate the fact that the Microvox is available in kit form.

Whether you choose an assembled unit or the kit, the Microvox comes with complete schematics and numbered parts. This is not true with the Type 'N Talk.

Either system is about as easy to use as a printer. In fact, I connect them to my computer using a standard RS-232C printer interface. You activate it exactly as if it were a printer (PR#1 for example), and the system simply says anything that would normally be printed.

Figure 5.2 shows the hardware organization for using a synthesizer. A RS-232C serial card connects the unit to the Apple. The connecting cable may need to be slightly different for different serial boards, but any qualified dealer should be able to assist you.

There is an amplifier built into the speech synthesizers, but it is small and only meant to drive one or two speakers. I connected the synthesizer output to a 5-watt transistor amplifier that had been gathering dust in the garage for years. Since I did not want a booming voice from the house, the 5 watts was plenty to drive several more speakers.

To keep the speaker load as close to 8 ohms as possible, you should use a series–parallel arrangement such as the one in Figure 5.2. Depending on the number of speakers you require, you may not be able to get an exact match, but you should at least keep it in the right ball park.

The Type 'N Talk has a frequency control that allows you to control the pitch of the voice manually. At the high end the computer sounds like a chipmunk, and at the low end it is more like a 45 record playing at the 33 speed. Experiment a little with the frequency until you find a sound you like.

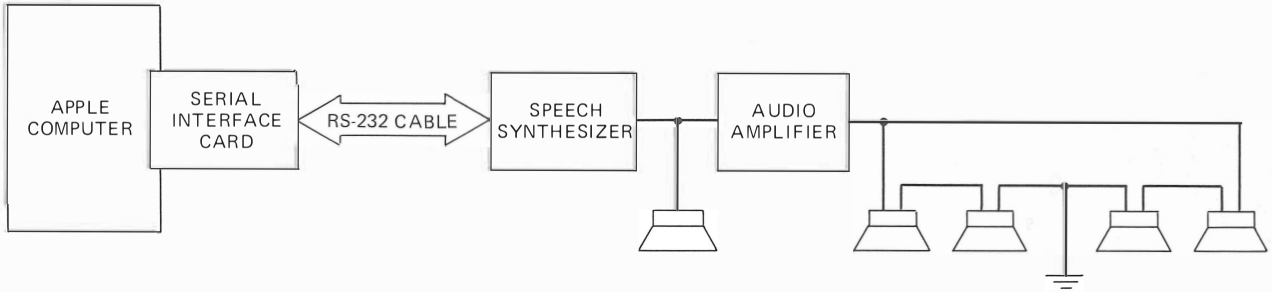


Figure 5.2 An additional amplifier allows the synthesized voice to be heard throughout the house.

The Microvox defaults on power up to a mode similar to the Type 'N Talk, that is, monotone speech. If you wish, you can insert your own pitch variations under software control or even choose a mode where inflection is added automatically, although somewhat arbitrarily.

Remember, this only provides the computer with the ability to speak. The software is what will give it the intelligence to know what to say.

The System Clock

One of the most important capabilities you can have in a home control computer is the ability to tell time. This capability is not only desirable but essential for many of the tasks we expect our home to perform. Let's look again at some of those tasks.

Whenever the system is first turned on, we will want it to initialize itself. Part of this initialization is to establish if anyone is home. We will see later that it will simply ask (verbally, of course) to see if anyone answers. If a short power failure were to cause a system reinitialization in the middle of the night though, we would not want the house to wake us just to ask if we were home.

In such a case the system will be able to ascertain whether it should check to see if anyone is home by reading the system clock. If the time falls within a given range, the house will make some appropriate assumptions and carry on without disturbing anyone.

To handle the preceding situation, we need a system clock with two capabilities. First, as with any clock, it must be able to keep track of the time. It does not need to be extremely accurate. Hours, minutes, and seconds will be more than ample for our needs. We will also need a means to determine if it is A.M. or P.M.

The second requirement is the ability to operate in the event of a power failure. This necessitates some form of battery backup. Let's look

A3	A2	A1	A0	USE	RANGE
0	0	0	0	LSD - SECONDS	(0-9)
0	0	0	1	MSD - SECONDS	(0-5)
0	0	1	0	LSD - MINUTES	(0-9)
0	0	1	1	MSD - MINUTES	(0-5)
0	1	0	0	LSD - HOURS	(0-9)
0	1	0	1	MSD - HOURS	*
0	1	1	0	DAY OF WEEK	(0-6)
0	1	1	1	LSD - DATE	(0-9)
1	0	0	0	MSD - DATE	(0-3)
1	0	0	1	LSD - MONTH	(0-9)
1	0	1	0	MSD - MONTH	(0-1)
1	0	1	1	LSD - YEAR	(0-9)
1	1	0	0	MSD - YEAR	(0-9)

*D1 – D0 USED FOR HOURS
D2 – 0 FOR AM OR 1 FOR PM
D3 – 0 FOR 12 HOURS OR 1 FOR 24

Figure 6.1 Functions available on the 5832 clock chip.

at some of the other expected uses of our clock to see what other functions will be needed.

The event timing module was mentioned briefly earlier. It will give us the capability to arrange for events to occur at prescheduled times. These events will be stored in time tables on the disk. For them to be effective, there will be a separate table for each day of the week. You could, for example, schedule different wake-up calls on different days or to turn the TV off at 9 P.M. on weeknights.

For our system to provide us with such flexibility, we must provide it with the ability to know what day it is. Our clock then should also include a calendar. Actually, we can see that for our purposes we do not need a complete date, but only the day of the week. There will be other uses for the clock in our home control program, but the capabilities listed so far will cover these uses.

To provide our system with such a clock, we only need to visit a local computer store or flip through the pages of a personal computer magazine. Many clock boards are available for the Apple computer, and nearly all provide at least the capabilities that we have mentioned. Most in fact are vastly superior to our modest needs.

Because of this and due to my love of tinkering with hardware, I decided to build my own clock. After comparing several of the possible alternatives, I decided to center my efforts on the MSM5832 clock/calendar chip from OKI. It had all the necessary requirements, including the fact that it was inexpensive.

Some of its features are a crystal-controlled oscillator on the chip, a single 5-volt supply, a 12- or 24-hour format, and a low power dissipation for battery backup. The entire clock is packaged in an 18-pin DIP.

Data are sent to and read from the 5832 over four data lines. These

data lines are connected internally to the clock chip's 13 major registers. The function of these registers is shown in Figure 6.1. If, for example, you wish to find out what day it is, you could have a program read register 6. The chip uses four address lines to select the register to be used.

For some functions you need to read two registers. The seconds are a good example. Suppose the time was 28 seconds. Register 1 would hold a 2 and register 0 would be 8. By manipulating the address lines and then reading the data lines, we can have access to the correct time and date. We would set the time of course by writing to the same registers.

In addition to the address and data lines, four other lines control the 5832. These lines are the chip select, hold, read, and write. Figure 6.2 shows how all these lines will be connected to a peripheral interface adapter (PIA) I/O chip. The PIA provides a convenient means to connect something to a computer. Chapter 11 will discuss the PIA in more detail. For now, just assume that the computer can read or write over any of the port lines.

The four least significant bits of port A connect to the clock chip's

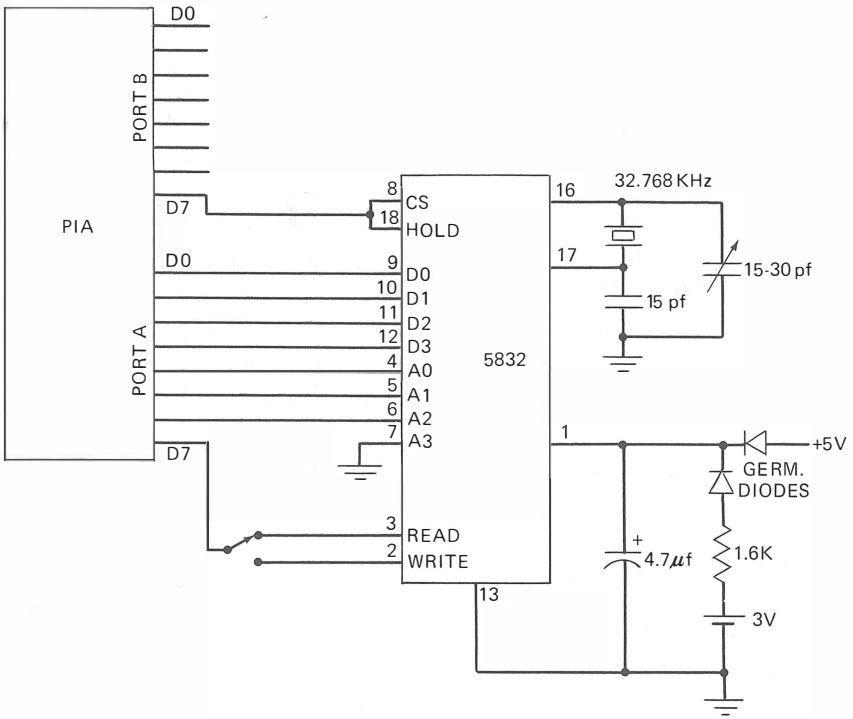


Figure 6.2 The 5832 clock chip can easily and economically provide the house with the time and day of the week.

data lines. Reading these will give the contents of one of the 13 registers, depending on the address lines. In my case, I tied the most significant address line to ground (pin 7). This means that only the registers 0 to 7 are available to be read from or written to. These eight registers are enough to provide all the capability we discussed earlier.

I did not require the ability to set the time by writing to the clock's registers without my intervention, so I used a switch to manually select either the read or the write line. This uses up all the lines on port A. Unfortunately, we also need to control the chip select and the hold line. These two lines can be connected together and will allow us to effectively stop the clock momentarily. This is important during a read, because if a register is changing at that time, extraneous data might result.

Since I had to use more than one port to control the clock, you might wonder why I did not go ahead and use the second port to control the read and write lines separately. I could also have used a line for address 3 rather than grounding it. Such a method would certainly give the clock more flexibility and power. My method results in all the capability I need, and it leaves seven lines free on port B, which is enough to drive many peripherals, such as a printer, or for expansion of the home control system.

A crystal is connected between pins 16 and 17 to ensure accuracy. Even so, you will need to make some minor adjustments with the associated capacitors to fine tune the clock speed.

The battery backup circuit that I used is a little simpler than others that I have seen. It is meant to be used with two ordinary nonrechargeable batteries. I have been using AA cells for nearly a year with no need for replacement. You should make sure the diodes used are germanium rather than silicon in order to keep the supply voltage within tolerances. There is one point that may be obvious, but it should be mentioned anyway. The ground for the clock (and all peripherals) should be connected to the Apple's ground.

As simple as it looks, that's all that is required to make a clock for our system. Of course it will take the right software to read it and set it. This software will be discussed in detail in later chapters, and I hope you will find that it will be easier than you think.

I do wish to remind you that the home control program is designed to work with just about any clock available for the Apple. As we will see, only a few minor modifications will be necessary.

7 The Failsafe System

If I am going to have a computer control my home, I want that computer to work—always! It must be able to contend with every reasonable situation that I can anticipate and perhaps even some that I cannot.

There will of course be some limitations. We cannot reasonably expect it to work when someone unplugs it or attacks it with a hammer. We can, however, make it intelligent enough to handle power outages and perhaps even recover from its own software errors and intermittent hardware problems.

Perhaps you are wondering why I am worrying about such a "trivial" problem. For those of you that fall into this category, a short explanation can be beneficial.

When you put the computer in charge of your home, you are delegating tremendous responsibility. Let's examine some of the functions given to the computer. One is to act as your alarm clock. Imagine how inconvenient it would be if you could not depend on the house to get you up at the correct time. Have you ever had a clock that was not dependable? How long did it take you to get rid of it?

Consider getting up in the winter to a cold house because the computer has failed to properly control the heat. Don't forget how failures in the phone answering or security system could affect you.

These and other functions represent very important tasks. If the

home control system is to really be valuable, it must be given responsible tasks. If we are going to trust part of our daily activity to a computer, we must make sure that it can react appropriately to problems that might occur.

I don't mean to imply that personal computers are not reliable or that software cannot be debugged completely. On the contrary, microcomputer systems are extremely reliable and my software has gone through considerable testing.

Even so, you never know when one of the thousands of tiny transistors inside just one of the chips is going to fail. You never know when just the right pattern of events will put the software through a sequence that was never anticipated. It is unlikely that either of these situations will occur, but neither you nor I can guarantee that they will not.

Furthermore, there are other potential failures that are nearly impossible to predict. They all center around the power lines. No matter how good a power company you have in your area, the line voltage is constantly fluctuating because of changing loads like air conditioners and other large appliances. In addition, there may occasionally be large noise spikes on the line due to line switching at the power company, lightning striking a transformer, or even a shorted vacuum cleaner at your neighbor's home. To keep things simple, we will group these types of power line failures into two categories: (1) lengthy failures that cause the computer (and everything else in your home) to be inoperative, and (2) short, but large fluctuations in the line voltage.

Let's examine each of these failures. Lengthy delays are probably the easiest to deal with. The Apple computer has a power on reset and special initialization software in its auto-start ROM. This may sound complicated, but it boils down to the fact that an Apple computer will automatically RUN the "HELLO" program on whatever disk is in the drive whenever the Apple is turned on.

Thus whenever a lengthy power failure occurs, the "HELLO" program will take control as soon as power is restored. To restart the system, we need only have two things happen. First, the "HELLO" program should perform any special initialization and then RUN the main home control program. The home control program then has the responsibility of finding out what is going on. It has to determine if anyone is home. It can do that by just asking and seeing if anyone answers. You would not want the system to wake you in the middle of the night just to ask if you were home, though, so we will expect it to have some intelligence.

The house should check the time and determine if you should be

asleep. If so, we will want it to make certain assumptions until such time as they can be verified. We will discuss the actual assumptions in later chapters, but I hope you get the idea. The computer has got to be able to intelligently restart itself anytime there is a massive power failure.

If you have been following closely, you are probably wondering about the short noise spikes that might occur. You can, and probably should, purchase a noise suppressor at your local computer store. Such devices are relatively cheap and will solve all but the largest spike problems. Those will, unfortunately, cause us many problems when they occur.

Notice I said when, not if. With the computer controlling your home, it will be on 24 hours a day. Eventually, some spike is bound to happen, and when it does the result usually is that a few memory locations will be changed. It is possible, depending on the locations changed, that everything will continue on as if nothing had happened; more likely, the system will "hang" somewhere.

In this case the hardware is fine, but the software has failed. It has become *insane* for all practical purposes. We need some means to prevent such insanity from wrecking the integrity of our system. I wanted a simple and inexpensive method to achieve the desired results. I realize that no system can be perfect, but because of the responsibility delegated to this system, I wanted it as failsafe as possible.

My solution was a System Sanity Timer. Functionally, it works like this. The timer is nothing more than a resettable counter that is always counting forward from zero. If it ever gets to 15, it will cause a system reset. A reset, as we just described, will cause the system to rerun the home control program. Our assumption is that the counter will never get to 15 unless the software is insane.

We will attempt to ensure this by having commands throughout the program that will reset the counter to zero. As long as everything is going well, the program will reset the counter before it reaches 15. If anything causes the system to hang up, the counter will time out and the system will completely reinitialize itself.

Figure 7.1 shows the circuitry required to implement a system sanity timer. A 74191 counter chip is the basis for the timer. Any pulse on the load line (pin 11) will cause the counter to clear by forcing a parallel load of the data in, which is zero. The counter is driven from a 555 oscillator set to produce one pulse every 3 seconds or so. This means we have around 45 seconds before the counter must be reset again.

If the switch S1 is open, the Apple's reset line is not connected to the

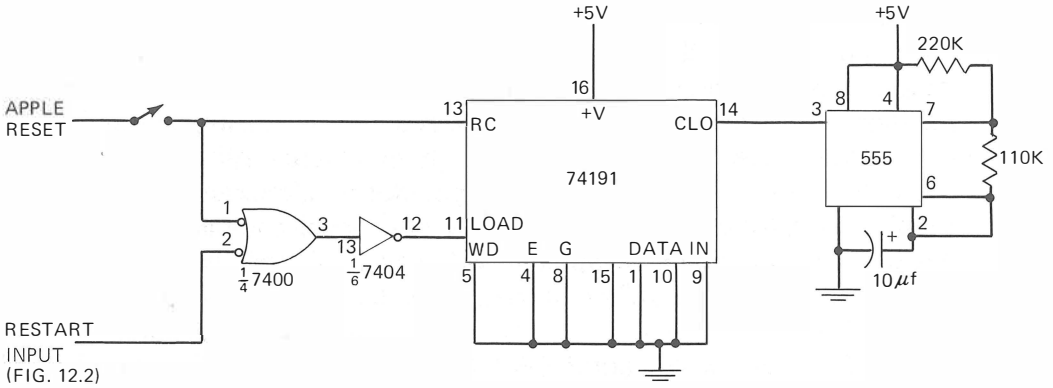


Figure 7.1 A simple counter provides the basis for a unique failsafe system.

counter and the sanity timer is not functional. Since most programs will not reset the counter, you will want to leave the switch open unless you are running the home control software.

When the switch is closed, the sanity timer is enabled. Pin 13 produces a low pulse whenever the counter reaches 15. This will reset the Apple and also the counter. The counter can also be cleared by pushing the reset button on the Apple or by pulsing the restart input. This can be connected to any output pin on the PIA. We will see how this is handled in the chapter on I/O ports.

Under constant control of intelligent software, the system sanity timer makes our home control computer almost invincible.

8

The BSR Control System

A primary capability needed in our home control computer is to be able to manipulate lights and appliances throughout the house. There are many approaches from which to choose.

One option would be to rewire the house. Each light could be controlled using a relay or a solid-state switch such as an SCR or TRIAC. Not only would we have to add these devices to each circuit we wished to control, but we would also have to run control lines from one of the computer's output ports to each device. This approach is certainly feasible, but hardly cost effective.

As mentioned in Chapter 2, the BSR System X-10 remote control system provides the solution for us. Figure 8.1 shows some of the elements in a BSR system. Let's look at it now in more detail.

The center of the system is the command console. It has 16 buttons to designate one of 16 lights to control and 6 additional buttons to indicate what should be done to the lights. These six functions are ALL LIGHTS ON, EVERYTHING OFF, DIM, BRIGHT, ON, and OFF. Let's look at each function in more detail.

The first thing you probably noticed is that the ALL ON refers to lights only and the ALL OFF means everything. This distinction can be made because the remote switches can be designated for use with appliances or with lights. As we will see later, this can be very beneficial in our home control system.

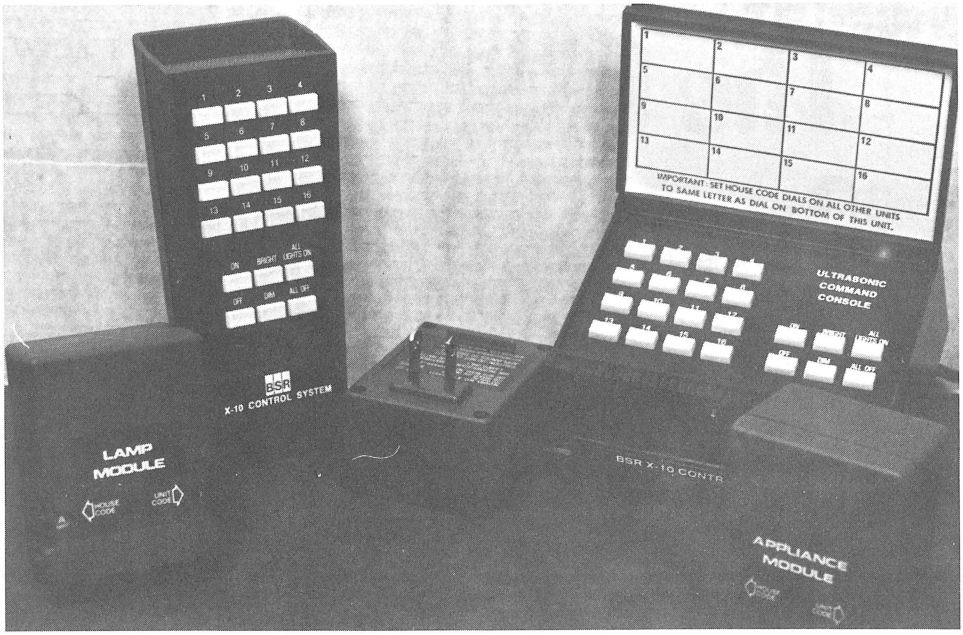


Figure 8.1 Lights and appliances can be easily controlled remotely using the BSR system.

The remote switches come in a variety of packages. The easiest to install are just small boxes that plug into any standard outlet, just like a mechanical timer. You may then plug a lamp or appliance into the receptacle on the box. For those persons not wishing to have unsightly boxes, there is a BSR receptacle that can completely replace your present one. If you wish to control overhead lights, you may replace the normal room switch with the appropriate BSR model designed for that purpose.

Each BSR remote has a concealed small switch that allows you to specify its operating number. This has to be between 1 and 16, just like the buttons on the command console. There is also a house code switch. Its purpose is to make sure you and any neighbors that also have a BSR will not interfere with each other's units.

All the remotes, as well as the console, have some very sophisticated electronics in them. There are no extra wires connecting the console to any of the remotes. Each unit is attached only to the house wiring. When a button is pressed on the console, a specific high-frequency code sequence is injected into your house wiring. The amplitude of this signal is such that it will be totally ignored by normal lights and appliances.

The BSR remotes have a special filter to trap out this special frequency. Once isolated, the frequency is amplified and then decoded to

determine its content. Let's use an example to see how things are controlled. Suppose the button marked 3 was pressed on the console. The coded signal (indicating 3) would be added to the power lines. Every remote would analyze that code. Only the module that finds a match between its switch code and the one from the power lines will activate itself.

If you were to press several other number buttons, let's say 6 and 7, on the console, there would be a total of three remotes activated. If we now press the ON button, each of the active remotes will turn itself on. Similarly, if we hold down the DIM button, they will each dim the light they control. For the safety of your appliances, the appliance modules will not respond to a DIM command.

This product alone can provide your home with a great deal of flexibility. Imagine the things you could do if the computer could just press the buttons on the command console. BSR makes a device that will help us to do just that. The command console also comes in an ultrasonic model. It is identical to the standard model except that it can be controlled from across the room using a BSR ultrasonic controller.

The ultrasonic controller sends coded signals to the command console in much the same way as some TV sets are controlled remotely. If we can produce the same signals as the controller, we can easily take control of the command console and indirectly have control of up to 16 functions in the home.

To simulate the signals from the controller, we will have to know a little more about them. I obtained information about the BSR signals from an article by Steve Ciarcia in the January, 1980 issue of *Byte* magazine. They are made up of short bursts of a 40-kilohertz tone. To make things easier, let's assume that the actual code is made up of 1's and 0's. A 1 will be 160 cycles of the 40-kilohertz tone followed by 4 milliseconds of silence. A 0 will be 48 cycles, followed this time by a 6.8-millisecond pause. Figure 8.2 shows this more clearly.

Figure 8.3 shows how the 1's and 0's just described can be put together to form the code word sent by the ultrasonic controller. The first

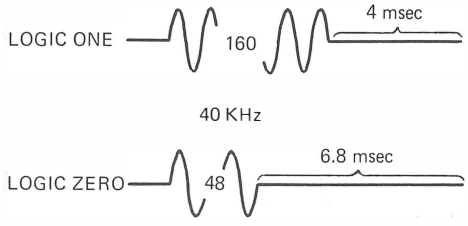


Figure 8.2 The ultrasonic model of the BSR System X-10 uses 40-kilohertz tones to represent 1's and 0's.

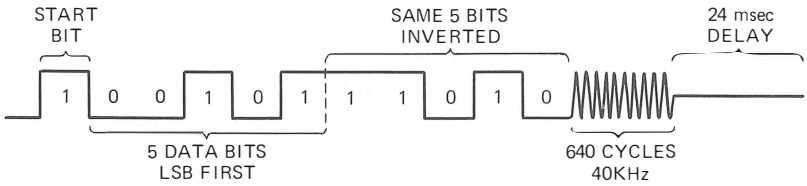


Figure 8.3 The 40-kilohertz 1's and 0's can be combined to form data signals to control the BSR unit.

bit in the word will always be a 1. It could be thought of as a start bit. The function of this bit is to indicate the start of a new transmission so that the receiving circuitry will be ready for it.

The next five bits make up the actual code indicating which button was pressed. To prevent extraneous errors due to noise on the lines, the same button code is transmitted again but in reverse order. The end of the word is marked by 640 cycles of the 40-kilohertz tone, and there should be at least 24 milliseconds of delay before the next word is sent.

Figure 8.4 lists the five-bit codes for each BSR button. With this information, all we need do is figure out a way to control a 40-kilohertz tone as previously described. We could do it with hardware, but I am one of those people who would rather resort to software. Not only is it usually cheaper, but I would rather change a program than unsolder and resolder wires.

If you own an Apple or know someone that does, you have probably heard it play music by toggling the output line going to the speaker. Obviously, we can produce tones in such a manner. After a few calculations, I determined that it was possible to produce a 40-kilohertz tone using the same technique.

Of course, I could not use a speaker owing to its low frequency

BUTTON	CODE	BUTTON	CODE
1	6	12	13
2	7	13	0
3	4	14	1
4	5	15	2
5	8	16	3
6	9	ALL OFF	16
7	10	ALL L. ON	24
8	11	ON	20
9	18	OFF	28
10	15	DIM	18
11	12	BRIGHT	26

ALL CODES ARE IN DECIMAL

Figure 8.4 The table shows the data codes required for each of the BSR buttons.

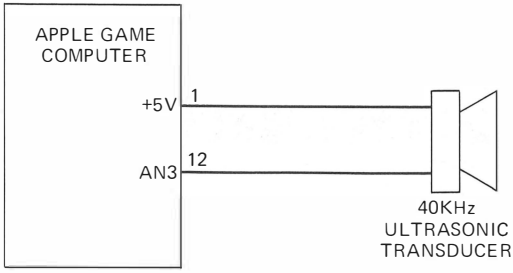


Figure 8.5 An ultrasonic transducer allows the Apple to control the BSR unit.

response. I connected a 40-kilohertz transducer to the Apple game connector, as shown in Figure 8.5. The proper software can easily generate all the possible codes and allow the computer to control the BSR, and thus anything that can be plugged into an outlet. The software for generating the codes will be discussed further in Chapter 20.

9 The Telephone System

The ability to control the telephone is a very important part of the home control system. The telephone is used in many of the modules. You may, for example, verbally request the computer to call someone or to answer the phone when you are home.

When you are not home, the house should be able to answer the phone and record messages without any human intervention. You should also be able to call the computer and get a status report or to control lights in the house. If a security problem occurs, you should expect your house to call you or a neighbor and report the problem.

As you can see, without the ability to control the phone, the capabilities of the home control system would be significantly reduced. In keeping with my overall philosophy, I will keep the hardware to a minimum. I also will use commercially available equipment whenever possible. This will be especially true when we actually connect something to the phone lines.

The phone company has many regulations governing what may be connected to their lines. This may seem unfair to you since you rent the lines, but look at it from their point of view. The phone company has a large quantity of expensive equipment that might be damaged if you were to inject improper signals. Perhaps even more importantly, the service of other phone company subscribers could be impaired or even eliminated for a time if improper equipment is used.

Any manufacturer may apply to the FCC for permission to produce a device for direct connection to the phone lines. Since there are many devices on the market that are approved for direct connection, we will utilize them for our interface. Although you are allowed to connect approved items to the lines, you are required to notify the phone company of the connection and of the FCC registration number, which should be included either on the device itself or in the owner's manual.

The first of these devices that we are going to use is the D.C. Hayes Micromodem. A modem (modulator demodulator) is a device that converts the digital signals in the computer to analog tones that can be easily transmitted over the phone lines to another computer. In effect, a modem makes it just as easy to talk to a computer in another state as it is to talk to your printer.

The reasons for owning a modem are increasing everyday. Many computer services are becoming available over the phone lines. In some areas you may get your bank balance or order merchandise using a personal computer equipped with a modem. You can also subscribe to networks that contain enormous data bases that have the potential of allowing a home computer to make truly useful decisions.

A D.C. Hayes Micromodem can provide your Apple with all these capabilities. It also has some very special features that will aid us tremendously in our home control telephone system. The Micromodem has auto-dial and auto-answer, which means that it has the firmware and hardware required to dial a number for you and to connect itself to the phone lines whenever it detects a ring.

We will use these features whenever the home control program needs to call someone or to determine when the phone is ringing. Since the Micromodem is FCC approved for direct connection to the phone line, we have these capabilities without any hassles with the phone company.

In addition to detecting rings and dialing the phone, we must also be able to connect a cassette recorder and player to the phone lines if the computer is to act as a phone answering system. Again I solved the problem by going to a commercially available device. The Duofone 101 is an electronic telephone amplifier from Radio Shack.

The amplifier connects directly to the phone lines and allows the phone to perform like an intercom. Since the amplifier is powered from the phone lines, it can be controlled very easily from the computer. All we need do is replace the on/off switch on the Duofone with the contacts of a relay. Anytime the computer wants the amplifier on, it only needs to activate the relay.

Since the amplifier provides intercom-type operation, all our phone

company interfacing is solved. The computer can monitor the Micromodem to determine if the phone is ringing. If you are home, the Duophone can be activated so that you can talk from anywhere in the room.

If you are not home, the computer can activate the amplifier first and then the cassette player. The player would play a 30-second endless loop tape with a message for the caller. At the end of the tape the computer should turn off the player and start the recorder. As long as someone is talking, the recorder should be left on.

To perform all the functions just mentioned, we will need to build some special hardware. Figure 9.1 shows the circuit we will need. We will use three of the game connector outputs to control the telephone amplifier and the two tapes.

The 7404 inverters are used to buffer the game connector outputs. Each inverter controls a relay by turning on or off a transistor. The telephone amplifier relay should have its contacts substituted for the amplifier's switch.

Most cassette recorders have a remote jack next to the microphone jack. The relay contacts should be connected to plugs that will mate with the remote jacks on the recorders. When they are plugged in and the play and record buttons are depressed, your computer will have complete control of both tape machines.

Controlling the telephone amplifier and the tape recorders is essential for our system, but it is not enough. If the computer is to know when to hang up on a caller, it must be able to "hear" when the call is over. Figure 9.2 shows a circuit to give the computer ears.

You might be wondering why we just don't use the Speech Link for this purpose. There are two reasons. First, the Speech Link is connected into the computer by way of a wireless mike and is not active unless the wireless mike is on. Second, we do not need to know what words are actually being said. If we can just determine if there is a changing sound present, we will have all the information that we need.

The circuit of Figure 9.2 is essentially the same as the one found in Chapter 4 except that a crystal microphone is used as the input. As long as a sound is present, the game connector pin will be a logic 1. The 200K potentiometer can be used to control the sensitivity.

If we place the crystal microphone in front of the telephone amplifier, someone leaving a message will cause the game connector pin to alternate somewhat randomly between a 1 and a 0. If the person does not say anything for a period of time, the input will remain 0. If the person hangs up and produces a dial tone, the pin will remain high.

