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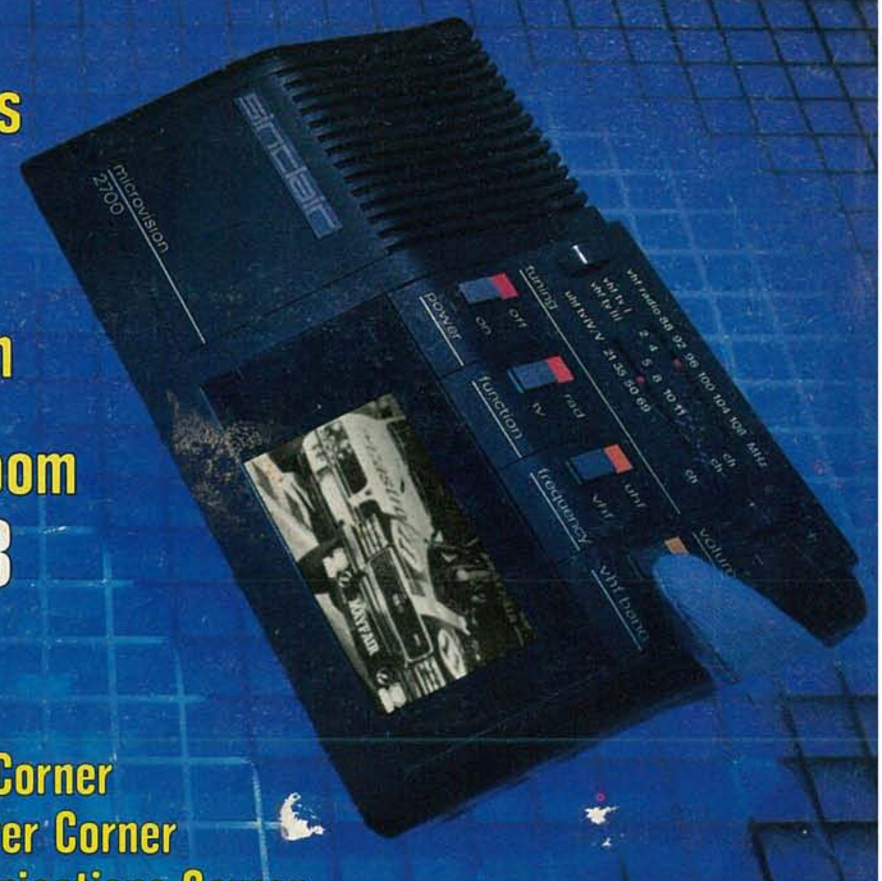

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Radio-Electronics

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OCTOBER 1981 Vol. 52 No. 10

ON THE COVER

Flat-screen displays to make truly-portable, or "skinny" large-screen, TV's have been long awaited. Now, not one, but *two*, totally different means for achieving that goal have been demonstrated in working prototypes. The story of how those displays function starts on page 39.

SPECIAL COMPUTER SECTION explains what to look for in setting up a system for home or business use. The section begins on page 51.

MANY FINE RECORDINGS have been made without using noise-reduction techniques. A dynamic noise-reduction system can improve their sound. Find out how the process works starting on page 90.

Due to lack of space in this issue, Part 3 of the Programma-2 RF generator project will appear next month. We apologize for any inconvenience that may cause.

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Radio-Electronics®
OCTOBER 1981

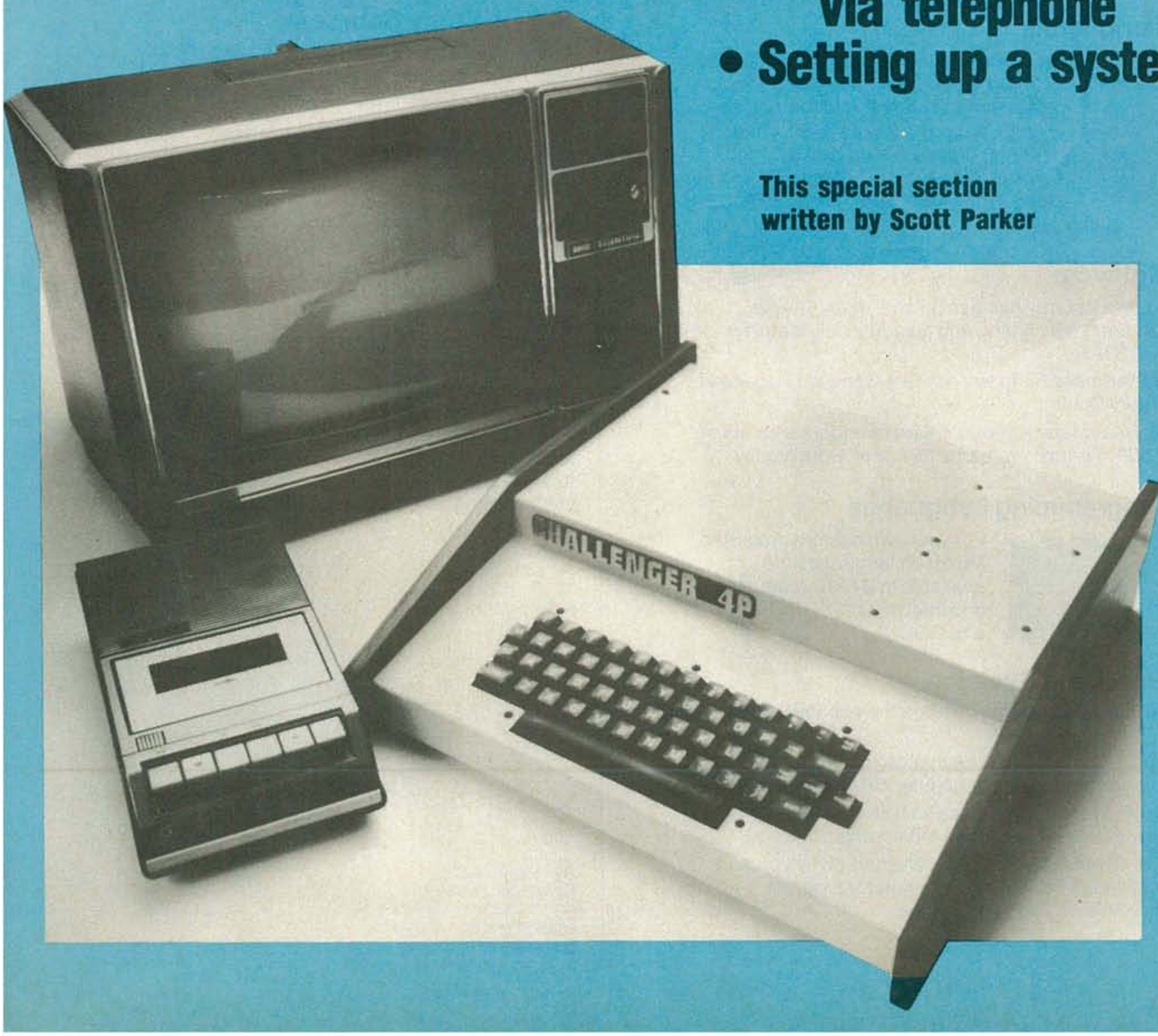
YOUR OWN Computer®

BUYER'S GUIDE TO HOME COMPUTERS

What You Should Know Before You Buy

- What to look for
- Floppy disks and versatility
- All about printers
- Modems — computing via telephone
- Setting up a system

This special section written by Scott Parker



WHAT TO LOOK FOR IN A PERSONAL COMPUTER

There are a number of points that have to be considered when selecting a computer. This guide supplies information that can help you to make a few of the more important decisions.

WHEN PERSONAL COMPUTERS WERE FIRST INTRODUCED, SIX years ago, they were a novelty to be enjoyed only by a few dedicated hobbyists. But today, the personal computer has advanced far beyond that initial, limited use and is now found in a wide variety of applications ranging from financial tools for businessmen to sophisticated, interactive video games for the consumer.

For those of you who have not yet been bitten by the computer bug, there are probably a lot of unanswered questions that are bothering you. For example, you might want to know just what a personal computer system is and what it's composed of. How is it possible for something to be both an aid for the businessman and a toy for a youngster? While some of those things may bewilder you at first, once you understand some of the basics of personal computers, it will be easy for you to answer such questions.

Getting down to basics

To begin with, let's take a look at just what a computer system is composed of. In its simplest form, a computer system can be broken down into four basic elements as shown in Fig. 1. The first is the central processing unit (often abbreviated CPU) which handles all of the computations and controls everything connected to the system. That is the "brain" of the system.

In order to send information to the central processing unit, it is necessary to connect some sort of input device to the system. When large mainframe computers were in their heyday, one of the most common input devices was a punch-card reader. With personal computers, typewriter-like keyboards and CRT terminals are the most common input devices.

Getting information *into* the computer is only half the job. It must also be possible to get information *out* of the computer. Two common ways of outputting information are by using a printer or a video display.

The last block in our generalized drawing of a computer system is memory. Memory is a very important component in any computer system. It allows the computer to perform calculations and store temporary results for later use. It also makes it possible to use the computer like an electronic filing cabinet. The amount of memory that is available has a great effect on the complexity of the programs you can run on the computer. The more memory you have, the more complex the programs that can be handled.

Getting a closer look

Now that we have an overall idea of what a personal computer is, let's take a closer look at the individual components. All personal computers available today use a microprocessor as the central processing unit. Also known as a computer-on-a-chip, a microprocessor is an integrated circuit that contains all the circuitry necessary for it to act as the "brain." It usually contains several temporary storage registers and something known as an arithmetic logic unit (sometimes abbreviated ALU). The ALU is a logic circuit that manipulates and transforms the data.

There is a wide variety of microprocessors available today, but the most commonly used ones are the 6502 and the Z80. Which one is better? Does it really matter? Should you select the computer you are going to buy based on the microprocessor used? Answering the last question first: Unless you have a very specific reason for using a particular microprocessor, such as wanting to use CP/M-based software, your choice of computer should not depend on the type of microprocessor used. That statement is probably going to upset some people, but they are mostly dedicated hobbyists who are interested in getting into the nuts and bolts of things. For the majority of people, who are interested in eating an omelette and not in how an egg is laid, the question of which microprocessor is used is irrelevant.

To be sure, there are some significant differences between the Z80 and the 6502; but unless you're going to write

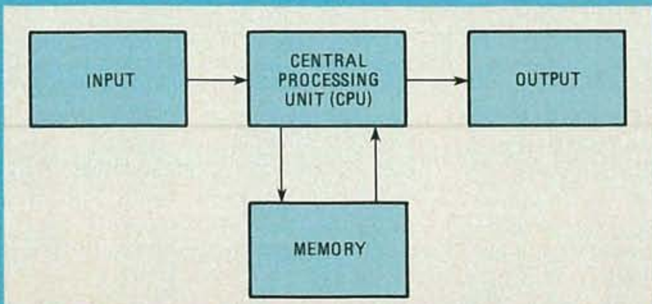


FIG. 1—The CPU is the heart of the system and manipulates and routes all the data handled by the computer.

THE IMAGINATION MACHINE, from APF, with peripherals.

machine-language programs, you'll never notice them. When the *PET* and *TRS-80 Model I* computers were first announced, a lot of people wanted to buy the *TRS-80* because it had a Z80 microprocessor with a speed specification that was twice as fast as that of the 6502 (in the *PET*). It also had a more powerful machine-language instruction set. That seemed to mean that anything containing a Z80 should be faster and more efficient than its 6502 counterpart—but such was not always the case.

One example is Sargon II, a popular chess program for personal computers. If one compares the *TRS-80* Z80 version to the *Apple II* 6502 version, one finds that the *Apple II* implementation is significantly faster than the *TRS-80* version, even though the *TRS-80* is operating at a clock speed that is almost twice that of the *Apple II*. That does not mean that *all* 6502 software is faster than all Z80 software; it only means that unless you take advantage of all the subtleties associated with the various microprocessors, you're not going to reap all of the potential advantages.

For CP/M use a Z80

The one exception to my previous statement about the unimportance of the microprocesor used arises if you are considering using the CP/M (*C*ontrol *P*rogram for *M*icrocomputers) operating system. That is a popular operating system that is compatible with a lot of business software. It is compatible with the 8080 and Z80 microprocessors, as well as some of the newer microprocessors introduced by Intel. While it is possible to use CP/M on an *Apple II* computer (which is a 6502-based machine), to do so requires the installation of an accessory card that contains a Z80 microprocessor.

While the microprocessor is rightly considered the "brain" of the system, it would not be possible for it to do very much without some memory. There are several different types of memory used in computer systems. Some contain information and instructions for the microprocessor that always remain the same and must be available to the CPU whenever it is powered up. That type of memory is known as ROM (*R*ead-*O*nly *M*emory) and is generally provided by the manufacturer of the computer because it is usually not modified by the user. (To do so would require changing some of the integrated circuits within the computer.)

The main advantage of ROM's is that they never lose the information that is stored in them, even if the power to the computer is removed. For that reason, computer manufacturers generally build into the computer a set of ROM's that contain a special program called the monitor.

For those of you who are not familiar with it, a monitor program is a short machine-language program that is capable of handling some of the elementary functions required by the system. Those include interfacing to the keyboard, so that data can be entered, and generally an interface to a video circuit so that information can be displayed.

Not all of the memory for a computer system is of the ROM type. And in fact, much of the memory in a computer *must* have the ability to be easily and quickly changed. That type of memory, known as RAM (*R*andom *A*ccess *M*emory) can be changed at will and is the type of memory that is normally used to store a person's own programs. It is also used as temporary storage for variables used by the program being run. Unlike ROM's, RAM's have the disadvantage that as soon as power to the computer is removed, they lose all of the information that was stored.

