# GENERAL PURPOSE COMPUTERS FOR CABLE TELEVISION SYSTEMS

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NOTE: Statements in this paper are those of the author and do not necessarily represent the position of the Federal Communications Commission.

## ABSTRACT

Computers have a significant place in cable television systems. For example, a general purpose microcomputer/video synthesizer could be a practical first step in developing viable interactive (two-way) cable television systems. A working microcomputer/video synthesizer is demonstrated at the presentation of this paper. The paper will endeavor to show that the difficulties in creating such computer systems arise in developing the computer programs (software), not in the computer equipment (hardware).

*Hardware.* A computer in every headend is now a possibility. Powerful microcomputers developed by the personal computer industry can be purchased for about $2,500 or less. Some computer basics are explained to indicate the simplicity of a minimum microcomputer circuit.

*Software.* The potential applications of microcomputers to cable television systems are staggering. Applications such as "cable television games" and non-duplication switching are just two possibilities. But in implementing any such microcomputer system, the development of the necessary computer programs may be the major expense.

## INTRODUCTION

Computers are finding a place in the home. Over 20,000 consumers have purchased computers for their own personal use. The author decided to consider how such computers could be used in a cable television system.

## MICROCOMPUTERS IN HEADENDS

A computer in every headend is now a real possibility. While the cable television industry has been concerned with satellite technology, the electronics industry has developed and fallen in love with a large-scale integrated (LSI) circuit: the microprocessor. Though these devices are generally something less than a "computer on a chip," as they are often touted, they have nonetheless resulted in a revolution. One of the products of this revolution is the microcomputer at a low cost.

Microcomputers do not carry a big price tag. Business computers can cost millions, but for a cable television system, a useful and complete microcomputer can be purchased for considerably less. For about $2,500 or less, a cable television system can buy a powerful microcomputer.

This raises the question, "What would a computer be used for at a headend?" An example of a microcomputer application which could be used on a cable television system is demonstrated with the presentation of this paper. The demonstrated microcomputer system simulates a subscriber playing a video game over his local cable television system from his own home.

Two-way capacity is <u>not</u> required on the cable television system. The only equipment needed for this "cable television game" would be located at the headend. At the headend, a microcomputer would be interconnected with a standard telephone line. The computer generates a color video signal as the output. This particular system is capable of color graphics as well as alphanumeric characters. In other words, it can display on a television screen letters, numbers, and color symbols. There is no equipment needed in the subscriber's home, provided that the subscriber has a push-button telephone.

It works very simply. The subscriber tunes his television set to the channel dedicated by the cable television system for "cable television games." On this channel a telephone number appears which the subscriber calls. The computer answers the phone and asks the subscriber, via the television channel, which game the subscriber wants to play. The subscriber responds by pressing a button on the telephone and the game instructions are given. The subscriber plays against the computer until a winner is decided. Then the computer hangs up and waits for another subscriber to call.

This computer system could also be used as a non-duplication switcher at user-selected time intervals. One could set the switcher from any push-button telephone by watching a dedicated

cable television channel, and access to the switcher could be controlled by a private access code. This remote control feature would be particularly helpful when a sporting event runs overtime. If while watching a game it was apparent that the show was going to run over, a cable system employee could call the computer at the headend to change the switcher before the game was blacked out.

This system can be expanded. Add another phone line and two subscribers can play a game against each other over the cable system even though they may never meet each other in person. Another application is that subscribers could request health and safety information. Educational programs could be included. Some type of library service could be offered to the public. When used in conjunction with addressable taps, this system could be used by subscribers to order pay television programs on a per-program basis.

There are many other possible applications of a computer in a cable television system. Some traditional automated services presently used on cable television systems can be done with a computer, e.g., weather information, bulletin boards, and television program guides. On the television program guide the computer could automatically delete old or out-dated information such as television programs which were already over. The same thing could be done on the bulletin board. Also, messages could be displayed on the bulletin board only during certain times of the day, if this were desired. Though it may be impractical, a sophisticated weather system could be programmed to forecast the weather on the basis of past and current weather information.1/

Business applications could also be done on a cable television microcomputer. Subscriber billing, payroll, inventory, and bookkeeping could be managed on a sophisticated microcomputer system. Other cable system records, such as trouble call reports, could be stored in computer files. With this varied information, the computer could analyze the data and produce reports as needed.