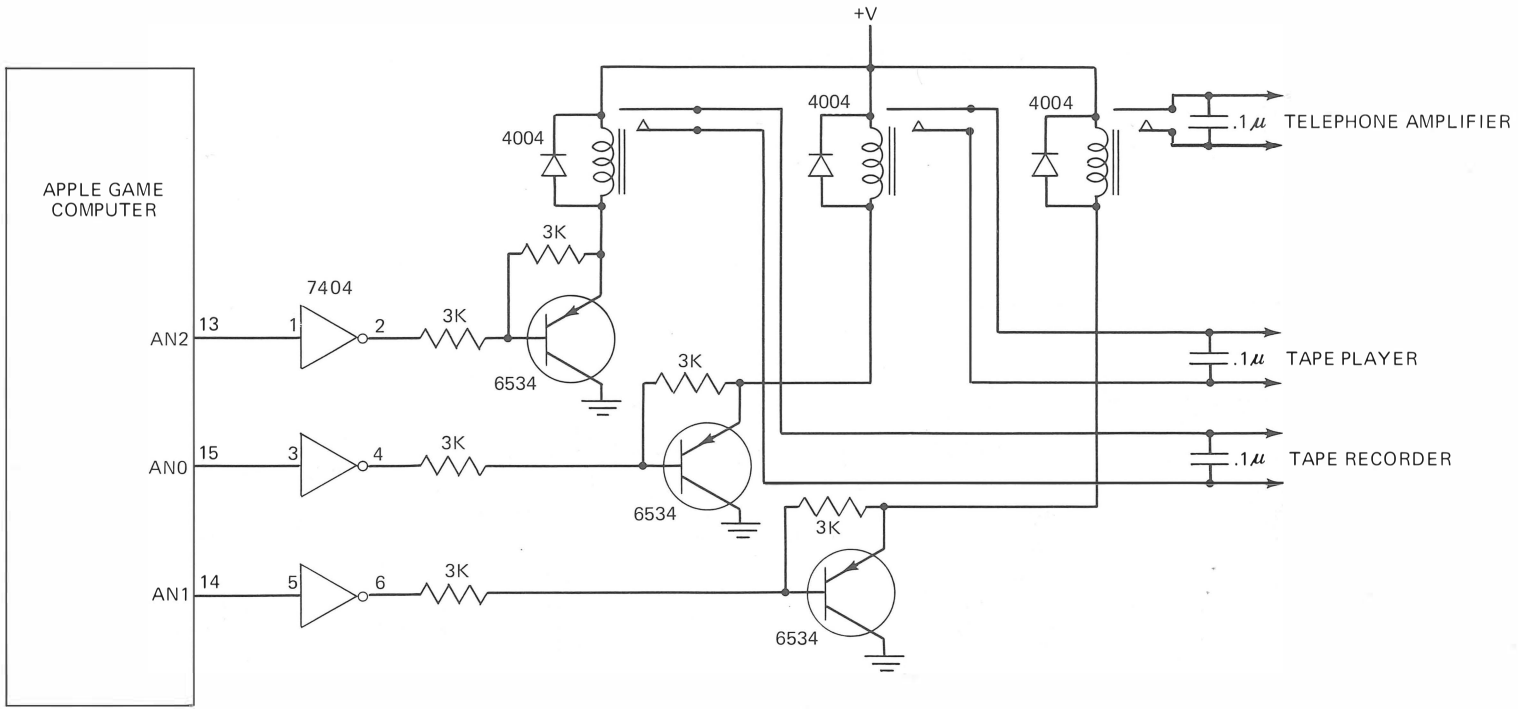


Figure 9.1 Using a driver circuit and small relays, the computer can control two tape recorders and a telephone amplifier.

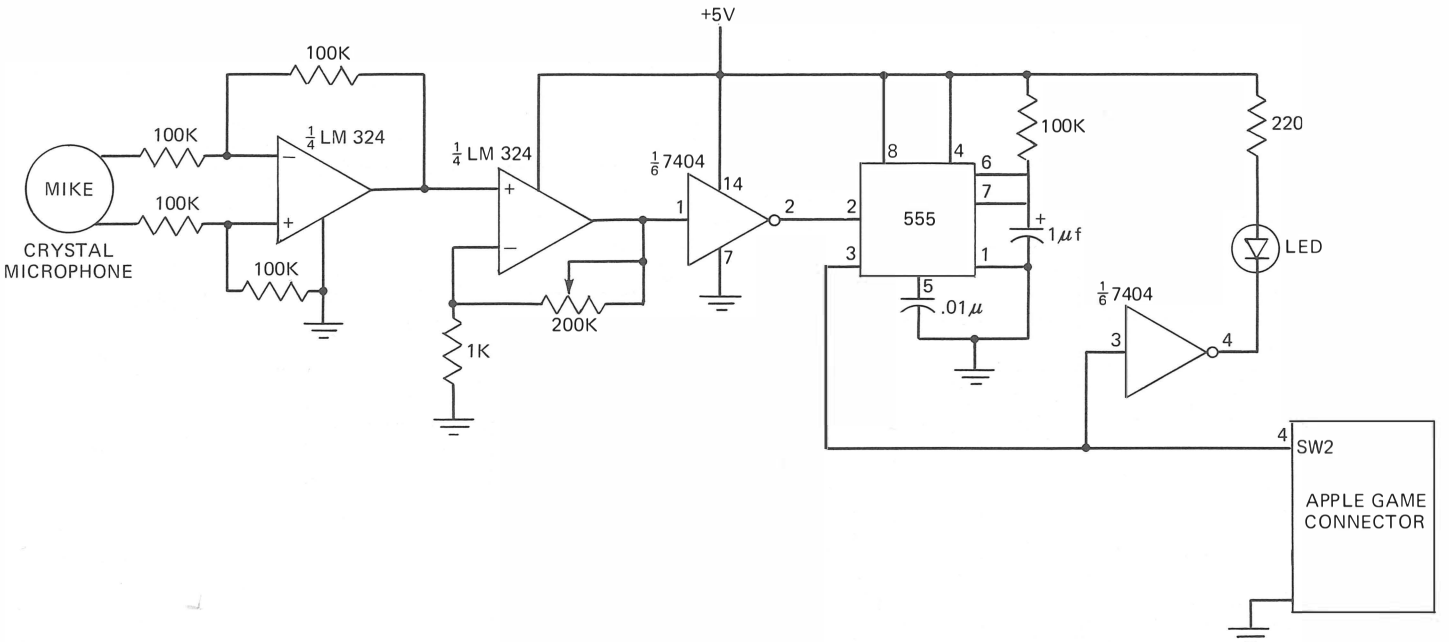


Figure 9.2 A sound detector provides a means for the computer to listen to phone calls.

The home control program will sample this input pin on the game connector and determine when to hang up on a caller that is leaving a message. This completes the principal hardware required if the home control program is to take charge of your phone. The only thing left out is the ability to control your house by calling from a remote location. This addition will be explored in Chapter 11.

10 The Interrupt System

As was mentioned earlier, the majority of the home control system is sequential in nature. Each task is usually completed before the next is started. Some tasks, though, such as watching for movement throughout the house, require that the controlling module be running at the time of the event that is being monitored.

The Apple's microprocessor is a 6502, and it, as well as other microprocessors, has an interrupt line. Actually, the 6502 has two interrupt lines, a nonmaskable (NMI) and an interrupt request (IRQ). My system will use the IRQ. When this line is pulsed low, the 6502 will abandon the program that it is presently running and jump to a second program. When the second program is complete, the original program is continued as if nothing had happened.

The program to handle the special events that cause interrupts will be covered later, but right now we want to look at the hardware required to generate the interrupts at the appropriate times. To better understand the requirements of this hardware, we need to examine each event that will cause an interrupt.

One such event is the movement of people throughout the house. We will detect this movement by using strategically placed switches under the carpet. Refer to Figure 10.1 to see my switch arrangement, which handles four rooms. Anytime someone walks from one room to another, the person will step on two of the switches. The first switch pressed indicates

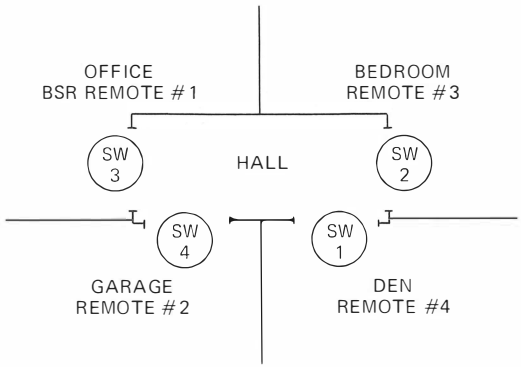


Figure 10.1 Under-the-carpet switches tell the computer about the movement of people in the house.

the room the person came from and the second switch tells the computer which room was entered.

You can buy pressure-sensitive switches for this purpose, but I found it cheaper to make mine by attaching tape switch to a 12-inch square of aluminum. Tape switch looks like a thick piece of tape, but it has two conductors that touch whenever a few pounds of pressure is applied. You can decrease the sensitivity by placing a sheet of foam rubber between the aluminum and the floor. This will make sure that pets will not activate the switches.

If you do not have carpet, you can still utilize the home control program, but your switches will be much more expensive. Instead of a physical switch at each doorway, you will need some kind of beam and a way to detect if it is broken. You could use either a light or an ultrasonic system, depending on your preference.

Regardless of what type of switch arrangement we use, we will need a means for the computer to determine both when a switch is pressed and which one it is. If we were to connect each of the four switches to four bits of an eight-bit input port, the computer could read that port and determine which was pressed. If the system could constantly monitor the port, it could also tell when a switch was pressed.

Such monitoring would require so much attention that the system would not be able to get much else done. If we could somehow generate an interrupt whenever any of the switches is pressed, then the main program would not have to keep checking and the interrupt program could easily determine which switch caused the interrupt by reading the input port.

Figure 10.2 shows a circuit that will solve our problems. As you can see from the drawing, there are eight switches instead of the four we have been using. More on this later. Each switch is connected to a network of two resistors and a capacitor that helps eliminate bounce (noise) that

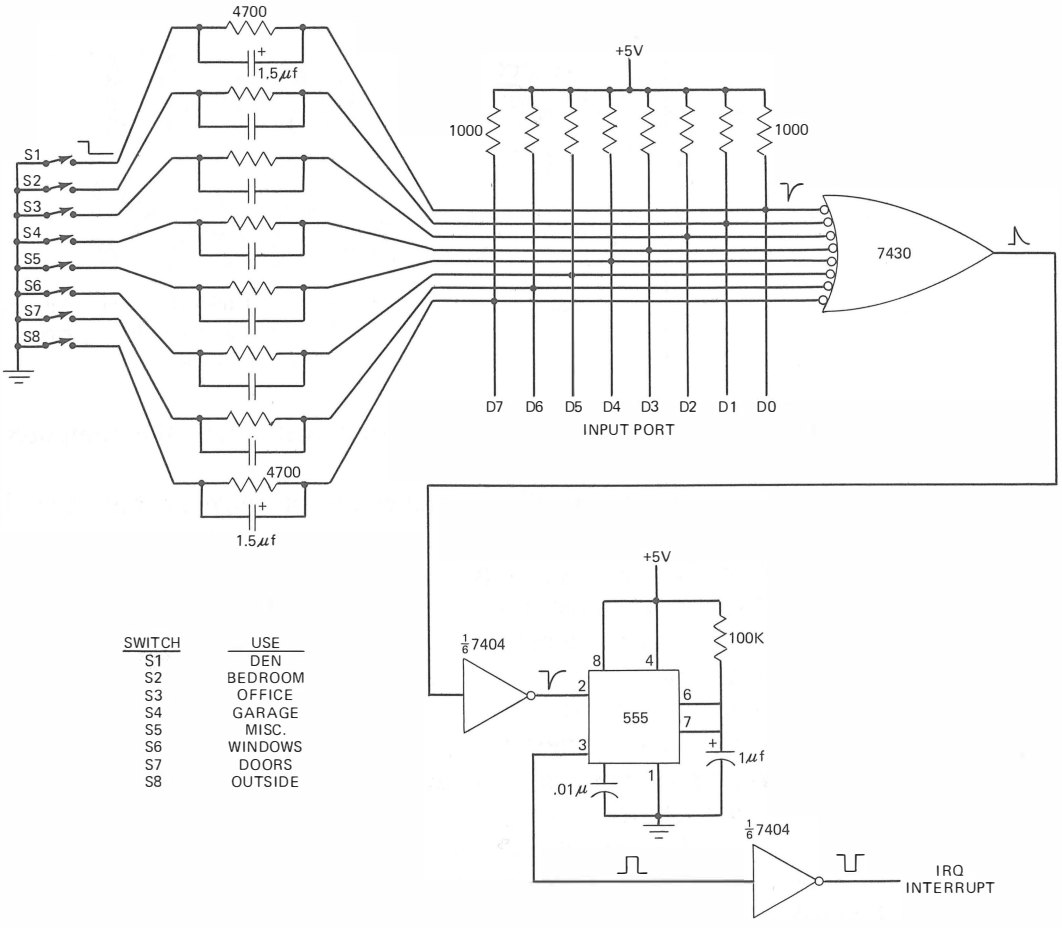


Figure 10.2 Internal and external movement switches are connected to a computer port, as well as to the interrupt line. When an interrupt occurs, the port can be read to determine the exact cause.

occurs when mechanical contact is made. This network also ensures that even if a switch is held closed for extended periods of time the pulse generated will be only momentary.

All the inputs are sent to the input port. They are also functionally ORed together using a NAND gate and an inverter. If any switch is closed, the 555 monostable multivibrator will be triggered. It will produce a short pulse, which is inverted again and sent to the Apple's interrupt line.

Whenever any switch is stepped on, an interrupt is generated. This will cause the interrupt program to be run. This program, which is discussed in Chapter 20, will read the port and utilize the information

obtained to determine the actual movement. Once the system determines which lights should be altered, it will produce the required ultrasonic tones to activate the BSR console.

The remaining four switches are intended for use in the security system. A closure of any of these switches will also run the interrupt program. If it determines that it was one of these switches that was pressed, the program will set and clear some memory locations that BASIC can PEEK at to determine what security problem has occurred.

One of my security inputs is connected to magnetic reed switches on the doors. Since the doors are heavily deadbolted, activation of these switches will imply that the owner of the house has returned. A second input is connected to window switches in series so that any open window will activate the pin. Such a signal will indicate that someone is entering the house without proper authority.

My third security input is used to indicate movement outside the house. Many commercially available sensors can provide such an indication. The least expensive are usually infrared beams or ultrasonic movement detectors. If you wish to spend a little more, there are devices that react to body heat. The actual type of sensor or sensors you use should be based on the physical conditions around your house.

The fourth and last input for the security port is simply labeled miscellaneous and generally is not used in the system described in this book. Activation of this input will set a flag so that your software can react as you see fit. A potential use for this input that I am exploring is a driveway sensor. This would allow the system to determine when a car enters or leaves the driveway.

As with most of the hardware in the home control system, the real potential will not be apparent until the software is explained. We will soon see how the software can utilize the limited information gained from a few switches and create a system that can react intelligently to movement both inside and outside the house.

11 The Tone Generator

In Chapter 9 we discussed most of the telephone system. The only capability left out in that chapter was the ability to control lights and other items in the house when you are away by calling your home computer.

To provide a simple means to communicate with the computer by phone, we will need some special hardware. We cannot use the Speech Link system for two reasons. First, the Speech Link is connected through the radio receiver and would not be able to listen to phone conversations. Second, the distortion and noise on the phone line make the Speech Link much less effective.

This does not cause us any real problems. We just need to analyze our needs. The first thing the system must be able to do is to recognize the difference between a standard caller trying to leave a message and you wishing to control something in the house or wanting a status report.

Your system must also be able to understand what you want once it has determined it is you calling. Without the luxury of using a speech recognition system, we must severely limit the commands that we expect the system to understand. One of my initial ideas was to use the tones on a push-button phone. Each tone was to be used as a separate command. It sounded like a good idea until I tried building the required tone decoder.

It turns out that such a tone decoder is either very unreliable or more expensive than I was willing to accept. My next step was to consider decoding only two tones, in order to keep the cost down. One of these

tones would be used to answer 'yes'' and the other for ''no.'' I figured that the system could ask the proper questions, using the speech synthesizer, and I could answer either yes or no.

It occurred to me that the system really did not need to be able to recognize 'yes'' and ''no.'' Just ''yes'' would be enough. A ''no'' would simply be the absence of a ''yes.'' I also decided that if I used a short tone sequence rather than the tone itself I would be able to recognize a ''yes'' using the sound detection hardware covered in Chapter 9. Some software would be required, but the thought of avoiding additional decoding hardware was very appealing.

We will need one piece of additional hardware, a tone sequence generator. One of my objectives for the design of the generator was that the code could be easily changed. I might want to change my own code from time to time, and I felt certain that anyone duplicating my system would want a code of his or her own.

Let's look at the circuit I finally arrived at. It is shown in Figure 11.1. It is made of two 555 timers acting as oscillators, an eight-switch DIP, and a 74165 shift register. The principle of operation is really rather simple. We want the speaker to produce a sequence that the computer can detect. Figure 11.2 shows a possible sequence.

There is a short burst of tone first, followed by a pause. The second burst is a little longer than the first. The length of time required for the two bursts and the pause is labeled I, J, and K. It will be the responsibility of the detecting software to measure these lengths and compare them to a predetermined sequence for ''yes.'' Any other sequence will be taken for the word ''no.''

The circuit of Figure 11.1 is used to produce the desired sequence. The 555 timer on the left outputs a tone from pin 3 to the speaker. This tone can be turned on or off by placing a logical 1 or 0 on pin 4. This controlling signal will come from the serial output of the eight-bit shift register. The on/off sequence of the tone will be equivalent to the one/zero pattern in the shift register. The second 555 timer is used to clock the shift register. It will run much slower than the first timer.

The actual frequencies of the two timers are not critical. The software can adapt to almost any reasonable combination we wish to use. The leftmost timer should produce a tone within the bandwidth of the phone lines. Somewhere between 1000 and 2000 hertz is ideal.

The second timer needs to be slow enough to create a recognizable sequence, and yet fast enough to complete the entire sequence within a second or so. This implies a frequency of 5 to 10 hertz. The fact that your frequencies are different from mine will just help make your system more

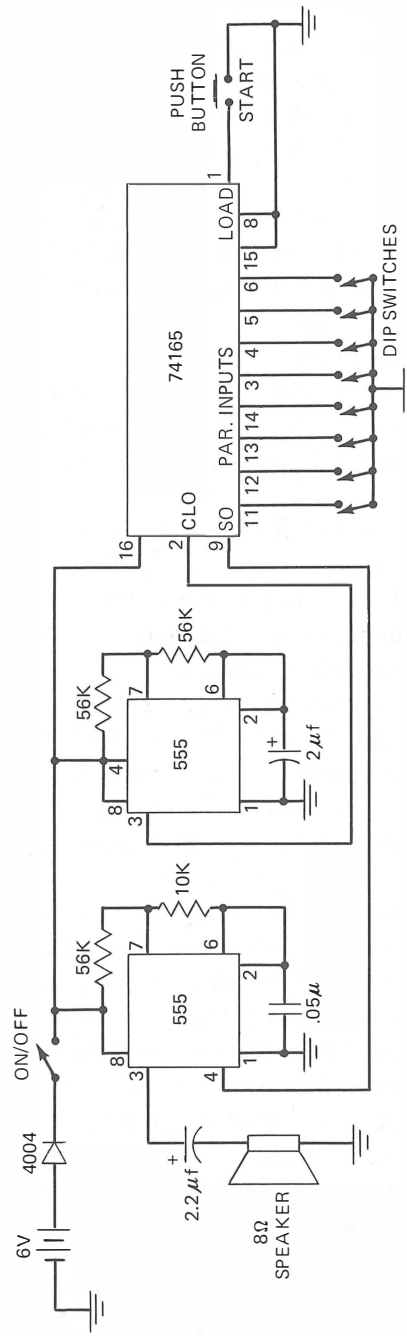


Figure 11.1 The DIP switches create a unique code that only your computer can understand. Using this signal you can control your home from any telephone.

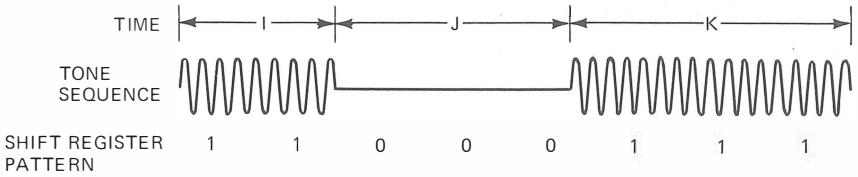


Figure 11.2 The switch settings (see Figure 11.1) produce a tone sequence as shown. The computer will measure the times and store the relative results in the variables I, J, and K.

secure. In addition to the frequencies, though, we will want to have control of the tone sequence.

The sequence, remember, is reflective of the pattern in the shift register. When pin 1 on the shift register is pulsed low, the shift register is loaded with the data controlled by the eight dip switches. The open switches will produce a tone. Likewise, closed switches will cause a pause.

Any pattern can be detected, but my software will expect a tone, a pause, and another tone. The length of each of these can be easily varied by the setting of the DIP switches. As we will see in later chapters, the software can be easily modified for any size of tones and pauses.It will even be easy to have another pause and a third tone if you wish.

I use four AA cells as my power supply. If you use a small speaker, the entire generator will fit easily in the palm of your hand. To use it, just hold the unit so that the speaker is close to the telephone mouthpiece and press the push button. The tone sequence, when played, will be ''heard'' by the computer at the other end of the phone line.

As mentioned earlier, the circuitry used to allow the computer to ''listen'' will be the same circuit described in Chapter 9. The circuit was used there to determine when a caller stopped talking so that the computer could hang up at the end of the message. As you remember, the circuit worked by sending the computer a logic 1 whenever the sound level exceeded a preset threshold.

This same capability is all we need for the tone detector. When the tone sequence is played over the phone, it will trigger the sound detector. The software can monitor how long each tone and pause lasts. These times can be compared to see if they are within tolerance. For these measurements to be valid, the computer must know when to start taking readings.

The computer will not continually monitor the sound detector for the presence of the tone sequence. The first time it watches for the sequence will be when the caller starts to record his or her message. If the sequence

is not the first sound heard, the system will assume it is a standard call and process it appropriately.

If the sequence is detected, though, the recorder will be turned off and the computer will communicate using the speech synthesizer. It will ask if a status report is desired. If the next sound conforms to the proper tone sequence, the computer will interpret it as a "yes" answer. Any other sound will be a "no." The most obvious sound to use for "no" is to actually say "no." Of course, any word, even "yes," would be interpreted as a negative response since it will not match the expected tone sequence.

After the status report the system will continue to ask questions and act on the answers accordingly. We will see later that the software will ask the questions in a manner that will provide easy remote control of the home.

12 Input/Output (I/O) Ports

In previous chapters several devices were connected to a computer using some form of parallel input or output port. There are many such ports on the market, but I chose to build my own. Even if you plan to purchase your ports, this chapter may be of value to you as it discusses the general software required to transfer data to and from a port.

To begin with, you need to realize that a port is nothing more than a memory location made up of discrete components. Let's look at an example. Each memory chip in the Apple contains 16,384 memory cells. If these cells were made out of individual gates or flip-flops, you could attach wires to the flip-flop (F/F) outputs. If that wire controlled a transistor, which in turn controlled a relay, then external devices could be turned on and off by simply storing a 1 or 0 into that particular memory cell.

Using similar reasoning, external switches could be connected to the set and clear inputs of a flip-flop cell. Software could easily be used to read the state of that cell and thus determine the state of the external switch. This simple example should demonstrate that there is nothing mysterious about I/O ports.

Of course, we don't build memories out of discrete flip-flops. Not only would such memories be very expensive and consume much more power than LSI memories, but they would also take up much more space.

In addition, all the discrete wiring would provide potential faults and make such a system less reliable.

We can build an output port using F/Fs if we wish. We would need one F/F for each data line. Whenever the 6502 executes a STORE instruction to a particular address, the address and data lines will simultaneously hold the data and the address of where those data are to be stored. All we need do is to detect or decode the proper address and use that signal to gate the data into the flip-flops at the end of the cycle.

It is equally simple to build an input port. Whenever the processor is reading from a given address, it expects to find the proper data on the data bus. If we again detect the appropriate address, we can use that signal to let the data on the bus. This enabling will usually be done using tristate buffers. When enabled, the tristates transfer their inputs to their outputs, and when disabled the outputs have an infinite impedance.

Figure 12.1 shows simple output and input ports for an Apple computer. The address decoding for the Apple is simple because 16 addresses have already been partially decoded for each slot on the mother board. Any of these addresses will activate the device-select pin on the slot. In this case we have not decoded the device-select any further. This means that any of the 16 addresses could be used when addressing either the input or the output port. A decoder chip could have been used to allow 15 more ports to be added to this one slot. The read/write line is used to determine whether we are reading from or writing to the port.

You can certainly use I/O ports like those just discussed. There are chips on the market, though, that offer several advantages over constructing the port out of discrete gates and F/Fs. These chips are called PIAs (peripheral interface adapters) and VIAs (versatile interface adapters). Since we don't need the advanced features found in VIAs, let's examine how to build a port using a PIA.

The 6820 PIA from Motorola has all the buffering and tristate capabilities built in. It has six registers, of which two are used as the actual input and output ports. The decoding required to select one of the six registers is unique, as we will soon see, and is also built into the chip itself.

Another advantage of the PIA is that the pins of each eight-bit port can be individually programmed to be either an output or an input. This makes it extremely flexible and adds to the usability of the ports. Figure 12.2 shows an I/O design for an Apple that will give you four 8-bit ports, any of which can be either input or output.

The 7442 is a decoder chip that aids in the selection of one of the 16

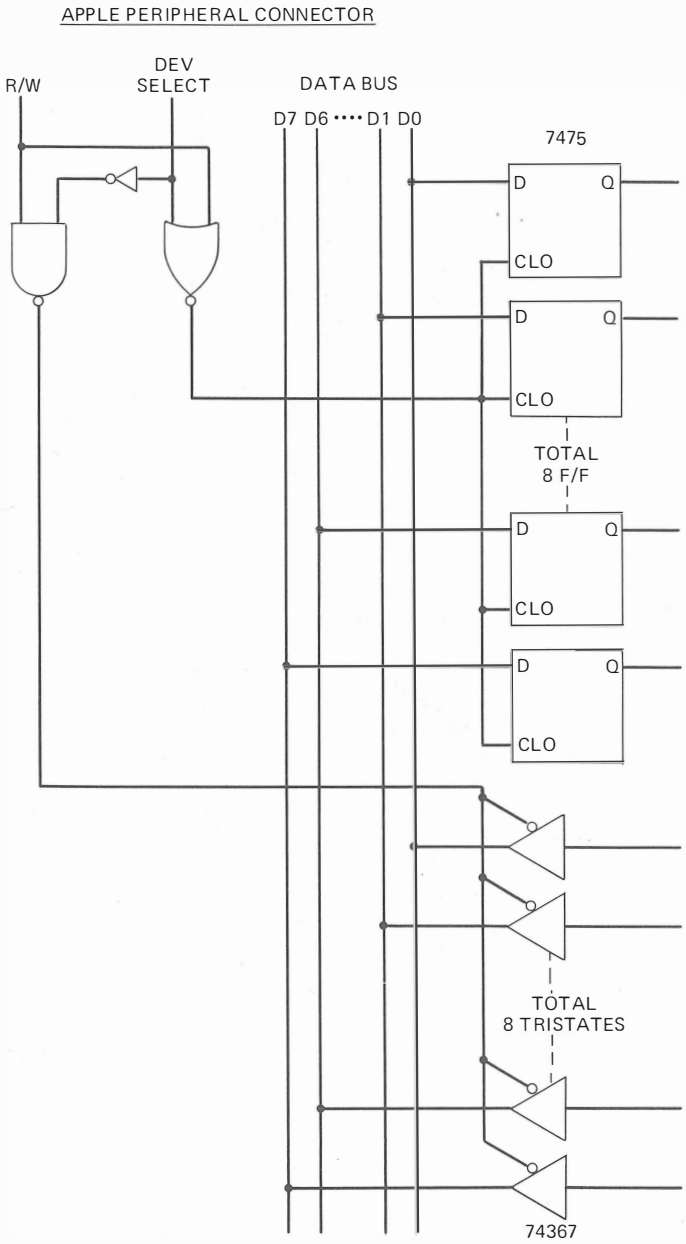


Figure 12.1 Input/output ports on an Apple are nothing more than special memory locations.

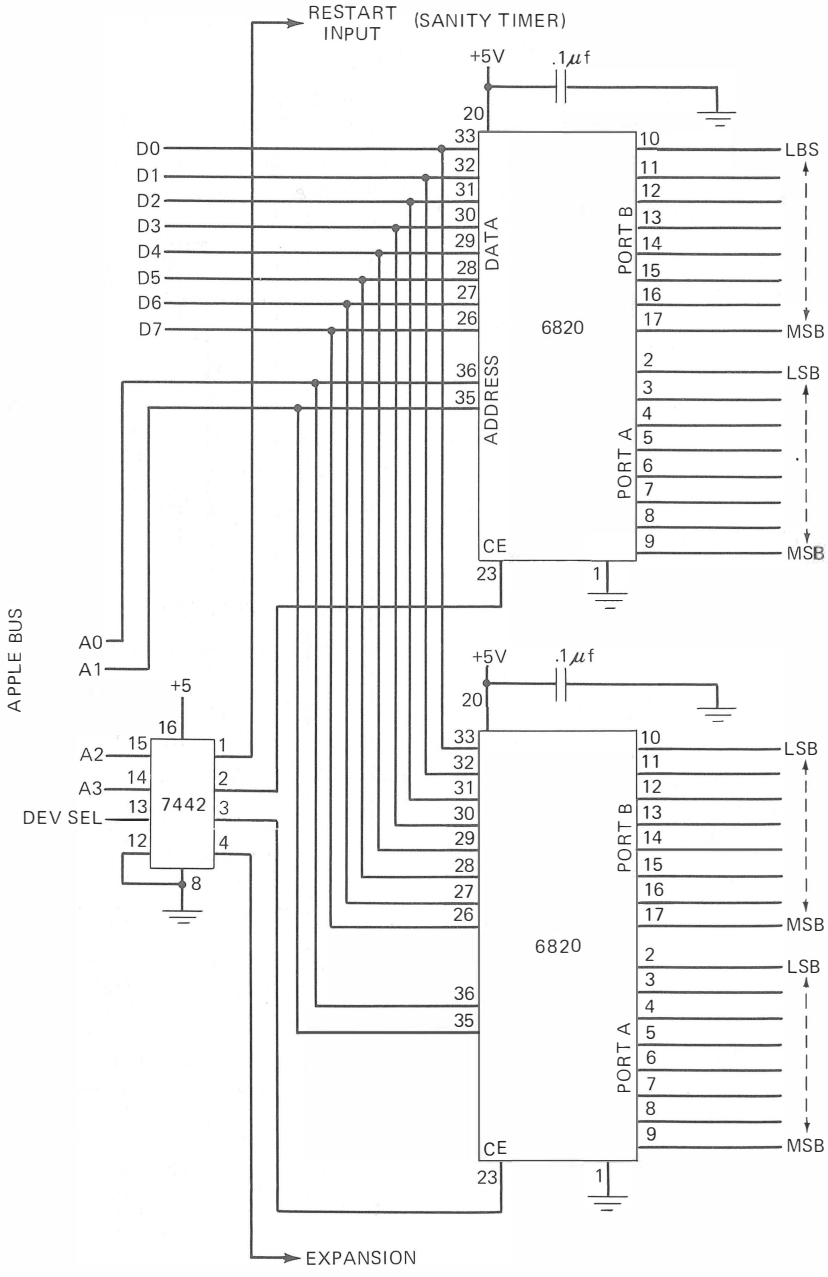


Figure 12.2 PIA chips provide an efficient and versatile means to build input/output ports.

addresses reserved for each Apple slot. Any of these addresses will activate the device select, which in turn activates the decoder.