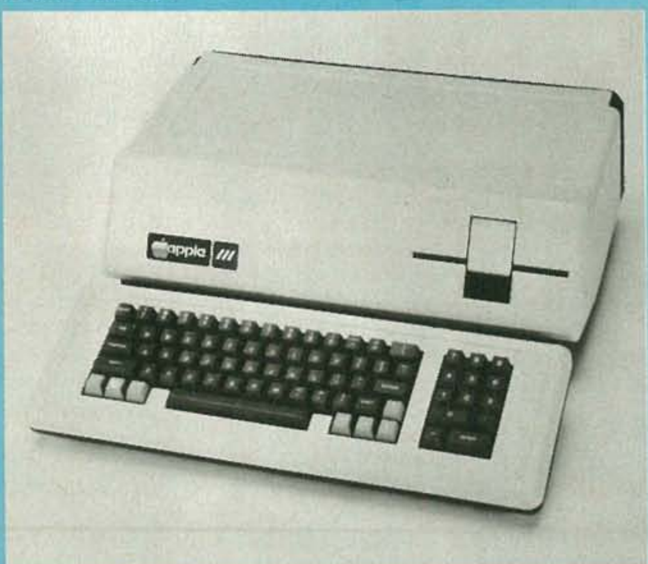
How much memory is enough?

A question frequently asked by new and prospective computer users is, "How much memory do I need?" The answer is: It depends on the user. Just as a gas always expands to fill the volume of the container that it is housed in, programmers will tend to use as much memory as is available. A corollary to that rule is that no matter how much memory you have, somehow it is never enough.

Computers come with a wide range of memory sizes. They range from 4K for the *TRS-80 Color* computer to 128K for the new *Apple III* computer. For games and home applications, 4K to 16K of memory is generally sufficient, but for business applications 32K and 48K is required. And if you want to use CP/M, 56K of memory is generally needed.

The ins and outs of computers

It is frequently necessary or desirable to connect additional equipment to a personal computer to perform a certain task. One common piece of equipment is a printer for producing printed reports and program listings. Further peripheral devices that can be connected to a computer include: plotters, modems, graphics tablets, music synthesizers, speech sythesizers, speech processors, EPROM programmers, and a host of other devices.



THE APPLE III, with built-in disk drive.

With the possibility of connecting all of those devices to a personal computer, some thought must be given to how they are connected. In general, there are two ways in which peripheral devices can be connected to a computer: via a serial interface (or port), or via a parallel one. Each has its advantages and disadvantages.

If the distance between the computer and the accessory is going to be a large one, it is best to use a serial interface. The reason for that is that only a relatively few number of wires is needed. That reduces the cabling cost, but more importantly reduces the susceptibility to stray noise pick-up. A limitation of this approach is speed of data transmission, since data are sent serially, one bit at a time, until all of it has been sent.

Since a lot of devices communicate with computers in a serial fashion, the industry has developed a standard serial interface that simplifies the interconnection of peripherals. That standard is known as RS-232C and it defines the type of connector to be used and which pins on the connector contain which function.

Do it faster in parallel

For short distances, and where it is very important to transfer data quickly (such as to a floppy disk), a parallel interface is used. With such an interface, 8 or more bits of information are sent to the peripheral device simultaneously.

Unlike serial interfaces, where there is one dominant method of interconnection, several exist for parallel interfaces. Two of the most common are the Centronics-compatible printer-interface standard and the IEEE 488 interface standard. While the former is used almost exclusively to connect to printers, the latter is frequently used to connect to scientific instruments and other computers as well as printers.

Each interface connection is called a port. There are two types of ports, input and output. A single port can either input data or output data, but not both. If you want to connect a device that only receives data, such as a printer, then the device must be connected to an output port on the computer. A device that both receives and sends data requires two ports; an input port and output port. Both input and output ports can be of the serial or parallel type. In addition to ports, a computer generally has its own internal connectors, called a bus structure, whereby additional circuit boards can be added to the computer. Using those connectors, you can add circuit boards that contain additional RAM memory, input and output ports, and various other circuits. In the *Apple II* computer, for example, there are 8 internal connectors into which external devices can plug. The *TRS-80 Model I* also has a provision for connecting external devices to it, but those require an extra piece of hardware known as the expansion interface.

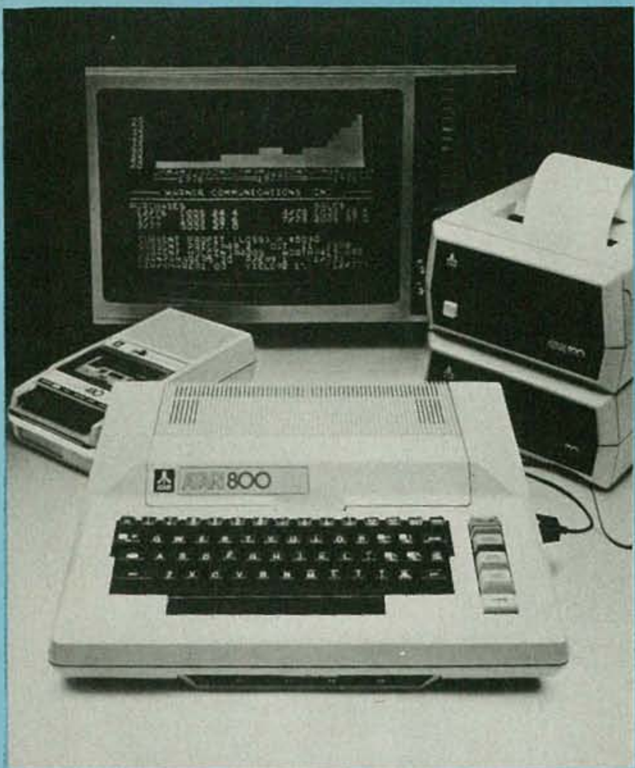
How many ports you will need depends on how many accessories you want to connect to the computer. In general, the manufacturer's standard configuration for the computer provides sufficient room for most accessories that will be available for it.

Keyboards vary with the computer

The keyboards that are available on today's personal computers vary quite a bit, and it is wise to pay attention to that when you think about buying a computer. Most people are familiar with typewriters and their keyboards, so it is not surprising that most manufacturers of personal computers and computer terminals have opted for a keyboard that is similar to that on a typewriter.

Some manufacturers however, felt that they could provide more functions in a smaller space (or save money), by using the widely available and inexpensive calculator-type switches for a keyboard. The public has resisted that. People know how to use a typewriter and many are even quite proficient with it. But the calculator-type keyboards have non-standard spacing and do not permit touch typists to work efficiently. Commodore discovered this the hard way with their 8K *PET 2001* computer and after a few years gave up and came out with a unit that had a standard typewriter keyboard on it.

Texas Instruments, which was a latecomer to the personal computing field, unfortunately did not learn from Commodore's mistake and had to find out for itself that the public



THE ATARI 800. Top opens to accept plug-in modules.

wants a typewriter-quality keyboard on its computers. The result was that its *99/4* computer was not as successful as it could have been. But like Commodore, they did learn and have recently introduced a new version of the computer known as the *99/4A* which has a full-size typewriter keyboard in it. Already TI has indicated that there has been a substantial increase of interest in its computer because of that.

Typewriter compatibility is not the only important factor to be considered with keyboards; configuration is, too. Some keyboards go a step beyond and include, in addition to the standard typewriter keyboard, a numeric keypad on the right-hand side of the keyboard to speed the entry of numeric data. Radio Shack offered that initially as an option on their early *Model I* computers, and found it so popular that they made it a standard feature. And, because the *Apple II* computer does not have this feature, an independent manufacturer has developed an add-on set of numeric keypads.

While most typewriters can be used to produce both upper and lower-case letters, some of the early computers could only produce upper-case letters. For most applications, that was OK. But when people started to use those computers as word processors, a serious problem arose because the computers didn't support lower-case letters. Ingenious programmers overcame the limitation by writing special software to accommodate the lower-case characters, and even more ingenious hardware designers figured out ways to display those lower case letters on the screen.

THE H89 ALL-IN-ONE-computer from Heathkit.

How wide is the display screen?

One thing that should be considered when purchasing a personal computer is the number of characters it can display on the video screen. Depending on the computer, you will be limited to 40, 64, or 80 characters per line. Apple, Atari and *PET* computers are limited to 40 characters. The primary reason is that they use standard television technology for the display, and that is inherently limited to 40 characters per line. The *TRS-80 Model I* and *Model III* computers use a specially designed monitor so that they can display 64 characters per line, while the *TRS-80 Model II* and the *Apple III* use standard video monitors and can display 80 characters per line.

The desirable line length is 80 characters, because that is roughly what you get on a piece of paper in a standard typewriter. Shorter line lengths limit the amount of information that can be displayed on the screen at one time and make the presentation of columnar data difficult.

In addition to the line length, the user interface to the information displayed on the screen is important. Most personal computer systems have what is known as memory-mapped video displays, which simply means that the memory dedicated to displaying information on the screen looks like any other memory in the computer and is treated as such. That means that it is possible to write to the screen by storing data in specific memory locations directly, rather than through the standard video-output circuitry.

Most personal computers have a blinking prompt, either an underline or a little square, that is called a cursor. Frequently the ability to move that cursor anywhere on the screen in combination with internal software makes it possible to edit things that appear in the screen. That is a feature of the Atari, Apple and *PET* computers. Radio Shack has opted for the line editor approach where only numbered lines can be edited. While this has some definite advantages, it also has some shortcomings and programmers have come up with screen-editor programs for the *TRS-80* to make it more flexible. **R-E**

TABLE 1—DIRECTORY OF MANUFACTURERS

For more information from the manufacturers listed below, circle No. 96 on the Free Information Card inside the back cover.

ACTION COMPUTER ENTERPRISES, INC.
55 West Del Mar Blvd.
Pasadena, CA 91105

ALPHA MICRO SYSTEMS
17881 Sky Park North
Irvine, CA 92714

ALTOS COMPUTER SYSTEMS
2360 Bering Dr.
San Jose, CA 95131

APF ELECTRONICS, INC.
1501 Broadway
New York, NY 10036

APPLE COMPUTER, INC.
10260 Bandley Dr.
Cupertino, CA 95014

ATARI, INC.
1196 Borregas Ave.
Sunnyvale, CA 94086

CALIFORNIA COMPUTER SYSTEMS
250 Caribbean Dr.
Sunnyvale, CA 94066

continued on next page

COMMODORE INTERNATIONAL, LTD.
950 Rittenhouse Rd.
Norristown, PA 19401

COMPUPRO
Box 2355
Oakland Airport, CA 94614

CROMEMCO, INC.
280 Bernardo Ave.
Mountainview, CA 94043

DELTA PRODUCTS
15392 Assembly La.
Huntington Beach, CA 92649

DYNABYTE BUSINESS COMPUTERS
115 Independence Dr.
Menlo Park, CA 94025

E&L INSTRUMENTS, INC.
61 First St.
Derby, CT 06418

GIMIX, INC.
1337 West 37th Place
Chicago, IL 60609

HEATH CO.
Benton Harbor, MI 49022

HEWLETT-PACKARD
1000 N.E. Circle Dr.
Corvallis, OR 97330

IMS INTERNATIONAL
2800 Lockheed Way
Carson City, NV 89701

INTELLIGENT SYSTEMS CORP.
225 Technology Park
Norcross, GA 30092

INTERTEC DATA SYSTEMS
2300 Broad River Rd.
Columbia, SC 29210

ITHACA INTERSYSTEMS, INC.
1650 Hanshaw Rd.
Ithaca, NY 14850

MARINCHIP SYSTEMS
16 St. Jude Rd.
Mill Valley, CA 94941

MICROACE
1348 East Edinger Ave.
Santa Clara, CA 92705

MICROBYTE, INC.
2499 Cerritos Ave.
Signal Hill, CA 90806

MICRODASYS
Box 36051
Los Angeles, CA 90036

MICRO EXPANDER, INC.
6835 West Higgins Ave.
Chicago, IL 60656

MICROMATION
1620 Montgomery St.
San Francisco, CA 94111

MIDWEST SCIENTIFIC INSTRUMENTS, INC.
220 West Cedar
Olathe, KS 66061

NEC AMERICA, INC.
1401 Estes Ave.
Elk Grove Village, IL 60007

NETRONICS RESEARCH AND DEVELOPMENT
333 Litchfield Rd.
New Milford, CT 06776

NORTH STAR COMPUTERS, INC.
1440 Fourth St.
Berkeley, CA 94710

NOVELL DATA SYSTEMS, INC.
1170 North Industrial Park Dr.
Orem, UT 84057

OHIO SCIENTIFIC
1333 South Chillicothe Rd.
Aurora, OH 44202

OSBORNE COMPUTER CORP.
26500 Corporate Ave.
Hayward, CA 94545

PRODIGY SYSTEMS, INC.
497 Lincoln Highway
Iselin, NJ 08830

QUASAR DATA PRODUCTS
10330 Brecksville Rd.
Brecksville, OH 44141

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

RCA MICROCOMPUTER MARKETING
New Holland Ave.
Lancaster, PA 17604

ROCKWELL INTERNATIONAL
Microelectronics Division
Box 3669
Anaheim, CA 92803

SD SYSTEMS
10111 Miller Rd., Suite 105
Dallas, TX 75228

SINCLAIR RESEARCH
50 Staniford St.
Boston, MA 02114

SMOKE SIGNAL BROADCASTING
31336 Via Colinas
West Lake Village, CA 91361

SOUTHWEST TECHNICAL PRODUCTS CORP.
219 West Rhapsody
San Antonio, TX 78216

SYNERTEK SYSTEMS CORP.
150 South Wolfe Rd.
Sunnyvale, CA 94086

SYSTEMS GROUP
1601 Orangewood Ave.
Orange, CA 92668

TEI, INC.
5075 South Loop East
Houston, TX 77033

TEXAS INSTRUMENTS
Box 225012, MS 84
Dallas, TX 75265

VECTOR GRAPHIC, INC.
31364 Via Colinas
Westlake Village, CA 91362

VISTA COMPUTER CO.
1317 East Edinger Ave.
Santa Ana, CA 92705

WESTERN DIGITAL
3128 Red Hill Ave.
Newport Beach, CA

WINTEK CORP.
1801 South St.
Lafayette, IN 47904

ZENITH DATA SYSTEMS
950 Milwaukee Ave.
Glenview, IL 60025

FLOPPY DISKS ADD VERSATILITY

Floppy-disk systems are not inexpensive, but the advantages they offer frequently makes them worth their cost.