Other functions can also be performed. Satellite earth stations and microwave functions could be monitored and controlled. The computer could be used for engineering problems and needs. If a signal processor failed, the computer could sense this and switch in a standby processor. The computer could do headend security and tower lighting monitoring. And a computer will be required for addressable taps and for two-way cable applications.

One might assume that one computer would be needed to do each different type of job: one to play the "cable television games," another to do non-duplication switching, et cetera. This is not the case. The general purpose computer can do a variety of tasks, seemingly simultaneously. It is this ability which makes general purpose computers practical for cable television headends.

## PERSONAL COMPUTERS

Such computers are available today. Cable television systems can use the microcomputers, peripheral devices, and other products developed for the personal computer market. A large selection of these computers is available from many personal computer manufacturers. In addition to these manufacturers, there are over twenty-five other manufacturers of peripheral equipment (accessories).

Personal computers offer other benefits in addition to their availability and low cost. First, the personal computer field makes significant use of video displays on home television receivers. These are the same television sets that cable television systems deliver their signals to. Many different character displays and some sophisticated color graphic displays are being sold to computer hobbyists. The cable television industry could use these products without having to develop their own products.2/ A side benefit of the reliance of computer hobbyists on video displays is that many of the hobbyists' programs are written for such displays and could be adopted for use in a cable television computer system.

Second, personal microcomputer stores are being established across the country. These stores can be a valuable resource for cable television systems. Not only can they provide current information and sell imcrocomputers, but they could service microcomputers used in cable television systems.

Third, the literature on personal computers is readily available and abundant. Several magazines are specifically dedicated to the personal computer field. There are also many books available which deal specifically with microcomputers. And manufacturers will gladly furnish literature on their products. Following this paper is a partial listing of these books and magazines including all those referenced in the preparation of this paper.

Fourth, an *ad hoc* standard has evolved which allows various computer circuit boards to plug into different personal computers adhering to the standard. This standard has prompted many manufacturers to enter the field and has resulted in a wide variety of products at competitive prices. To date this standard has no agreed upon name, so products are advertised as "Altair/IMSAI compatible" or as "using the standard S-100 bus." In other words, the product is compatible with the first hobby computer: the MITS, Inc. "Altair 8800" microcomputer.3/

And lastly, though the personal computer industry is relatively new, one can say it has a bright future. One of the indications of this is that the industry has products that have "second sources."4/ In other words, the same product is available from more than one manufacturer. Furthermore, a recent study indicates that the industry is expected to grow at a rate of 32.7% per year.5/

## COMPUTER BASICS

For a better appreciation of just how simple computers can be, some computer basics will be explained. Just the word "computer" seems to scare many people. Advertisers have used it to awe us, and large corporations use it to bill us. And it is a scapegoat for many mistakes. But computers can be quite simple and a microcomputer circuit need not be complex.

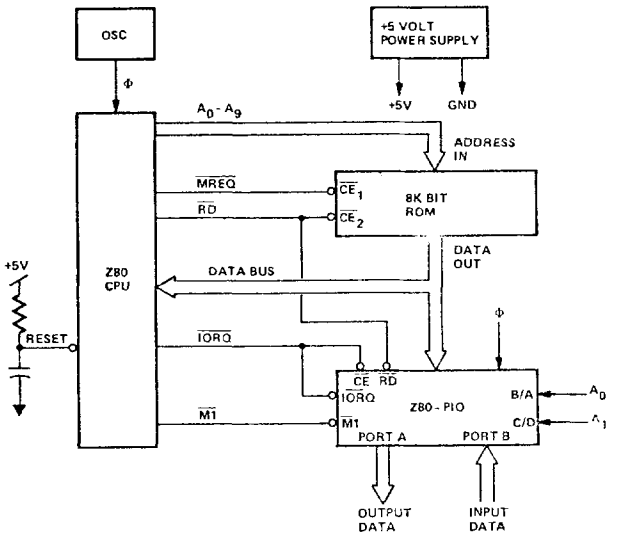
Actually computers are stupid. They can only do a surprisingly small number of things and one must give them precise instructions in a numeric code and logical order. But the power of a microcomputer is that these instructions can be executed in millionths of a second (i.e., microseconds). Therefore, a computer becomes useful when a series of instructions, known as a computer program, is executed. The speed of a computer becomes painfully clear when, after hours have been spent in creating a program, it is completed in a blink of the eye.