Once enabled by the device select, the decoder uses address lines A2 and A3 to force one of its pins (1, 2, 3 or 4) to go low. These pins can be used to enable four additional devices. Each device may have up to four addresses, which should be selected with A0 and A1.

Two of the four possible devices will be PIAs. Pin 2 selects the top PIA, while pin 3 enables the bottom PIA. Each PIA requires four addresses for access to its internal registers. A0 and A1 are used for this purpose. These internal registers will be discussed momentarily.

This leaves two pins for other devices. Pin 1 is used to restart the system sanity timer. This failsafe system was explained in Chapter 7. Since we did not use the lower two address lines in this case, there will be four different addresses that will restart the sanity timer.

The last pin, pin 4, can be used for expansion if you want to experiment. It can handle any device with four addresses, so you could easily add another PIA or even a serial port, using something like a 6850 communications chip.

For full use of the 6820 PIA chips, you should consult a Motorola specification sheet. I will only discuss the necessary information required for using the PIA in the context of the home control system.

There have been many needs in previous chapters for a parallel I/O port. The system clock, for example, needed a full port and one pin from another. The interrupt system also needed an eight-bit input port. My voice output system used a serial port, but your particular choice might require a parallel port. In all these cases, you can utilize one of the PIA ports just described.

As I have mentioned, there are four addresses used for each PIA. Since I also stated there are six different registers in the PIA, you should be wondering how they all can be accessed. To explore this more efficiently, we need to realize that each PIA has two separate ports. They are referred to as port A and port B. There are two addresses and three registers used for each.

Let's examine port A for a moment. One address is for the control register. Most of the bits in this register are used to control the handshake lines. Since these lines are not used in the home control system, they will not be discussed here. There is one bit in the control register, however, that we will need to use. It allows the second address for port A to access either one of the two remaining registers.

The important bit we are dealing with is data line 2 or D2. The data

lines are labeled from D0 through D7, where D7 is the most significant bit. When D2 is set to a 1 in the control register, the second address of port A becomes the I/O register. If bit D2 is cleared in the control register, the second address provides access to the data direction register (DDR).

The DDR provides the PIA I/O port with its flexibility. Each individual bit in the DDR controls whether the corresponding bit in the I/O register is to be used as an input or an output. A 1 indicates an output pin whereas a 0 represents an input. The eight pins of the I/O port can be made all inputs, all outputs, or any combination that you require.

The software must initialize the DDR before it tries to use the I/O registers. We will see how this is done in Part III when we explore the programs that make up the home control system. You can use any commercially available I/O board as long as you follow the instructions provided for its use. You may also use an I/O port instead of the Apple game connector. This would be required if you prefer to keep your paddles connected or if you are using some computer other than an Apple.

This completes our discussion of the hardware required for implementing the home control system. Part III will cover the software that will bring the hardware to life.

13 The Software Organization

We are finally to the software, the heart of the home control system. I hope you have read the previous two parts of the book first. I realize the tendency, especially for those of you that detest hardware, will be to begin your reading here. Even if you are not planning to actually computerize your home and are just reading for information, I urge you to start at the beginning.

I think my treatment of the hardware has been straightforward. I tried not to get bogged down in detailed discussions of transistors and integrated circuits. You should have found my discussions informative and easy to follow. I have tried to center the discussion around what the hardware is going to do for the software. And that is exactly why reading the book in order is important.

In this chapter I have several objectives in mind. First, I want to make sure you understand the principles of structured programming. Second, I want to show you the flow charting symbols I will be using in the chapters to follow. And, last, this chapter will serve as an overview of the total software architecture of the system. A thorough understanding of how the home control program is organized is very important if the remaining chapters are to be easily digested.

Structured programming is the best thing to happen in the computer industry in a long time. It has turned programming from an art into a science. You hear all sorts of key words and phrases in a discussion of

structured programming. Two of the most important are *modular* and *top down design*.

Actually, structured programming is really so logical that after you have been exposed to it you will probably find it very simple and obvious. The real key to building a structured program is to plan the entire program completely before any code is written. To plan completely, you must fully define the problem.

In the past two sections of the book, I have tried to define the problem of home control, or at least my approach to it. Since the problem has been broken down into its fundamental parts, it will be easy to write the program in modules called *subroutines*. Each subroutine will solve the problems found in each of the fundamental parts.

This principle of structured programming does not stop here though. Each subroutine should be further divided into simpler problems that will also be solved by additional subroutines. And those subroutines can be further divided, and so on. This process, starting at the top and working down, should continue until the tasks to be solved are trivial.

Figure 13.1 shows the symbols used to indicate tasks. Simple tasks are represented by just a box. If the box has vertical lines on each side, it indicates a subroutine. The subroutine boxes should be described in more detail by using a separate flow chart. A slanted box indicates an input or output operation.

The process previously described will yield a program made up of fundamental actions that are linked together to build larger and more complex actions. This linking is accomplished with logical control structures. We will call these *constructs* for short. Figures 13.2 through 13.5 show the primary constructs we will be using. Modules A, B, and C represent tasks and are used for example purposes only.

The IF-THEN-ELSE construct is used to decide which of two

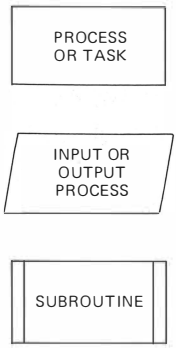


Figure 13.1 These symbols will be used to identify functions in the home control flow charts.

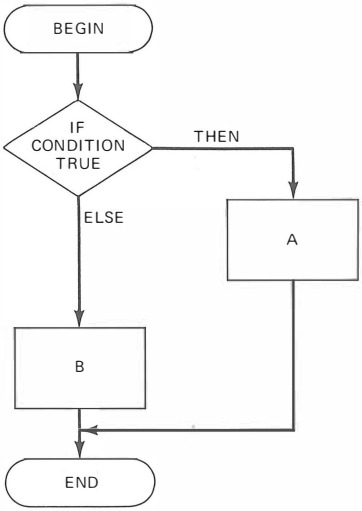


Figure 13.2 The IF-THEN-ELSE control structure is the basis for all decision making.

modules, or groups of modules, is to be executed based on some condition. Many BASIC interpreters have such a statement. Applesoft only has an IF-THEN, but it can be used along with a GOTO to perform the IF-THEN-ELSE.

A special case of the IF statement occurs if we wish to do one of several things depending on the value of some variable. Figure 13.3 describes such a situation using IF statements. Figure 13.4 shows the much easier to follow construct, the CASE of X. In both of these situations, module A is performed if X = 1, module B is performed when X = 2, and module C is performed when X = 3.

Some of the most powerful constructs are based on a loop structure. There are three forms of loops. These are the WHILE, the UNTIL, and the ITERATE loop. Although any of the three loops can be created using only IF and GOTO statements, Apple BASIC only has ITERATE loops. Applesoft implements them using FOR/NEXT statements. To keep things as simple as possible for the reader, I have chosen to use only ITERATE loops in this book. The symbol I will use for a loop is shown in Figure 13.5. The dotted line is shown here only for clarity. Normally it will be omitted.

The architecture of the home control program is going to be top down, as I have described. At the bottom of the pyramid of tasks will be those that are very basic and fundamental. As it turns out, these fundamental tasks are very important for several reasons.

They are important primarily because they form the center core of the program. Knowing how they work will provide you with a true understanding of how larger tasks can be created by linking smaller ones

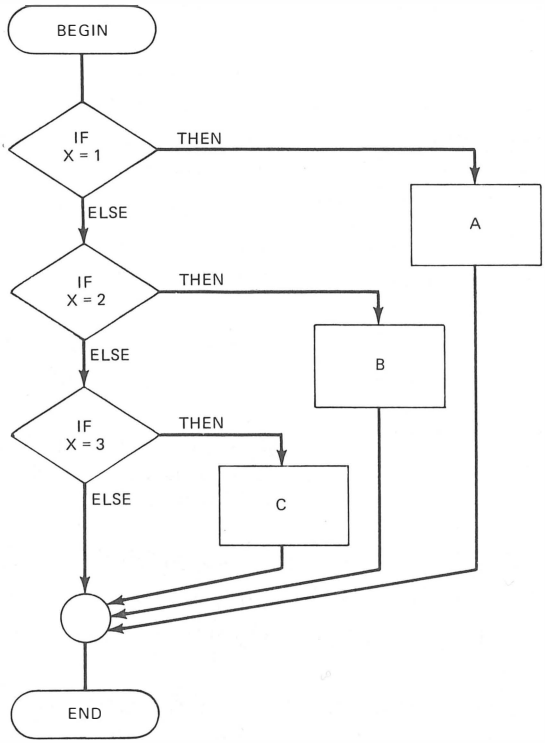


Figure 13.3 The IF-THEN-ELSE can be used to select more than just two alternatives.

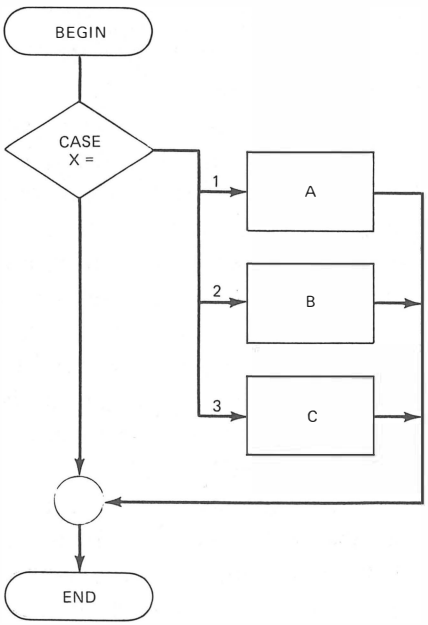


Figure 13.4 Special constructs provide diagrams that are easier to read and follow than combinations of IF-THEN-ELSE blocks.

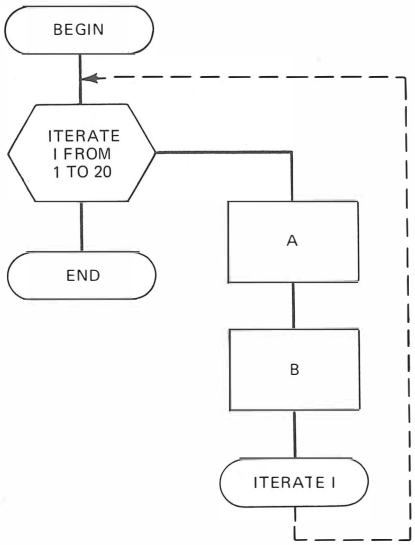


Figure 13.5 To keep the flow charts from looking like spaghetti, loops will be drawn as shown, but without the dotted line.

together. They are also important because they provide an easy means to transfer the home control program to a system other than an Apple computer.

Examples of the fundamental tasks are dialing the phone, recognizing a spoken word, pausing for a specific period of time, and pushing a button

LINE NOS.	USE
1-99	MAIN PROGRAM
100-149	CHECK FOR PHONE RINGING
150-199	CHECK FOR SOUND CHANGE
200-249	DELAY SC SECONDS
250-299	CHECK FOR OWNER CODE
300-374	SAY MESSAGE NUMER ME
375-399	INITIALIZE SPEECH LINK
400-449	DELAY BASE ON DE
450-474	CHECK FOR WIRELESS MIKE ON
475-499	LOAD TIME TABLE
500-524	TURN THINGS ON BY PHONE
525-599	TURN THINGS OFF BY PHONE
600-649	READ TIME
650-699	DIAL PHONE
700-749	STATUS REPORT
750-799	PUSH BUTTON BU ON BSR
800-849	RECOGNIZE VERBAL YES/NO
850-899	RECOGNIZE A WORD
900-949	MAIN INITIALIZATION
950-999	VARIABLE INITIALIZATION
1000-1999	PROCESS VOICE COMMANDS
2000-2999	PROCESS PHONE CALLS
3000-3999	PROCESS SECURITY FLAGS
4000-4999	PROCESS TIME TABLE
5000-5999	TIME TABLE SUBROUTINES

Figure 13.6 This table summarizes where each module in the home control program is located.

on the BSR unit. Each of these routines is very short and is explained individually in Chapter 14. If any of the major modules wishes to perform a fundamental task, it simply calls that subroutine. If your computer or peripheral operates differently than mine, you can change the appropriate fundamental subroutines and have the program working on your system with minimal effort.

Figure 13.6 shows the line numbers reserved for different areas of the home control program. The main program lies between lines 1 and 99. The fundamental subroutines occupy from 100 to 999. The major modules are each given 1000 possible lines. There is nothing special about my choices in this matter. Other line numbers could just as easily have been used.

In addition to the BASIC program, we will also need a machine language program to process interrupts and an area of memory to store the vocabulary templates for the Speech Link. Both of these situations will be discussed in detail in later chapters. At this point, however, you can refer

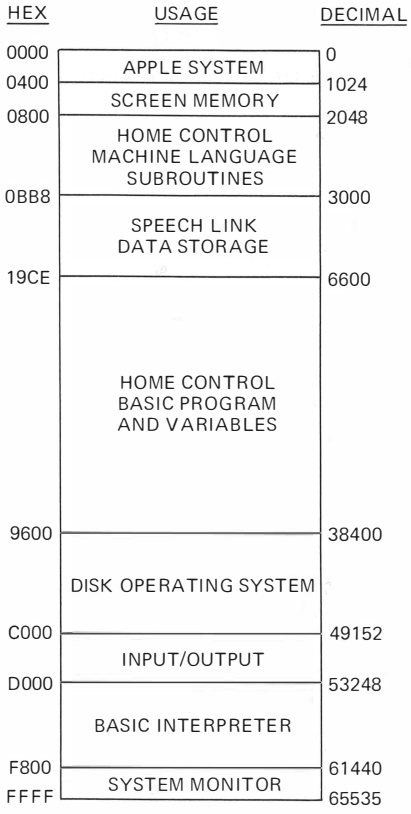


Figure 13.7 This memory map shows where each section of the home control program resides. Note that the normal Apple LOMEM has been altered to make room for special programs and data.

to the memory map in Figure 13.7 to see the areas of memory reserved for different parts of the home control system.

You should now have a good overview of how the software is organized. The main program consists primarily of a few GOSUBS that call the major modules in the proper order. These major modules use constructs to link together the fundamental tasks in such a manner that an intelligent system is created. In the next chapter we will look at the fundamental tasks in detail.

14 The Primary Tasks

A primary task in the home control system is one of the fundamental functions used to build larger modules. These simple, almost trivial actions form the foundation of the entire system. The tremendous power of the home control program comes from the intelligent linking of subroutines that perform the actions required to solve trivial tasks.

In this chapter I wish to cover all the primary tasks in considerable detail. A good understanding of these tasks and how the computer performs them will aid you greatly when we look at the major modules in later chapters. The name of each task and its starting line number were given in Figure 13.6. The actual program listings can be found in Appendix A. Let's look at each of them separately.

The first module, as its name implies, checks to see if the phone is ringing. Anytime the main program wants to know such information, it will call this subroutine. This subroutine, as well as several others, will use the variable YES to pass status information back to the calling program. In this case, when the program returns, the variable YES will equal a 1 if the phone is ringing and a 0 if it is not.

As previously mentioned, you can refer to Appendix A to see the code for this module. It begins at line 100. As you can see, it is very short, so short in fact that no flow charts will be used to describe this or any of the fundamental tasks. The subroutine is very simple. First, the phone is assumed not to be ringing, so YES is set to 0. A FOR loop causes the

system to check a location of the Micromodem card 30 times. The variable RING has been set equal to the actual address of this location.

This Micromodem location is special. It was designed to contain a number smaller than 128 whenever the phone is ringing. The program checks for such a situation and sets YES equal to 1 when it exists.

At this point, I hope you are thinking, "Boy, he wasn't kidding when he said the fundamental tasks would be simple." Remember, if you happen to be using a different commercial device for detecting a ring, you will need to change this routine. Once that is done, any module that needs to know if the phone is ringing will GOSUB 100 and check the value of the variable YES upon return.

If you do not wish to buy special hardware, you should refer to back issues of such magazines as *Byte*, *Microcomputing*, and *Micro*. These magazines are filled with many interesting and informative articles that can aid those of you that wish to design and construct circuits of your own. Of course, my hardware chapters have given you some ideas, but I suspect many will wish to alter my initial ideas to match particular objectives.

You should also check the book section of your local computer store. There are many books available on subjects ranging from telephone projects to interfacing the Apple computer. I point all this out because you should now realize how simple it is to adapt my program to any hardware you might have or want to build.

For completeness, I should discuss the magic number 128. Many peripheral input pins, such as the location RING and the Apple game connector input pins, are each connected only to the most significant bit of an input port. The remaining 7 pins are left unconnected and therefore appear to be random 1's and 0's when read. Any external event forcing the most significant bit to 0 will appear, when read, as a number smaller than 128, no matter what state the rest of the bits are in.

The second fundamental task is to check for a changing sound from the microphone and its associated amplifier discussed in Chapter 9. This subroutine also passes its answer in the variable YES, like the ring detection module. It is not quite as easy though to detect a change as it is a simple presence.

The problem is as follows. Usually, when no one is talking, the input pin will be zero. For example, if someone called and just quit talking, the input pin would stay low. If they hung up, though, the dial tone would be a continuous sound that would result in a 1 on the input pin. To ensure that someone is still talking, the computer must check to see if the input pin is alternating between 1 and 0.

To do this, the subroutine starts by assuming there is no change,

which again means that YES is set to 0. The location SOUND has been set to the address of one game connector input pin. Depending on whether SOUND contains a number greater or less than 127, the temporary variable S(6) is set to a 1 or a 0. For a couple of seconds the system loops and checks to see if the location SOUND still contains the same information. If it does not, a change has occurred and the variable YES is set to 1.

This subroutine does not return as soon as it detects a sound, but always checks for the same period of time. This will provide an easy means to monitor how long a call is taking. Using this information, the phone module (Chapter 17) can easily impose a maximum limit on the length of recorded messages. The listing for this fundamental task, as for all the others, is in Appendix A.

There are two delay routines, one at 200 and another at 400. Let's look at both of them now. The one at 200 will delay a number of seconds equal to the contents of the variable SC. It performs this task by setting up the variable DE and calling the general-purpose delay routine at 400.

You might be wondering why I did not use the clock for these routines. For many situations the clock would be excellent. Remember, however, that my clock is only accurate to 1 second. The delay at 400 is accurate to one cycle of the FOR loop, about 1/400 of a second. This accuracy was needed to time the 30-second message tape. If the tape stopped a half-second early each time, it would not take many phone calls to have it starting up in the middle of the message.

There is one line that I did not mention in the explanation. It PEEKs at the location SANITY. This statement will occur throughout the home control system. Its purpose is to reset the system sanity timer as discussed in Chapter 7.

At line 250 we have a subroutine that checks for the special tone sequence described in Chapter 11. The principle of its operation is not very difficult. The program monitors the same microphone as the subroutine at line 150, which detects sound changes. The difference is that this module will measure how long the first sound, the first pause, and finally the second sound last. The relative lengths of these three periods are stored in the variables I, J, and K. This is done in lines 262 through 286.

At line 292 the measured values are checked to see if they are within tolerance of the code values. If they are, then YES is set to 1; otherwise it is set to 0. The lines prior to 262 are used to wait for a sound to start. If it does not start within a few seconds, the subroutine will return with YES equal to 0.

The PRINT statement at line 293 is not required for normal operation. If you are changing your code or starting up your system for the first time,

you may use this line to help you decide on your ranges for I, J, and K. The easiest way to do this is to simply call your computer while you are out running an errand and play your tone sequence. Since it will not match, the computer will hang up on you; but when you get home, it will have printed the values it found on the screen and you can alter lines 294 through 298.

The Say a Message module at line 300 may appear to be long at first, but the program itself is really very short. Most of the listing is made up of the messages. To use the message module, you need only to set the variable MESSAGE equal to a number between 1 and 64 and call this subroutine. Not only will the corresponding message be said, but the delay routine will be called to force a pause so that the message and the program will stay in sync.

This need to stay in sync may not be very obvious, so let me discuss it further. Suppose the computer asks you a question such as, "What do you wish me to do to the floodlights?" You would be expected to respond by saying either "Turn it on" or "Shut it off."

Once the computer has sent the message to the speech synthesizer, it will then enable the speech recognition unit in order to hear your reply. If the system begins "listening" too early, it will hear itself talking. This is possible because of the buffer in the voice synthesizer. If the wait is too long, you might begin speaking before the system is ready to listen. The solution to this problem is to have the computer pause whenever it speaks for just the right amount of time.

Line 303 is used to enable the speech synthesizer. Depending on the variable MESSAGE, one of the print statements will send a phrase to the synthesizer. If MESSAGE is 1, line 311 will be executed. If MESSAGE is 2, line 312 will be spoken. Each print statement must end with a RETURN in order to send the program flow back to line 306.

In line 306 the variable SC is set to an element in the array MT. The variable MESSAGE is used to select which element is to be used. Each element in the array has been initialized to equal the number of seconds required to say each corresponding message. When the subroutine at 200 is called, a pause of SC seconds will be generated. Note that the delay routine we are using is also one of the fundamental tasks.

By reading through the messages, you can see the phrases that my house can say. You can easily customize these to give your home the personality you desire. If you wish, you can add additional messages in lines 365 through 374. If you need more than ten additional messages to customize your home, you will have to expand line 305.

The last thing done in this module is to turn off the speech synthesizer using a PR#0 command.

The next task is to initialize Speech Link. The Speech Link voice recognition system needs to have memory set aside for work space. It also needs to know where the word templates are stored. Once all this has been done, a control "I" must be sent to the slot holding the Speech Link board.

If you own a Speech Link, you can get a full description of what is happening in this module from your manual. If you are using some other recognition system, I will not bother you with the details about mine.

The subroutine at line 450 checks to see if the wireless mike is on. It looks at the Apple game connector pin that is connected to the wireless mike (see Chapter 4) and sets the variable YES equal to 1 or 0 depending on the value found. Whenever the wireless mike is off, the RF radiation from my early model Apple keeps the input pin high, which means that the reading will be 128 or greater. If the mike is turned on, the receiver locks onto the carrier, and the reading will drop to 127 or lower. Because of this, I can get the computer's attention by just turning on the microphone.

If you are using a later model Apple or any computer that is well shielded, or if you have a different type of wireless mike than mine, you may have to alter this routine somewhat, although I doubt it. If you should need to make changes, you will just have to experiment a little with your equipment. In general, though, if my subroutine is not suitable, the Check For Sound Change routine at line 150 should work if the variable SOUND is replaced with the variable VOICE. Copy it at line 450 and make the appropriate changes.

Don't forget that the sensitivity of the hardware discussed in Chapter 4 can be varied using a potentiometer.

At line 475 there is a subroutine to perform another fundamental task. In this case it loads a two-dimensional array from disk. This array contains the time table information that the main program will use to control the automatic actions preprogrammed by you. A complete discussion of the contents of this array will come later. The listing for this subroutine is relatively short. The variable D$ is equal to a control "D" as required by the Apple for recognition of disk commands.

We need to skip ahead just a little in the program listing to the module at line 750. This routine utilizes a machine language program (details in Chapter 20) to "push" a button on the BSR unit. To use this subroutine, the variable BU should be set to the appropriate code for the button desired. The codes were listed in Figure 8.4.

The subroutines at 500 and 525 are used to turn things ON and OFF using the telephone. They both use other fundamental tasks to help

perform their functions. These subroutines are only called if the main program has determined that something is to be controlled. Let's look first at the Turn On By Phone module.

The program immediately goes to the subroutine at 540. Using the Say Message task, the computer will say, "Give me a yes to each valid device" (message 38). A FOR loop is then used to say the seven items that my program can control from a telephone. After each is said, the caller can respond by saying the word "no" or playing the proper tone sequence for a "yes." The subroutine at 250 is used to check for the code. If a YES was given (YES = 1), the correct button on the BSR will be pressed.

When all seven items have been said, a RETURN sends the program back to line 510. At this point the ON button is pressed, which will turn on every item whose button was pressed earlier. The only difference in the OFF subroutine is that the OFF button is pressed in line 534. The power of using fundamental tasks to create more powerful functions should be becoming very clear. If it is not clear at this point, I urge you to study the listings in Appendix A for the modules discussed so far.

At line 600 there is a routine that will read the time from the clock circuit discussed in Chapter 6. This time is stored in two ways. The first way uses the array T(X), where X ranges from 0 to 6. When this subroutine is exited, T(1) and T(0) will contain the present time in seconds. T(0) contains the least significant digit. Likewise, T(3) and T(2) contain the minutes information. The hours are found in T(5) and T(4). T(6) will contain a number from 0 to 6 indicating the day of the week.

Each of these digits is read using the subroutine at line 620. It sets up the proper data direction on the I/O port, sends the proper address, and reads in the digit desired. During the read operation the clock is disabled from counting so that false reads will not occur. The variables used here are A, B, CA, and CB, which represent data registers A and B and their associated control registers.

A small machine language subroutine (Appendix B) is called from line 630. Its purpose is to mask the top four bits of the digit being read to 0.

Line 616 converts the present time in minutes and hours to a single number, which is stored in the variable TM. Since my clock chip adds 4 to the most significant digit of hours if the time is P.M., each time will have a unique TM. If you are using a different clock board, simply replace this routine with one that reads your clock and puts the appropriate data into the variables T(X) and TM. If you do write your own routine, don't forget to indicate A.M. and P.M. by adding 4 to the most significant hours digit to indicate P.M.

The Dial the Phone module does exactly as its name implies. Before calling this routine, PN$ should be set equal to the desired phone number. Line 655 activates the D.C. Hayes Micromodem, which is in slot MSLOT. The phone is actually dialed by sending a control Q, the phone number, and a line feed to the modem. When the modem receives this sequence, it will dial and attempt to communicate with a computer at the other end of the line.

Since we don't want such a communication to take place, the modem must be instructed to hang up by sending it a control Z. This would normally disconnect us from the phone line. To solve this problem, we activate the intercom phone in line 665 before the control Z is sent. The variable TN is the game connector pin controlling the phone. TN stands for telephone on. Location TF turns the phone off.

After the modem is completely turned off with a PR#0, the variable S5 is set to a 1. This serves as a flag to other modules so they will know that the phone is off the hook.

At line 700 there is a module to verbally report the present status of the house. Variables S8 and S9 keep track of the number of outside and inside triggers of the security sensors This module uses the Message module to notify you of any security problems if S8 or S9 are not equal to 0. It also uses the variable NC (number of calls) to let you know how many phone calls have occurred that day.

Three modules are associated with the Speech Link voice recognition unit. The initialization routine at line 375 was discussed earlier. The other two are at lines 800 and 850. Let's look at 850 first.

This routine is highly dependent on the Speech Link. If you own one, the code should be obvious. If not, you will have to create a similar program to perform the same functions. Lines 858 to 865 cause the Speech Link to wait until a word is spoken. If the word is recognized, it is stored in the variable W$. If no match is found, W$ will be an empty or null string.

If recognition does not occur, the computer will respond (line 870) by asking you to repeat your request. The rest of this routine is a little peculiar and will require a little more information about the Speech Link system.

The Speech Link not only puts the recognized word in W$, but it also puts the number of the word recognized in a location we can PEEK at. Since I said each word three times during training, I needed to map three different word numbers into the desired number. This is accomplishd by the formula in line 875. Essentially, if the peeked location contains a 0, 1,

or 2, the word number (WN) will be 1. If it is 3, 4, or 5, then WN will be 2. This continues for all the possible words.

You could set WN using IF-THEN statements, but this feature of the Speech Link is much more efficient. A second feature of the Speech Link is selective recognition. This means that the word to be recognized can be compared to less than all the words in the vocabulary. This is not always a useful feature. In many cases, however, an intelligent program can determine that the next input should be one of several particular words.

For example, if the command given to the house is a room name, like kitchen, the system will ask, "What do you wish me to do to the kitchen?" It will expect you to give only one of the following four commands.

Turn it on
Shut it off
Dim it
Nevermind

The first three obviously control the light. Notice that I have tried to make each command sound as different as possible. The last command is used to get out of the sequence. It is used primarily to cancel a misunderstood command. Suppose you said "kitchen" and the house replied, "What do you wish me to do to the bedroom," because it misunderstood the word "kitchen." By replying "nevermind" the command will be aborted.

Since only four different words are expected, the system can be much more accurate if it compares a spoken word to only the four possible and not to all 63 in the vocabulary. To select which words to use during the recognition process, the Speech Link has a table that starts at the location specified by the variable MASK.

Lines 880 to 890 set each element of the table equal to zero so that the corresponding word will be ignored during the recognition process. Any module wanting to recognize a word will be required to set up the MASK table for the words it expects before calling this module. Since the home control program is intelligent, it will always know what type of command or response it expects from you.

I should remind you that this chapter makes no attempt at explaining how actions such as the preceding one are accomplished. The intelligence of the system will be explained in detail in the chapters that follow. All you are expected to understand now is what each fundamental task does.

The last task associated with the Speech Link resides at line 800. It is very similar to the word recognition module, except a control V is sent to the Speech Link before and after a word is recognized. The control V is used to toggle the speech system into and out of a special form of recognition. In this mode it can recognize only two words, "yes" and "no."

As in other modules with such a response, the variable YES will be set to a 1 for "yes" and a 0 for "no." This mode is particularly nice because it is speaker independent and does not require training.

At line 950 there is a module that initializes all the major variables. Refer to the listing in Appendix A as I discuss the use for each variable.

In lines 955 to 960, PF, PN, RF, RN, TF, and TN stand for tape PLAYER off/on, tape RECORDER off/on, and PHONE off/on. Any access of these variables, such as a PEEK or a POKE, will perform the named operation. Refer to the appropriate hardware chapters for more information on the use of these game connector locations.

The variable VOICE is equal to the location that indicates whether the wireless mike is off or on. Similarly, SOUND is a location that indicates if a noise exceeds the preset threshold. Lines 965 to 967 establish which slots the Speech Link, the Voice Synthesizer, and the Modem are in. RING is the Micromodem location that indicates if the phone is ringing.

At line 969 the array SP contains the Security Phone numbers. These numbers will be called in case of an emergency. Lines 970 to 971 set up the addresses for the PIA ports, A and B, and their respective control registers. The next line sets SANITY equal to the address of the system sanity timer. There will be accesses of the sanity timer throughout the program so that it will not cause a reset.

The array MT stands for message time. It is initialized to the number of seconds required to say each message in the lines 973 to 975. Next, N1$ and N2$ are set to the names of the two people for whom you have set up vocabularies. The respective vocabularies must be saved on disk under the same names.

Lines 979 to 980 set up the array DAY$ as the days of the week. PN$ in line 981 holds the phone numbers you can ask the computer to call. If you have single-digit dialing on your phone, you may increase the dialing speed by using a one-digit code.