THE MORE YOU USE YOUR COMPUTER, THE MORE YOU WILL learn about it. You will soon want to put the computer to practical use. Unfortunately, complicated tasks require a sizeable amount of computer memory and you will soon need more memory than is available with your computer's internal RAM. Also, you will want a fast method for saving and loading your computer programs. You can enter programs using the computer's keyboard, but for long and complicated programs this method is tedious and time consuming.

The solution to those problems is to add a mass-storage device to your computer. A mass-storage device, such as a floppy-disk system or an audio cassette-recorder, will increase your computer's memory capacity. In addition, a mass-storage device provides a nonvolatile method of storing programs and data.

Chief among the advantages of a floppy-disk system over cassette tapes are higher speed and faster access time. Yes, a cassette recorder is cheap, fairly reliable, and easily adaptable to a personal computer. But it is slow, with a typical data-transfer rate between 30 to 150 characters-per-second (CPS). This means it may take as long as five minutes to load 10K of RAM. A floppy disk is faster and has other distinct advantages.

Access is faster since the read/write head in a floppy-disk system can reach a desired block of information without the need to pass through preceding data; that is termed random-access. On the other hand, data stored on a cassette tape is recorded serially, so all data preceding a desired block of information must first pass by the read/write head.

Let's illustrate what long access times can mean. A typical audio cassette used for small personal computers operates at a speed of 1.875 inches-per-second, and a 60-minute or 500-foot tape can store 500K bytes. To read one side of a cassette would take 30 minutes. Suppose you were to enter a list of names and addresses into your computer and then store it on cassette tape. If you then wanted to retrieve a particular name and address that was in the middle of the list, it would take 15 minutes to locate the address. A floppy-disk system with its random-access capability would retrieve that particular address in less than one second.

Once the particular block of information was located, the cassette recorder would transfer the data to the computer at a much slower rate than a floppy-disk system would. Stating it another way, a cassette system may have a data-transfer rate of 500 bits-per-second, compared to 15,600 bits-per-second for a 5¼-inch floppy disk, and 31,000 bits-per-second for an 8-inch floppy disk. (Eight bits are required for each character transferred. Also, bits-per-second is commonly referred to as baud rate.) In addition, most cassette recorders require manual operation, whereas a disk drive runs automatically after the disk is inserted.

Each 8-inch floppy disk can store up to 500K bytes (single-sided, double-density) or one megabyte (double-sided, double-density) of data. The smaller 5¼-inch diskette can store about 180K bytes (single-sided, double-density) or 360K bytes (double-sided, double density).

What is a floppy disk?

The flexible or floppy disk was introduced in the late 1960's by IBM to replace keypunch cards. It is soft and easily bent: hence the name "floppy disk". The disk is currently available in two sizes, 8-inch (203 mm) and 5¼-inch (135 mm). The smaller 5¼-inch floppy disk is commonly referred to as a minifloppy diskette. The size is a measure of the sides of a nonremovable square cardboard jacket that houses and protects the .003-inch thick, flexible Mylar disk. The disk is coated on both sides with a layer of magnetic oxides and revolves inside the protective jacket. The 8-inch disk rotates at 360 rpm while the minifloppy runs at the slightly slower speed of 300 rpm.

During reading or recording, a read/write head makes light contact with the disk surface. When data is not being written to or read from the disk, the read/write head is lifted from the disk surface to reduce wear.

As shown in Fig. 1, the jacket does not totally cover the Mylar disk. There is a slot to allow the read/write head to contact the oxide, a center hole to permit the drive-motor spindle to rotate the disk; an index hole to provide specific timing information, and a notch (optional on the 8-inch disk, always present on the 5¼-inch disk) for "write-protection" to avoid accidental erasure of data recorded on the disk.

The "write-protect" notch is similar to the plastic tab on cassette tapes; when the tab is snapped off, the tape cannot be re-recorded. On a 5¼-inch floppy disk, the "write-protect" notch is covered to write-protect the disk and thus prevent wiping out programs and data stored on it. The procedure is reversed with the 8-inch disk. If the optional write-protect notch is present, it is covered to write-enable the disk.

Tracks and sectors

In some ways, a floppy disk is similar to a phonograph record. A record stores music within grooves on a plastic surface; a floppy disk stores data as a sequence of magnetic pulses on a smooth magnetic surface. To read, or sense, the music on a phonograph record, a needle rides in the spiral groove and its mechanical vibrations are converted into electrical signals. In a disk system, there are no grooves; instead there are invisible tracks along which magnetic pulses are recorded. To read the data, a magnetically-sensitive read/write head is placed over the track while the disk is rotated. When data is to be stored on a floppy disk, the read/write head either changes the magnetic state of the oxide area it is contacting or else makes no changes; that produces the equivalent of a logic "1" or "0".

Continuing the analogy to a phonograph record, music is recorded in one continuous groove or track on the record surface, starting from the outermost edge of the record to the center hole. That arrangement is fine, since the music will be played from start to finish—generally without the need for interruption. In a floppy-disk system, a great deal of data will be stored and fast access to any particular section of the data is essential. Now think how difficult it would be to locate a particular passage exactly on a phonograph record. It's not easy, but fortunately it's not often necessary.

To allow more rapid access of data on a floppy disk, a series of concentric tracks is arranged, with each track located at a specific distance from the center (or the edge) of the disk, as shown in Fig. 2. Now each track can be identified easily or addressed by its specific location. Although there is a standard number of tracks (77) in the IBM 8-inch disk format, some manufacturers use different numbers of tracks. Some floppy disks are single-sided, with data stored on one side of the disk, while others are available with tracks and data stored both sides (double-sided floppies).

Although it is easier to locate a specific section of data using concentric tracks instead of a single continuous track, let's consider some of the drawbacks. If an 8-inch disk is divided into 77 tracks and various blocks of data (files) are assigned to individual tracks, there may be some degree of inefficiency. It is possible that one file may contain a relatively small amount of data; thus the track assigned to this file would barely be used. Another file may be much larger and use almost an entire track. A third file may require a bit more than one track and thus be assigned two entire tracks, again with little data on the second track.

To improve efficiency, tracks are divided into sectors, as shown in Fig. 3. Now data can be placed, and located quickly, by assigning a specific track and sector as its address. In the IBM format, for example, each 8-inch disk is divided into 77 tracks with 26 sectors per track for a total of 2002 sectors. Each sector holds 128 bytes or 1024 bits of information. Thus, a short file might fill a dozen sectors while a larger file could use an entire track of 26 sectors.

To locate the sectors on the surface of the floppy disk,

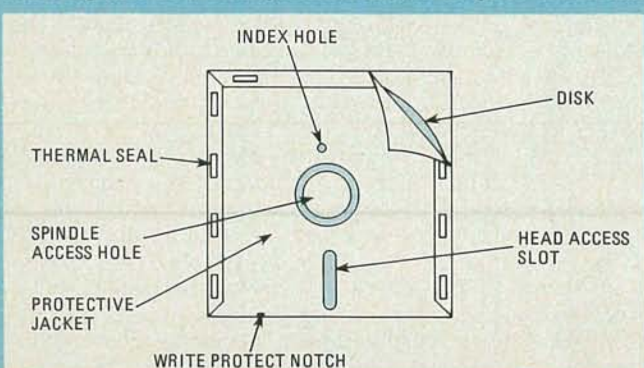


FIG. 1—THIN MYLAR DISK with its oxide coating is protected by a nonremovable jacket.

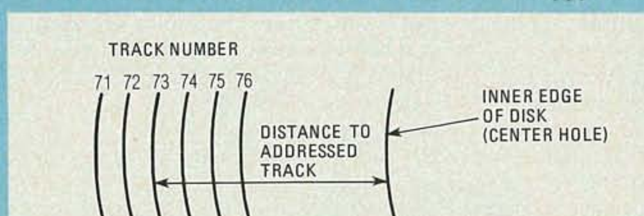


FIG. 2—THE SURFACE of the floppy disk is divided magnetically into concentric tracks for data storage.

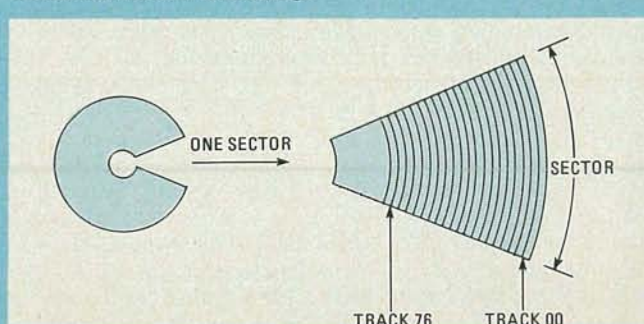


FIG. 3—EACH TRACK is divided into sectors so that the data can be stored more efficiently.

either soft-sectoring or hard-sectoring is used. A soft-sectored disk has a single index hole; sector locations are identified by information recorded on the disk. That information must be stored within the sector and thus reduces the disk's actual storage capacity. A hard-sectored disk (Fig. 4) uses a number of punched holes to act as index markers; this scheme is about 25% more efficient in data storage. Hard-sectored disks contain 10 to 16 holes (32 holes in the case of some 8-inch disks) in addition to the index hole that is centered between two of the sector holes. Circuits in the disk controller sense the shorter spacing between the index hole and the holes on either side of it and thus the system is aware of the starting point.

Still another analogy to the phonograph record: Just as an audiophile builds up a distinctive collection of choice records lovingly, so too can a computer buff collect pre-programmed disks or disks that he has written and perfected. Disks, just like records, can be exchanged to permit other users to borrow special programs without the need to develop them. However, to exchange software via floppy disks, the formats of the disks must be compatible. In other words, you can not purchase software recorded on a 5¼-inch hard-sectored disk and enter it into your computer if your floppy-disk system requires soft-sectored disks.

One final analogy. Audiophiles take precautions when they handle their prized records; they hold the records by the edges to prevent fingerprints, dirt, or body oils from penetrating the record grooves and thus mar the fidelity of the sound. Floppy disks are considerably more vulnerable to careless handling; a dust particle or a strand of human hair deposited on the surface of a floppy disk could damage a number of sectors or impair good contact between the read/write head and the oxide coating. For that reason, users are advised to store the disk in its original envelope after use.

Floppy-disk formats

To promote the exchange of software among users, the computer industry has adopted the IBM 3470 format as a standard. Unfortunately, that standard can only be applied to 8-inch disks. If you are contemplating the purchase of a floppy-disk system, you should be aware that there is no industry-standard format for 5¼-inch disks. Also, if you are contemplating the purchase of an 8-inch disk system, you should make sure that the system is compatible with the IBM 3470 format.

The IBM 3470 format is shown in Fig. 5. The disk is divided

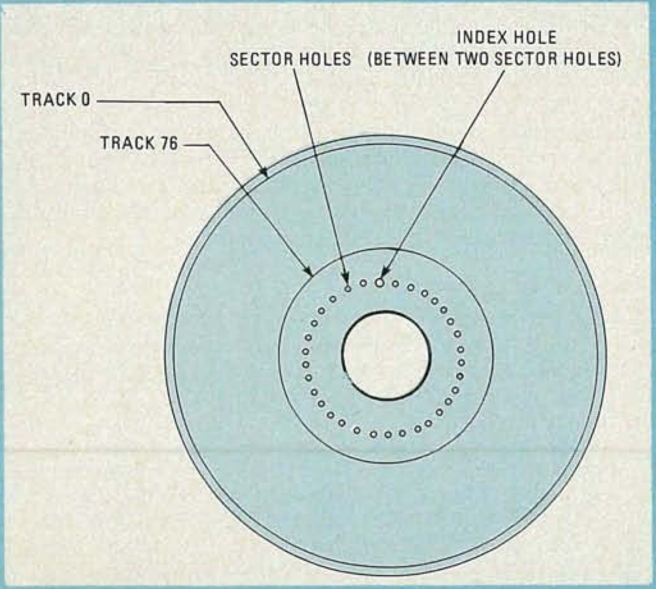


FIG. 4—SECTOR LOCATION is accomplished using an index hole. Hard-sectored disks use a series of holes, one for each sector plus the index hole.

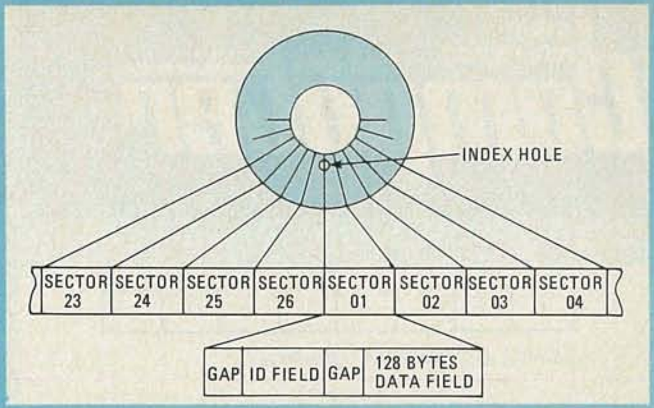


FIG. 5—WITH THE IBM 3470 FORMAT, each disk is divided into 77 tracks. Each track is subdivided into 26 sectors, and each sector is subdivided into four sections.

into 77 tracks or concentric circles, with the count (00) starting at the outer edge; the innermost track is No. 76. Each track is subdivided into 26 sectors. Thus, there are 2002 sectors on a standard single-density 8-inch disk. The sectors are identified by soft-sectoring. Each sector is further subdivided into four sections: one to identify the sector and track number, one to accommodate 128 bytes (or 1024 bits) of data, and two gaps to separate the ID and data sections. The ID and data sections are further broken down so that in addition to containing the ID and data information, they contain pulses that are used to synchronize the controller circuitry to allow for variations in the rotational speed of the floppy disk. The ID and data sections also contain error-checking bits so that the controller circuitry can recognize an error when it occurs.