But nonetheless the computer is quite simple. It consists of only three elements: input/output (I/O) devices, memory, and the CPU. The I/O devices interface the computer to the "real world." Their function is to input and output information. The memory stores the computer programs and data. The programs are stored in a numeric code, as is the data. Generally the more memory the computer has, the more powerful it is. The CPU is the heart of the computer. Its function is to obtain instructions (and data) from the memory and perform the desired operations. These operations include input/output routines to receive or send data. For example, a set of instructions might require data to be input from keyboard and stored in memory. Then more data is entered from the keyboard, added to the stored data, and the result sent to a printing device. This would stimulate an operation of a calculator.

A microcomputer circuit can be constructed quite simply with a microprocessor and some other large-scale integrated (LSI) circuits. In the following circuit diagram, a minimum microprocessor circuit is depicted which is based on the Zilog Z80 microprocessor and its associated input/output circuit. The other three components of this circuit are a memory device, an oscillator, and a 5-volt power supply.

The input/output circuit for this example is the Z80-PIO LSI circuit. Though in this example only one I/O circuit is used, the microprocessor has the capacity to use 256 input/output ports. An input/output device can require one or more ports for operation. Examples of I/O devices with which a computer can interface are: keyboards, LED and LCD displays, magnetic tape recorders, teletype machines, typewriters, clocks, switchers, paper tape readers and punchers, telephone modems, floppy disks and video displays (television screens).

This computer circuit uses a ROM memory. There are three major types of LSI memory devices: ROM's, PROM's, and RAM's. ROM's are read-only memories




*A MINIMUM MICROCOMPUTER CIRCUIT*

which have their contents determined in the manufacturing process and can not be altered thereafter. PROM's are programmable read-only memories whose contents are determined by the user and erasable only by special devices and not during normal computer operations. RAM's are random-access, read-write memories into which the user can read data and store data by writing over the old data during the normal computer operations. RAM's lose their data when they are disconnected from the power supply, but ROM's and PROM's do not. A PROM or a RAM circuit could easily be inserted into this microcomputer circuit.

A memory device works simply. The device consists of many cells. A signal is sent to the device indicating which cell(s) is of interest. Another signal is sent to indicate whether the cell(s) will be read or written into. If "read" is indicated, the data stored in the cell is sent out of the device. If "write" is indicated, the data is sent to the device and is stored in the cell(s). The microprocessor has the capability of addressing over a half-million individual cells or 65,536 bytes (one byte = 8 cells or bits).

The two other parts are the oscillator and the 5-volt power supply. For low speed operation an RC oscillator can be used while at high speeds a crystal is needed. The only requirement for the power supply is that it be well regulated.

The microprocessor is the most important component of the microcomputer; it is what makes a computer a microcomputer. The processor reads instructions from memory, performs instructions, reads and writes data from and into memory, and inputs and outputs data to the "real world" via the input/output circuits.

The Z80 microprocessor was chosen for this example for several reasons. First, the Z80 has an instruction set which is compatible with the Intel 8080A instruction set.6/ This allows computer

programs written for the 8080A to work on the Z80. This is important because the 8080A appears to be the electronics industry standard.7/

Second, the Z80 requires less complicated circuitry than the 8080A processor. While the Z80 requires only a single 5-volt power supply, the 8080A requires a 5-volt, a +12-volt, and a -12-volt power supply. The Z80 also needs a less complicated oscillator than the 8080A and is capable of higher and slower speed operations.

Third, the Z80 may become the new industry standard. It has been heralded as the "third generation" microprocessor and it has all of the features of the 8080A plus more.8/ But only time will tell.