Lines 984 to 986 establish the variables TEEN$ and TN$. These will be used to allow the Speech Synthesizer to announce the time correctly. Lines 987 to 992 set up the addresses for the tables, work space, and control characters used by the Speech Link.

Line 993 dimensions the time table array TT. This table will contain the events that should occur automatically, as well as their scheduled times. The appropriate codes mentioned in Chapter 8 for the BSR buttons are put in the array BU at lines 995 to 996.

The control codes used by the Modem are established in line 997. Line 998 makes sure that the phone and the two tapes are all off.

This completes the fundamental tasks required to control the hardware for the computerized home. All that is left to do is to see how these tasks can be linked together to create an intelligent system.

15 The Initialization Module

In this and the following five chapters I am going to discuss the major modules that actually form the home control program. As you recall from earlier chapters, these modules are initialization, voice request, phone control, security, event timing, and monitor movement. The initialization module is run only once and then control is passed sequentially among each of the other modules until conditions indicate that a particular function is needed.

These chapters will be presented differently than Chapter 14, which covered the fundamental tasks. Each of the tasks was small and, although important, they were lacking in overall complexity. The tasks are also the most probable sections of the program to be rewritten if your system is not identical to mine. For these reasons, the fundamental tasks were discussed in the context of their actual code.

The major modules are much larger and more complex. Rather than exploring their code, I will discuss them in terms of flow charts. Even though they are more complex, you should not hesitate to examine them. As you will see, their increased complexity does not necessarily mean that they must appear more complicated. Remember, these modules are little more than a series of control structures that link the fundamental tasks together in such a manner that a larger goal is accomplished.

Figure 15.1 shows the flow chart for the initialization module. The

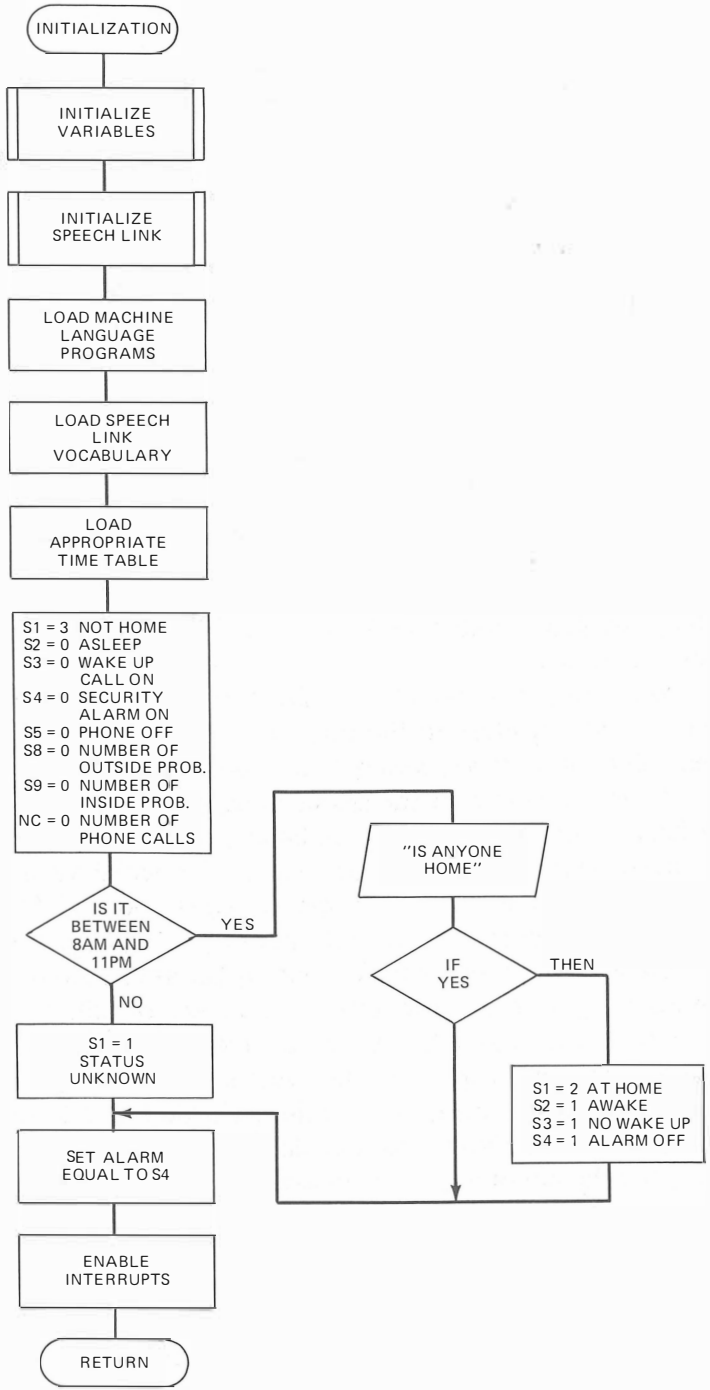


Figure 15.1 The initialization routine makes appropriate choices, even if no one is home.

first two items are calls to fundamental tasks to initialize the variables and the Speech Link hardware. Next the module loads the machine language portions of the home control program, including the vocabulary templates for the Speech Link. The final disk transfer is used to load the appropriate time table (depending on what day it is).

Except for enabling interrupts, the rest of this module is used to initialize some very special variables that are used as flags or status indicators. The contents of these flags provide a means for the system to remember important status information. The primary status variables will be S1, S2, . . ., S9. I will define each of them as they are initialized in the flow chart.

S1 can be one of three values. If it is a 2, it means someone is home. A 3 means the computer thinks the house is empty and a 1 means that the status is unknown. At this point in the initialization, S1 is set to 1, thus making the assumption that no one is home.

The variable S2 can only be a 1 or a 0. A 0 means that everyone is asleep, while a 1 indicates they are awake. The initial assumption is that they are asleep.

Both S3 and S4 are alarm indicators. S3 is for alarm clock or wake-up calls, while S4 refers to the security or burglar alarm. In both cases a 0 means the alarm is on, whereas a 1 indicates off.

S5 is a 0 whenever the phone is hung up and a 1 if it is in use. S8 and S9 keep track of how many outside and inside security breaches have occurred while the house was empty. A special variable NC is used to keep track of the number of phone calls. S6 and S7 are reserved for temporary variables and do not have any global significance.

Once the computer makes the initial assumptions and sets the flags accordingly, it then attempts to confirm or change as many of the assumptions as possible. It will do this primarily by asking verbally if anyone is home. To prevent the system from waking you in the middle of the night just to confirm its decision, I added an additional check.

If the clock shows that people should be sleeping, the computer will not make the announcement. Instead, it will alter only the S1 flag to show that the status is unknown. If the clock indicates that people should not be sleeping, it proceeds to ask if anyone is there.

If someone responds to the question by turning on the wireless mike, four of the flags are changed. The house will now assume someone is home, that they are awake, and that no alarms have been set.

The last portion of this module POKES the security alarm value of S4

into a memory location called ALARM. This location is used as a flag to the machine language portion of the home control system and causes it to act differently depending on the value. The actions of the machine language program will be discussed in Chapter 20.

You can refer to Appendix A to see the actual code used to implement this and the other major modules of the home control program. The initialization module begins at line 900.

16 The Voice Request Module

The purpose of the voice request module is to provide a means to control the house using verbal commands. Because of its complexity, much of this module is broken down into submodules, which are in turn made up of primary tasks.

Figure 16.1 shows the first-level flow chart for the main module. Let's examine the chart in detail. You can refer to Appendix A for a complete listing of the program if you wish to see how the flow chart is implemented in code.

The voice request module begins by using a fundamental task to determine if the wireless microphone is on or off. If the mike is off, the control returns to the main program loop. If the mike is on, it means that someone wants to verbally command the house to do something.

Assuming someone turned the microphone on, the flags are set to show that someone is home and that they are awake. The security alarm is shut off, as is the wake-up call function. These operations are representative of how the home control program is intelligent. The user does not have to "tell" the computer that he is home or that she is no longer in bed. These conclusions are "inferred" by the system.

If, for example, you wake up early and ask the computer to turn on the bedroom light, it will automatically, because of the flags, act differently. It will not try to wake you up later as it was scheduled to do. It won't

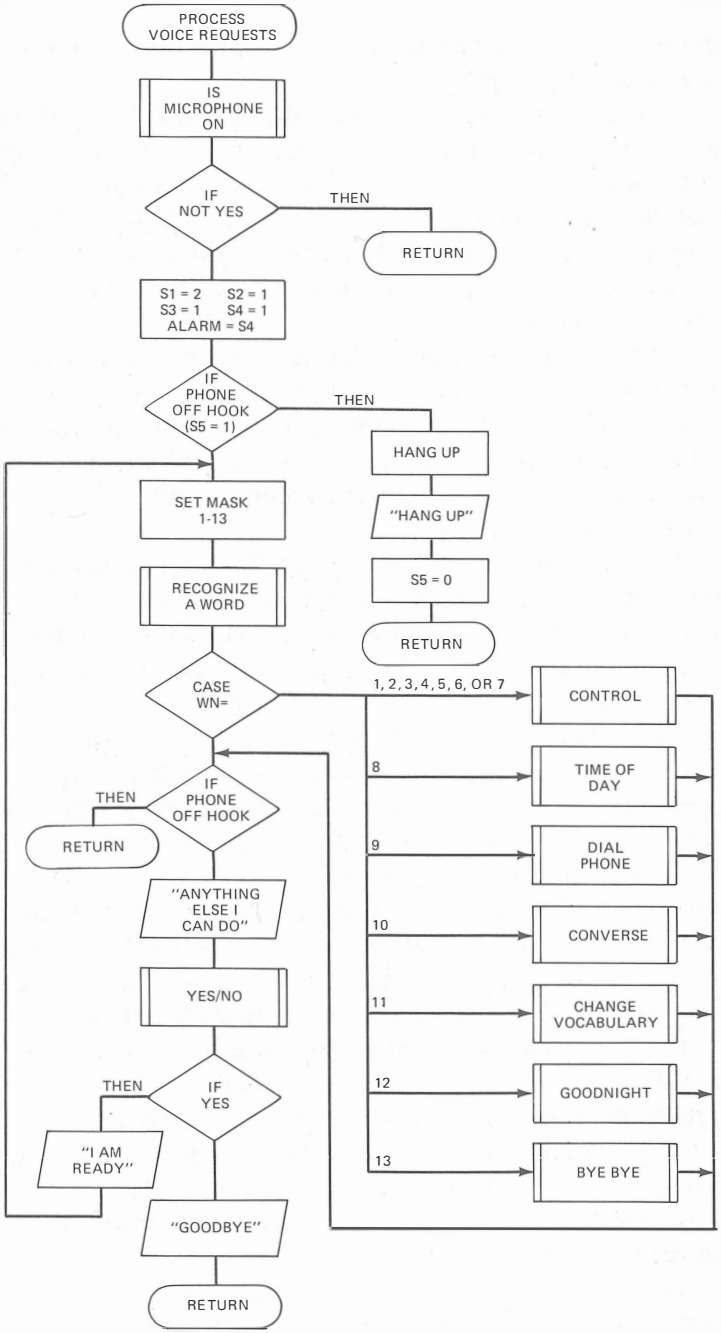


Figure 16.1 This section of the voice control module passes control to one of seven submodules.

mind if inside security sensors are triggered because it will now assume it is you and not an intruder.

The next item in the flow chart is to check to see if the phone is off the hook. This needs a little explanation before we look further at the flow chart. Later in this chapter and in Chapter 17 we will find that you can command the computer to dial or answer the phone for you and place the call on the intercom phone. Once that is done the program will set a flag to indicate that the phone is off the hook, and it will proceed to handle other tasks.

The assumption will be that if you are talking on the phone you will not be giving verbal commands to the house. Consequently, whenever the phone is off the hook and the computer sees the microphone on, it will assume that the phone call is over and it will terminate the call. This may seem complicated now, but it will seem simpler after we have discussed it in more detail later.

For now, we can see from the flow chart that if the microphone is turned on while the phone is in use, then the computer will hang up, say it has hung up, and set the flag to indicate that the phone is no longer in use.

At this point in the flow chart we can assume that someone really wants to give the computer a verbal command. The command must be one of the 13 that is expected, so the mask is set to only allow recognition of the proper words. A fundamental task is called to do the actual recognition. This task, as discussed in Chapter 14, will set the variable WN (word number) equal to the appropriate number between 1 and 13.

Depending on WN, control is passed to one of seven secondary or submodules that process the command given. We will look at each of these modules in a moment. For the sake of continuity, though, let's complete our discussion of Figure 16.1. After the appropriate secondary module performs its task, the flow proceeds down the flow chart.

If a flag shows the phone is off the hook, which would indicate that the system has just been requested verbally to make a phone call, then the program returns to continue processing other tasks. Otherwise, the computer asks if there is anything else you want and waits for a verbal yes or no. If YES, it says that it is ready and waits for a new command. If NO, the system will say goodbye and return to loop until another situation requires attention.

You should note that the computer always responds verbally to the commands you give. When a human talks to a machine, some type of feedback to the user is very important in order to convey that the machine is understanding.

Let's look at each of the seven secondary modules that execute the

verbal commands. The first of these is the *control* module. It is called when the word spoken was one of the items that can be controlled, such as office, stereo, or bedroom. The flow chart for this module is shown in Figure 16.2.

In the first block of the flow chart we can see that the variable BU is set to the correct button code for the BSR unit. The button codes were stored in the BU array during initialization. The word number WN is used to select the correct code.

The computer uses a fundamental task to ask what you wish to do to the item specified. Since the name of the item being controlled is stored in the variable W$, the house can call the item by name. The mask is then prepared to recognize only one of four words. The acceptable words are "turn it on," "shut it off," "dim it," and "nevermind." Another fundamental task is called to determine what you responded with. I should point out that the words "on" and "off" were not used alone because the recognition system had trouble telling them apart.

This is a good time to reemphasize the importance of the fundamental task subroutines. They handle all the drudgery associated with the task. In this case, for example, if the human response is not recognized, the task subroutine will ask you to repeat the answer. This verbal response from the computer is handled by still another task, which also takes care of all the little details associated with its job. With the tasks taking care of all the details, the major modules become not only simple to understand but also very easy to write.

Let's continue with the flow chart. If the user's response was "nevermind," the program simply returns to the main module. Otherwise, we can be sure that WN is 14, 15, or 16, because those were the only words that were acceptable. Since the item in question is going to be turned ON, OFF, or DIMMED, a fundamental task first "presses" a button to select the item.

Control is then passed to one of three sections of the module to press the ON or OFF button or in the case of DIM to press the button 50 times. This completes the control module.

If the verbal command is "Time Please," the *time of day* submodule is called. Figure 16.3 shows the organization of this routine. It first calls the *read time task* in order to set the array T to the individual digits.

These digits are analyzed, converted to their English equivalents, and announced verbally by the speech synthesizer. You can refer to the flow chart to see how this is accomplished. The reason for it should be obvious. Suppose the time is 10945. If the synthesizer read those numbers, you would have to translate them yourself.

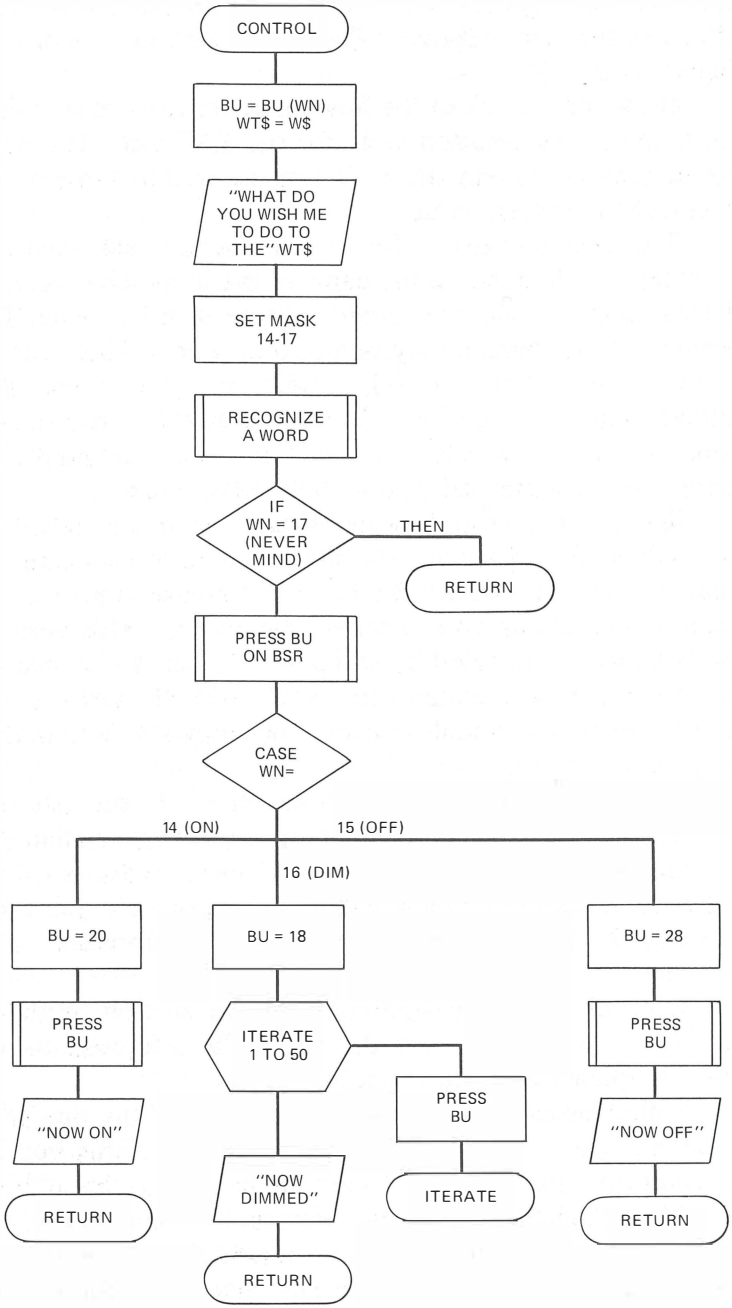


Figure 16.2 This submodule allows you to control lights using verbal commands.

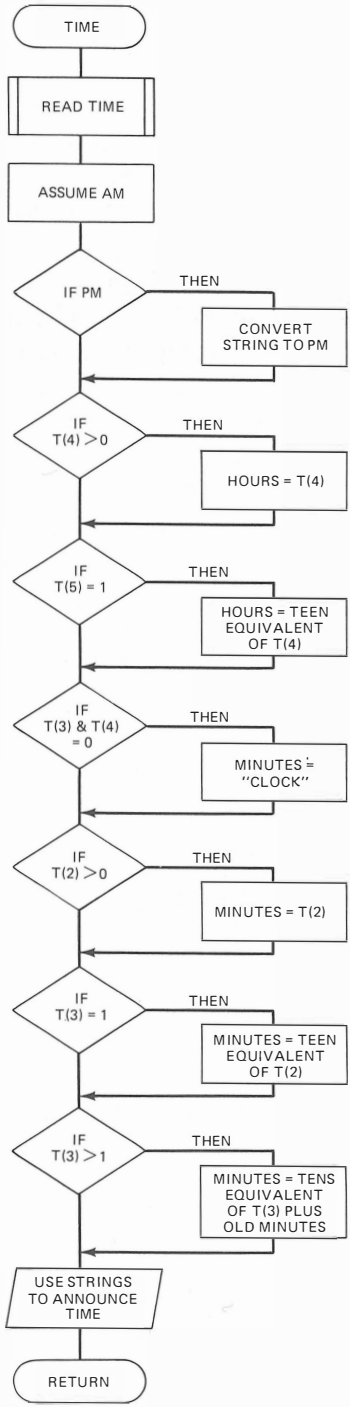


Figure 16.3 The numeric time from the clock must be converted to its string equivalent so that the voice synthesizer can properly announce it.

The program will convert 10945 into "Monday 9 forty five A.M." This string of characters will be used by the voice output task to announce the time.

If the input word was "telephone," control is passed to the submodule shown in Figure 16.4. The computer begins by asking who you wish to call. Since there are only five acceptable answers, four names or places plus "nevermind," the mask is set to allow only words with numbers 17 to 21.

The task to recognize a word is called again, and if the answer is not "nevermind," then *message task* states that the phone call is being made. The number is looked up in the array PN$ and then dialed by a

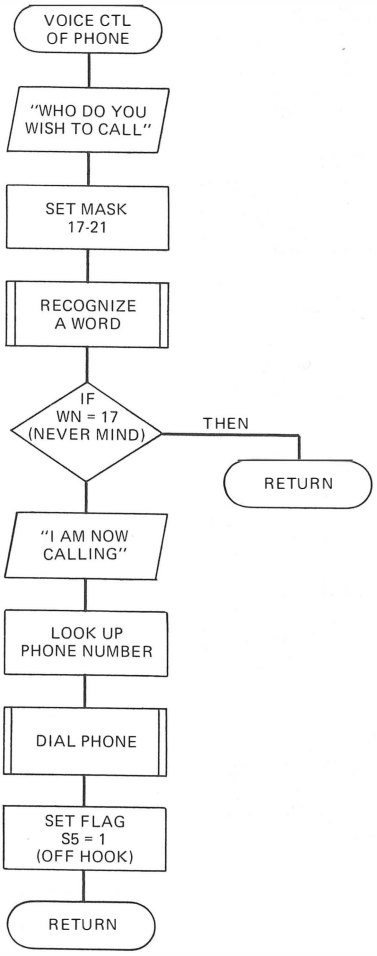


Figure 16.4 Using this module, you can ask the computer to call someone for you.

fundamental task. Finally, a flag is set to convey the information that the phone is off hook to other modules.

The *conversation mode* is entered in response to the command "are you busy?" This module simulates a conversation between you and the house. All the questions asked by the computer expect a YES or NO answer, or some short phrase that is ignored. There is no real intelligence displayed here except that the computer's response will be appropriate for YES or NO answers. This mode was added more for fun than to serve a useful purpose. If you don't want such a mode, you can easily add another command or extra phone numbers for verbal calling. I think if you try it though you might find it has some value.

I find it most useful when someone visits that has heard about my "computerized home" and yet knows nothing about computers. They seldom are impressed when it dials the phone or turns on lights, but they never cease to be amazed when it appears to be conversing with me.

This module is actually very simple as it is made up only of a couple of fundamental tasks. Refer to Figure 16.5 to see how the conversation is created.

The next submodule allows you to change vocabularies while the program is running. Since the Speech Link must be trained for each user, I placed two vocabularies on the disk. In my case, one of these is saved under the name JOHN and the other as WANDA. Chapter 21 discusses some utility programs, one of which can create these vocabulary files.

A couple of techniques are used here that make the house seem intelligent. Initially, the variables N1$ and N2$ are set equal to JOHN and WANDA, respectively. Whenever the house is talking, it refers to the person as N1$. For example, it might say, "What can I do for you "N1$"? This makes the comments much more personal.

When training my vocabulary, I said all my commands but one. I had Wanda say the phrase, "This is Wanda." Likewise, in her vocabulary I said the phrase "This is John." If when the computer says, "What can I do for you "N1$"? the variable N1$ is JOHN, then Wanda can respond with "This is Wanda." The recognition of that phrase as a command word will send control to the *change vocabulary* submodule shown in Figure 16.6.

As you can see from the flow chart, the computer will apologize to Wanda (or the alternate person) and then load her vocabulary. Afterward the contents of N1$ and N2$ are exchanged so that everything works equally well for either person.

The next command is "goodnight." When this command is issued,

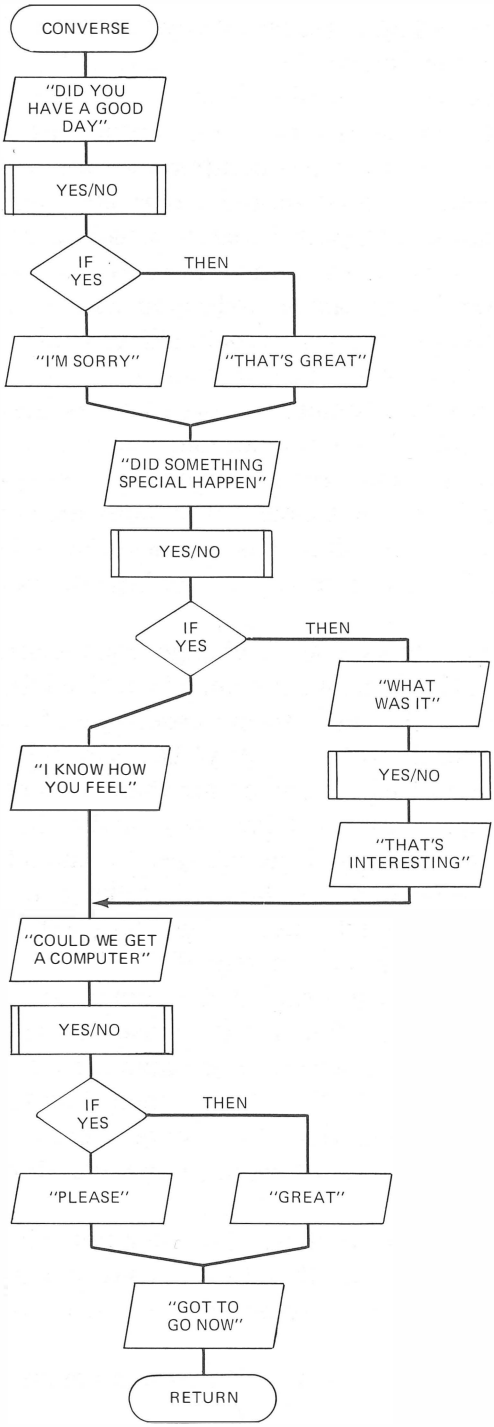


Figure 16.5 The simulated conversation provided by this module can really impress a nontechnical user.

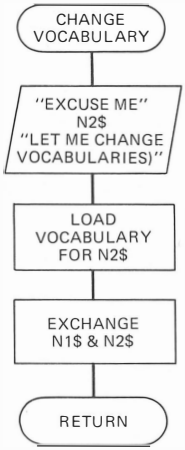


Figure 16.6 My system will allow two separate vocabularies to alternate automatically, depending on who is talking to the computer.

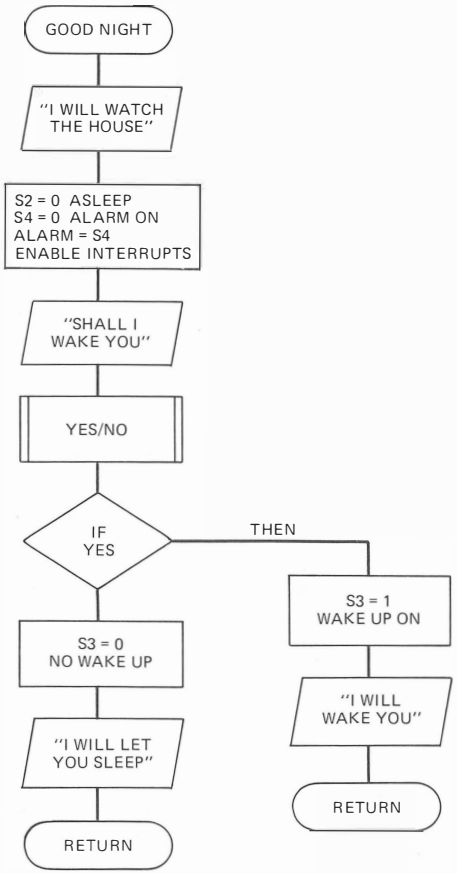


Figure 16.7 Telling the house "goodnight" tells the system to adjust the status of the alarms.

the system will assume you are going to bed. As you can see from Figure 16.7, it will first tell you that it will watch the house for you. This means that the security system is enabled.

The flags are set to indicate that you are asleep and the security alarm is on. The machine language program that handles security (Chapter 20) is notified of the change by poking ALARM with the value of S4. By

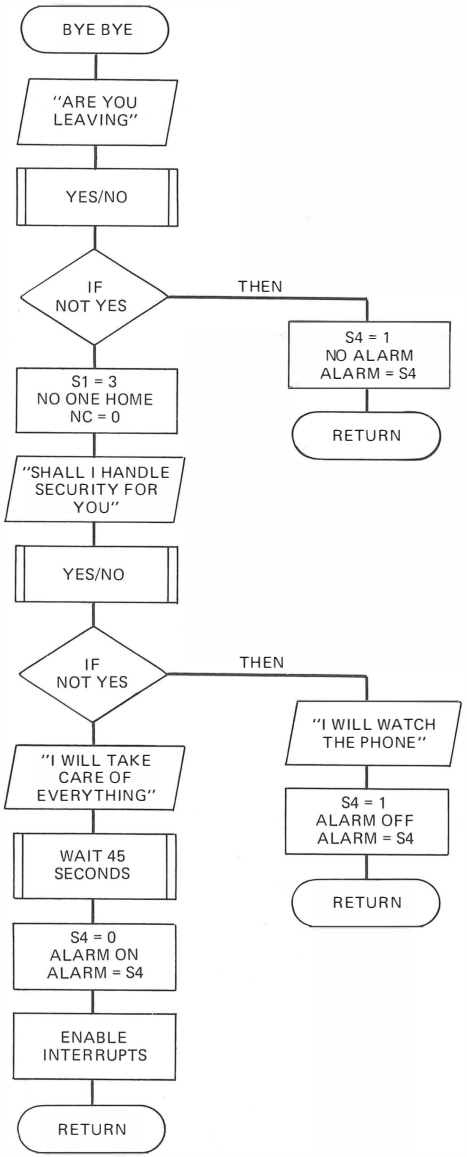


Figure 16.8 When you leave, the house will set flags so that it will answer the phone and handle security.

enabling the interrupts we are insured that the machine language program is operational.

The system will ask if you wish to be awakened in the morning. Depending on your answer, the wake-up flag is altered and the appropriate verbal response is given.

The computer will continue to remember that you are asleep and the status of the wake-up alarm until one of two things happens. If the house was instructed to wake you, it will verbally try to arouse you at the correct time. This will be discussed in detail in Chapter 19. At that time the system will assume that you are awake and adjust all the appropriate flags.

The second way that the flags can be altered is for someone to turn on the wireless mike and try to issue a command. As mentioned earlier, such an action will cause the house to assume that you have gotten up early.

The last verbal command is "bye-bye." I used this instead of "good-bye" because it was easier for the system to tell it apart from "good-night." Figure 16.8 shows the flow chart for its implementation. It begins by asking you if you are leaving. If your answer is "no," it turns off the security alarm and returns.

If you said "yes" you were leaving, then it sets up a flag to indicate that no one is home. This flag will be used primarily by the telephone answering module and the automatic event scheduler. These modules will be discussed in detail in later chapters.

The house will then ask if you want the security alarm on. If not, it announces that it will handle phone calls, sets the appropriate flags, and returns. If you answered "yes," it acknowledges your request and waits for 45 seconds so that you can get out of the house before it turns on the alarm.

This concludes the discussion on the modules that process the verbal commands. Although you should now understand how the commands are carried out, I expect that some of the interactions this module has with other modules might still be a little confusing. I suggest that you read on and get the details on the other major modules first and then return to this chapter if you are still unsure of some details.

17 The Phone Control Module

We saw in the last chapter that you could verbally command the phone to place a call for you. In this chapter we are going to examine the module that handles incoming phone calls.

Figure 17.1 shows how this module begins. A major task is used to determine if the phone is ringing. If not, the program returns and continues the major loop. If the phone is ringing, two things happen.