When a blank floppy disk is first purchased, its surface is non-magnetized and thus it must first be formatted to organize tracks and sectors. The microcomputer performs this function upon command, using the pulse representing the index hole as the reference point. After the disk has been formatted, it is ready to have information written on it or read from it. An unformatted 8-inch disk has a capacity of 400K bytes while its IBM 3470 formatted version can accommodate 256K bytes.

As previously stated, there is no standard format for the 5¼-inch minifloppy diskettes. The number of tracks and sectors can and does vary. For example, 5¼-inch diskettes for the *Apple II* computer were originally formatted with 35 tracks, each subdivided into 13 sectors with 256 bytes-per-sector. Later, that format was modified to 35 tracks with 16 sectors-per-track, resulting in a net increase of 24K of storage capacity. Diskettes for the Heath *H89* computer are formatted with 40 tracks and 10 sectors-per-track.

A 5¼-inch minifloppy diskette has an unformatted capacity of 110K bytes. With soft-sectoring, this figure drops to 80.6K bytes. The minifloppy diskette can be formatted with anywhere from 35 to 77 tracks and 10 to 16 sectors-per-track.

Single density, double density

Data is placed on a disk using frequency modulation (FM). A 250-kHz clock generator produces pulses that repeat every four microseconds to form data cells on the surface of the Mylar disk. When writing data to the disk, if a data bit is supplied during the interval between clock pulses, a magnetic transition will occur as the read/write head contacts the oxide surface of the disk; that corresponds to a logic 1. If no data bit is sent, there will be no magnetic transition and thus the oxide is unchanged, representing a zero, as shown in Fig. 6.

When reading data from the disk, the stream of pulses would include the 250-KHz clock pulse and pulses representing ones and zeros. When a data cell includes a clock pulse and a data pulse, the presence of the two pulses identify a logic 1; the presence of only the clock pulse indicates a logic 0. That encoding technique is called FM encoding and is commonly referred to as single-density.

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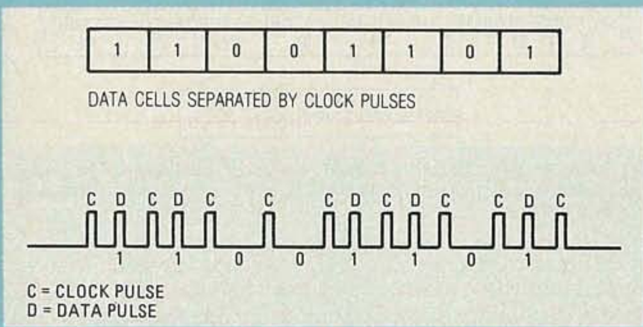

FIG. 6—WHEN RECORDED ON THE DISK, a logic 1 consists of a clock pulse plus a data pulse; a logic 0 consists of only the clock pulse.

With FM encoding, the IBM 3470 format specifies a recording density of 3408 bits-per-inch. Thus, with 77 tracks, 26 sectors, and 128 bytes-per-sector, a total of 256,256 bytes can be stored on a single-sided 8-inch disk.

To double the storage capacity, a double-density technique was developed based on an MFM (*M*odified *FM*) encoding. Basically, many of the clock pulses are removed and the presence of a pulse signifies a logic 1 while the absence represents a logic 0. Synchronization is accomplished by inserting a clock pulse at certain intervals. By eliminating many of the clock pulses, more room for data is available within each sector and twice as much information can be stored on a given length of track using MFM encoding rather than FM. Of course, there is a tradeoff...more sophisticated pulse-circuitry is required for clock timing and data writing.

Other techniques have been developed to increase the storage capacity of disks even farther. One scheme involves the use of drives with two read/write heads, one for each side of the disk. Thus, data can be stored on both sides of the disk. Some manufacturers have even introduced a quad-density recording technique that they claim will offer four times the storage capacity of a single-density drive.

Table 1 lists the unformatted storage capacity for both 5¼ and 8-inch disks using various data storage techniques. As shown, a single-sided single-density minifloppy (5¼ inch) provides 128,000 bytes of storage capacity while a double-sided double-density 8-inch disk provides almost 2 megabytes. In practical terms, a single-sided minifloppy would hold the equivalent of 30 single-spaced typewritten pages while the 2-megabyte capacity of a double-sided double-density 8-inch floppy could hold as many as 400.

Those storage capacities, however, are for unformatted disks. After the disk is formatted, the data-storage capacity decreases depending on the formatting technique used. The actual storage capacity of a double-sided double-density 8-inch disk formatted with 77 tracks and 26 sectors-per-track is around 1.1 megabytes. A dual-drive, double-density, double-sided 8-inch disk drive system can store over 2 million bytes.

Obviously, the added capacity of the double-sided double-density technique is a definite asset. However, drawbacks include the lack of standardization. Thus, a double-density diskette prepared on one system very often cannot be used with another disk system. Double-sided drives also have a drawback. Here, two read/write heads are used—one acting as the pressure pad for the other. Excess head wear and/or diskette damage is more likely to occur than with single-sided systems.

Table 1—STORAGE CAPACITY

Type	Sector Type	Unformatted Storage Capacity (Kilobytes)	Transfer Rate (Kilobytes Per Second)
5¼-inch Floppies			
Single-density/ single-sided	Soft	128	15.6
Single-density/ dual-sided	Soft	256	15.6
Double-density/ single-sided	Soft	512	31.2
8-inch Floppies			
Single-density/ single-sided	Soft	400	31.2
Single-density/ dual-sided	Soft	800	31.2
Double-density/ single-sided	Soft	800	62.4
Double-density/ dual-sided	Soft	1,600	62.4

Access time and transfer rate

In addition to storage capacity, access time and transfer rate are important specifications for a disk drive. Access time is the time it takes for the drive to access data in a random manner. Thus, the access time depends on the time it takes for the read/write head to arrive at the proper track (track-to-track seek time) and then wait for the data in the proper sector (latency time). Specifications for disk drives generally list an average access time derived by using one half the unit's poorest access time. Maximum, or worst, latency time is when the read/write head arrives at the proper track just as the correct sector passed by. In that case the head must wait for a full rotation of the disk and thus produces the maximum delay.

Typical average track-to-track seek times vary from 3 ms to 100 ms for an 8-inch disk drive and 3 ms to 25 ms for a 5¼-inch disk drive. Latency time (average) for an 8-inch drive is about 85 ms and about 100 ms for a minifloppy. Total access time for an 8-inch drive might range from 150 ms to 300 ms and about 400 ms to 600 ms for a minifloppy.

The transfer rate, or speed at which the disk drive can transfer its data to the computer, is another measure of disk-system performance. Obviously, a quick access time and rapid transfer rate means the computer can start to perform its operations with less time wasted. Typically, a single-sided minifloppy can transfer data at a 15 kilobytes-per-second rate and at twice this speed with double-density techniques. An 8-inch disk can transfer data at typical rate of 62.5 kilobytes-per-second, although models are available with transfer speeds as high as 125 kilobytes-per-second.

Disk-system components

So far we've talked abut the floppy disk and the disk drive. However, a complete floppy-disk systsem consists of more components, as shown in Fig. 7. So, let's list all of the components that make up a complete disk system.

1. The floppy disk itself.
2. A disk-drive assembly to rotate the disk and position the read/write head to the desired track position. Inside the cabinet that houses the drives is a power supply to provide the operating voltages to power the drives.
3. A disk controller to specify head position, control the drive motor, check and correct errors, and perform other functions.
4. Interface circuits to connect the computer control-signals properly to the disk controller.

continued on page 66

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FLOPPY DISKS ADD VERSATILITY

continued from page 64

5. Programs (software) to control the operation of the disk drive, such as specifying to which track and sector of the disk data should go, handling the actual reading and writing of data, and monitoring that the data transfer is correct. Those programs are called disk-operating systems (DOS's) and they operate with a file management system (FMS) to identify files of data and route data to individual tracks and sectors on the disk.

The disk controller has the responsibility of read/write head positioning, sector identification, disk-motor control, head loading and unloading, error detection and correction, and of controlling the transfer of data to the interface circuits between the disk drive and the main computer. In most instances, the interface board contains the disk controller circuitry. This board mounts inside the computer and is connected to the disk drive(s) by a ribbon cable.

The disk-operating system (DOS) controls the operation of the controller circuitry. It resides on a floppy disk. One of the functions of the DOS is to transfer data and programs between the computer and the floppy-disk system. Thus, when you first turn on the computer system, it is necessary to load the DOS from the floppy disk into the computer. That task is handled by a short program called a bootstrap loader. The bootstrap loader is contained in a ROM, usually on the interface board. Depending on the computer system, the bootstrap program is called up by a simple keystroke on the computer's keyboard. Once the system has been "booted," the computer and floppy-disk system are ready to accept operator commands. The DOS takes care of labeling the files, editing, error detection, and file copying. A file-management system designates the track and sector allocations on the disk for files.

Since the DOS occupies a rather substantial portion of a

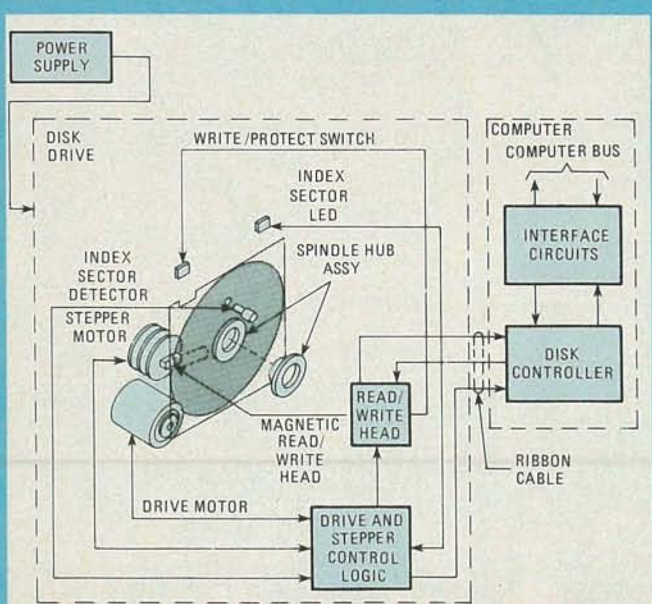


FIG. 7—A COMPLETE FLOPPY DISK SYSTEM consists not only of the disk and disk drive, but also includes control and interface circuits, as well as the software to handle disk-access operations.

diskette, a system with only a single floppy-disk drive is rather limited. Thus, it is common for packaged computers, such as those offered by Radio Shack, Apple, and others, to include two or more floppy-disk drives. One disk controller can generally handle several disk drives.

After the diskette is inserted through the front door of the floppy-disk drive and the door is closed, the drive spindle grips the center of the diskette and the motor brings the disk up to full rotational speed. The DOS directs the controller circuitry to position the read/write head to track 00 and the index hole, in conjunction with an optoelectronic sensor, generates a location pulse for timing. As the floppy disk spins, the heads are carefully positioned above the desired track. Then, the read/write head is pressed against the oxide coating with the help of pressure pads on the opposite side of the disk. That is called "head loading" and it is directed by the DOS. When a different track is desired, the read/write head is unloaded (lifted off the surface of the disk), moved to a different track, and loaded once again.

Before the read/write head is actually loaded, a sensor inside the drive senses the write-protect notch and determines whether the floppy disk can be written to. Of course, during a read operation, the notch is not sensed. When the read/write head is loaded, an LED on the front panel of the drive alerts the user that the drive is in operation and the disk should not be removed. When the drive completes its operation, the read/write head is unloaded, the LED goes out, and the disk may be removed.

Just as a computer is useless without proper software, so, too, is a disk drive. A well-prepared disk-operating system (DOS) is required to keep track of what is stored on the disk, and where it is located. The DOS handles such tasks as transferring programs from one device to another, locating read/write errors, providing a means to make backup copies of a diskette, and other chores.

Although basically similar, most DOS's are unique in their own way, and vary from one manufacturer to another. The DOS must be configured for the particular computer system it is to be used with. Also, if you decide to buy software on disk, the software must be compatible with the DOS. That condition also includes high-level languages such as BASIC.

Disk errors

Disk errors are categorized as either soft or hard errors. Hard errors are caused by defects on the disk surface; soft errors are due to program or processing troubles or power-line transients. An example of a soft error is what is commonly called a seek error, which occurs when the read/write head appears at the wrong track. Part of the disk-conroller's job is to locate and correct those disk errors. For example, the disk controller will compare the track being read with the track number that was called for by the DOS and determine whether a discrepancy exists. If a deviation is noted, the disk controller will initiate a new positioning routine and place the read/write head over the correct track.

A soft error is also classified as a recoverable error, one that the disk controller can spot and (sometimes) correct. A hard error is a non-recoverable error; the controller can detect it but cannot correct it.

It is estimated that a soft-sector disk system has an error rate of one per 108 bits during a read operation; one per 1011 bits during a read operation is the estimate for a hard-sectored disk. Under normal usage a disk is expected to last about two years; a track is considered to be worn or defective when it output level drops to 20 percent of its original value.