But this minimum microcomputer circuit does not make full use of the capabilities of the microprocessor. The memory and the input/out capacity are restricted. A more sophisticated circuit is needed to take full advantage of a microprocessor and to have some flexibility. Though one could design such a circuit, as many hobbyists have, there is no need to do so. Many microcomputer systems, which make full use of the microprocessor's capabilities, are available either as kits or fully assembled. As indicated previously, a powerful microcomputer for a cable television system would cost $2,500 or less.

## SOFTWARE

But the hardware is only half of what is needed. In order to use the computer, computer programs are required. This is a problem since programs are not yet available for cable television applications. Even if programs were available, they would most likely require some modification. This is because programs are written to be stored in a particular memory location and to work with certain I/O devices with these devices in a certain arrangement. A cable system's computer might have another program in a given memory location, the necessary I/O devices might not be available, or these devices might be arranged differently. A computer firm could write the programs or one could learn to write the programs.

Learning how to program is neither impossible nor difficult. A good way to get a taste for programming is to buy a programmable calculator and play with it. These calculators now sell for as little as $80. Most of the programmable calculators are sold with a helpful instruction book.9/

Or one could by a microcomputer just to learn programming. Such a computer can be bought for less than $500. Or one could take a microcomputer course. An advantage of these two methods is that one learns the actual numeric code of the computer instructions (machine language).

Another alternative is to buy a personal computer system with the capability of using a higher level computer language such as BASIC. BASIC is fun and easy to learn. It uses English and not numeric codes and many programs are available in this language. There are many books available which teach computer programming with BASIC. This method is more expensive than either of the previous two methods but one has a very powerful computer system at the end. The disadvantage of this method is that it does not teach one the machine language which will have to be learned sooner or later.

There are countless other ways. Anyway it is not too difficult but it is costly. Not only is money spent on hardware, but it is time-consuming. But it must be fun since over 20,000 people have spent about $2,000 each to have their own computer to program.10/

## CONCLUSION

Computers are now affordable and can be very useful in cable television headends. The computer hardware is available at a low cost and is not a problem. The difficulty is the software. It takes time and money to write programs and this expense may be more costly than the hardware.

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FOOTNOTES:

1/ "Do It Yourself Weather Predictions" by Michael R. Firth, Byte, December 1976.

2/ Specifications on the video signal of personal computer devices are not often given, so it is not known what, if any, modification would be required for use on a cable television system.

3/ There are several manufacturers of personal computers who do not follow this standard. One such manufacturer has recently written an article critical of the standard: "The Jupiter II" by Dennis Brown, Kilobaud, March 1977.

4/ "n Source" by R. D. Boudinot, Byte, May 1976.

5/ "Electronics Newsletter" Electronics, January 20, 1977.

6/ There is an exception. See "Will the Z80 Crush All Competitors?" by Carl Galletti, Kilobaud, February 1977.

7/ "The 8080 looks like a bandwagon" Electronics, June 24, 1976.

8/ "Will the Z80 Crush All Competitors?" *op. cit.*
"Is the Z80 the Wave of the Present?" by Pat Godding, Kilobaud, January 1977.
"The Circuit for Z80's" by Dr. Robert Suding, Byte, September 1977.
"Microprocessor Update: Zilog Z80" by Burt Hashizum, Byte, August 1977.

9/ A good primer is "Programming? It's Simple" by Peter A Stark, Kilobaud, January 1977.

10/ "Publisher's Remarks" by Wayne Green, Kilobaud, March 1977. Articles such as "Home Input" by David Gumpert, Wall Street Journal, February 4, 1977, have indicated that "up to 100,000"

people have home computers. This may be much too high of an estimate.

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TTL Cookbook and TV Typewriter Cookbook, by Don Lancaster, published by Howard W. Sams and Company, Inc., Indianapolis, Indiana 46268.

Scelbi's '8080' Software Gourmet Guide and Cookbook, by Robert Findley, published by Scelbi Computer Consulting, Inc., 1322 Rear-Boston Post Road, Milford, Connecticut 06460.

Z80-CPU Technical Manual, published by Zilog, 170 State Street, Los Altos, California 94022.