First, a variable that keeps track of the number of phone calls is incremented. This variable will be used later in the status report module to tell you how many calls have been received.

The system must now decide what to do about the call. This depends on the status flag S1. Depending on its value, control will be passed to one of three sections of this module. These three sections handle three different situations, which are "someone home," "no one home," and "unsure if anyone is home." This last situation could occur only if there had been a power failure and the system had to be reinitialized.

Let's look at each of these situations individually. I will start with section A, which is shown in Figure 17.2. It handles the phone when no one is home, which means it must function like an answering machine. It begins by turning on the intercom phone and the tape player. This is done by POKEing the appropriate game connector addresses. The system then waits in a loop for just enough time for the endless loop message tape to

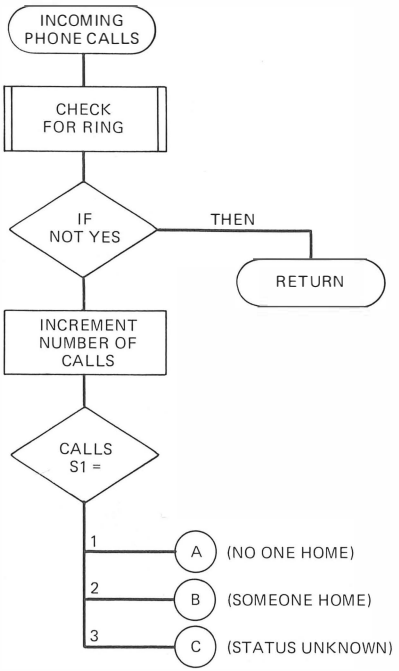


Figure 17.1 When the phone rings, the phone may be handled in one of three ways.

finish. My timing loop is based on my tapes, which may be different from yours. Experiment with the delay a little to get it just right for your system.

At the time when the tape should be finished, the player is turned off and the recorder is turned on. Immediately, the system begins watching for the special code that indicates that you are calling. If it does not get the proper code as the first sound, it records the caller's message and turns everything off. Although a maximum time is allotted for each message, the system will hang up early if there are no changes from the sound sensor.

If it was determined that it was you calling, the system reacts by turning off the recorder and asking if you want a status report. Again it checks for the special code. If it does not occur, the status report task is not called.

It then will ask you if you want to turn something on. If you give the code for YES, a task module is called to let you select the items to be turned on. Similarly, you are given the choice to turn off items in the house. When all this is complete, the house will say "good-bye" and hang up.

Section B of this module is shown in Figure 17.3. It handles calls when you are at home. It begins by asking you if you would like for it to get

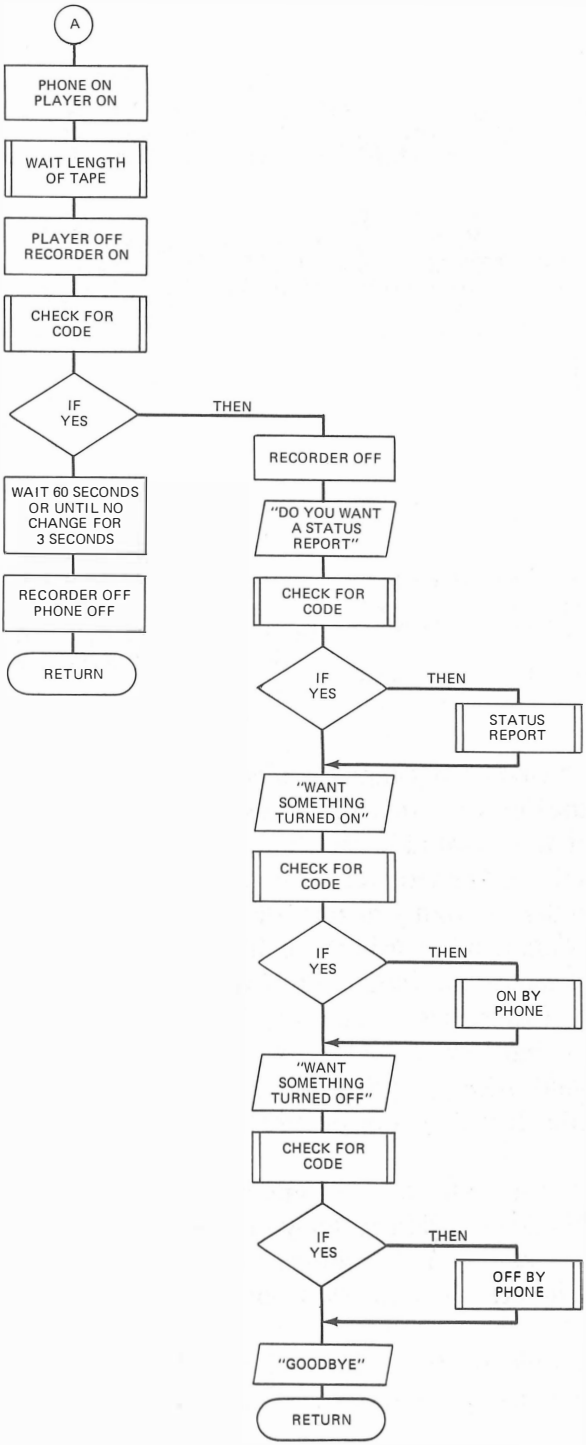


Figure 17.2 If no one is home, the house becomes an answering machine that can also accept commands from you.

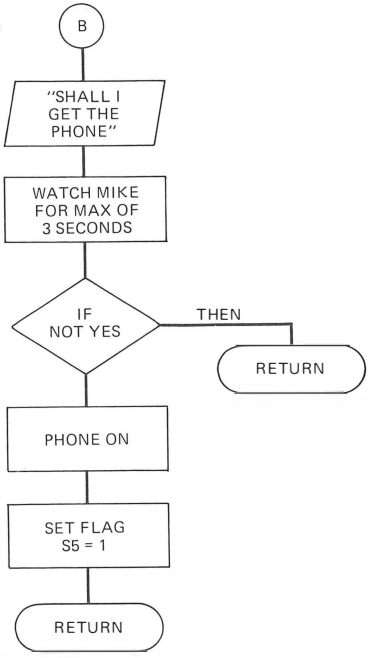


Figure 17.3 Even if you are home, the house can help when the phone rings by turning on the intercom phone.

the phone for you. The system will wait about 3 seconds for your reply, which in this case is simply turning on the wireless microphone.

If you fail to turn it on in the prescribed time, the house will assume you answered the phone yourself and will tend to other tasks. If the mike did come on, the system will turn on the intercom phone so that you may talk with the caller. A flag is set so that all modules will know the phone is presently turned on.

Figure 17.4 shows how section C handles a call if the system is unsure if anyone is home. It waits for several seconds to give you a chance to answer the phone. If it is still ringing, it assumes that no one is home and proceeds to section A to handle the phone call in the proper manner.

Even though it assumes you are not home if the phone is still ringing, it will not assume the opposite if the ringing has stopped. The reason for this is that it is possible that the caller just hung up. This means that, although the house can assume incorrectly at times, I have tried to make the default assumptions the best choice.

In this case, for example, an assumption of you being home when you are not would cause the burglar alarm to be deactivated. Since I find this inexcusable, my system will not allow it. The opposite case, however, assuming you are away when you are really home, is acceptable. If you do happen to be home and you set off the alarm, you can easily deactivate it.

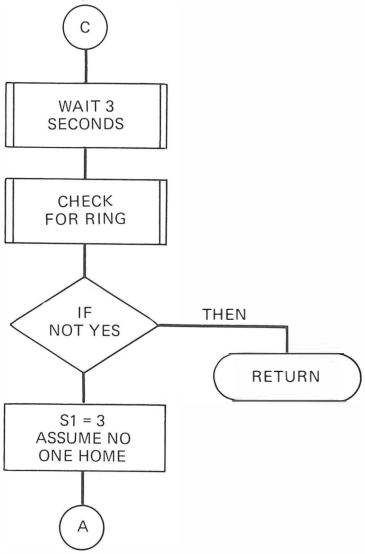


Figure 17.4 If the computer is unsure of whether you are home, it will take advantage of a ringing phone to find out.

Remember that this type of assumption is not an everyday occurrence. It can only happen if there is a power failure at night and you receive a phone call before morning that hangs up early. If the power failure happened during the day, the system would have verbally inquired to see for sure if anyone was home. After all, your house should be polite and not wake you in the middle of the night just to see if you are home—even if that means a potentially incorrect assumption now and then.

18 The Security Module

Many of the capabilities of the home control system can be considered a bit frivolous. After all, how many people do you know with a house that talks to them? The security aspect of the system, though, is very practical. If you price a full-featured commercial security system for your home, you may find the computerized home to have some attractive economical advantages, especially when you consider all its other capabilities.

I don't wish to imply that the security program offered here will provide total security. With custom changes in the program, however, its capabilities can be increased to almost any degree that you wish.

You might be asking yourself why I did not publish the "perfect" security module. The answer is really very simple. First, as you see from the module given, I think the best security must be designed to function in a particular environment. The best for my home would probably not be the best for yours.

The second and probably the most important reason for not publishing the perfect security module is that, if you can read it to see how it works, then an intruder can also read it to see how to overcome it. My intention will be to show you a workable security system. Using it as a guide, I hope you will customize it to meet your particular needs.

In my system there will be several groups of sensors that can indicate a security problem. The doors and windows should have some kind of

magnetic or contact switches. Refer to Figure 18.1 to see how these switches may be connected to an input port on the computer.

Most input ports will "float" high, which means they will read as a 1 if nothing is connected to them. If this happens not to be true for your ports, you can force it to happen by using a 5K pull-up resistor as shown. Such a resistor is always a good idea, even for ports that float high.

Since the port will normally be high, any closure of a switch will short it to ground and cause a 0. Sensory switches may be purchased in normally open or normally closed varieties. This means that you can have a 0 indicate that the door is open or closed, depending on your choice of switches.

You can add an inverter between the switch and the port if you cannot find the type of switch that you prefer. In all my examples, a 0 on the port will indicate a security problem. You should also notice from the figure that you do not need a separate input pin for each switch. By paralleling all the window switches, for example, any window opening will force a 0 at that pin.

Another type of sensor should be used to indicate outside movement. This could be an ultrasonic motion detector or an infrared beam that triggers if broken. There are even sophisticated sensors on the market that can detect the body heat of someone near your home. The type of sensor or sensors you choose will depend on your home and its surroundings. I will assume that the appropriate external sensors have been paralleled so that we have a single pin indicating external movement.

Similar types of sensors could also be used inside the house to

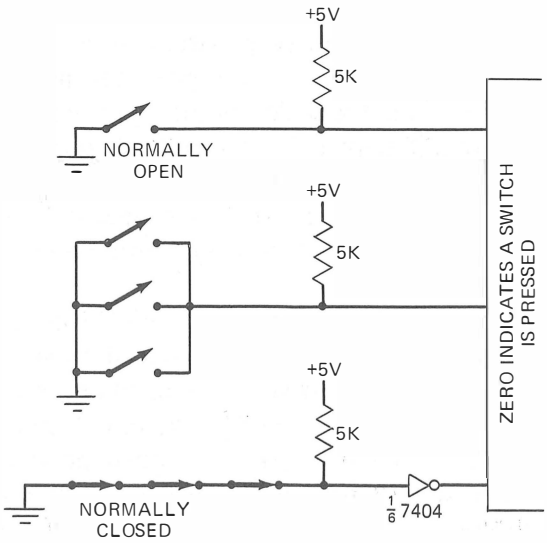


Figure 18.1 The security switches may be combined in many combinations as required.

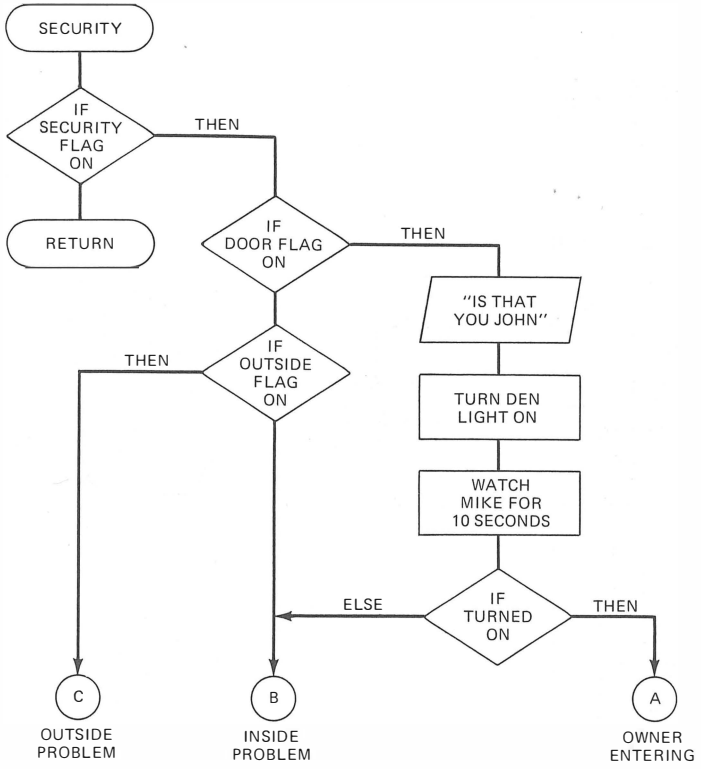


Figure 18.2 If the security flag has been set, the indicator flags will be checked and an appropriate action taken. (a) When you come home, you are asked if you want a status report, which summarizes the day's activity, including such things as the number of phone calls received. (b) An inside problem requires drastic measures. The computer will call you and your neighbors and inform them of the situation. (c) In response to an outside problem, the house will attempt to scare off an intruder by turning on lights and playing the radio.

indicate internal movement. Since I have floor switches already installed, I decided to let them act as the internal sensors when the security alarm was on.

All the security port inputs will be ORed together so that any of them can trigger an interrupt. This will run a machine language program that will set up several memory locations to indicate whether there is a security problem and, if so, if it was a door or window or if the problem was internal or external.

The details of the machine language program and the interrupt circuitry will be discussed in Chapter 20. For now, let's just assume we can make such determinations. The flow chart in Figure 18.2 shows the security module.

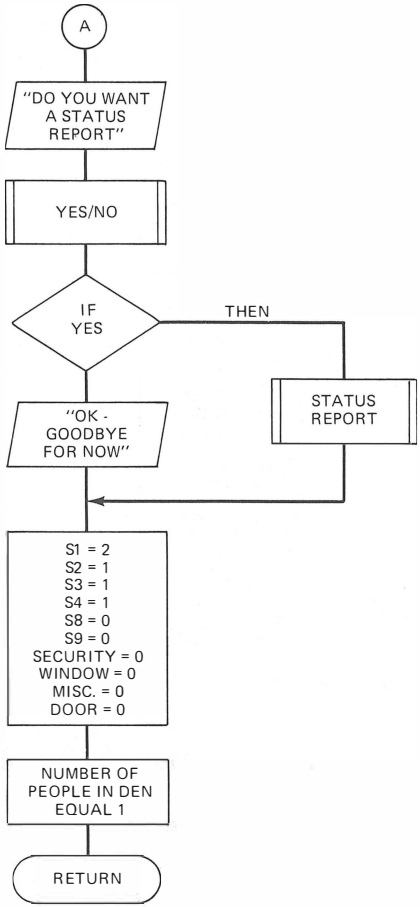


Figure 18-2A

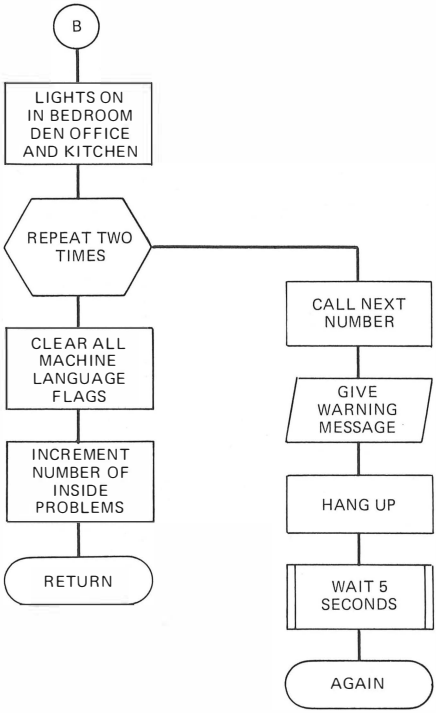


Figure 18-2B

A PEEK at the proper location will first determine if any security problems have occurred. If not, the program returns to its normal state of looping. If a problem is indicated, another location is checked to see if it is a door opening. Since my doors are heavily deadbolted, the house will assume that a door opening means that I have come home.

The house will react to my presence by turning on a light and asking if it is me. If the wireless mike is not turned on within 10 seconds, it will assume that I am an intruder. More on this in a moment. If the mike is turned on, the house asks if I want a status report. Depending on my answer, either one is given or the system says good-bye. Finally, all the flags are set to appropriate conditions. This includes such things as someone being home, that there is one person in the den, which is where I normally enter the house, and that the alarm is now off.

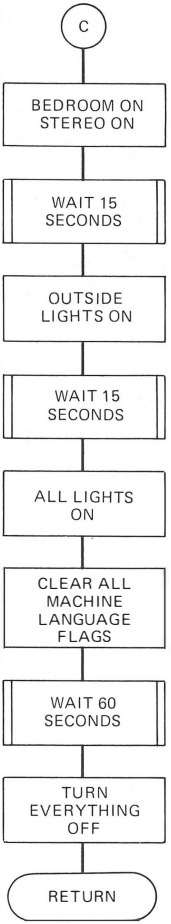


Figure 18-2C

Backing up the flow chart, we can see what would have happened if the security problem had not been a door. The system will then check to see if outside movement caused the indication. If so, it turns on various lights and the radio in the hope that an intruder will assume someone is home and leave.

In this example, the same thing is done if the intrusion is in the daytime or at night, if you are home or if you are away. I figured the radio would work either day or night and that if I was home I would certainly be warned of an external intruder by all the lights flashing, even if I was asleep.

You could easily modify this module so that special sequences could occur for different situations. Remember, there are task modules that can

easily turn on or off any light, wait for a specific amount of time, dial the phone, or do almost anything else that you would want to do.

Going back to the original flow chart, we can see that if the problem was not the door or an outside movement then it is assumed that an intruder is inside the house. In this case, several lights are turned on and phone calls are placed sequentially to the phone numbers established during initialization.

Since the intruder and the person called on the intercom phone can both hear the message, we will want something that will not only inform the person being called that a break-in is occurring, but that may also serve as a deterent to the intruder. My message indicates that the owner has already been contacted and that now someone else is being called. This type of activity should convince almost anyone that some other house is better suited for a robbery than yours.

Please don't hesitate to customize this section to meet your needs. Carefully study the code that implements these charts and I think you will see how simple programming is when you use task modules.

19 The Event Timing Module

The event timing module adds the ability to automatically schedule events such as waking you up in the morning or controlling the lights to give a lived-in look while you are away. I have 20 events in my program, but you can easily add more or alter mine to your preference.

The heart of this module is the time table array. It is stored in the program under the variable name TT(I,J). Figure 19.1 shows how this two-dimensional array is organized. The index J allows access to any row in the table. Each row contains the information for scheduling one event.

The index I provides access to one of three columns in each entry. Column 1 holds the time that this event should occur. Column 2 always contains the number 1, 2, or 3, which indicates if this event should be done always, only if someone is home, or only if no one is home. The third column contains the number of the actual event to be scheduled, which in my case is between 1 and 20.

A utility program is described in Chapter 22 for creating and editing the time tables. You will need to create seven tables, one for each day of the week. These tables are stored on diskette and are named TT.0 for Sunday's table, TT.1 for Monday's, and so on. This allows you to have total flexibility when scheduling events. Such flexibility will not only create a more lived-in look when you are away, but it can also add to your convenience when you are home.

For example, the house could be used to remind you on Thursday

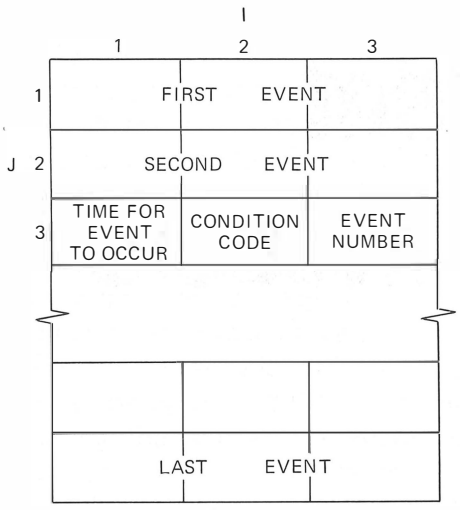


Figure 19.1 My time table can handle up to 20 preprogrammed events per day. Each event can occur based on several conditions explained in the text.

mornings at 8:15 that you should pick up doughnuts for the office. It might announce the bedtime for the kids at 8:30 on weeknights and 9:30 on weekends. Even the morning wake-up calls are handled using an event in the time table array. The possibilities are endless. Use your imagination.

One very economical use I found for the time table was controlling my heating system. Since I already had a usable BSR system for remote control, I decided to use it to control the heat. An inspection of my thermostat showed that the OFF switch simply disconnected it from the furnace. I used a 12-volt multipole relay to perform the disconnection when activated. A 12-volt wall transformer provides the power for the relay. The secret of my control is that the wall transformer is just plugged into a BSR remote unit. This means I can enable the furnace by pressing buttons on the BSR command console, or the computer can do it using my BSR interface.

Using this method, you cannot really turn down the heat. Either its off completely or it runs normally based on the thermostat. I found, though, that I could leave the heat off entirely from the time I went to bed until 15 minutes before I got up and never notice the drop in temperature. Granted, my house is well insulated and I use an electric blanket. If you have problems with the temperature dropping too low, you can easily schedule the heat to come back on several times during the night for 10 or 15 minutes.

Figure 19.2 shows the list of my events. You can see that they are very easily implemented because they are almost entirely made up of calls to the primary tasks. You should also notice that the wake-up call

EVENT NUMBER	ACTION
1	TURN DEN LIGHT ON
2	TURN DEN LIGHT OFF
3	TURN KITCHEN LIGHT ON
4	TURN KITCHEN LIGHT OFF
5	TURN FLOODLIGHTS ON
6	TURN FLOODLIGHTS OFF
7	TURN OFFICE LIGHTS ON
8	TURN OFFICE LIGHTS OFF
9	TURN ALL LIGHTS ON
10	TURN ALL LIGHTS OFF
11	TURN STEREO ON
12	TURN STEREO OFF
13	TURN HEAT ON
14	TURN HEAT OFF
15	WAKE UP CALL
16	ENABLE INTERRUPTS
17	ANNOUNCE TIME
18	TURN BEDROOM LIGHT ON
19	TURN BEDROOM LIGHT OFF
20	DISABLE INTERRUPTS

Figure 19.2 The events in the time table can be chosen from the list of Figure 19.1. You can, of course, create any activity that your needs dictate.

subroutine is conditional based on the flags S2 and S3, which indicate if someone is awake and if the sleep alarm is on. The sleep alarm, remember, was set when you used the verbal command "goodnight."

There are a couple of requirements concerning the construction of a time table. First, a special numbering system must be used to indicate the time an event is scheduled (column 1). Figure 19.3 shows some example translations you should use if you are using my clock. The reason for these is that my clock, as discussed in Chapter 6, adds 4 to the most significant digit of the hours to indicate P.M.

My event timing algorithm requires that the times from my clock from midnight to midnight be in numeric order. The automatic addition of 4000 to P.M. numbers by my clock helps to make this true since P.M. numbers will always be larger than A.M. numbers. To have proper order, I also had to convert 12:00 to zero or 4000, depending on whether it was A.M. or P.M.

What this all boils down to is that the time 8:12 A.M. should be

ACTUAL TIME	TABLE ENTRY
MIDNIGHT	0
12:15 AM	15
8:00 AM	800
8:12 AM	812
11:30 AM	1130
NOON	4000
12:30 PM	4030
1:00 PM	4100
8:12 PM	4812
11:20 PM	5120

Figure 19.3 Standard times must be converted for use in the time table. Some example entries are shown.

entered into the time table as the number 812. If it was 8:12 P.M. you would use 4812. If your clock has a 24-hour format, you can eliminate much of the preceding. I decided to write my program for a 12-hour clock to provide more information for those using other hardware.

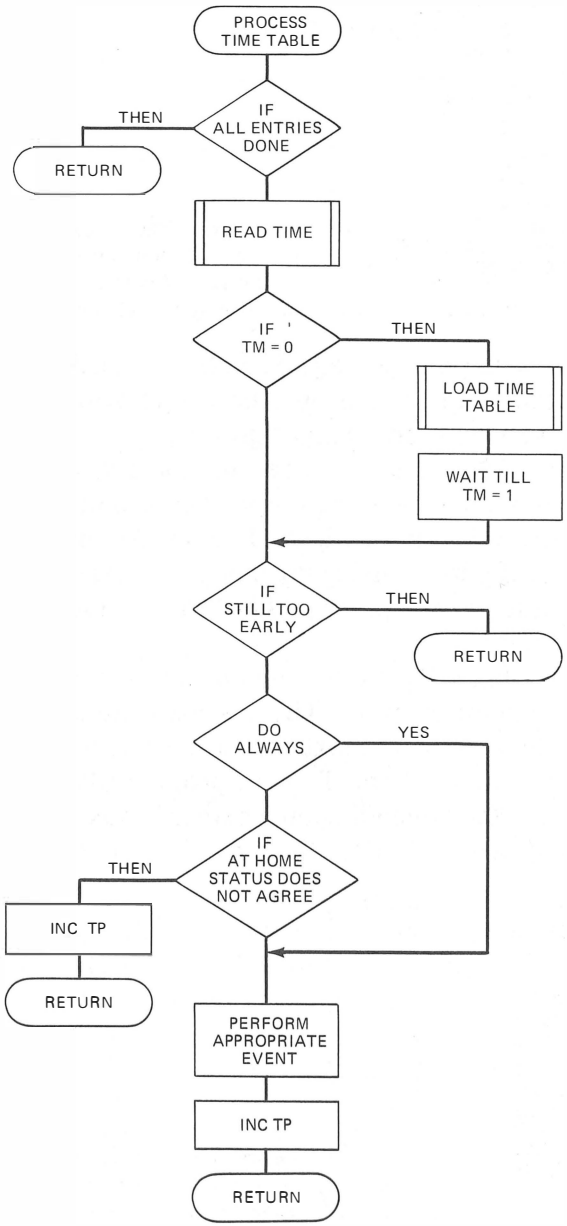


Figure 19.4 Each item in the time table is processed sequentially. A table pointer (TP) keeps track of the present position.

The second requirement of the time table is that all entries have to be in chronological order. The reason for this is that my algorithm does not search the table to find events that need executing. This would be too time consuming for my sequential system. If the events are in order, it need only check to see if it is time for the next event. If not, it loops again to see if any other modules require attention. Once an item is executed, a pointer (the variable TP) is moved on to the next entry in the table.

Figure 19.4 shows the flow chart for the event timing module. If all the items in the present table have been completed, the system returns without any further checking. If the time is zero (midnight), then it is time to load a new table. The system clock is checked to see what day it is, and the corresponding table is transferred from the disk.

If the present time is smaller than the time of the item presently being considered (pointed to by TP), nothing happens. Once the time equals or exceeds the scheduled time, the item is processed depending on whether the present "at home status" matches column 2 of the table. In any event, the pointer TP is incremented to the next line of the table.

20 The Monitor Movement Module

For the average reader of this book, this module will probably be the hardest to understand. It is not that this section is really any more difficult, but because of the speed requirements it is written entirely in machine language. Even if you are not familiar with machine language, though, I think you can understand the principles here by following the flow charts.

You will recall from Chapter 18 that all the security and under-the-carpet switches are connected to the Apple interrupt pin. When any of these switches are activated, a machine language program is automatically run. This chapter discusses that program. Even though this program can be viewed pretty much as an independent package, it must communicate with the other major modules in the home control system.

The major information passed to this module from the main program is whether the security alarm is on or off. Location 822H will serve as a flag to the machine language program and contains a 0 when the alarm is on. A 1 will indicate it is off. BASIC can turn the alarm on and off by POKING location 2082, which is the decimal equivalent of 822H.

The machine language program has the responsibility of performing one of two different tasks depending on the status of the alarm. If the alarm is on, the input port must be read and the cause of the interrupt determined. Four memory locations are used to keep track of the number of violations that have occurred at a door, window, outside, or at the miscellaneous switch mentioned earlier.

Whenever the program determines that a window has been opened, for example, it will increment the location associated with the window violations. In this case the location is 820H or 2080 decimal. If a door switch caused the interrupt, location 81FH would be incremented.

In addition to a location for a door, window, and so on, a second location will also be incremented. This location is 81DH. Its use was discussed in Chapter 18. The main program will not take the time to check each flag for the doors, windows, and so on, unless the security flag (81DH) is greater than 1. It is the responsibility of the main program to clear each of these locations after the security problem has been attended to.

The second task given to this module is to handle interrupts when the alarm is off. In this case, the switches to be monitored are those under the carpets. Refer to Figure 10. 1 for the placement of my switches. They were arranged by trial and error to get a spot that would always get stepped on when someone walks between rooms.

It takes the tripping of two switches to determine movement. For example, if the computer determines that switch 1 was pressed followed by closure at switch 2, it should be obvious that someone left the den and went to the bedroom. A pulse from switch 2 followed by switch 3 would indicate movement from the bedroom to the office.

There are of course some other possibilities. Two people could have tried to enter the hall from different rooms at the same time. Such actions will definitely confuse my house. In practice, though, I found that such occurrences were very rare. I can easily tolerate such errors, especially since a foolproof system would be immensely more complicated.

The computer must keep track of the number of people remaining in each room and tend to the lights accordingly. To control lights, a submodule of this program is used for producing the BSR codes as described in Chapter 8.

Figure 20.1 shows the flow chart for the complete machine language module. When an interrupt occurs, the program first saves all the 6502's registers. It then waits for about 1 millisecond to let any contact bounce from the switches subside. Then the switches are read from the port. If none are pressed, the program assumes that noise caused the interrupt and returns to the original program by way of DONE.

If a switch is pressed, the program handles it in one of two ways, depending on the status of the alarm byte. If the alarm byte is a 0, meaning on, the security section is performed. If it is a 1, the internal switches are checked.