Is a backup copy necessary?

A backup is an exact duplicate copy of a disk. A backup copy is almost mandatory since it can be expected, sooner or later, that a disk will become defective due to wear, or dirt contamination, or possibly due to the read/write head's damaging the oxide coating of a disk. When that calamity occurs, and a backup copy has not been made, it will be necessary to reconstruct the lost information (if still available) and prepare a new disk.

How critical the data is, how often it changes, and how costly the loss will be will determine how frequently a data backup copy should be made. Large investment houses or banks might back up data every hour; small-business users perhaps only once a week. To make creating backup copies convenient, the DOS software usually contains a command for duplicating disks.

Selecting your disk drive

Computers and their peripherals are costly. So selecting a computer, printer, disk drive, or other accessory demands a hard look at the future, as well as the present. Among the questions to be answered are: What capacity do, and *will*, you need? A novice, or someone interested in games, can possibly be content with a cassette system and need not invest in a floppy system at all. Others, requiring a mass-memory storage capacity of, say, 250K bytes may settle for a single-drive unit—bearing in mind that an 8-inch disk holds twice as much data as a 5¼-inch diskette at less than double the cost. Generally, a single disk controller and DOS can operate up to three drives; thus it is common to start with a minimum investment and gradually add more drives to it.

Is the disk-drive hardware and software you have selected compatible with your computer? Your computer, keyboard, printers, and display must interface with the disk-system's electronics and DOS. Is the software you intend to use available for the disk system you are about to purchase? How important to you is access time and data transfer rate? Is size critical? Are there any unusual environmental considerations such as excessive heat or humidity where the drive will be located?

And, of course, there are basic considerations that must always be evaluated. How long has the manufacturer, whose units you are considering, been in business, what is his reputation, what is his warranty policy? Are there local places for service or must units be shipped back to the factory? Will spare parts be readily available? Also, it's wise to ask dealers and members of computer clubs about their reliability experiences with the models you are considering. Do they have a good record in their field or are they notoriously poor? Don't hesitate to ask many questions before the final purchase...once you've bought the disk system, you'll be tied to it for a long time. A list of manufacturers of disk drives appears in Table 2; contact them for specs and performance details. Remember, they are in business to respond to your needs. **R-E**

TABLE 2—DIRECTORY OF DISK DRIVE AND CONTROLLER MANUFACTURERS

For more information, circle No. 97 on the free information card inside the back cover.

A.M. ELECTRONICS
3366 Washtenaw Ave.
Ann Arbor, MI 48108

APPARAT, INC.
4401 South Tamarak Pkwy.
Denver, CO 80237

APPLE COMPUTER, INC.
10260 Bandley Ave.
Cupertino, CA 95014

CALIFORNIA COMPUTER SYSTEMS
250 Caribbean Dr.
Sunnvale, CA 94086

COMMODORE BUSINESS MACHINES
950 Rittenhouse Rd.
Norristown, PA 19403

COMPUTHINK
965 West Maude Ave.
Sunnyvale, CA 94086

CROMEMCO, INC.
280 Bernardo Ave.
Mountainview, CA 94043

DATA SYSTEMS DESIGN
3130 Coronado Dr.
Santa Clara, CA 95051

DELTA PRODUCTS
15392 Assembly Lane
Huntington Beach, CA 92649

HEATH COMPANY
Benton Harbor, MI 49022

IMS INTERNATIONAL
2300 Lockheed Way
Carson City, NV 89701

INTERFACE, INC.
20932 Cantara St.
Canoga Park, CA 91304

INTERNATIONAL MEMORIES, INC.
10381 Bandley Dr.
Cupertino, CA 95014

JADE COMPUTER PRODUCTS
4901 West Rosecrans
Hawthorne, CA 90250

LOBO DRIVES INTERNATIONAL
935 Camino Del Sur
Goeleta, CA 93017

MATCHLESS SYTEMS
18444 South Broadway
Gardena, CA 92048

MICROMATION
1620 Montgomery St.
San Francisco, CA 94111

MICROPOLIS
7959 Deering Ave.
Canoga Park, CA 91304

MICRO-SCI
1405 East Chapman, Suite E
Orange, CA 92666

MORROW DESIGNS
5221 Central Ave.
Richmond, CA 94804

NETRONICS RESEARCH & DEVELOPMENT
333 Litchfield Road
New Milford, CT 06776

NORTH STAR COMPUTERS, INC.
1440 Fourth St.
Berkeley, CA 94710

OHIO SCIENTIFIC
1333 South Chillicothe Rd.
Aurora, OH 44202

PERCOM DATA CO.
211 North Kirby
Garland, TX 75042

QT COMPUTER SYSTEMS, INC.
15620 South Inglewood Ave.
Lawndale, CA 90260

QUANTUM CORP.
448 Whitehead Rd., Box 5141
Trenton, NJ 08619

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

SD SYSTEMS
10111 Miller Rd., Suite 105
Dallas, TX 75228

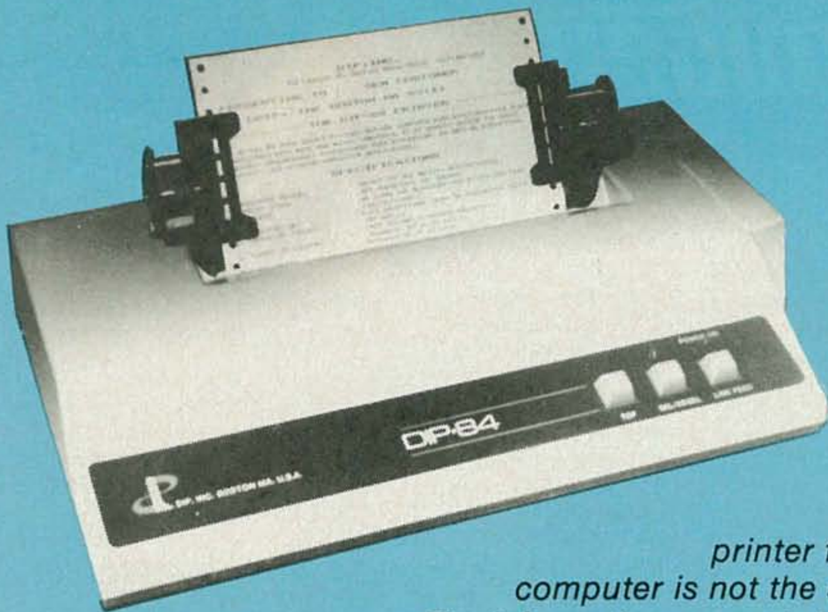
SMOKE SIGNAL BROADCASTING
31336 Via Colinas
West Lake Village, CA 91361

SOUTHWEST TECHNICAL PRODUCTS CORP.
219 West Rhapsody
San Antonio, TX 78216

TARBELL ELECTRONICS
950 Dovlen Place, Suite B
Carson, CA 90746

VISTA COMPUTER CO.
1401 Borchard St.
Santa Ana, CA 92705

WAMECO
Box 877, 455 Plaza Alhambra
El Granada, CA 94018



Choosing a printer for your personal computer is not the simplest of tasks. The information presented here can make it easier for you to make your decision.

ALL ABOUT PRINTERS

ONCE THE PROUD OWNER OF A PERSONAL COMPUTER HAS learned how to operate his machine, write programs, and beat the computer at some of its games, he tends to turn serious. He'll prepare his taxes, perhaps file his wife's favorite recipes, and use his computer to keep track of his stamp, coin, or record collection. If he owns a business, he may file his inventory, prepare payrolls, and list bills on the computer. At this point he can no longer rely on his CRT display alone for there comes a time when the data from the computer cannot be analyzed sufficiently while the user stares at his display. He needs hard copy, on paper, to put in his briefcase, to carry to meetings and discussions, and to distribute to others involved in decision-making.

So it's off to the computer store to select a printer. And that's where the fun (or frustration) begins. A multitude of different models are available from close to 100 printer manufacturers. Salesmen will confront the puzzled buyer with a flurry of terms such as "dot matrix," "KSR or RO," "daisy wheel," "pin feed," "characters per second," and the like. So, rather than face that bewildering barrage of terms unprepared, it is appropriate for the prospective buyer of a printer costing from hundreds to thousands of dollars to learn a bit about them before taking the plunge.

To start, let's differentiate between a *print head*, a *printing mechanism*, and a *printer*. A *print head* is the component that creates the character on the paper. It can be a dot-matrix impact-type, thermal non-impact-type, or one of a number of other designs. Without the mechanical elements to move that print head to the proper position, without the electronics to control positioning and carriage return, the print head is entirely useless.

The *printing mechanism* is a mechanical assembly, including a print head, with the necessary gears and drive to perform the movements required for printing; it may or may not include a cabinet or electronics section. The *printer* is the complete assembly, including print head, printing mechanism, cabinet, and the necessary electronics (see Fig. 1).

KSR and RO

Printers can be classified in a number of ways. First, whether they include a keyboard to enable them to send, as well as receive, data. A printer/terminal includes a keyboard that permits the user to input or output data by direct connection to the computer, or via a telephone line and modem. Those two-way units are called KSR (*K*eyboard *S*end/*R*eceive) printers. Many manufacturers supplying KSR's also market similar assemblies—less the keyboard and output-electronics section—that serve as one-way or *R*eceive-*O*nly (RO) printers.

Impact vs. non-impact

Impact printers generate a character by having the print head strike the paper through an inked ribbon; portable and office typewriters are common examples of impact printers. Non-impact printers generate characters without mechanical force; the small thermal printers in some low-cost printing calculators are examples of non-impact printers.

Impact printers have two major advantages over their non-impact rivals: they produce high-quality print, and can provide multiple copies. Their major drawbacks are a high noise-level and low speed. Non-impact printers are quiet and many are low in cost. They generally operate at much higher speeds than impact types. Their drawbacks include the inability to produce more than one copy at a time and the need for relatively expensive paper. Also, their output is frequently less legible than that of impact types.

Impact printers that use solid type-fonts (as opposed to dot-matrix fonts) have their character sets on cylinders, balls (like the IBM *Selectric* print-elements), drums, bands, or wheels. As the computer informs the printer of the character required, that character is moved into position and struck so that an inked ribbon makes an impression on the paper. The next character is then moved into place and the process is

FIG. 1—THE *MODEL IPS 5000A* FROM DATAROYAL is a dot-matrix printer with a 120 cps print speed and a tractor-type paper feed.

repeated.

Non-impact printers include thermal, electrosensitive, ink-jet, and laser types. While the latter two are still far too expensive for the personal-computer user, thermal and electrostatic printers are generally available for less than $1000 and that, coupled with their quietness, makes them well suited to home or small-business applications.

Low-cost printers (under $400) in those categories may use narrow rolls of paper, similar to those used by printing calculators, that are limited to 32 characters (or columns) per line. Printers costing over $500 generally accept 8½-inch wide paper and can print 80 or more characters per line.

Generally speaking, printers selling for under $1000 are of the dot-matrix type (with the exception of used Teletype machines). Dot-matrix printers with special features—like very high speed, or special head or paper-movement capabilities—may be more expensive.

In the $2000-and-up range are the "solid-character" printers using "golf balls," daisy wheels, or thimbles. They offer very high print quality, suitable for business letters and lengthy reports.

Serial printers vs. line printers

Printers can also be classified as *serial* or *line*. *Serial* printers—which are what we are discussing here—print one character at a time. *Line* printers print an entire line at a time and are generally used where very high volume and speed are required, as in the case of printing thousands—or even millions—of mailing labels or paychecks.

Serial printers have a single print head that moves horizontally across the page, printing one character at a time. If the printer is fast enough, it can print each character as it is received from the computer; otherwise the data must be stored in a *buffer* and fed to the print mechanism more slowly.

Line printers contain many print heads and hammers, or print actuators—one for each column. When an entire line's worth of characters has been stored in the line printer's buffer, the print mechanism is actuated and the entire line printed at once.

Speeds of serial printers are usually given in characters-per-second (cps); speeds of line printers are specified in lines-per-minute (lpm). A low-speed line printer may be rated at 300 lpm, a medium-speed one at 300-600 lpm and a high-speed one at over 600 lpm.

Typically, dot-matrix serial printers operate at speeds in the range of 60-400 cps. "Solid-character" serial printers operate at the rate of 25-60 cps.

Naturally, the high-speed line printers are considerably more expensive than the slower serial printers. The most popular types of line printers are *drum*, *chain*, and *scanning matrix*.

Fully-formed (solid) or dot-matrix characters

Depending on the type of printer used, the characters formed may be either *fully-formed* (solid, typewriter-quality) or *dot-matrix*.

Dot-matrix characters are formed by a series of dots arranged in a matrix measuring from four to seven dots horizontally by seven to nine dots vertically (see Fig. 2-a). Thus, a 7×7 matrix could have up to 7 dots in both directions.

continued on page 74

SOME QUESTIONS BEFORE BUYING

Here are some of the points you will have to consider:

1. Will noise be a problem? If so, a non-impact printer is recommended.
2. Will print quality be critical? If the printer is to be used for word processing or for correspondence, a fully-formed-character printer is the best choice.
3. Will multiple copies (for billing, records, etc.) be required? If so, a non-impact printer is ruled out.
4. Will frequent changes of typeface be required? If so, a printer with interchangeable elements ("golf balls" or print wheels), or a programmable matrix-printer, will be needed.
5. Will a lot of printing be done? If so, paper costs could become prohibitive if a thermal or electrosensitive printer were used. (Also make sure that ribbon changes on impact printers are simple to accomplish.)
6. How fast does the printer have to be? Speed is directly related to cost—the faster the printer, the more expensive it will be. There also tends to be a tradeoff between speed and print quality—the higher the speed, the lower the quality.
7. What form of paper transport is required? For continuous-form paper, or for multiple copies, pin or tractor feed is the choice.
8. Will the printer be running unattended? If so, it should have alarms and/or shut-off devices to handle "out-of-paper" and other situations.
9. What is the maximum number of columns (characters per line) that will be required?
10. Will both upper and lower case characters be required? Will any special characters or symbols be needed? Make sure they are available.
11. Will a one-way, receive-only (RO) device be sufficient or will a two way (KSR) unit be required? The obvious choice is a RO printer, but give some thought to future needs.
12. How reliable is the printer manufacturer? How long has he been in business? What have you heard or read about his equipment? A "steal" on a printer whose manufacturer has gone out of business could mean problems should the device require parts or servicing.