Let's look first at the flow chart for the security section in Figure

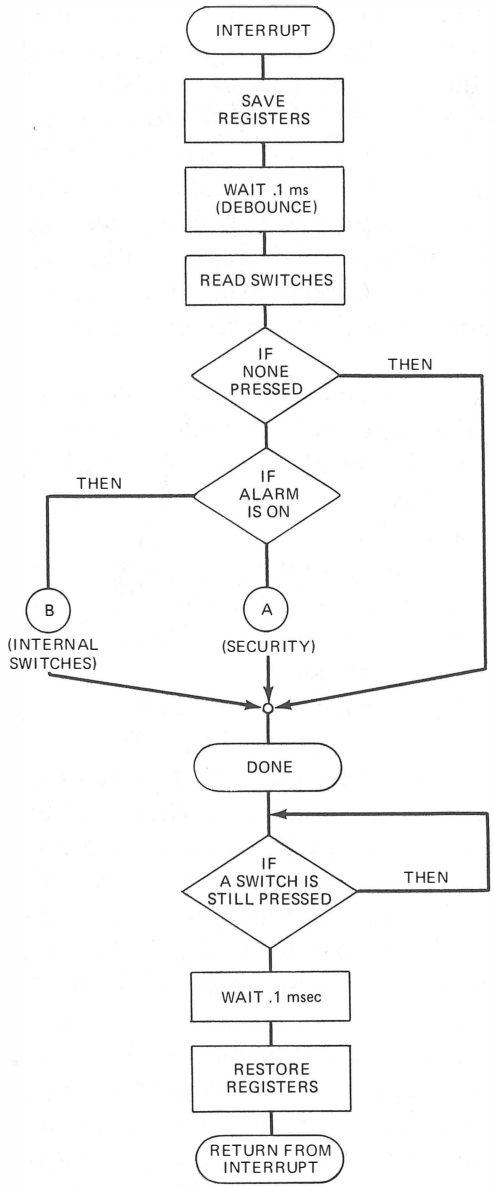


Figure 20.1 The interrupt program passes control to one of two sections depending on whether the security alarm is on or off.

20.2. Each bit in the input byte is checked to see which switches are pressed. Everytime a closed switch is found, the appropriate indicator byte is incremented. Finally, a byte is incremented to indicate to BASIC that some kind of security problem has occurred. The program then returns through DONE.

If the alarm is off, only the internal switches need monitoring. Figure 20.3 shows the details of this section. If one of the internal switches is not pressed, the program returns. The normal action, though, is for the program to determine which switch (0, 1, 2, or 3) is pressed and save it as the FROM room. The program then waits until that switch is released so that it will not be read as the second switch.

If someone is actually moving from one room to another, a second switch should be pressed fairly quickly. I have my program watch for the second switch for about 2 seconds. If the second press does not occur in the allotted time, a return is forced.

The second switch is stored as TO. We now have the room number that someone came from and the room they went to. Four locations are used as counters to keep track of how many people are in each room. A room that is entered for the first time will have its light turned on, while a room that is empty will have its light turned off. As an effort to correct errors on its own, the system will not decrement the number in a room below 0.

A special subroutine called SSONIC is used to "press" the buttons on the BSR controller. This routine presses each button twice to ensure

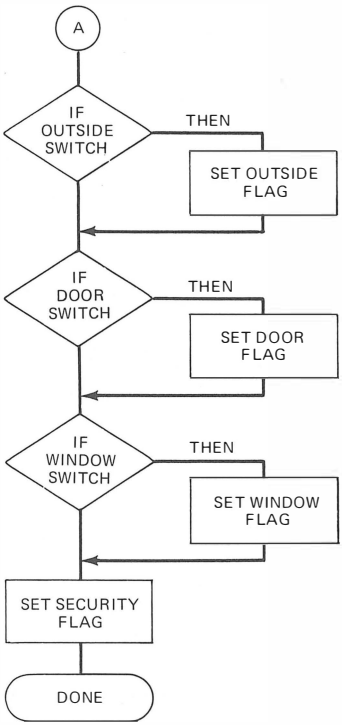


Figure 20.2 Security problems cause flags (memory locations) to be changed. The main program monitors these flags and takes the appropriate actions.

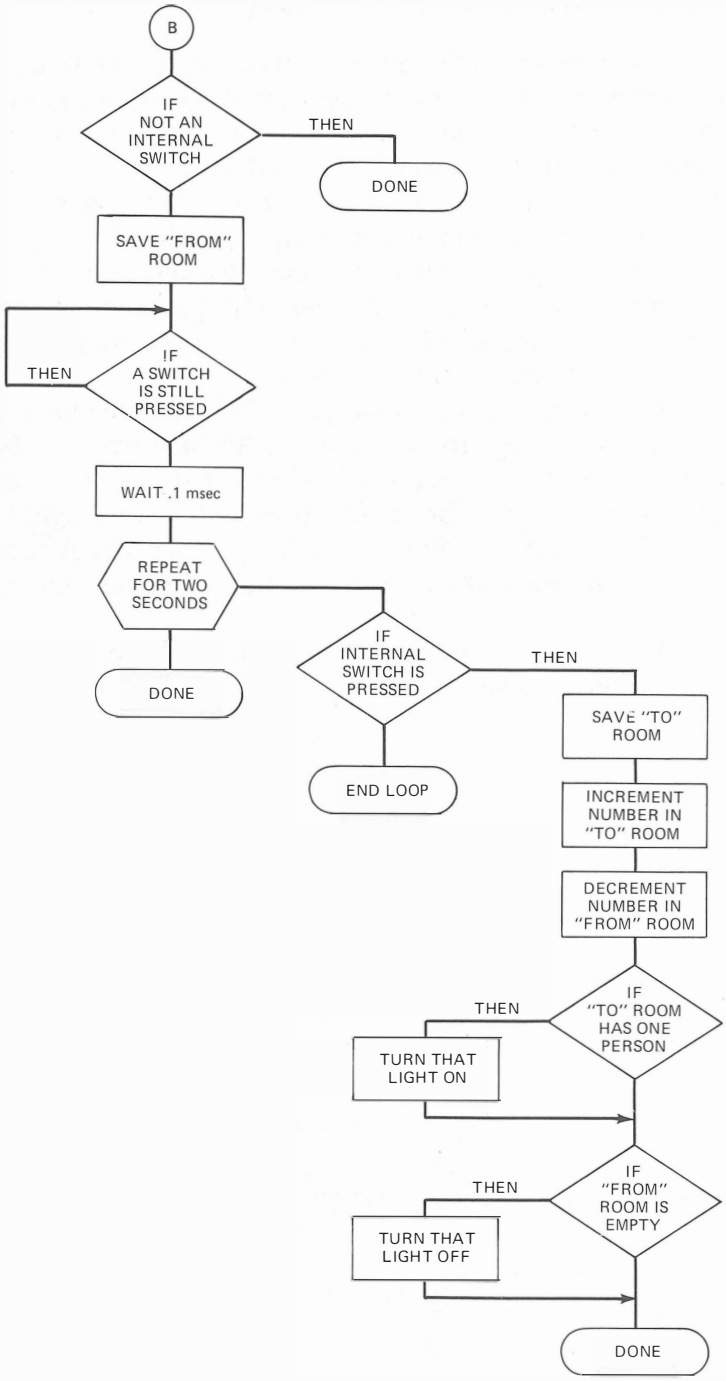


Figure 20.3 Internal movement is monitored so that the system can turn lights on and off as required.

reliability. Typically, SSONIC sends the code in the accumulator. BASIC also uses this routine by POKEing the code to be sent into location 2093 and CALLing 2300. Refer to Chapter 8 to review what the requirements of SSONIC are.

Although the BASIC portion of my home control program does not utilize all the information created here (such as the number of people in each room), you could use PEEK statements to retrieve it if you should want such data for your modifications.

As I said at the beginning of this chapter, this portion of the program looks more complicated than it is simply because it is written in machine language. If you take the time to go through it using the flow chart, I think you will find it very easy to follow, even if you are not a programming whiz.

The principles used here can be utilized for most houses, especially if you only want to automate the lights in three or four major rooms. Actually, a few rooms are usually very acceptable. If you do need more rooms, you will have to make extensive modifications to the program, but the basic principles still apply.

The key thing to remember here is that the only things implemented in machine language are the things that absolutely require it. The security flags are a good example of this. The machine language program only sets the flags. BASIC still is used to determine what action is to be taken. This approach provides the speed and flexibility of machine language interrupts and still maintains the ease of modification of BASIC.

The computer's capability to monitor movement, either inside or outside the house, is contingent on interrupts, Because of this, you can easily stop the monitoring by telling the Apple to ignore interrupts. For the convenience of persons requiring this action, I have provided two routines, which are also listed in Appendix B. To use them from BASIC, just CALL 2058 to enable interrupts and CALL 2075 to disable them.

21 Installation and Maintenance

In previous chapters I have covered each module of the home control program. Unlike many pieces of software, you cannot just type these programs into the computer and run them. Many of the modules require special data tables or machine language sections.

Not only do we need a means to create and maintain these items, but we also have to reserve sections of memory for them to fit in. This chapter will offer a number of programs that can aid us in these tasks.

First, refer to Chapter 8, where we discussed the hardware needed to build your own clock. Although the home control program contains the subroutines needed to use the clock, you will also need a program that will allow you to set the time and to test the clock by observing it in operation.

Appendix C contains a listing of a program to perform these tasks. When it is run, you are asked if you wish to set or observe the clock. The program is very short and is well commented to help you see how each section works.

The next program maintains the speech recognition system. As was discussed in Chapter 4, the Speech Link has to be trained by each user. The words and their templates can be stored on the disk so that programs can utilize speech input without being retrained each time they are run.

The program in Appendix E can be used to create these templates, as well as to perform several other useful tasks. For instance, it provides a

means for you to test different words in a vocabulary. This will allow you to try substitutes for a word that is hard to recognize and then to retrain and test the vocabulary. The program also serves as a structured tutorial for many of the functions of the Speech Link.

You can try new words by altering the DATA statements. I use each word three times to increase the recognition capabilities. Each word must be different if Speech Link is to differentiate among them, so I create two additional words by adding a period and an exclamation point to the original word.

If you retrain the words without reinitializing, the Speech Link will average the present templates with the new word. Further information can be obtained from the Speech Link manual for those of you that plan to use it in your home control program.

We also need to create the time tables used for the event timing module. The program to do this is shown in Appendix D. Like the other maintenance programs, this program is menu driven and self-prompting to make it easy to use. It not only allows you to create but also to edit the time tables specified in Chapter 19.

Each of these programs is well commented and almost self-explanatory. Because of this, as well as the fact that they are only maintenance programs, I will not go into lengthy explanations of their operations. I think you will find them pleasantly easy to follow if you decide to examine them in detail.

Now that we have looked at how the data sections for the home control program are created, let's see how the space for these sections is reserved. To put the initialization procedure into proper perspective, we need to pause for a moment and reexamine the requirements of a system start-up.

If you refer to Chapter 7, you will remember that the failsafe system will force a reset whenever the software becomes so "insane" that it can no longer keep retriggering the system sanity timer. This reset must cause the disk to reboot. The HELLO program, the one that runs automatically after a boot, must set up everything required and then run the home control program itself.

This HELLO program is our next topic. You can find a complete listing for it in Appendix F. The program is actually very short, but it performs several vital functions. First, it must POKE a 0 into the power-up byte, which is decimal 1012. Doing this will make an Apple with an autostart ROM reboot if a reset occurs.

The program must now reserve the space for the machine language

sections of the program. It does this by POKEing a new LOMEM address of 6600 into locations 103 and 104. In addition, a 0 must be stored into 6600 to meet the requirements of Applesoft.

When this is done, the area from 2048 to 6600 is no longer used by BASIC and is free for our machine language programs and data. You can refer to your Apple documentation for more details concerning the movement of the start of a BASIC program.

The last thing the HELLO program must do is to RUN the home control program, which will in turn load all the appropriate data and machine language programs into the space just created. The sanity timer will be triggered just before each disk operation to ensure that a reset will not occur during the transfer.

At this point you should be able to install the home control system software in your Apple. First, initialize a diskette with the HELLO program just discussed. That diskette should also contain all the programs listed in the appendixes. Use the maintenance programs to create the required data tables and you are all set.

For the convenience of those persons not wishing to spend their weekends typing, you may receive a diskette prepared as just described by sending $12.50 to

John Blankenship
P.O. Box 47934
Doraville, GA 30362.

22 Expansions and Enhancements

In the last 21 chapters I have described a complete home control system that can automate your home. I have tried to create a system that offers as much power per dollar as possible. Wherever I could, I used commercially available equipment so that tinkering with hardware would not be a major undertaking when computerizing your home.

I have tried to design the system so that it is not only cost effective but also usable. No matter how many features I add or how many ways I come up with to make your home easier to live in, I suspect that each of you will want to change one little item here or add something there.

And because of that, my most important goal when creating the system was to make it easy to alter and expand. Everything is modular, and although interaction between modules is essential, I hope you will be able to make your modifications as painlessly as possible.

Although I believe that modifications can be relatively easy, there is no way around the fact that you must understand my system in order to make them. And you must understand it in detail. I believe the proper use of this text can provide you with that understanding.

There are many areas open to you for expanding the system, and this book would not be complete if it did not at least mention a few. One of the easiest to implement would be to add an automatic lawn sprinkler system. BSR has recently added an electric valve to their list of accessories. With it, some plastic pipe, and the proper entries into the time tables, you have

established the basis for the system. To make it intelligent, you might connect some type of moisture-sensitive resistance to the Apple paddle ports. Your program could then decide if the grass needs watering and then use the clock to decide when during the day to actually perform the operation.

The Apple paddle inputs could also be used to make my suggested heating system more intelligent. For example, a thermistor could enable the software to determine the temperature in the house and therefore provide a more elaborate basis for controlling the heating system.

If you interfaced a smoke detector to an input pin, your house could deal with a fire in a manner similar to how security problems are handled. There is no way to put a price tag on the safety and peace of mind such a system could offer.

If you have an electric garage door opener, your computerized home can decrease the possibility of someone else being able to open it. The opener could be plugged into a BSR remote. The computer would only energize the remote during the time you are expected home. Once this is done, even if someone had the transmitter, they would not be able to activate the door except for the brief periods during the day when the computer is programmed to permit entry.

You might also consider wiring your doorbell to an input pin. The computer could then handle someone at the door in much the same manner as it monitors the telephone. The possibilities for this one enhancement can be almost limitless.

In fact there are almost unlimited possibilities in almost every area you can imagine. So let your imagination run wild. Don't rule out anything you are interested in having. Anything and everything is possible. You might have to make compromises or develop a creative strategy, but in the end any goal can be met.

Computerizing my home has been one of my most exciting and rewarding projects. I hope you find the same satisfaction as you computerize yours.