Don't be afraid to ask questions—of yourself, of dealers, and of printer owners at local computer clubs. Remember, you'll be spending hundreds—if not thousands—of dollars on a piece of equipment that you'll be depending on for years.

Take your time; call or write to manufacturers for specifications or definitions of terms on their data sheets. And, once you've made up your mind, visit your dealer and ask him to let you get some first-hand experience with the printer you've chosen to make sure it really is right for you.

ALL ABOUT PRINTERS

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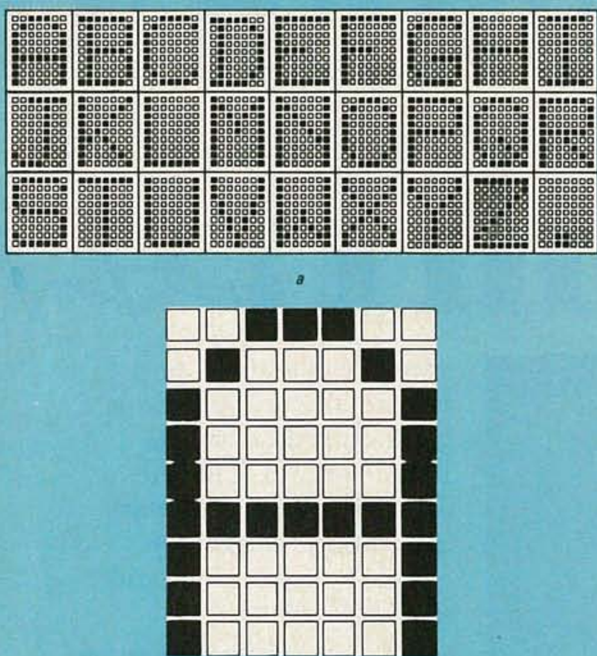

FIG. 2—DOT-MATRIX CHARACTERS are formed by dots in a matrix as shown in *a*. The "dots" in the 7 × 9 matrix shown in *b* form the letter "A".

Characters are determined by the number and positions of the dots within the matrix, as shown in Fig. 2-b. Since the characters are not formed from continuous lines, legibility is not as good as that obtained from printers using fully-formed characters. The more dots used in the matrix, however, the better the appearance will be.

Impact-type dot-matrix printers produce characters using a moveable print-head mechanism that consists of solenoid-actuated pins arranged as shown in Fig. 3. As data arrives from the computer, a character-generator ROM in the printer selects the appropriate dot-pattern for the character to be printed and energizes the solenoids required. The solenoids cause print needles to strike the ribbon and form the dot-pattern on the paper.

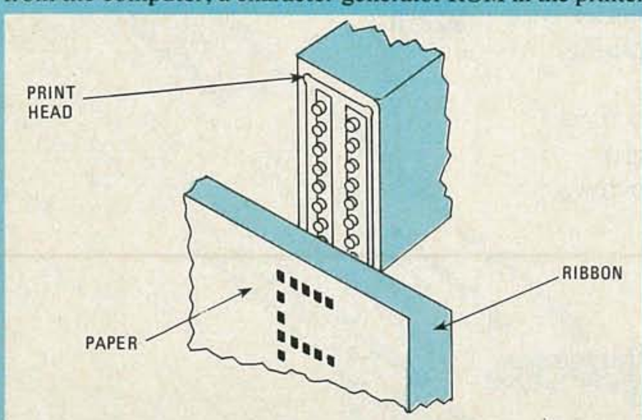

FIG. 3—SOLENOID-ACTUATED PINS produce the dots that form the characters in an impact-type dot-matrix printer.

Some dot-matrix printers, instead of using a ribbon, make use of a special paper that contains "micro-bubbles" of encapsulated ink. When the bubbles are struck by the print needles they burst and release the ink.

One technique used to obtain higher-quality output from dot-matrix printers involves multiple passes of the print head across the same line, with the head position *slightly* offset for each pass. That allows more dots to be printed and creates denser, more legible, characters. The drawback, of course, is a reduction in print speed.

A recent innovation in the dot-matrix field is the "throw-away" print head. When it wears out—as will eventually happen in any case—no expensive service is needed. You can just unplug the worn-out head yourself and replace it with a new one that costs about $30.

Cylinders, balls, and wheels

The earliest version of a full-character printer was the cylinder or Teletype, which had its type on a cylinder that rotated along a vertical axis on a moveable carriage, (see Fig. 4). As the computer requests a particular character to be printed, the carriage moves to the correct location on the paper and the cylinder is rotated, and also raised or lowered, to place the proper character into position so that a hammer can strike and force the character against the ribbon, printing the letter on the paper. The Teletype models 33, 35, and 38 are considered noisy, slow, (10 cps) unreliable and difficult to service—but they do fulfill the need for a low-cost printer.

The "golf-ball" print head (see Fig. 5) developed by IBM for its *Selectric* typewriters, contains a full set of characters embossed on a sphere. Printing is performed as the ball strikes an inked ribbon placed between the ball and the paper. When a change in font or typeface is required, ball replacement is simple and the cost for the print elements is low. Speed is relatively slow, about 15 cps, and the mechanism is quite noisy. However, print quality is good, and used, reconditioned models are available at low cost.

The daisy wheel, introduced by Diablo Systems, Inc. in 1972, is three to five times faster than the "golf-ball" or cylinder types, with speeds of up to 80 cps. Its name is derived from a resemblance to a flower with its petals outstretched (see Fig. 6). The mechanism consists of a central hub which has up to 96 arms, each containing an embossed character. When the required petal or character is rotated into the proper position, a hammer strikes the petal against an inked ribbon to produce the letter-image on the paper. The daisy-wheel elements, available in steel or plastic, come in a variety of typefaces and can be interchanged simply and rapidly. Print quality is very good but noise level is somewhat high.

Thermal, electrosensitive and ink-jet printers

The thermal matrix-printer is a popular form of a non-impact system. As the print head moves horizontally across the

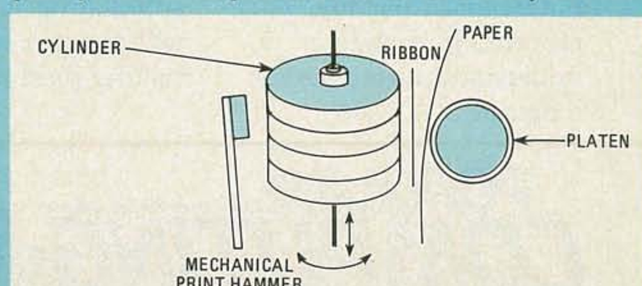

FIG. 4—CYLINDER PRINTERS USE a rotating cylinder on a movable carriage. When the cylinder is in position, a hammer strikes it to print a letter.

specially manufactured paper, characters are formed as the heating elements in the print head discolor the paper into a dot-matrix pattern. Thermal printers are light, compact and quiet, and the print head is inexpensive and easy to replace. However, the heat-sensitive paper is expensive and only one copy at a time can be produced.

The electrosensitive matrix printer requires a special aluminum-coated paper which forms a dot-matrix pattern when voltage is applied between the print head and a metal plate, burning off the aluminum to expose a black layer below. The paper travels between the print head and the metal plate (see Fig. 7). As data is fed to the print head, electrodes in the print-head housing are pulsed selectively, causing a charge to jump between the electrode and metal plate (rear electrode), creating black dots on the paper and thus the character. Although the electrosensitive printer is inexpensive and its quality is good, paper is expensive and requires delicate handling. A newcomer to this printer family is the laser printer which uses a low-power laser to burn dots off of a specially-treated paper.

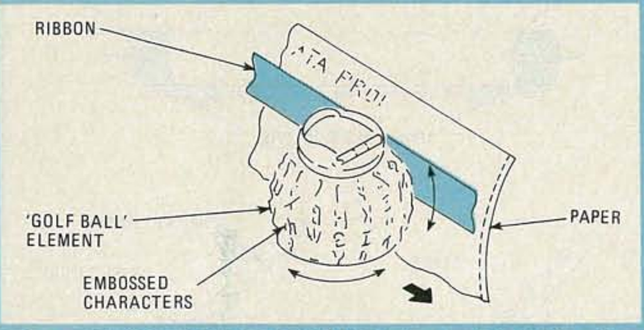

FIG. 5—THE IBM *SELECTRIC* PRINT HEAD is a "golf-ball" like sphere embossed with a full set of characters.

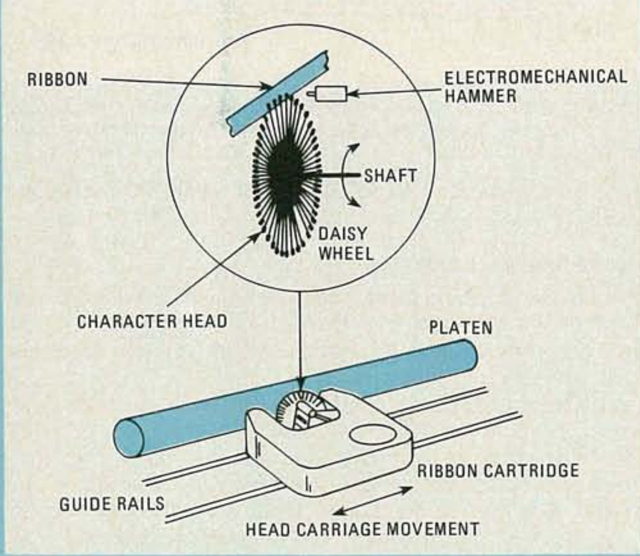

FIG. 6—A DAISY-WHEEL printer is much faster than a *Selectric* or cylinder-type. The print wheel gets its name from its resemblance to the flower.

Ink-jet printing is a non-contact process. Neither cylinders nor "golf balls" nor ribbons touch the paper. In an ink-jet mechanism, ink is pumped through a tiny nozzle, forming a steady stream of fluid; the nozzle is vibrated to modify the stream into a series of droplets rather than a steady flow. As an individual droplet leaves the nozzle and is directed towards the paper, its position is controlled so that its final placement, relative to other released droplets, will form the desired characters.

Several droplet-placement techniques are in use, including electrostatic deflection, controlled nozzle movement, and controlled paper movement. Another technique involves the use of a number of independent nozzles tightly packed into a print head with selective firing of individual nozzles determining character creation. In the "drop-on-demand" technique, shown in Fig. 8, an electrical signal is converted into a pressure pulse in the ink chamber. That causes droplets of ink to be discharged from the independently controlled ejection chambers and form printed characters.

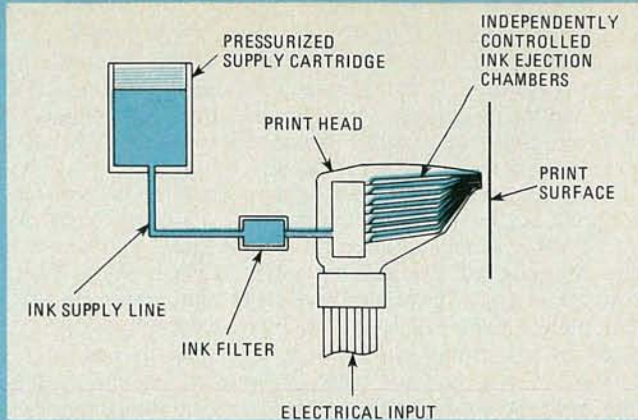

FIG. 8—INK IS DISCHARGED from independently-controlled ejection chambers to form letters in the "drop-on-demand" technique.

Serial vs. parallel transmission

Computers transmit data to a printer in either serial or parallel format. In serial transmission, single bits of a byte follow each other in a steady stream; in parallel transmission, all the bits required to define a character are routed along parallel wires at the same time. Therefore, serial transmission is slower than parallel transmission. However, only one communications channel is required for serial transmission which means that serial data can be transmitted over a telephone line; in addition, serial data can be transmitted over a longer distance than parallel data without the need for special amplifying repeaters.

Serial data-transmission can be synchronous or asynchronous. In synchronous transmission, it is necessary for the system to be aware of the exact time-position of each data byte representing a character to be fed to the printer. The flow of characters is split into blocks, with all bits in each block transmitted at equal time intervals. Even if no data is fed during a brief time period, data bits, called "nulls," must be used to fill in the blocks. Stable oscillators act as clocks at both ends of the transmission to maintain synchronization and precise timing. The computer, acting as the transmitter, starts each block with a series of synchronization signals to denote the start of a block and thus synchronize the oscillators; the block is generally ended with an error-checking character.

Asynchronous transmission is less complex and does not rely on precise timing-blocks. The receiver (printer) and transmitter (computer) are synchronized by a "start bit" which is inserted before the bit-pattern for a character and a "stop bit" added after the character. Specific spacing between bytes is not required; however, it is necessary to establish the baud rate, or transmission speed in bits-per-second, between the transmitter and receiver. Commonly used baud rates are 110, 300, 600, 1200, 2400, 4800, 9600, and 19,200.

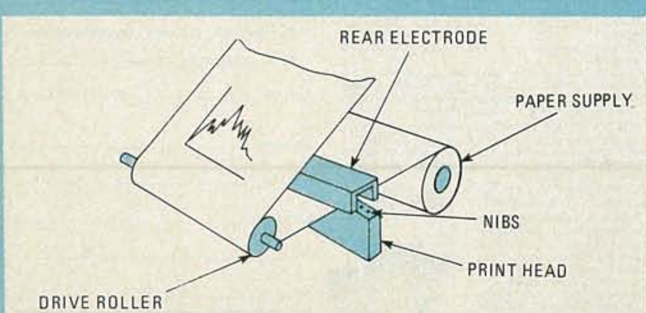

FIG. 7—AN ELECTROSENSITIVE PRINTER uses a spark from the print head to "burn" dot-matrix characters on specially-treated paper.

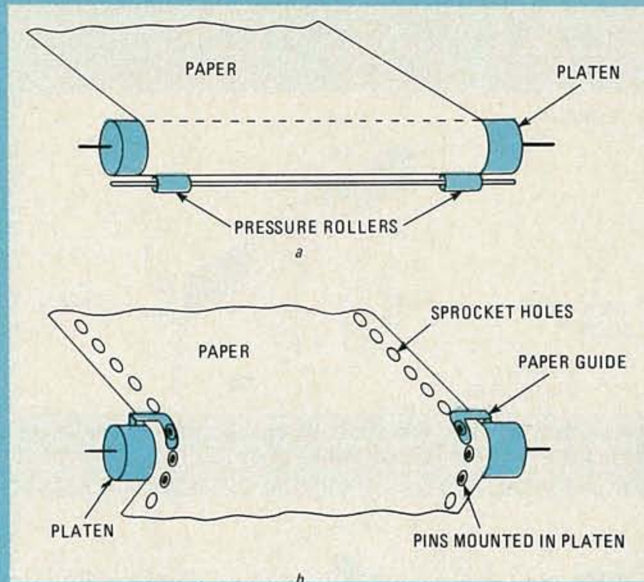

FIG. 9—A FRICTION PAPER-FEED SYSTEM (*a*) works well if just one copy is required. For multiple copies, a pin-feed system (*b*) can be used.

Paper-feed mechanisms

An important, and commonly overlooked, consideration in printer selection is the paper-transport arrangement. The three common transport mechanisms are friction feed, pin feed, and tractor feed.

In a friction-feed system, like that used in an office typewriter, gear-driven rollers hold and move the paper (see Fig. 9-a). The system is simple and relatively trouble-free, provided a single sheet of paper is used; when multiple sheets are loaded, it is not uncommon for them to become misaligned.

To solve that annoying problem, pin-feed systems (Fig. 9-b) were developed. Metal pins are mounted around the outer rim of the platen and engage holes punched in the outer margins on the paper. That arrangement allows long rolls of paper (with multiple copies if desired) to be used without alignment problems. Since the pins are at a fixed distance apart on the roller, only one width of paper can be used.

To accommodate a variety of paper widths, the tractor-feed mechanism was developed. The pins in the platen are eliminated and adjustable sprockets are connected to two chain-drives that slide on rods extending the width of the paper opening. A gear train, driven by the paper-feed drive-motor, turns the sprockets, which pull the paper as a tractor would pull a cart. The sprockets can be moved and locked to handle any paper width. **R-E**

PRINTER MANUFACTURERS

For more information from the manufacturers listed below, circle No. 98 on the Free Information card inside the back cover.

ANACOM GENERAL CORPORATION
Computer Products Division
1116 E. Valencia Drive
Fullerton, CA 92631

ANADEX, INC.
9825 De Soto Ave.
Chatsworth, CA 91311

APPLE COMPUTER COMPANY
10260 Bandley Drive
Cupertino, CA 95014

AXIOM CORPORATION
5932 San Fernando Road
Glendale, CA 91202

BASE 2, INC.
P.O. Box 3548
Fullerton, CA 92634

CENTRONICS DATA COMPUTER CORPORATION
1 Wall Street
Hudson, NH 03051

C. ITOH ELECTRONICS, INC.
666 Third Ave.
New York, New York 10017

COMMODORE BUSINESS MACHINES
950 Rittenhouse Rd.
Norristown, PA 19403

DATAPRODUCTS
6200 Canoga Ave.
Woodland Hills, CA 91365

DATAROYAL
235 Main Dunstable Road
Nashua, NH 03060

DATASOUTH COMPUTER CORPORATION
4740 Dwight Evans Road
Charlotte, NC 28210

DIABLO SYSTEMS, INC.
24500 Industrial Blvd.
Hayward, CA 94545

DIGITAL EQUIPMENT CORP (DEC)
129 Parker Street
PK3/M18
Maynard, MA 01754

DIP, INC.
745 Atlantic Ave.
Boston, MA 02111

EATON PRINTER PRODUCTS
Technical Industrial Park
Riverton, WY 82501

EPSON AMERICA, INC.
2384 Hawthorne Blvd.
Torrance, CA 90505

GENERAL ELECTRIC COMPANY
GE Drive
Waynesboro, VA 22980

HEATH COMPANY
Benton Harbor, MI 49022

HOWARD INDUSTRIES
1 North Dixie Hwy.
Milford, IL 60953

INTEGRAL DATA SYSTEMS, INC.
Milford, NH 03055

LEAR SIEGLER, INC.
714 N. Brookhurst St.
Anaheim, CA 92803

MALIBU ELECTRONICS
2301 Townsgate Road
Westlake Village, CA 91361

MICROTEK INC.
9514 Chesapeake Drive
San Diego, CA 92123

MPI
4426 South Century Drive
Salt Lake City, UT 84119

NEC INFORMATION SYSTEMS, INC.
5 Militia Drive
Lexington, MA 02173

OKIDATA CORPORATION
111 Gaither Drive
Mt. Laurel, NJ 08057

QUME CORPORATION
P.O. Box 50039
San Jose, CA 94140

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

SANDERS TECHNOLOGY, INC.
Columbia Drive
Amherst, NH 03061

TELETYPE CORPORATION
5555 Touhy Ave.
Skokie, IL 60077

TEXAS INSTRUMENTS, INC.
P.O. Box 225012
M/S 84
Dallas, TX 75265

TRENDCOM
480 Oakmead Parkway
Sunnyvale, CA 94086

XEROX CORPORATION
Xerox Square
Rochester, NY 14644

XYMEC
17905 Skypark Circle, Suite J
Irvine, CA 92714

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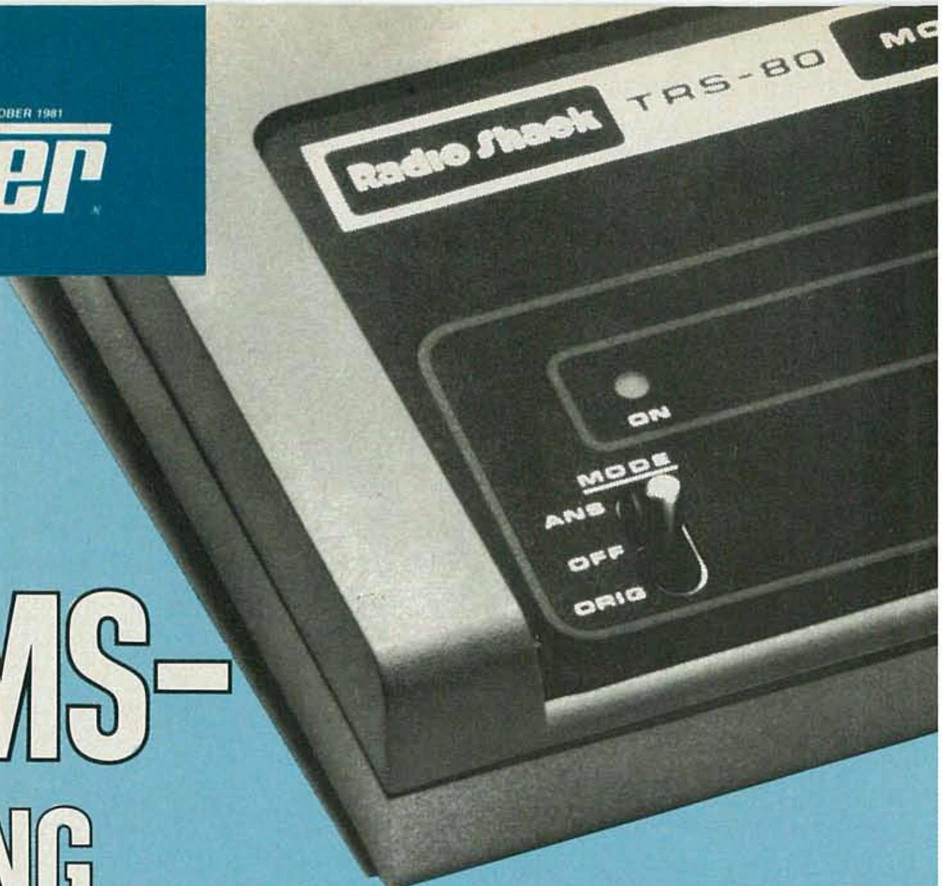
Computer



MODEMS—COMPUTING via TELEPHONE

Whether it's a printer in Peoria, a terminal in Texas, or a data base in Denmark, your computer can communicate with it using a modem and a telephone.

LIFE CAN BE SIMPLE AND UNCLUTTERED IF YOU ARE CONTENT TO have your keyboard and printer at arm's length from your computer. If you are satisfied writing and running your own programs, with contact to the outside world limited to reading magazine articles, purchasing pre-packaged programs and exchanging ideas with others via computer clubs, letters and/or phone calls, then that's fine.

But should you decide to expand your world, and tie your personal computer to a time-sharing system—or write your output to a distant printer or terminal—you suddenly are involved with data trasmission and the need for a modem (*M*odulator-*De M*odulator). Your computer can send its data stream to a remote terminal over telephone lines with a modem at each end. The modem at your end converts the digital bits to a more convenient form to transmit over the phone lines, and another modem at the distant location restores the original stream of data bits.

Similarly, if you wish to make use of the rapidly-growing time-shared computer networks, such as the Source or MicroNet a modem must be inserted between your terminal (or computer) and the telephone line.

Why are modems necessary? Why not simply route computer signals along the telephone wires to a peripheral device such as a printer or remote terminal?

Telephone lines were designed to carry audio signals in the 300 Hz to 3500 Hz range. Frequencies below 300 Hz are attenuated and thus a stream of data pulses routed along such a line would suffer waveform distortion as shown in Fig. 1. Here a logic-pulse train of three O's is followed by five 1's as shown in Fig. 1-a. If this pulse train were to be transmitted over the telephone lines, then attenuation would result as shown in Fig. 1-b. Many of the logic 1's transmitted over the telephone line would be recognized as 0's at the remote peripheral, with resultant errors.

Since the telephone line is optimized to handle the 300-Hz to 3500-Hz frequency range, it is practical to convert the data bits to sine waves or sinusoidal tones that can be trans-

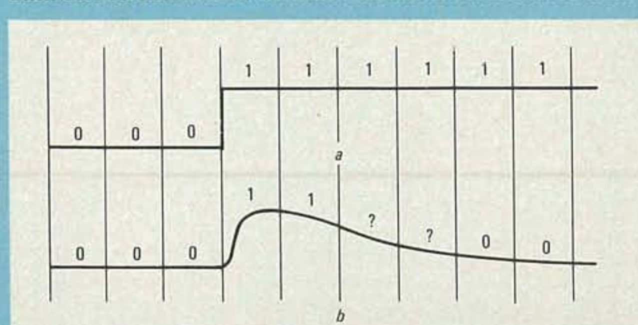


FIG. 1—A STREAM OF DATA PULSES (a) would be distorted (b) if sent over a telephone line because of the bandwidth limitations of that line.

mitted without distortion. Computer data is in the form of pulses—a pulse represents a logic-1 level, the absence of a pulse represents a logic-0 level, as shown in Fig. 2. Thus, a pulse or digital signal has two distinct states with nothing in between.

An analog signal, or sinusoidal signal, is a continuously-varying voltage, as shown in Fig. 3; its frequency and amplitude remain constant as long as nothing is done to alter or modulate it. In that form, the sinusoidal voltage is termed a carrier and, since it is at a fixed frequency and amplitude, it conveys no information. However, if its amplitude were deliberately changed—such as reduced to zero for a few seconds—and then allowed to return to its original condition, it would convey information that some input had caused the change in the carrier.

As an example, the light beam in a photosensitive burglar alarm system sends a steady beam of light from a lamp, across a doorway, to a detector. The beam is a carrier that conveys no information until someone passes through the doorway, interrupting the light beam; the short duration during the absence of light at the detector conveys information that something has changed the carrier. Changing or altering the carrier is termed modulation.

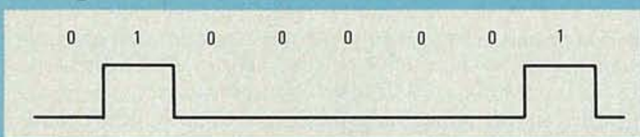


FIG. 2— IN COMPUTER DATA, a pulse represents a logic-1, the absence of a pulse a logic-0.

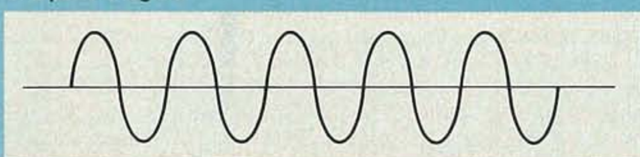


FIG. 3—THE FREQUENCY AND AMPLITUDE of a sinusoidal signal remain constant as long as it is unmodulated.j

AM, FSK, and PSK

The three common techniques used to modulate or alter a fixed-frequency signal (carrier) are: amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM).

With amplitude modulation, Fig. 4, the level or intensity of a constant-frequency sinewave is varied. For example, an increase in amplitude could signify a logic-1 level while a decrease in amplitude would signify a logic-0 level.