Appendix

A

Home Control Program (BASIC Portion)

```
]
]LIST

1   REM   !=========================!
2   REM   !    APPLE II HOME CONTROL  !
3   REM   !           PROGRAM         !
4   REM   !             BY            !
5   REM   !       JOHN BLANKENSHIP    !
6   REM   !     COPYRIGHT  JUNE 1982  !
7   REM   !=========================!
8   REM
9   REM
10   GOSUB 900: REM  INITIALIZATION
20   GOSUB 1000: REM  PROCESS VOICE REQUESTS

30   GOSUB 2000: REM  PROCESS INCOMING PHONE
       CALLS
40   GOSUB 3000: REM  PROCESS SECURITY INFOR
      MATION
50   GOSUB 4000: REM   PROCESS NEXT TIME TAB
      LE ENTRY
60   GOTO 20: REM  LOOP BACK AND DO IT AGAIN

100   REM   !-------------------------!
101   REM   ! CHECK FOR PHONE RINGING !
102   REM   !    YES = 1 IF RINGING   !
103   REM   !    YES = 0 IF NOT       !
104   REM   !-------------------------!
110   LET YES = 0
115   FOR I = 1 TO 30
120   IF  PEEK (RING) < 128 THEN YES = 1: RETURN

130   NEXT I
140   RETURN
```

```
150  REM  !-------------------------!
151  REM  ! CHECK FOR SOUND CHANGE  !
152  REM  !  FOR PERIOD OF  4 SEC.  !
153  REM  !     YES =1 IF CHANGE    !
154  REM  !-------------------------!
155  LET YES = 0
160  LET S6 = 0
165  IF  PEEK (SOUND) > 127 THEN S6 = 1
170  FOR I1 = 1 TO 400
175  LET S7 = 0
180  IF  PEEK (SOUND) > 127 THEN S7 = 1
185  IF S6 <  > S7 THEN YES = 1
190  NEXT I1
195  RETURN
200  REM  !----------------------!
202  REM  ! DELAY OF SC SECONDS !
204  REM  !----------------------!
205 DE = 420
210  FOR S7 = 1 TO SC
215  LET Z =  PEEK (SANITY)
220  GOSUB 400
225  NEXT S7
230  RETURN
250  REM  !----------------------!
251  REM  ! CHECK FOR OWNER CODE !
252  REM  !----------------------!
253  LET YES = 0
254  FOR I = 1 TO 2000
256  IF  PEEK (SOUND) > 127 THEN 262: REM
     SOUND STARTED
258  NEXT I
260  RETURN : REM  NO TONE IN TIME
262  FOR I = 1 TO 200
264  IF  PEEK (SOUND) <  = 127 THEN 270: REM
      SOUND STOPPED
266  NEXT I
268  RETURN : REM TONE TOO LONG
270  FOR J = 1 TO 30
272  IF  PEEK (SOUND) > 127 THEN 278: REM
     SOUND RESTARTED
274  NEXT J
276  RETURN : REM  PAUSE TOO LONG
278  FOR K = 1 TO 100
280  IF  PEEK (SOUND) <  = 127 THEN 286: REM
      SOUND STOPPED
282  NEXT K
284  RETURN : REM  2ND TONE TOO LONG
286  REM   AT THIS POINT I,J,&K =
288  REM   LENTH OF TONE1,LENTH OF PAUSE
290  REM   AND LENTH OF TONE2 RESPECTIVELY
292  LET YES = 1
293  PRINT I,J,K
294  IF I < 95 OR I > 110 THEN YES = 0
296  IF J < 13 OR J > 21 THEN YES = 0
298  IF K < 55 OR K > 70 THEN YES = 0
299  RETURN
300  REM  !------------------!
301  REM  ! SAY MESSAGE # ME !
302  REM  !------------------!
303  PRINT : PRINT D$"PR#"VSLOT
304  ON MESSAGE GOSUB 311,312,313,314,315,3
     16,317,318,319,320,321,322,323,324,325
     ,326,327,328,329,330,331,332,333,334,3
     35,336,337,338,339,340,341,342,343,344
     ,345,346,347,348,349,350
```

```
305  IF MESSAGE > 40 THEN  ON (MESSAGE - 40
     ) GOSUB 351,352,353,354,355,356,357,35
     8,359,360,361,362,363,364,365,366,367,
     368,369,370,371,372,373,374
306 SC = MT(MESSAGE): REM  SET DELAY TIME
307  GOSUB 200
308  PRINT D$"PR#0"
309  IF MESSAGE <  > 50 THEN Z =  PEEK (SAN
     ITY)
310  RETURN
311  PRINT "YES "N1$" HOW CAN I HELP YOU": RETURN
312  PRINT "CAN I DO ANYTHING ELSE FOR YOU"
     : RETURN
313  PRINT "I AM READY": RETURN
314  PRINT "O K    GOOD BYE FOR NOW": RETURN

315  PRINT "WHAT DO YOU WISH ME TO DO TO TH
     E "W$: RETURN
316  PRINT "THE "WT$" IS NOW ON": RETURN
317  PRINT "THE "WT$" IS NOW OFF": RETURN
318  PRINT "THE "WT$" IS NOW DIMMED": RETURN

319  PRINT "WHO DO YOU WISH TO CALL": RETURN

320  PRINT "I AM NOW CALLING "W$: RETURN
321  PRINT "PLEASE EXCUSE ME "N2$" I'LL CHA
     NGE VOCABULARIES": RETURN
322  PRINT "THE PHONE IS NOW HUNG UP": RETURN

323  PRINT "NOT RIGHT NOW              DID Y
     OU HAVE A GOOD DAY": RETURN
324  PRINT "THAT'S REALLY GREAT": RETURN
325  PRINT "I'M SORRY ABOUT THAT": RETURN
326  PRINT "DID SOMETHING SPECIAL HAPPEN": RETURN
327  PRINT "WHAT WAS IT": RETURN
328  PRINT "I NO  HOW YOU FEEL
      NOTHING SPECIAL HAPPENED HERE EITHER"
     : RETURN
329  PRINT "THAT'S REALLY INTERESTING": RETURN

330  PRINT "SAY "N1$" DO YOU THINK WE COULD
      GET ANOTHER COM PEWTER": RETURN
331  PRINT "DON'T SAY NO WITHOUT THINKING I
     T OVER             EVEN A LITTLE ONE WO
     ULD BE O K": RETURN
332  PRINT "BOY THAT'S GREAT       I WOULD
     LOVE TO HAVE SOME COM PAN E WHEN YOU A
     RE NOT HERE": RETURN
333  PRINT "WELL I'D BETTER GET BACK TO WOR
     K            I HAVE LOTS OF THINGS PILI
     NG UP        GOOD BYE FOR NOW": RETURN
334  PRINT "GOODNIGHT    I WILL WATCH THE H
     OUSE FOR YOU": RETURN
335  PRINT "SHAL I WAKE YOU IN THE MORNING"
     : RETURN
336  PRINT "I WILL LET YOU SLEEP IN THEN": RETURN
337  PRINT "I'LL WAKE YOU AT THE CORRECT TI
     ME": RETURN
338  PRINT "ARE YOU LEAVING": RETURN
339  PRINT "SHAL I HANDLE SECURITY FOR YOU"
     : RETURN
340  PRINT "O K    I'LL WATCH THE PHONE FOR
      YOU TILL YOU GET BACK": RETURN
341  PRINT "HAVE A GOOD TIME     I WILL TAK
     E CARE OF EVERYTHING": RETURN
```

```
150   REM  !-------------------------!
151   REM  ! CHECK FOR SOUND CHANGE  !
152   REM  !  FOR PERIOD OF  4 SEC.  !
153   REM  !     YES =1 IF CHANGE    !
154   REM  !-------------------------!
155   LET YES = 0
160   LET S6 = 0
165   IF  PEEK (SOUND) > 127 THEN S6 = 1
170   FOR I1 = 1 TO 400
175   LET S7 = 0
180   IF  PEEK (SOUND) > 127 THEN S7 = 1
185   IF S6 <  > S7 THEN YES = 1
190   NEXT I1
195   RETURN
200   REM  !---------------------!
202   REM  ! DELAY OF SC SECONDS !
204   REM  !---------------------!
205 DE = 420
210   FOR S7 = 1 TO SC
215   LET Z =  PEEK (SANITY)
220   GOSUB 400
225   NEXT S7
230   RETURN
250   REM  !-----------------------!
251   REM  ! CHECK FOR OWNER CODE !
252   REM  !-----------------------!
253   LET YES = 0
254   FOR I = 1 TO 2000
256   IF  PEEK (SOUND) > 127 THEN 262: REM
      SOUND STARTED
258   NEXT I
260   RETURN : REM  NO TONE IN TIME
262   FOR I = 1 TO 200
264   IF  PEEK (SOUND) <  = 127 THEN 270: REM
       SOUND STOPPED
266   NEXT I
268   RETURN : REM TONE TOO LONG
270   FOR J = 1 TO 30
272   IF  PEEK (SOUND) > 127 THEN 278: REM
      SOUND RESTARTED
274   NEXT J
276   RETURN : REM  PAUSE TOO LONG
278   FOR K = 1 TO 100
280   IF  PEEK (SOUND) <  = 127 THEN 286: REM
       SOUND STOPPED
282   NEXT K
284   RETURN : REM  2ND TONE TOO LONG
286   REM   AT THIS POINT I,J,&K =
288   REM   LENTH OF TONE1,LENTH OF PAUSE
290   REM   AND LENTH OF TONE2 RESPECTIVELY
292   LET YES = 1
293   PRINT I,J,K
294   IF I < 95 OR I > 110 THEN YES = 0
296   IF J < 13 OR J > 21 THEN YES = 0
298   IF K < 55 OR K > 70 THEN YES = 0
299   RETURN
300   REM  !------------------!
301   REM  ! SAY MESSAGE # ME !
302   REM  !------------------!
303   PRINT : PRINT D$"PR#"VSLOT
304   ON MESSAGE GOSUB 311,312,313,314,315,3
      16,317,318,319,320,321,322,323,324,325
      ,326,327,328,329,330,331,332,333,334,3
      35,336,337,338,339,340,341,342,343,344
      ,345,346,347,348,349,350
```

```
305  IF MESSAGE > 40 THEN  ON (MESSAGE - 40
     ) GOSUB 351,352,353,354,355,356,357,35
     8,359,360,361,362,363,364,365,366,367,
     368,369,370,371,372,373,374
306 SC = MT(MESSAGE): REM  SET DELAY TIME
307  GOSUB 200
308  PRINT D$"PR#0"
309  IF MESSAGE <  > 50 THEN Z =  PEEK (SAN
     ITY)
310  RETURN
311  PRINT "YES "N1$" HOW CAN I HELP YOU": RETURN
312  PRINT "CAN I DO ANYTHING ELSE FOR YOU"
     : RETURN
313  PRINT "I AM READY": RETURN
314  PRINT "O K     GOOD BYE FOR NOW": RETURN

315  PRINT "WHAT DO YOU WISH ME TO DO TO TH
     E "W$: RETURN
316  PRINT "THE "WT$" IS NOW ON": RETURN
317  PRINT "THE "WT$" IS NOW OFF": RETURN
318  PRINT "THE "WT$" IS NOW DIMMED": RETURN

319  PRINT "WHO DO YOU WISH TO CALL": RETURN

320  PRINT "I AM NOW CALLING "W$: RETURN
321  PRINT "PLEASE EXCUSE ME "N2$" I'LL CHA
     NGE VOCABULARIES": RETURN
322  PRINT "THE PHONE IS NOW HUNG UP": RETURN

323  PRINT "NOT RIGHT NOW              DID Y
     OU HAVE A GOOD DAY": RETURN
324  PRINT "THAT'S REALLY GREAT": RETURN
325  PRINT "I'M SORRY ABOUT THAT": RETURN
326  PRINT "DID SOMETHING SPECIAL HAPPEN": RETURN
327  PRINT "WHAT WAS IT": RETURN
328  PRINT "I NO  HOW YOU FEEL
      NOTHING SPECIAL HAPPENED HERE EITHER"
     : RETURN
329  PRINT "THAT'S REALLY INTERESTING": RETURN

330  PRINT "SAY "N1$" DO YOU THINK WE COULD
      GET ANOTHER COM PEWTER": RETURN
331  PRINT "DON'T SAY NO WITHOUT THINKING I
     T OVER             EVEN A LITTLE ONE WO
     ULD BE O K": RETURN
332  PRINT "BOY THAT'S GREAT        I WOULD
     LOVE TO HAVE SOME COM PAN E WHEN YOU A
     RE NOT HERE": RETURN
333  PRINT "WELL I'D BETTER GET BACK TO WOR
     K            I HAVE LOTS OF THINGS PILI
     NG UP        GOOD BYE FOR NOW": RETURN
334  PRINT "GOODNIGHT     I WILL WATCH THE H
     OUSE FOR YOU": RETURN
335  PRINT "SHAL I WAKE YOU IN THE MORNING"
     : RETURN
336  PRINT "I WILL LET YOU SLEEP IN THEN": RETURN
337  PRINT "I'LL WAKE YOU AT THE CORRECT TI
     ME": RETURN
338  PRINT "ARE YOU LEAVING": RETURN
339  PRINT "SHAL I HANDLE SECURITY FOR YOU"
     : RETURN
340  PRINT "O K     I'LL WATCH THE PHONE FOR
      YOU TILL YOU GET BACK": RETURN
341  PRINT "HAVE A GOOD TIME      I WILL TAK
     E CARE OF EVERYTHING": RETURN
```

```
342  PRINT "DO YOU WISH A STATUS REPORT": RETURN

343  PRINT "DO YOU WISH SOMETHING TURNED ON
     ": RETURN
344  PRINT "DO YOU WISH SOMETHING TURNED OF
     F": RETURN
345  PRINT "IS THAT YOU MASTER": RETURN
346  PRINT "PLEASE EXCUSE ME     DUE TO A TE
     CHNICAL PROBLEM I AM RE INITIALIZING
               IS ANY ONE HOME": RETURN
347  PRINT "WARNING   WARNING     WARNING
        THE OWNER HAS ALREADY BEEN CALLED A
     ND TOLD YOU ARE ENTERING THE HOUSE
     I AM NOW TRYING TO CALL SOMEONE ELSE
       FOR YOUR OWN SAFE TE IT WOULD BE BES
     T FOR YOU TO LEAVE IMEEDEITELY": RETURN

348  PRINT "GIVE ME A YES FOR EACH VAL ID D
     E VIE HHSS": RETURN
349  PRINT "OFFIS": RETURN
350  PRINT "STEREO": RETURN
351  PRINT "BEDROOM": RETURN
352  PRINT "DEN": RETURN
353  PRINT "KITCHEN": RETURN
354  PRINT "OUT SIDE": RETURN
355  PRINT "HEAT": RETURN
356  PRINT "THERE HAVE BEEN NO SECURITY PRO
     BLEMS": RETURN
357  PRINT "THERE HAS BEEN "S8" OUTSIDE WAR
     NINGS": RETURN
358  PRINT "THERE HAS BEEN "S9" INSIDE WARN
     INGS": RETURN

359  PRINT "THERE HAS BEEN "NC" PHONE CALLS
     ": RETURN
360  PRINT "PLEASE REPEAT THAT": RETURN
361  PRINT "IT IS "DAY$(T(6))"      THE TIME
      IS "HR$" "MIN$" "M$: RETURN
362  PRINT "WAKE UP    WAKE UP        IT IS TI
     ME TO GET UP       YOU CAN NOT STAY IN B
     ED ALL DAY       WAKE UP ": RETURN
363  PRINT "DO YOU WANT ME TO GET THE PHONE
      ": RETURN
364  PRINT "I'M SORRY BUT I MUST GO NOW    G
     OOD BYE": RETURN
365  RETURN
366  RETURN
367  RETURN
368  RETURN
369  RETURN
370  RETURN
371  RETURN
372  RETURN
373  RETURN
374  RETURN
375  REM  !------------------!
376  REM  ! INIT. SPEECHLINK !
377  REM  !------------------!
382  LET HI =  INT (WAA / 256)
384  LET LO = WAA - HI * 256
386  POKE (1144 + SSLOT),LO
388  POKE (1272 + SSLOT),HI
391  LET HI =  INT (TAA / 256)
392  LET LO = TAA - HI * 256
393  POKE (WAA + 2),LO
394  POKE (WAA + 3),HI
```

```
395  PRINT D$"PR#"SSLOT
396  PRINT I$
397  PRINT D$"PR#0"
398  RETURN
400  REM  !-------------------!
402  REM  ! DELAY BASED ON DE !
404  REM  !-------------------!
410  FOR D = 1 TO DE
420  NEXT D
430  RETURN
450  REM  !---------------------!
452  REM  ! WIRELESS MIKE ON ? !
454  REM  !---------------------!
455  LET YES = 0
460  IF  PEEK (VOICE) < 128 THEN YES = 1
470  RETURN
475  REM !-----------------------!
476  REM !   LOAD TIME TABLE     !
477  REM !-----------------------!
480  GOSUB 600
482  PRINT D$"OPEN TT."T(6)
484  PRINT D$"READ TT."T(6)
486  FOR J = 1 TO 20
488  FOR I = 1 TO 3
490  INPUT TT(I,J)
492  NEXT I,J
494  PRINT D$"CLOSE"
496  LET TP = 1
498  RETURN
500  REM  !-------------------!
502  REM  ! TURN ON BY PHONE !
504  REM  !-------------------!
505  GOSUB 540
510  LET BU = 20: GOSUB 750
515  RETURN
525  REM  !--------------------!
527  REM  ! TURN OFF BY PHONE !
529  REM  !--------------------!
530  GOSUB 540
534  LET BU = 28: GOSUB 750
538  RETURN
540  REM  ----SUBR. FOR ON/OFF----
541  LET MESSAGE = 38: GOSUB 300
542  FOR M = 1 TO 7
543  LET MESSAGE = M + 38: GOSUB 300
544  GOSUB 250
545  IF YES THEN BU = BU(M): GOSUB 750
546  NEXT M
547  RETURN
600  REM  !-----------------!
602  REM  ! READ TIME T(X) !
603  REM  !      &  TM      !
604  REM  !-----------------!
605  FOR Y = 0 TO 6
610  GOSUB 620
612  LET T(Y) = X
614  NEXT Y
616  LET TM = T(2) + T(3) * 10 + T(4) * 100
      + T(5) * 1000
618  RETURN
620  REM  ----SUBR. TO READ T(X)----
621  POKE CB,0: POKE B,128: REM  SET DDR
622  POKE CB,4: POKE B,0: REM  HOLD CLOCK F
     OR READING
624  POKE CA,0: POKE A,240: POKE CA,4: REM
      PORT A READY FOR READ
```

```
626  POKE B,128: REM  CHIP ON
628  POKE A,(128 + Y * 16): REM  Y IS ADDRE
     SS
630  POKE 2048, PEEK (A): CALL 2048:X =  PEEK
     (2048)
632  POKE A,0: REM  RESET READ LINE
634  POKE B,0: REM  TURN CHIP OFF
636  RETURN
650  REM  !----------------!
651  REM  ! DIAL THE PHONE !
652  REM  !----------------!
655  PRINT D$"PR#"MSLOT: REM  MODEM ON
660  PRINT Q$;PN$;LF$: REM  DIAL #
665  POKE TN,0: REM  PHONE ON
670  PRINT Z$: REM  MODEM OFF
675  PRINT D$"PR#0"
678  LET S5 = 1: REM   FLAG FOR PHONE ON
680  RETURN
700  REM  !--------------------!
702  REM  !   STATUS REPORT    !
704  REM  !--------------------!
705  IF (S8 + S9) = 0 THEN MESSAGE = 46: GOSUB
     300
710  IF S8 > 0 THEN MESSAGE = 47: GOSUB 300

715  IF S9 > 0 THEN MESSAGE = 48: GOSUB 300

720  LET MESSAGE = 49: GOSUB 300
725  RETURN
750  REM  !----------------!
752  REM  ! PUSH BU ON BSR !
754  REM  !----------------!
755  POKE 2093,BU
760  CALL 2300
765  RETURN
800  REM  !--------------------!
802  REM  !  RECOG. YES / NO   !
804  REM  !--------------------!
805  LET Z =  PEEK (SANITY)
808  PRINT D$"PR#"SSLOT
810  PRINT V$
815  PRINT D$"PR#0"
818  PRINT  CHR$ (7): REM  BELL
820  PRINT D$"IN#"SSLOT
825  INPUT W$
830  PRINT D$"IN#0"
835  IF W$ = "" THEN MESSAGE = 50: GOSUB 30
     0: GOTO 818
840  PRINT D$"PR#"SSLOT
842  PRINT V$
844  PRINT D$"PR#0"
845  LET YES = 0: IF W$ = "YES" THEN YES =
     1
846  LET Z =  PEEK (SANITY)
847  RETURN
850  REM  !---------------!
852  REM  ! RECOG. A WORD !
854  REM  !---------------!
855  LET Z =  PEEK (SANITY)
858  PRINT D$"IN#"SSLOT
860  INPUT W$
865  PRINT D$"IN#0"
870  IF W$ = "" THEN MESSAGE = 50: GOSUB 30
     0: GOTO 855
```

```
875  LET WN =  INT ((( PEEK (WAA + 6)) / 3)
      + 1)
880  FOR X = MASK TO MASK + 63
885  POKE X,0
890  NEXT X
894  LET Z =  PEEK (SANITY)
895  RETURN
900  REM !---------------------!
902  REM ! MAIN INITIALIZATION !
904  REM !---------------------!
906  GOSUB 950: REM  INIT VARIABLES
908  GOSUB 375: REM  INIT SPEECH LAB
909  LET Z =  PEEK (SANITY)
910  PRINT D$"BLOAD HOME.ML"
911  LET Z =  PEEK (SANITY)
912  PRINT D$"BLOAD JOHN": REM  VOCABULARY
913  LET Z =  PEEK (SANITY)
914  GOSUB 475: REM  LOAD TIME TABLE
916  LET Z =  PEEK (SANITY)
917  GOSUB 600: REM    READ TIME
918  IF TM < 1300 AND TM >  = 1200 THEN TM =
     TM - 1200
920  IF TM < 5300 AND TM >  = 5200 THEN TM =
     TM - 1200
922  LET S1 = 3:S2 = 0:S3 = 0:S4 = 0:S5 = 0
     :S8 = 0:S9 = 0:NC = 0
924  IF TM > 5100 OR TM < 900 THEN S1 = 1: GOTO
     940
926  LET MESSAGE = 36: GOSUB 300
930  FOR I = 1 TO 400
932  GOSUB 450
934  IF YES THEN S1 = 2:S2 = 1:S3 = 1:S4 =
     1:MESSAGE = 4: GOSUB 300: GOTO 940
936  NEXT I
940  POKE 2082,S4: REM  ALARM FLAG
944  CALL 2058: REM  ENABLE INTERUPTS
946  RETURN
950  REM  !-------------------------!
951  REM  !VARIABLE  INITIALIZATION!
952  REM  !-------------------------!
955  LET PF = 49240
956  LET PN = 49241
957  LET RF = 49242
958  LET RN = 49243
959  LET TF = 49244
960  LET TN = 49245
961  LET VOICE = 49249
963  LET SOUND = 49251
965  LET SSLOT = 1
966  LET VSLOT = 7
967  LET MSLOT = 2
968  LET RING = 16 * MSLOT - 16251
969  LET SP$(1) = "399-8030":SP$(2) = "452-
     1562"
970  LET A = 49400:CA = A + 1
971  LET B = A + 2:CB = A + 3
972  LET SANITY = 49393
973  DIM MT(64)
974  FOR I = 1 TO 64: READ MT(I): NEXT I
975  DATA 3,3,1,2,4,4,4,4,1,3,4,2,6,1,1,3,1
     ,7,1,4,8,8,9,3,2,1,1,1,2,4,5,2,2,2,1,1
     1,28,2,1,1,1,1,1,1,1,3,2,3,2,1,5,9,2,2
     ,0,0,0,0,0,0,0,0,0,0
977  LET N1$ = "JOHN"
```

```
978  LET N2$ = "WANDA"
979  FOR I = 0 TO 6: READ DAY$(I): NEXT I
980  DATA  SUNDAY,MONDAY,TUESDAY,WEDNESDAY,
     THURSDAY,FRIDAY,SATURDAY
981  FOR I = 1 TO 4: READ PN$(I): NEXT I
982  DATA  "452-1954","399-8030","7","8"
983  FOR I = 0 TO 9: READ TEEN$(I): NEXT I
984  DATA  TEN,ELEVEN,TWELVE,THIRTEEN,FOURT
     EEN,FIFTEEN,SIXTEEN,SEVENTEEN,EIGHTEEN
     ,NINETEEN
985  FOR I = 2 TO 5: READ TN$(I): NEXT I
986  DATA  TWENTY,THIRTY,FORTY,FIFTY
987  LET WAA = 3000
988  LET TAA = WAA + 557
989  LET MASK = TAA + 2177
990  LET D$ = "": REM  CTL D
991  LET I$ = "": REM  CTL I
992  LET V$ = "": REM  CTL V
993  DIM TT(3,20)
995  FOR I = 1 TO 7: READ BU(I): NEXT I
996  DATA  6,7,4,5,8,9,10
997  LET Q$ =  CHR$ (17):LF$ =  CHR$ (10):Z
     $ = "": REM   CTL Z
998  POKE TF,0: POKE PF,0: POKE RF,0
999  RETURN
1000  REM !=======================!
1001  REM ! PROCESS VOICE COMMANDS !
1002  REM !=======================!
1012  GOSUB 450: REM  IS MIKE ON
1014  IF  NOT YES THEN  RETURN
1015  LET S1 = 2:S2 = 1:S3 = 1:S4 = 1: POKE
     2082,S4
1016  IF S5 = 1 THEN  POKE TF,0:S5 = 0:MESS
     AGE = 12: GOSUB 300: RETURN
1018  LET MESSAGE = 1: GOSUB 300
1019  FOR I = MASK TO MASK + 38: POKE I,1: NEXT
     I
1020  GOSUB 850: REM  RECOG. A WORD
1022  ON (WN) GOSUB 1100,1100,1100,1100,110
     0,1100,1100,1200,1300,1400,1600,1700,1
     800
1023  IF S5 = 1 OR S4 = 0 THEN 1030
1024  LET MESSAGE = 2: GOSUB 300
1026  GOSUB 800
1028  IF YES THEN MESSAGE = 3: GOSUB 300: GOTO
     1019
1030  LET MESSAGE = 4: GOSUB 300
1032  RETURN
1100  REM !--------------------!
1101  REM ! CONTROL WITH VOICE !
1102  REM !--------------------!
1112  LET BU = BU(WN):WT$ = W$
1114  LET MESSAGE = 5: GOSUB 300
1116  FOR I = MASK + 38 TO MASK + 50: POKE
     I,1: NEXT I
1118  GOSUB 850
1120  IF WN = 17 THEN  RETURN
1122  GOSUB 750: REM  PRESS BUTTON BU
1124  ON (WN - 13) GOTO 1126,1132,1138
1126  LET BU = 20: GOSUB 750: REM   'ON'
1128  LET MESSAGE = 6: GOSUB 300
1130  RETURN
1132  LET BU = 28: GOSUB 750: REM   'OFF'
1134  LET MESSAGE = 7: GOSUB 300
1136  RETURN
```

```
1138  LET BU = 18
1140  FOR I = 1 TO 50
1142  GOSUB 750: REM  PRESSES 'DIM' ONCE
1144  NEXT I
1146  LET MESSAGE = 8: GOSUB 300
1148  RETURN
1200  REM !--------------------!
1201  REM ! ANNOUNCE THE TIME !
1202  REM !--------------------!
1210  GOSUB 600: REM  READ TIME
1212  LET M$ = " A M "
1214  IF T(5) > 1 THEN M$ = " P M ":T(5) =
      T(5) - 4
1216  LET HR$ = ""
1218  IF T(4) > 0 THEN HR$ =  STR$ (T(4))
1220  IF T(5) = 1 THEN HR$ = TEEN$(T(4))
1222  LET MIN$ = ""
1224  IF T(3) + T(2) = 0 THEN MIN$ = " O CL
      OCK ": GOTO 1232
1226  IF T(2) > 0 THEN MIN$ =  STR$ (T(2))
1228  IF T(3) = 1 THEN MIN$ = TEEN$(T(2)): GOTO
      1232
1230  IF T(3) > 1 THEN MIN$ = TN$(T(3)) + M
      IN$
1232  LET MESSAGE = 51: GOSUB 300
1234  RETURN
1300  REM !---------------------!
1301  REM ! VOICE CTL OF PHONE !
1302  REM !---------------------!
1310  LET MESSAGE = 9: GOSUB 300
1312  FOR I = MASK + 48 TO MASK + 62: POKE
      I,1: NEXT I
1314  GOSUB 850: REM  RECOG. A WORD
1316  IF WN = 17 THEN  RETURN
1318  LET MESSAGE = 10: GOSUB 300
1319  LET PN$ = PN$(WN - 17)
1320  GOSUB 650: REM  DIAL PHONE
1322  LET S5 = 1: REM   PHONE OFF HOOK
1324  RETURN
1400  REM !----------------------!
1401  REM ! "CONVERSATION" MODE !
1402  REM !----------------------!
1410  LET MESSAGE = 13: GOSUB 300
1415  GOSUB 800
1420  IF YES THEN MESSAGE = 14: GOSUB 300: GOTO
      1430
1425  LET MESSAGE = 15: GOSUB 300
1430  LET MESSAGE = 16: GOSUB 300
1435  GOSUB 800
1440  IF  NOT YES THEN MESSAGE = 18: GOSUB
      300: GOTO 1460
1445  LET MESSAGE = 17: GOSUB 300
1450  GOSUB 800
1455  LET MESSAGE = 19: GOSUB 300
1460  LET MESSAGE = 20: GOSUB 300
1465  GOSUB 800
1470  IF YES THEN MESSAGE = 22: GOSUB 300: GOTO
      1480
1475  LET MESSAGE = 21: GOSUB 300
1480  LET MESSAGE = 23: GOSUB 300
1490  RETURN
1600  REM !----------------------!
1601  REM ! CHANGE VOCABULARIES !
1602  REM !----------------------!
1610  LET MESSAGE = 11: GOSUB 300
```

```
1620  PRINT D$"BLOAD "N2$
1630  LET T$ = N1$
1640  LET N1$ = N2$
1650  LET N2$ = T$
1660  RETURN
1700  REM !------------------!
1701  REM ! HANDLE GOODNIGHT !
1702  REM !------------------!
1710  LET MESSAGE = 24: GOSUB 300
1715  LET S2 = 0:S4 = 0: POKE 2082,S4
1716  CALL 2058: REM  ENABLE INTERUPTS
1720  LET MESSAGE = 25: GOSUB 300
1725  GOSUB 800
1730  IF YES THEN 1750
1735  LET S3 = 1
1740  LET MESSAGE = 26: GOSUB 300
1745  RETURN
1750  LET S3 = 0
1755  LET MESSAGE = 27: GOSUB 300
1760  RETURN
1800  REM !----------------!
1801  REM ! HANDLE BYE BYE !
1802  REM !----------------!
1810  LET MESSAGE = 28: GOSUB 300
1815  GOSUB 800
1820  IF  NOT YES THEN S4 = 1: POKE 2082,S4
    : RETURN
1821 NC = 0: REM  RESET NUMBER OF CALLS
1822  LET S1 = 3: REM  SOMEONE HOME
1825  LET MESSAGE = 29: GOSUB 300
1830  GOSUB 800
1835  IF  NOT YES THEN MESSAGE = 30: GOSUB
    300:S4 = 1: POKE 2082,S4: RETURN
1840  LET MESSAGE = 31: GOSUB 300
1845  LET SC = 45: GOSUB 200
1850  LET S4 = 0: POKE 2082,S4
1851  CALL 2058: REM  ENABLE INTERUPTS
1855  RETURN
2000  REM  !=========================!
2010  REM  !   PROCESS PHONE CALLS   !
2020  REM  !=========================!
2025  LET Z =  PEEK (SANITY)
2030  GOSUB 100: REM  CHECK FOR RING
2040  IF  NOT YES THEN  RETURN
2045  LET NC = NC + 1
2050  ON S1 GOTO 2060,2340,2110
2060  REM -----STATUS UNKNOWN-------
2070  LET SC = 3: GOSUB 200: REM   3 SEC DE
    LAY
2080  GOSUB 100: REM  RING CHECK
2090  IF  NOT YES THEN  RETURN : REM  STILL
    UNSURE
2100  LET S1 = 3: REM  ASSUME NO ONE HOME
2110  REM ------NO ONE HOME--------
2115  POKE TN,0
2120  POKE PN,0: REM  PLAY MESSAGE
2125  LET Z =  PEEK (SANITY)
2130  LET DE = 11900: GOSUB 400: REM PLAYER
    DELAY
2135  LET Z =  PEEK (SANITY)
2140  POKE PF,0
2150  POKE RN,0
2160  GOSUB 250: REM  CHECK FOR OWNER
2170  IF YES THEN 2260
2180  FOR I = 1 TO 15: REM   MAX OF 60 SEC.
    MESSAGE
```

```
2185  LET Z =  PEEK (SANITY)
2190  GOSUB 150: REM  3 SEC SOUND CHECK
2200  IF  NOT YES THEN 2230
2210  IF  PEEK (2077) <  > 0 THEN MESSAGE =
     54: GOSUB 300: GOTO 2230
2220  NEXT I
2230  POKE RF,0
2240  POKE TF,0
2250  RETURN
2260  REM -----OWNER CALLING--------
2265  POKE RF,0
2270  LET MESSAGE = 32: GOSUB 300
2275  GOSUB 250: IF YES THEN  GOSUB 700
2280  LET MESSAGE = 33: GOSUB 300
2280  GOSUB 250: IF YES THEN  GOSUB 500
2300  LET MESSAGE = 34: GOSUB 300
2305  GOSUB 250: IF YES THEN  GOSUB 525
2310  LET MESSAGE = 4: GOSUB 300
2320  POKE TF,0
2330  RETURN
2340  REM ------SOMEONE HOME--------
2350  LET MESSAGE = 53: GOSUB 300
2360  FOR I = 1 TO 500: REM  SEVERAL SECOND
     S
2370  GOSUB 450
2375  IF YES THEN 2390
2380  NEXT I
2385  RETURN
2390  POKE TN,0
2400  LET S5 = 1: REM  FLAG FOR PHONE ON
2410  RETURN
3000  REM  !=======================!
3005  REM  ! PROCESS SECURITY FLAGS !
3010  REM  !=======================!
3015  LET Z =  PEEK (SANITY)
3020  IF  PEEK (2077) = 0 THEN  RETURN : REM
      NO SECUR. PROB.
3030  IF  PEEK (2079) > 0 THEN 3100: REM  D
     OOR
3040  IF  PEEK (2078) > 0 THEN 3200: REM  O
     UTSIDE
3050  GOTO 3300
3100  REM -------- DOOR OPEN -------
3105  LET MESSAGE = 35: GOSUB 300
3110  GOSUB 5000: REM  DEN ON
3115  FOR I = 1 TO 700
3118  LET Z =  PEEK (SANITY)
3120  GOSUB 450
3125  IF YES THEN 3140
3130  NEXT I
3135  GOTO 3300
3140  LET MESSAGE = 32: GOSUB 300
3145  GOSUB 800
3150  IF YES THEN  GOSUB 700: GOTO 3160
3155  LET MESSAGE = 4: GOSUB 300
3160  GOSUB 3400
3165  POKE 2085,1: REM  1 PERSON IN DEN
3166  POKE 2086,0: POKE 2087,0: POKE 2088,0
     : REM  NONE ANYWHERE ELSE
3170  LET S1 = 2:S2 = 1:S3 = 1:S4 = 1:S8 =
     0:S9 = 0:NC = 0
3175  POKE 2082,S4
3180  RETURN
3200  REM ----SOMEONE OUTSIDE-----
3205  GOSUB 5850: GOSUB 5500
3210  LET SC = 15: GOSUB 200
```

```
3215  GOSUB 200
3220  LET SC = 15: GOSUB 200
3225  GOSUB 5400
3230  GOSUB 3400
3235  LET SC = 20: GOSUB 200
3236  LET SC = 20: GOSUB 200
3237  LET SC = 20: GOSUB 200
3240  GOSUB 5450
3245  LET S8 = S8 + 1
3250  RETURN
3300  REM ----WINDOW OR INSIDE-----
3305  GOSUB 5050: GOSUB 5850
3310  GOSUB 5150: GOSUB 5300
3315  FOR I = 1 TO 2
3320  LET PN$ = SP$(I)
3325  GOSUB 650
3330  LET MESSAGE = 37: GOSUB 300
3335  POKE TF,0:S5 = 0
3340  LET SC = 5: GOSUB 200
3345  NEXT I
3350  GOSUB 3400
3355  LET S9 = S9 + 1
3360  RETURN
3400  REM  ----CLEAR ML FLAGS-------
3410  POKE 2077,0: REM  SECURITY FLAG
3420  POKE 2078,0: REM  OUTSIDE FLAG
3430  POKE 2079,0: REM  DOOR FLAG
3440  POKE 2080,0: REM  WINDOW FLAG
3450  POKE 2081,0: REM  MISC. FLAG
3460  RETURN
4000  REM !=======================!
4001  REM !   PROCESS NEXT ITEM   !
4002  REM !      IN TIME TABLE    !
4003  REM !=======================!
4015  GOSUB 600: REM  READ TIME
4016  IF TM >  = 1200 AND TM < 1300 THEN TM
      = TM - 1200
4017  IF TM >  = 5200 AND TM < 5300 THEN TM
      = TM - 1200
4018  IF TM <  > 0 THEN 4029
4020  GOSUB 475
4022  LET Z =  PEEK (SANITY)
4025  GOSUB 600
4028  IF TM = 0 THEN 4022
4029  IF TP > 20 THEN  RETURN
4030  IF TM < TT(1,TP) THEN  RETURN
4032  IF TT(2,TP) = 1 THEN 4035
4033  IF TT(2,TP) <  > S1 THEN TP = TP + 1:
      RETURN
4035  ON (TT(3,TP)) GOSUB 5000,5050,5100,51
      50,5200,5250,5300,5350,5400,5450,5500,
      5550,5600,5650,5700,5750,5800,5850,590
      0,5950
4040  LET TP = TP + 1
4050  RETURN
4997  REM !-----------------------!
4998  REM ! TIME TABLE SUBROUTINES !
4999  REM !-----------------------!
5000  REM ------- DEN ON ----------
5010  LET BU = 5: GOSUB 750
5020  LET BU = 20: GOSUB 750
5030  RETURN
5050  REM ------- DEN OFF ---------
5060  LET BU = 5: GOSUB 750
5070  LET BU = 28: GOSUB 750
```

```
5080  RETURN
5100  REM ------ KITCHEN ON -------
5110  LET BU = 8: GOSUB 750
5120  LET BU = 20: GOSUB 750
5130  RETURN
5150  REM ------ KITCHEN OFF ------
5160  LET BU = 8: GOSUB 750
5170  LET BU = 28: GOSUB 750
5180  RETURN
5200  REM ----- FLOODLIGHTS ON ----
5210  LET BU = 9: GOSUB 750
5220  LET BU = 20: GOSUB 750
5230  RETURN
5250  REM ----- FLOODLIGHTS OFF ---
5260  LET BU = 9: GOSUB 750
5270  LET BU = 28: GOSUB 750
5280  RETURN
5300  REM ------- OFFICE ON -------
5310  LET BU = 6: GOSUB 750
5320  LET BU = 20: GOSUB 750
5330  RETURN
5350  REM --------OFFICE OFF ------
5360  LET BU = 6: GOSUB 750
5370  LET BU = 28: GOSUB 750
5380  RETURN
5400  REM --------- ALL ON --------
5410  LET BU = 24: GOSUB 750
5420  RETURN
5450  REM --------- ALL OFF -------
5460  LET BU = 16: GOSUB 750
5470  RETURN
5500  REM ------- STEREO ON -------
5510  LET BU = 7: GOSUB 750
5520  LET BU = 20: GOSUB 750
5530  RETURN
5550  REM ------- STEREO OFF ------
5560  LET BU = 7: GOSUB 750
5570  LET BU = 28: GOSUB 750
5580  RETURN
5600  REM -------- HEAT ON --------
5610  LET BU = 10: GOSUB 750
5620  LET BU = 28: GOSUB 750
5630  RETURN
5650  REM -------- HEAT OFF -------
5660  LET BU = 10: GOSUB 750
5670  LET BU = 20: GOSUB 750
5680  RETURN
5700  REM ------ WAKE UP CALL -----
5705  IF S3 = 1 OR S2 = 1 THEN  RETURN
5710  LET MESSAGE = 52: GOSUB 300
5715  GOSUB 5850
5720  GOSUB 600
5730  LET MESSAGE = 51: GOSUB 300
5735  LET S2 = 1:S3 = 1:S4 = 1: POKE 2082,S
      4
5740  RETURN
5750  REM ----ENABLE INTERUPTS-----
5755  CALL 2058
5760  RETURN
5800  REM ----- ANNOUNCE TIME -----
5810  GOSUB 1200
5830  RETURN
5850  REM ------ BEDROOM ON -------
5860  LET BU = 4: GOSUB 750
5870  LET BU = 20: GOSUB 750
```

```
5880   RETURN
5900   REM ---- BEDROOM OFF ------
5910   LET BU = 4: GOSUB 750
5920   LET BU = 28: GOSUB 750
5930   RETURN
5950   REM  ----DISABLE INTERUPTS----
5955   CALL 2075
5960   RETURN
```

Appendix B

Home Control Program (Machine Language)

```
:ASM

                        1000 *-----------------------------------
                        1010 * UPPER NIBBLE MASK ROUTINE FOR
                        1020 * USE WITH THE 5832 CLOCK CHIP
                        1030 *-----------------------------------
0800- 00                1040 TEMCLK  .DA #0          CLOCK DATA
0801- AD 00 08          1050 CLOCK   LDA TEMCLK     GET DATA
0804- 29 0F             1060         AND #$0F       MASK HIGH NIBBLE
0806- 8D 00 08          1070         STA TEMCLK     REPLACE DATA
0809- 60                1080         RTS
                        1090 *-----------------------------------
                        1100 * ROUTINES TO CONTROL INTERRUPTS
                        1110 *-----------------------------------
080A- A9 30             1120 ENABLE  LDA #INTER     SET UP INTERRUPS
080C- 8D FE 03          1130         STA $3FE           VECTOR
080F- A9 08             1140         LDA /INTER
0811- 8D FF 03          1150         STA $3FF
0814- A9 04             1155         LDA #4         INITIALIZE THE
0816- 8D F7 C0          1156         STA SWPORT+1     PIA PORT
0819- 58                1160         CLI            ENABLE INTERRUPTS
081A- 60                1170         RTS
081B- 78                1180 DISABL  SEI            DISABLE INTERRUPTS
081C- 60                1190         RTS
                        1200 *-----------------------------------
                        1210 * INTERUPT ROUTINE FOR HANDLING
                        1220 * SWITCHPLATE INPUTS AND CONTROL-
                        1230 * ING LIGHTS THROUGH THE BSR
                        1240 * ULTRA SONIC COMMAND CONSOL
                        1250 *             BY
                        1260 *     JOHN BLANKENSHIP
                        1270 *-----------------------------------
FCA8-                   1280 WAIT    .EQ $FCA8      MONITOR DELAY
```

```
C0F6-             1290 SWPORT .EQ $C0F6     INPUT PORT
081D- 00          1300 SECF   .DA #0        SECURITY FLAG
081E- 00          1310 OUTF   .DA #0        OUTSIDE FLAG
081F- 00          1320 DOORF  .DA #0        DOOR FLAG
0820- 00          1330 WINDF  .DA #0        WINDOW FLAG
0821- 00          1340 INSDF  .DA #0        MISC.  FLAG
0822- 01          1350 ALARM  .DA #1        STATUS OF ALARM
0823- 00          1360 TO     .DA #0        ROOM MOVEMENT TO
0824- 00          1370 FROM   .DA #0        ROOM MOVEMENT FROM
0825- 00 00 00
0828- 00          1380 NUM    .HS 00000000  NUMBER IN EACH ROOM
0829- 05 04 06
082C- 07          1390 TABLE  .HS 05040607  BSR CODE TABLE
082D- 00          1400 DATA   .DA #0        PERM CODE HOLDER
082E- 00          1410 DATA1  .DA #0        TEMP CODE HOLDER
082F- 00          1420 DATA2  .DA #0        TIMES TO SEND EACH CODE
0830- A5 45       1430 INTER  LDA $45       RESTORE ACC
0832- 48          1440        PHA           SAVE REGISTERS
0833- 8A          1450        TXA
0834- 48          1460        PHA
0835- 98          1470        TYA
0836- 48          1480        PHA
0837- A9 04       1490        LDA #4        WAIT .1 MSEC
0839- 20 A8 FC    1500        JSR WAIT        DEBOUNCE
083C- AD F6 C0    1510        LDA SWPORT
083F- C9 FF       1520        CMP #$FF      CK FOR NONE PRESSED
0841- F0 3D       1530        BEQ DONE
0843- AC 22 08    1540        LDY ALARM     SEE IF ALARM SET
0846- F0 4A       1550        BEQ SECUR     DO SECURITY STUFF
0848- 09 F0       1560        ORA #$F0      MASK TOP NIBBLE
084A- A2 FF       1570        LDX #$FF      SET COUNTER
084C- E8          1580 AGAIN  INX
084D- 4A          1590        LSR           CK NEXT ROOM
084E- 90 06       1600        BCC FOUND     ROOM IS IN X
0850- C9 00       1610        CMP #$0       DONE LOOKING
0852- F0 2C       1620        BEQ DONE      YES AND NONE FOUND
0854- D0 F6       1630        BNE AGAIN     NO-KEEP LOOKING
0856- 8E 24 08    1640 FOUND  STX FROM      SAVE ROOM FROM
0859- AD F6 C0    1650 PAUSE  LDA SWPORT    WAIT TILL SWITCHES RELEASED

085C- C9 FF       1660        CMP #$FF
085E- D0 F9       1670        BNE PAUSE
0860- A9 04       1680        LDA #4        WAIT .1 MSEC
0862- 20 A8 FC    1690        JSR WAIT        FOR DEBOUNCE
0865- 20 DD FB    1700        JSR $FBDD     BELL
0868- A2 FF       1710 SECOND LDX #$FF      FOR 5 SECONDS LOOK
086A- A0 FF       1720 OVER   LDY #$FF        FOR 2ND SWITCH
086C- AD F6 C0    1730 MORE   LDA SWPORT    READ SWITCHES
086F- 29 0F       1740        AND #$F       MASK HIGH BYTE
0871- C9 0F       1750        CMP #$F       CK FOR PRESSED
0873- D0 3B       1760        BNE ONEWAS
0875- A9 04       1770        LDA #4        WAIT .1 MSEC
0877- 20 A8 FC    1780        JSR WAIT        FOR DEBOUNCE
087A- 88          1790        DEY           LOOP
087B- D0 EF       1800        BNE MORE        UNTIL
087D- CA          1810        DEX                2 SECONDS
087E- D0 EA       1820        BNE OVER             ARE UP
0880- AD F6 C0    1830 DONE   LDA SWPORT    WAIT TILL RELEASED
0883- C9 FF       1840        CMP #$FF
0885- D0 F9       1850        BNE DONE
0887- A9 04       1860        LDA #4        ANOTHER .1 MSEC
0889- 20 A8 FC    1870        JSR WAIT        DEBOUNCE
088C- 68          1880        PLA           RESTORE REGISTERS
088D- A8          1890        TAY
088E- 68          1900        PLA
```

```
088F- AA        1910          TAX
0890- 68        1920          PLA
0891- 40        1930          RTI             RETURN
0892- 0A        1940 SECUR    ASL             DO ALARM STUFF
0893- B0 03     1950          BCS DOOR
0895- EE 1E 08  1960          INC OUTF
0898- 0A        1970 DOOR     ASL
0899- B0 03     1980          BCS WINDOW
089B- EE 1F 08  1990          INC DOORF
089E- 0A        2000 WINDOW   ASL
089F- B0 03     2010          BCS INSIDE
08A1- EE 20 08  2020          INC WINDF
08A4- 0A        2030 INSIDE   ASL
08A5- B0 03     2040          BCS CONT
08A7- EE 21 08  2050          INC INSDF
08AA- EE 1D 08  2060 CONT     INC SECF
08AD- 4C 30 08  2070          JMP DONE
08B0- A2 FF     2080 ONEWAS   LDX #$FF        FIND WHICH ROOM
08B2- E8        2090 NEXT     INX
08B3- 4A        2100          LSR
08B4- 90 02     2110          BCC GOTIT
08B6- B0 FA     2120          BCS NEXT
08B8- 8E 23 08  2130 GOTIT    STX TO          "TO" ROOM
08BB- FE 25 08  2140          INC NUM,X       INC # IN ROOM TO
08BE- AE 24 08  2150          LDX FROM
08C1- DE 25 08  2160          DEC NUM,X       DEC # IN ROOM FROM
08C4- 10 0F     2170          BPL OK
08C6- A9 00     2180          LDA #$0         NEVER LET # BE NEGATIVE
08C8- 9D 25 08  2190          STA NUM,X
08CB- AE 23 08  2200          LDX TO          SEE IF 1ST
08CE- BD 25 08  2210          LDA NUM,X         PERSON TO
08D1- C9 01     2220          CMP #1              ENTER
08D3- D0 0E     2230          BNE OFF
08D5- AE 23 08  2240 OK       LDX TO
08D8- BD 29 08  2250          LDA TABLE,X     CONVERT TO CODE
08DB- 20 F9 08  2260          JSR SSONIC      TURN ON LIGHT
08DE- A9 14     2270          LDA #20         CODE FOR "ON"
08E0- 20 F9 08  2280          JSR SSONIC
08E3- AE 24 08  2290 OFF      LDX FROM
08E6- BD 25 08  2300          LDA NUM,X       SEE IF FROM ROOM
08E9- D0 95     2310          BNE DONE          IS EMPTY
08EB- BD 29 08  2320          LDA TABLE,X     CONVERT TO CODE
08EE- 20 F9 08  2330          JSR SSONIC      TURN OFF LIGHT
08F1- A9 1C     2340          LDA #28         CODE FOR "OFF"
08F3- 20 F9 08  2350          JSR SSONIC
08F6- 4C 80 08  2360          JMP DONE
08F9- 8D 2D 08  2370 SSONIC   STA DATA        KEY CODE
08FC- A0 03     2380 BEGIN    LDY #$3         SEND EACH TWICE
08FE- 8C 2F 08  2390          STY DATA2
0901- CE 2F 08  2400 TWO      DEC DATA2
0904- D0 0B     2410          BNE MAIN
0906- A2 01     2420          LDX #1          LONG WAIT
0908- A9 FF     2430 WT       LDA #$FF
090A- 20 A8 FC  2440          JSR WAIT
090D- CA        2450          DEX
090E- D0 F8     2460          BNE WT
0910- 60        2470          RTS
0911- A2 01     2480 MAIN     LDX #$1         START BIT
0913- 20 55 09  2490          JSR ONE
0916- AD 2D 08  2500          LDA DATA        PREPARE TO SEND DATA BITS
0919- 8D 2E 08  2510          STA DATA1
091C- 20 41 09  2520          JSR OUT
091F- AD 2D 08  2530          LDA DATA        PREPARE FOR COMPLEMENT DATA
0922- 49 1F     2540          EOR #$1F
0924- 8D 2E 08  2550          STA DATA1
```

```
C0F6-             1290 SWPORT .EQ $C0F6     INPUT PORT
081D- 00          1300 SECF   .DA #0        SECURITY FLAG
081E- 00          1310 OUTF   .DA #0        OUTSIDE FLAG
081F- 00          1320 DOORF  .DA #0        DOOR FLAG
0820- 00          1330 WINDF  .DA #0        WINDOW FLAG
0821- 00          1340 INSDF  .DA #0        MISC.  FLAG
0822- 01          1350 ALARM  .DA #1        STATUS OF ALARM
0823- 00          1360 TO     .DA #0        ROOM MOVEMENT TO
0824- 00          1370 FROM   .DA #0        ROOM MOVEMENT FROM
0825- 00 00 00
0828- 00          1380 NUM    .HS 00000000  NUMBER IN EACH ROOM
0829- 05 04 06
082C- 07          1390 TABLE  .HS 05040607  BSR CODE TABLE
082D- 00          1400 DATA   .DA #0        PERM CODE HOLDER
082E- 00          1410 DATA1  .DA #0        TEMP CODE HOLDER
082F- 00          1420 DATA2  .DA #0        TIMES TO SEND EACH CODE
0830- A5 45       1430 INTER  LDA $45       RESTORE ACC
0832- 48          1440        PHA           SAVE REGISTERS
0833- 8A          1450        TXA
0834- 48          1460        PHA
0835- 98          1470        TYA
0836- 48          1480        PHA
0837- A9 04       1490        LDA #4        WAIT .1 MSEC
0839- 20 A8 FC    1500        JSR WAIT        DEBOUNCE
083C- AD F6 C0    1510        LDA SWPORT
083F- C9 FF       1520        CMP #$FF      CK FOR NONE PRESSED
0841- F0 3D       1530        BEQ DONE
0843- AC 22 08    1540        LDY ALARM     SEE IF ALARM SET
0846- F0 4A       1550        BEQ SECUR     DO SECURITY STUFF
0848- 09 F0       1560        ORA #$F0      MASK TOP NIBBLE
084A- A2 FF       1570        LDX #$FF      SET COUNTER
084C- E8          1580 AGAIN  INX
084D- 4A          1590        LSR           CK NEXT ROOM
084E- 90 06       1600        BCC FOUND     ROOM IS IN X
0850- C9 00       1610        CMP #$0       DONE LOOKING
0852- F0 2C       1620        BEQ DONE      YES AND NONE FOUND
0854- D0 F6       1630        BNE AGAIN     NO-KEEP LOOKING
0856- 8E 24 08    1640 FOUND  STX FROM      SAVE ROOM FROM
0859- AD F6 C0    1650 PAUSE  LDA SWPORT    WAIT TILL SWITCHES RELEASED

085C- C9 FF       1660        CMP #$FF
085E- D0 F9       1670        BNE PAUSE
0860- A9 04       1680        LDA #4        WAIT .1 MSEC
0862- 20 A8 FC    1690        JSR WAIT        FOR DEBOUNCE
0865- 20 DD FB    1700        JSR $FBDD     BELL
0868- A2 FF       1710 SECOND LDX #$FF      FOR 5 SECONDS LOOK
086A- A0 FF       1720 OVER   LDY #$FF        FOR 2ND SWITCH
086C- AD F6 C0    1730 MORE   LDA SWPORT    READ SWITCHES
086F- 29 0F       1740        AND #$F       MASK HIGH BYTE
0871- C9 0F       1750        CMP #$F       CK FOR PRESSED
0873- D0 3B       1760        BNE ONEWAS
0875- A9 04       1770        LDA #4        WAIT .1 MSEC
0877- 20 A8 FC    1780        JSR WAIT        FOR DEBOUNCE
087A- 88          1790        DEY           LOOP
087B- D0 EF       1800        BNE MORE        UNTIL
087D- CA          1810        DEX                2 SECONDS
087E- D0 EA       1820        BNE OVER             ARE UP
0880- AD F6 C0    1830 DONE   LDA SWPORT    WAIT TILL RELEASED
0883- C9 FF       1840        CMP #$FF
0885- D0 F9       1850        BNE DONE
0887- A9 04       1860        LDA #4        ANOTHER .1 MSEC
0889- 20 A8 FC    1870        JSR WAIT        DEBOUNCE
088C- 68          1880        PLA           RESTORE REGISTERS
088D- A8          1890        TAY
088E- 68          1900        PLA
```

```
088F- AA        1910          TAX
0890- 68        1920          PLA
0891- 40        1930          RTI             RETURN
0892- 0A        1940 SECUR    ASL             DO ALARM STUFF
0893- B0 03     1950          BCS DOOR
0895- EE 1E 08  1960          INC OUTF
0898- 0A        1970 DOOR     ASL
0899- B0 03     1980          BCS WINDOW
089B- EE 1F 08  1990          INC DOORF
089E- 0A        2000 WINDOW   ASL
089F- B0 03     2010          BCS INSIDE
08A1- EE 20 08  2020          INC WINDF
08A4- 0A        2030 INSIDE   ASL
08A5- B0 03     2040          BCS CONT
08A7- EE 21 08  2050          INC INSDF
08AA- EE 1D 08  2060 CONT     INC SECF
08AD- 4C 30 08  2070          JMP DONE
08B0- A2 FF     2080 ONEWAS   LDX #$FF        FIND WHICH ROOM
08B2- E8        2090 NEXT     INX
08B3- 4A        2100          LSR
08B4- 90 02     2110          BCC GOTIT
08B6- B0 FA     2120          BCS NEXT
08B8- 8E 23 08  2130 GOTIT    STX TO          "TO" ROOM
08BB- FE 25 08  2140          INC NUM,X       INC # IN ROOM TO
08BE- AE 24 08  2150          LDX FROM
08C1- DE 25 08  2160          DEC NUM,X       DEC # IN ROOM FROM
08C4- 10 0F     2170          BPL OK
08C6- A9 00     2180          LDA #$0         NEVER LET # BE NEGATIVE
08C8- 9D 25 08  2190          STA NUM,X
08CB- AE 23 08  2200          LDX TO          SEE IF 1ST
08CE- BD 25 08  2210          LDA NUM,X         PERSON TO
08D1- C9 01     2220          CMP #1                ENTER
08D3- D0 0E     2230          BNE OFF
08D5- AE 23 08  2240 OK       LDX TO
08D8- BD 29 08  2250          LDA TABLE,X     CONVERT TO CODE
08DB- 20 F9 08  2260          JSR SSONIC      TURN ON LIGHT
08DE- A9 14     2270          LDA #20         CODE FOR "ON"
08E0- 20 F9 08  2280          JSR SSONIC
08E3- AE 24 08  2290 OFF      LDX FROM
08E6- BD 25 08  2300          LDA NUM,X       SEE IF FROM ROOM
08E9- D0 95     2310          BNE DONE          IS EMPTY
08EB- BD 29 08  2320          LDA TABLE,X     CONVERT TO CODE
08EE- 20 F9 08  2330          JSR SSONIC      TURN OFF LIGHT
08F1- A9 1C     2340          LDA #28         CODE FOR "OFF"
08F3- 20 F9 08  2350          JSR SSONIC
08F6- 4C 80 08  2360          JMP DONE
08F9- 8D 2D 08  2370 SSONIC   STA DATA        KEY CODE
08FC- A0 03     2380 BEGIN    LDY #$3         SEND EACH TWICE
08FE- 8C 2F 08  2390          STY DATA2
0901- CE 2F 08  2400 TWO      DEC DATA2
0904- D0 0B     2410          BNE MAIN
0906- A2 01     2420          LDX #1          LONG WAIT
0908- A9 FF     2430 WT       LDA #$FF
090A- 20 A8 FC  2440          JSR WAIT
090D- CA        2450          DEX
090E- D0 F8     2460          BNE WT
0910- 60        2470          RTS
0911- A2 01     2480 MAIN     LDX #$1         START BIT
0913- 20 55 09  2490          JSR ONE
0916- AD 2D 08  2500          LDA DATA        PREPARE TO SEND DATA BITS
0919- 8D 2E 08  2510          STA DATA1
091C- 20 41 09  2520          JSR OUT
091F- AD 2D 08  2530          LDA DATA        PREPARE FOR COMPLEMENT DATA
0922- 49 1F     2540          EOR #$1F
0924- 8D 2E 08  2550          STA DATA1
```

```
0927- 20 41 09 2560          JSR OUT
092A- A0 FF    2570          LDY #$FF       STOP BITS
092C- 20 68 09 2580          JSR PULSES
092F- A0 FF    2590          LDY #$FF
0931- 20 68 09 2600          JSR PULSES
0934- A0 82    2610          LDY #$82
0936- 20 68 09 2620          JSR PULSES
0939- A9 60    2630          LDA #$60       PAUSE BETWEEN
093B- 20 A8 FC 2640          JSR WAIT
093E- 4C 01 09 2650          JMP TWO
               2660 *--------------------------------
               2670 *  SUBROUTINE 'OUT' OUTPUTS
               2680 *   FIVE BITS IN DATA1
               2690 *--------------------------------
0941- A2 05    2700 OUT      LDX #$5        GET READY
0943- 4E 2E 08 2710 OUT1     LSR DATA1      GET NEXT BIT
0946- B0 0D    2720          BCS ONE        SEND A ONE
0948- A0 30    2730 ZERO     LDY #$30       OR A ZERO
094A- 20 68 09 2740          JSR PULSES     (48 PULSES)
094D- A9 31    2750          LDA #$31
094F- 20 A8 FC 2760          JSR WAIT       6.83 MSEC
0952- 4C 64 09 2770          JMP MOR        CONTINUE
0955- A0 A0    2780 ONE      LDY #$A0       (160 PULSES)
0957- 20 68 09 2790          JSR PULSES
095A- A9 24    2800          LDA #$24       3.82 MSEC
095C- 20 A8 FC 2810          JSR WAIT
095F- A9 05    2820          LDA #$05       .146 MSEC
0961- 20 A8 FC 2830          JSR WAIT
0964- CA       2840 MOR      DEX
0965- D0 DC    2850          BNE OUT1       KEEP GOING
0967- 60       2860          RTS            DONE HERE
               2870 *--------------------------------
               2880 *  OUTPUT Y PULSES AT 40 KHZ
               2890 *--------------------------------
0968- CD 5E C0 2900 PULSES   CMP $C05E       TRANSDUCER ON
096B- EA       2910          NOP
096C- EA       2920          NOP
096D- EA       2930          NOP
096E- EA       2940          NOP
096F- CD 5F C0 2950          CMP $C05F      TRANSDUCER OFF
0972- CD FF FF 2960          CMP $FFFF      JUST A DELAY
0975- 88       2970          DEY
0976- D0 F0    2980          BNE PULSES     KEEP GOING
0978- 60       2990          RTS            DONE HERE
               3000          .EN
```

SYMBOL TABLE

```
084C- AGAIN      0821- INSDF      0859- PAUSE
0822- ALARM      08A4- INSIDE     0968- PULSES
08FC- BEGIN      0830- INTER      081D- SEC F
0801- CLOCK      0911- MAIN       0868- SECOND
08AA- CONT       0964- MOR        0892- SECUR
082D- DATA       086C- MORE       08F9- SSONIC
082E- DATA1      08B2- NEXT       C0F6- SWPORT
082F- DATA2      0825- NUM        0829- TABLE
081B- DISABL     08E3- OFF        0900- TEMCLK
0880- DONE       08D5- OK         0823- TO
0898- DOOR       0955- ONE        0901- TWO
081F- DOORF      08B0- ONEWAS     FCA8- WAIT
080A- ENABLE     0941- OUT        0820- WINDF
0856- FOUND      0943- OUT1       089E- WINDOW
0824- FROM       081E- OUTF       0908- WT
08B8- GOTIT      086A- OVER       0948- ZERO
```

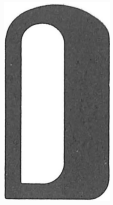
Clock Set and View Program

```
]LIST

0   REM  FIRST USE POKES TO
1   REM  LOAD SMALL MACHINE LANGUAGE PROGRAM

2   FOR I = 1 TO 9: READ X: POKE 768 + I,X: NEXT
    I
9   REM  SET UP PORTS AND DDR ADDRESSES
10  A = 12 * 16 ^ 3 + 15 * 16 + 8:C = A + 1
20  AB = A + 2:CB = C + 2
21   REM !--------------------!
22   REM ! MAIN PROGRAM STARTS!
23   REM !       HERE         !
24   REM !--------------------!
25   HOME
30   PRINT "CLOCK SET AND VIEW PROGRAM"
35   VTAB 5
40   PRINT "1. VIEW CLOCK"
45   PRINT "2. SET CLOCK"
50   PRINT : INPUT "WHICH ";NUM
55   ON NUM GOTO 1000,2000
60   GOTO 25
80   REM ----------------------------
90   REM  GENERAL PURPOSE SUBROUTINE TO
91   REM          READ AND WRITE
92   REM      BASIC IS SLOW ENOUGH TO
93   REM    PROVIDE THE CORRECT TIMING
94   REM         FOR THE 5832 CHIP
95   REM ----------------------------
100   POKE CB,0: POKE AB,128: POKE CB,4: POKE
      AB,0: REM   SET UP HOLD PORT
110   POKE C,0: REM  DDR
111   IF Z = 0 THEN  POKE A,255: REM  WRITE
112   IF Z = 1 THEN  POKE A,240: REM  READ
```

```
113   POKE C,4: REM  BACK TO OUTPUT
120   POKE AB,128: REM  TURN CHIP ON
130   POKE A,(128 + Y * 16 + D): REM  Y=ADDR
       D=WRITE DATA (0 IF READ)
140   POKE 768, PEEK (A): CALL 769:X =  PEEK
      (768): REM  MASK UPPER NIBBLE TO ZERO
145   POKE A,0: REM  RESET READ
150   POKE AB,0: REM  TURN CHIP OFF
170   RETURN
900   REM  !------------------------!
910   REM  !     READ AND DISPLAY     !
920   REM  !------------------------!
1000   REM  READ ALL ADDRESSES
1001   VTAB 19
1002   PRINT "D HR MI SC"
1005  Z = 1:D = 0
1010   FOR Y = 0 TO 6
1020   GOSUB 100
1030  T(Y) = X
1040   NEXT Y
1050   VTAB 20
1060   PRINT T(6)" "T(5);T(4)" "T(3);T(2)" "
      T(1);T(0)"      "
1070   GOTO 1005
1900   REM  !------------------------!
1910   REM  !      SET THE TIME      !
1920   REM  ! NOTE: SECONDS CANNOT   !
1930   REM  !        BE SET WITH     !
1940   REM  !        THIS CHIP       !
1950   REM  !------------------------!
2000   REM  SET TIME
2001   PRINT : PRINT "MOVE READ/WRITE SWITCH
       TO WRITE POS."
2002   PRINT : PRINT "USE 0 FOR SUNDAY,1 FOR
       MONDAY ETC."
2003   PRINT : PRINT "ADD 4 TO H10 FOR PM"
2004   PRINT : PRINT "ENTER 0-9 FOR OTHER DI
      GITS"
2005   PRINT : PRINT "SEE CHAPTER 6 FOR MORE
       DETAILS ON CLOCK "
2010  Z = 0: REM  SET UP WRITE
2020   PRINT "INPUT DAY,H10,H1,M10,M1"
2030   FOR Y = 6 TO 0 STEP  - 1
2035   IF Y < 2 THEN D = 0: GOTO 2050
2040   INPUT D
2050   GOSUB 100
2060   NEXT Y
2070  Z = 1:D = 0
2080   END
3000   DATA 173,0,3,41,15,141,0,3,96,200
```



Time Table Editor

```
]
]LIST

1 D$ =  CHR$ (4)
5  DIM TT(3,20)
10  REM !-------------------------!
12  REM ! TIME TABLE MAINTENANCE  !
14  REM !     PROGRAM      BY     !
16  REM !    JOHN BLANKENSHIP     !
18  REM !-------------------------!
20  REM
25  REM
80  REM !-------------------------!
90  REM !    MAIN PROGRAM MENUE   !
95  REM !-------------------------!
100  TEXT
110  HOME
120  PRINT "          TIME TABLE MAINTENANCE
     "
130  VTAB 5
140  PRINT "1. LOAD A TABLE"
145  PRINT "2. EDIT TABLE IN MEMORY"
150  PRINT "3. SAVE PRESENT TABLE"
155  PRINT "4. CREATE A NEW TABLE"
157  PRINT "5. END"
160  VTAB 20: PRINT "
     "
165  VTAB 20: PRINT "WHICH ";: GET A$
170 A =  VAL (A$)
171  IF A = 5 THEN  HOME : END
175  IF A < 1 OR A > 4 THEN 160
180  ON A GOSUB 1000,2000,3000,4000
190  GOTO 100
```

```
1000  REM !------------------------!
1005  REM ! LOAD A TABLE FROM DISK !
1010  REM !------------------------!
1020  HOME
1030  PRINT "                LOAD TABLE"
1040  VTAB 3
1050  INPUT "WHAT TABLE NAME (JUST RETURN
           TO VOID) ";TN$
1055  IF TN$ = "" THEN  RETURN
1060  PRINT D$"OPEN "TN$
1070  PRINT D$"READ "TN$
1080  FOR J = 1 TO 20
1090  FOR I = 1 TO 3
1100  INPUT TT(I,J)
1110  NEXT I,J
1120  PRINT D$"CLOSE"
1130  RETURN
2000  REM !--------------------!
2005  REM ! EDIT PRESENT TABLE !
2010  REM !--------------------!
2020  HOME
2040  GOSUB 5000: REM  PRINT ARRAY
2050  HOME
2060  INPUT "ENTER ELEMENT CO-ORDINATES AND
      NEW DATA (X,Y,DATA) ";I,J,K
2070 TT(I,J) = K
2080  HTAB (1): VTAB (J + 1): GOSUB 7000
2085  HOME
2090  PRINT "MORE CHANGES (Y/N) ";
2100  GET A$
2105  HOME
2110  IF A$ = "N" THEN  RETURN
2120  GOTO 2060
3000  REM !--------------------!
3005  REM ! SAVE TABLE TO DISK !
3010  REM !--------------------!
3020  HOME
3030  PRINT "                SAVE TABLE"
3040  VTAB 3
3050  INPUT "WHAT NAME TO USE (JUST RETURN
           TO VOID) ";TN$
3055  IF TN$ = "" THEN  RETURN
3060  PRINT D$"OPEN "TN$
3070  PRINT D$"WRITE "TN$
3080  FOR J = 1 TO 20
3090  FOR I = 1 TO 3
3100  PRINT TT(I,J)
3110  NEXT I,J
3120  PRINT D$"CLOSE"
3130  RETURN
4000  REM !--------------------!
4005  REM ! CREATE A NEW TABLE !
4010  REM !--------------------!
4020  HOME
4030  PRINT "WE MUST ENTER THREE NUMBERS FO
      R EACH    LINE IN THE TABLE": PRINT
4040  PRINT "THE ENTRIES ARE"
4050  PRINT "       1. EVENT TIME (24 HR FOR
      MAT)"
4060  PRINT "       2. USE (1-BOTH 2-HOME 3-
      AWAY)"
4070  PRINT "       3. TASK NUMBER (1-20)
4080  PRINT : PRINT
4082  PRINT "ENTER EVENTS IN CHRONOLOGICAL
      ORDER"
```

```
4084  PRINT "INPUT ZERO'S FOR UNUSED ELEMEN
    TS"
4086  PRINT : PRINT
4090  FOR J = 1 TO 20
4100  PRINT "LINE "J" (ET,U,T) ";
4105  INPUT TT(1,J),TT(2,J),TT(3,J)
4110  NEXT J
4120  RETURN
5000  REM !----------------------!
5005  REM ! PRINT PRESENT ARRAY !
5010  REM !----------------------!
5020  TEXT : HOME
5030  POKE 34,21
5035  INVERSE
5040  PRINT "            1           2
    3      "
5045  NORMAL
5050  FOR J = 1 TO 20
5060  GOSUB 7000
5070  PRINT
5080  NEXT J
5090  RETURN
6000  REM !------------------------!
6005  REM ! PRINT A WITH LENGTH K !
6010  REM !------------------------!
6020 A$ =  STR$ (A)
6030  IF  LEN (A$) < K THEN A$ = " " + A$: GOTO
    6030
6040  PRINT A$;
6050  RETURN
7000  REM !------------------------!
7004  REM ! PRINT LINE J OF TABLE !
7008  REM !------------------------!
7009  INVERSE
7010 K = 2:A = J: GOSUB 6000
7011  NORMAL
7020  FOR I = 1 TO 3
7030 K = 10:A = TT(I,J): GOSUB 6000
7040  NEXT I
7050  RETURN
```

Appendix E

Vocabulary Generator and Tester

```
]
]LIST

1  TEXT
2  IF  PEEK (104) <  > 25 THEN  POKE 103,20
     1: POKE 104,25: POKE 6600,0: PRINT  CHR$
     (4)"RUN VOCAB.CREATE&SAY"
3  REM  LINE 2 MAKES SURE LOMEM IS SET TO 6
     600
5 SLOT = 1
6 D$ = "": REM  CTL D
7 I$ = "": REM  CTL I
8 V$ = "": REM  CTL V
10  HOME : PRINT "SPEECH LINK TEST BY JOHN
     BLANKENSHIP"
12  VTAB (5)
13  PRINT "1. INITIALIZE"
14  PRINT "2. TRAIN WORDS"
15  PRINT "3. RECOGNIZE WORDS"
16  PRINT "4. SAVE VOCABULARY"
17  PRINT "5. YES AND NO"
18  PRINT "6. END"
50  INPUT "WHICH ";A
55  ON A GOSUB 1000,2000,3000,3500,3800,999

60  GOTO 10
300  REM **********************
302  REM *   TRAIN W$         *
304  REM **********************
310  PRINT W$
320  PRINT D$"PR#"SLOT
330  PRINT W$
340  PRINT D$"PR#0"
```

```
345 ERR =  PEEK (WAA + 9)
350  RETURN
400  REM **********************
402  REM *    RECOGNIZE W$    *
404  REM **********************
410  PRINT D$"IN#"SLOT
420  INPUT W$
430  PRINT D$"IN#0"
450 ERR =  PEEK (WAA + 9)
460  RETURN
999  END
1000  REM **********************
1010  REM *  INITIALIZATION  *
1020  REM **********************
1040 WAA = 3000
1050 HI =  INT (WAA / 256)
1060 LO = WAA - HI * 256
1070  POKE (1144 + SLOT),LO
1080  POKE (1272 + SLOT),HI
1090 TAA = WAA + 557
1100 HI =  INT (TAA / 256)
1110 LO = TAA - HI * 256
1120  POKE (WAA + 2),LO
1130  POKE (WAA + 3),HI
1140  PRINT D$"PR#"SLOT
1150  PRINT I$
1160  PRINT D$"PR#0": REM  SAME FOR D$
1170  RETURN
2000  REM **********************
2005  REM *   TRAIN WORDS     *
2010  REM **********************
2012  HOME
2014  PRINT "PLEASE SAY THE FOLLOWING WORDS
     "
2016  FOR I = 1 TO 1000: NEXT I
2020  RESTORE
2030  READ W$
2040  IF W$ = "END" THEN 2060
2045  GOSUB 300
2050  GOTO 2030
2060  RETURN
3000  REM **********************
3005  REM * RECOGNIZE WORDS  *
3010  REM **********************
3015  HOME
3020  PRINT "PLEASE SAY SOME WORDS (10) AND
      I WILL   PRINT WHAT I THOUGHT YOU SAI
     D"
3030  PRINT
3040  FOR I = 1 TO 10
3050  GOSUB 400
3060  PRINT W$
3070  NEXT I
3080  RETURN
3500  REM **********************
3510  REM *  SAVE VOCABULARY  *
3520  REM **********************
3530  HOME
3540  PRINT "WHAT NAME DO YOU WISH TO SAVE
     THIS       VOCABULARY UNDER (JUST RETUR
     N TO VOID)"
3550  PRINT : INPUT NAME$
3560  IF  LEN (NAME$) = 0 THEN  RETURN
3570  PRINT D$"BSAVE "NAME$",A"TAA",L3000"
3580  RETURN
```

```
3800  REM **********************
3805  REM *     YES AND NO     *
3810  REM **********************
3812  HOME
3814  PRINT "THIS WILL PERFORM 10 TESTS OF
    THE YES   AND NO INPUT"
3820  PRINT D$"PR#"SLOT
3830  PRINT V$
3835  PRINT D$"PR#0"
3840  FOR I = 1 TO 10
3845  GOSUB 400
3850  PRINT W$
3855  NEXT I
3860  PRINT D$"PR#"SLOT
3865  PRINT V$
3870  PRINT D$"PR#0"
3900  RETURN
4000  REM  **********************
4004  REM  *WORDS FOR TRAINING*
4005  REM  * LAST WORD = END  *
4010  REM  **********************
4020  DATA  OFFICE,OFFICE.,OFFICE!
4030  DATA  STEREO,STEREO.,STEREO!
4040  DATA  BEDROOM,BEDROOM.,BEDROOM!
4050  DATA  DEN,DEN.,DEN!
4060  DATA  KITCHEN,KITCHEN.,KITCHEN!
4070  DATA  FLOODLIGHTS,FLOODLIGHTS.,FLOODL
    IGHTS!
4080  DATA  HEAT,HEAT.,HEAT!
4090  DATA  TIME PLEASE,TIME PLEASE.,TIME P
    LEASE!
4100  DATA  TELEPHONE,TELEPHONE.,TELEPHONE!

4110  DATA  ARE YOU BUSY,ARE YOU BUSY.,ARE
    YOU BUSY!
4120  DATA  THIS IS WANDA,THIS IS WANDA.,TH
    IS IS WANDA!
4130  DATA  GOODNIGHT,GOODNIGHT.,GOODNIGHT!

4140  DATA  BYE BYE,BYE BYE.,BYE BYE!
4150  DATA  TURN IT ON,TURN IT ON.,TURN IT
    ON!
4160  DATA  SHUT IT OFF,SHUT IT OFF.,SHUT I
    T OFF!
4170  DATA  DIM IT,DIM IT.,DIM IT!
4180  DATA  NEVER MIND,NEVER MIND.,NEVER MI
    ND!
4190  DATA  BILL,BILL.,BILL!
4200  DATA  WANDA,WANDA.,WANDA!
4210  DATA  TOCCO HILLS,TOCCO HILLS.,TOCCO
    HILLS!
4220  DATA  VILLAGE TWIN,VILLAGE TWIN.,VILL
    AGE TWIN!
4230  DATA  END
```

Appendix F

The HELLO Program

```
]LIST

10   HOME
20   PRINT "HOME CONTROL PROGRAM DISKETTE"
30   PRINT "        COPYRIGHT    BY"
40   PRINT "       JOHN BLANKENSHIP"
50   POKE 1012,0: REM  RESET POWER UP BYTE
60   POKE 103,201: POKE 104,25: POKE 6600,0
70   REM  LOMEM NOW SET TO 6600
80   POKE 49393,0: REM  RESET SANITY TIMER
90   PRINT
100   PRINT  CHR$ (4)"RUN HOME CONTROL"
```

Appendix

Partial Product and Vendor Listing

Micromodem II
Hayes Microcomputer Products
5835 Peachtree Corners East
Norcross Ga 30092

Type 'N Talk Speech Synthesizer
Votrax
500 Stephenson Highway
Troy MI 48084

Microvox Speech Synthesizer
40-Khz Ultrasonic Transducer
Micromint
561 Willow Avenue
Cedarhurst NY 11516

5832 Clock chip and crystal
Miscellaneous semiconductors and electronic parts
Concord Computer Products
1971 So. State College
Anaheim CA 92806
and

JDR Microdevices
1224 S. Bascom Avenue
San Jose CA 95128

Mura WMS-49 Wireless Microphone
Herbach & Rademan
401 East Avenue
Philadelphia PA 19134
and
Mura
177 Cantiague Rock Road
Westbury NY 11590

THE APPLE HOUSE

JOHN BLANKENSHIP

Yours can be the first APPLE house on the block!

Here is a book that will show you how to save time and money by using your computer to control your home: the security, the lights, the heat, the telephone, and much more.

With John Blankenship's system, your house can accept verbal commands and respond with its own voice. It does not need human instruction and performs many useful tasks on its own. Once you get used to an intelligent house you will wonder how you ever got along without one.

Even though most items in the APPLE house can be readily purchased, the author shows how you can save even more money by building some from scratch. He also points out that you can substitute equipment you already own because of the system's modularity.

Although written with an APPLE computer in mind, the principles discussed can easily be transferred to other computer systems.

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