In frequency-modulation, shown in Fig. 5, the amplitude of the sinewave is kept constant but the frequency of the carrier is changed. For example, a logic-1 level could be represented by a carrier frequency of 1270 Hz; a 1070-Hz tone could be generated if the logic state changes to a 0. The term FSK (frequency-shift keying) is often used to indicate that the carrier's frequency is shifted between two distinct frequencies to designate logic 1's or 0's.

Phase modulation, shown in Fig. 6, involves instantaneous changes in the phase of the carrier relative to a fixed reference phase angle. A standard sine wave starts at zero amplitude and zero phase angle, rises to a peak positive amplitude at 90 degrees, and drops to zero at 180 degrees before returning to zero at 360 degrees (see Fig. 3.) It is possible to represent a logic-1 level as a signal with a particular phase angle and a logic-0 level as the same amplitude, same frequency carrier but displaced in phase by 180 degrees (see Fig. 6.) A phase-detector circuit can be used to detect the phase of the carrier and thus determine whether a logic 1 or logic 0 is present. That technique is called PSK or Phase-Shift Keying.

It is possible to combine amplitude modulation (AM) that has two states (high or low) with phase modulation, which

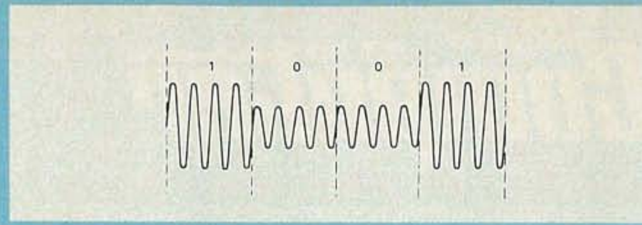


FIG. 4—IN AMPLITUDE MODULATION (AM), a change of amplitude is used to convey information.

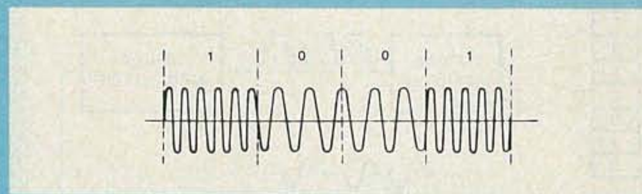


FIG. 5—THE FREQUENCY OF A CARRIER is varied while the amplitude is held constant in frequency modulation (FM).

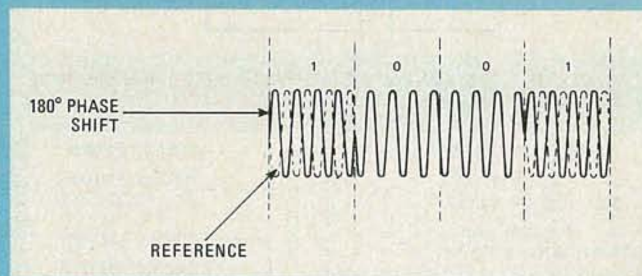


FIG. 6—IN PHASE MODULATION (PM) if a logic-1 is a signal with a particular phase angle, a logic-0 is the same signal shifted in phase 180 degrees.

can be extended to four phase shifts, to provide eight signal-state conditions; that technique is termed quadrature phase modulation. Using that technique, data rates as high as 9600 bits-per-second are achieved.

Frequency modulation or FSK is most commonly used for modems operating at 300 bits-per-second or less.

Parallel-to-serial interface

Letters or characters generated by a computer are generally coded in an 8-bit ASCII (*A*merican *S*tandard *C*ode for *I*nformation *I*nterchange) set. ASCII is a seven-bit code with 128 combinations for letters, numerals, and control functions. During serial transmission, the ASCII code is sent as an eight-bit word, with the additional bit used for parity or error checking. Those bytes of information, containing eight bits or pulses, cannot be sent over the conventional two-wire telephone line; the parallel or simultaneous transmission of bits must first be converted to a serial transmission, with bits moving along the phone line one at a time. The necessary parallel-to-serial conversion is performed by a RS-232 serial interface.

Assume that the computer is transmitting the letter "r", represented by Ø1Ø1ØØ1Ø in the ASCII code: The serial interface would accept the simultaneous group of bits and output them one bit at a time, as shown in Fig. 7. The string of bits would be represented by voltage levels of 0 and +5 for a logic 0 and a logic 1, respectively. Those pulses would then be fed to the modem that would convert them into audio tones. Those audio tones would be transmitted along the phone lines to the distant computer or terminal, where a receive modem would convert or demodulate the audio tones to their binary equivalents.

The RS-232 interface standard, adopted by the Electronic Industries Association (EIA), is the equivalent of the international CCIT TV24 standard. The 25-pin connector arrange-

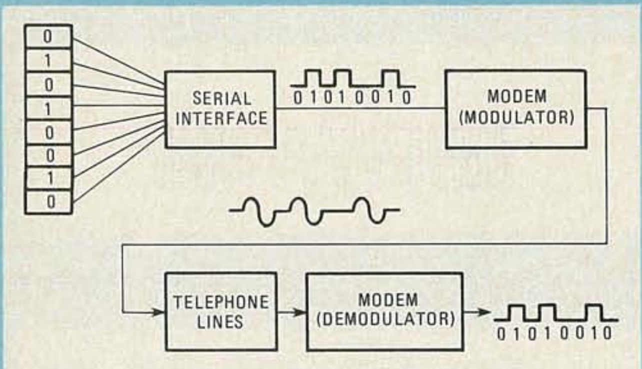


FIG. 7—ALL OF THE COMPONENTS required for serial communications are shown in this generalized block diagram.

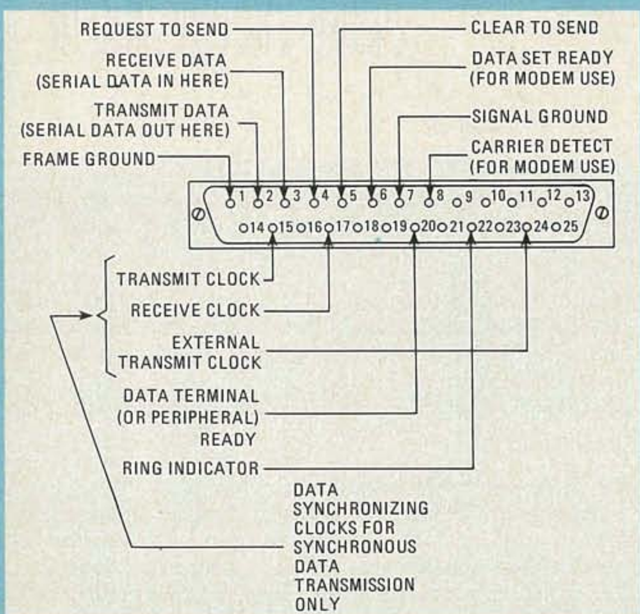


FIG. 8—THE FUNCTION OF EACH PIN in the RS-232 interface standard is shown here. The ±12-volt input shown in Table 1 have been omitted.

TABLE 1—MODEM INTERFACE FUNCTION

PIN NUMBER	SYNCHRONOUS	ASYNCHRONOUS
1	Frame ground	Frame ground
2	Transmit data	Transmit data
3	Receive data	Receive data
4	Request to send	Request to send
5	Clear to send	Clear to send
6	Data set ready	Data set ready
7	Signal ground	Signal ground
8	Carrier detect	Carrier detect
9	---	+12V
10	---	−12V
15	Transmit clock	
17	Receive clock	
20	Data terminal ready	Data terminal ready
22	Ring indicator	Ring indicator
24	External transmit clock	

ment used for modems involved with serial data transmission is shown in Fig. 8. Table 1 lists the pin functions for modems that are used for synchronous and asynchronous transmission.

Although EIA does not define how data is to be transmitted, it does define the control functions and their use. It also standardizes the pin connections on a 25-pin interface connector; the computer or terminal holds the male connector while the modem uses the female 25-pin connector. Terminals can be connected to a computer if cable length is less than 50 feet; for lengths extending to hundreds of feet, errors due to lost bits or extraneous noise-pickup may compromise the system.

If distances within a building involving several terminals exceed 50 feet, line drivers may be used at each terminal and at the computer. The line driver is basically a signal converter to amplify digital signals routed from an RS-232 interface connector; twisted-pair wires can be used between line drivers.

Simplex, half duplex, full-duplex

Data can be transmitted between a computer's I/O port and a peripheral device by simplex, half-duplex (HDX), or full duplex (FDX) modems. Simplex modems allow transmission in one direction only and thus are not often used. In a half-duplex system, data may be sent in either direction but not simultaneously. With full-duplex modems, transmission can take place in both directions at the same time. With full-duplex, two telephone channels are required, while simplex and half-duplex modems require only one. Most modems are designed for either half-duplex or full-duplex operation.

Modems are available for long-haul (extremely long distances) or short-haul (relatively limited distances). Long-haul modems are capable of satisfactory performances over thousands of miles of regular telephone or leased lines. Short-haul modems, generally slightly less expensive than long-haul versions, are designed to operate over limited distances with short, leased lines. There is no specific industry standard or definition for short- or long-haul distances. Modems may be classified by the speed of operation with these definitions. Low-speed: up to 600 bits per second; medium-speed: up to 2400 bits-per-second; high-speed: up to 9600 bits-per-second; and wideband: above 9600 bits-per-second. It is common to refer to data-transmission speed as baud or bits-per-second; however, this is strictly true if the transmission system only involves two signal states (on or off), as is the case with a computer.

Peripherals, such as a slow-speed printer, must operate at the same baud rate as the modem. Thus modems with multiple transmission rates may include a switch (or wiring connections) to match the data-transfer rate of the modem to the printer. For most installations, modems are hooked up to a dial-up line in a standard telephone network or perhaps an AT&T leased line; for short distances, one or several twisted pairs of wires may be used. When modems are used with the Bell telephone network, signals are limited to a specified level to avoid line overload and interference. Modems carrying FCC approval can be connected directly to the phone lines; otherwise, users must include a Data Access Arrangement (DAA), which is an FCC-approved interface, between the modem and telephone circuit.

Here's a simple example of how a modem would transmit and receive data in a full-duplex system (see Fig. 9).

The ASCII output from the computer, converted to serial form, is routed to the send modem that converts the logic state of 0 to a frequency of 1070 Hz and a logic 1 to 1270 Hz. The frequency-shifted (or FSK) signals are then sent along the telephone lines to a distant location where a receive modem accepts the signals from the telephone line via a band-pass filter that passes signals in the range of 950 to 1500 Hz and rejects all other frequencies. The 1070-Hz tones are

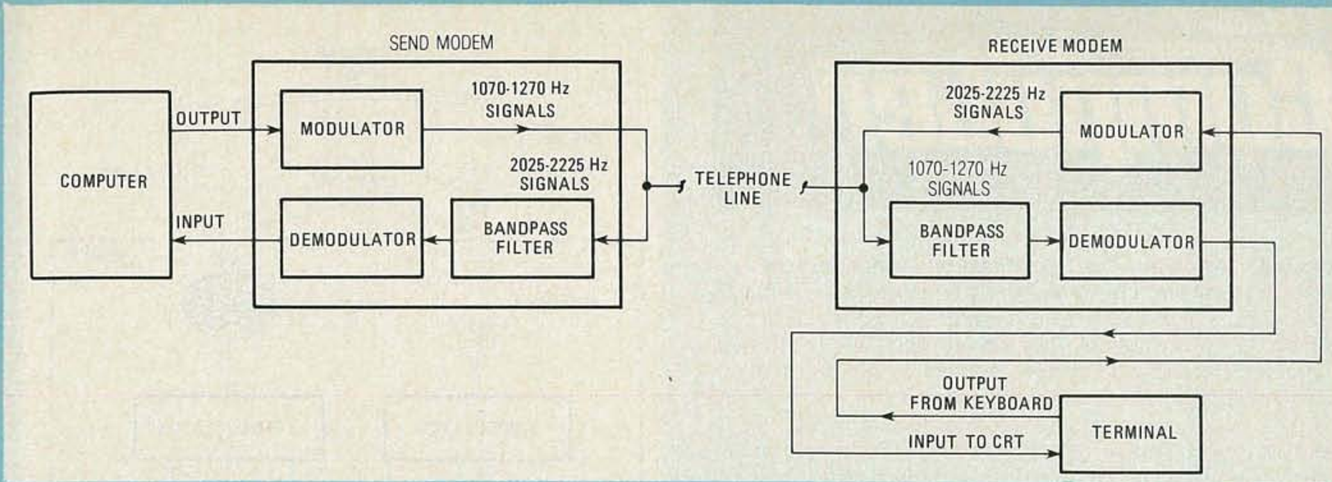


FIG. 9—THIS BLOCK DIAGRAM SHOWS how a modem would be used to transmit and receive data in a full-duplex system.

converted back to logic 0's and the 1270-Hz audio signals to logic 1's, restoring the original string of ASCII-coded pulses.

Now, the operator at the distant location may wish to send data or instructions back to the main computer to answer or respond. The keyboard output, in the form of ASCII-coded pulses, is fed to the modulator at the receiver modem where a logic 0 state generates a 2025-Hz audio tone and a logic 1 develops a 2225-Hz tone. Those audio signals are sent back, along the same telephone wires, to the main computer. At the main computer, a bandpass filter accepts the 2025-Hz and 2225-Hz signals and rejects other tones before they reach the demodulator. At the demodulator, the 2025-Hz and 2225-Hz tones are converted back to their logic 0's and logic 1's. Since two different sets of frequencies (1070-1270 Hz and 2025-2225 Hz) are used together, specially-designed bandpass filters are required to make the full-duplex system feasible using only one set of telephone lines.

Some modems on the market are available as originate only or answer only; although those units are less expensive than modems that include both originate and answer, they are obviously limited in performance.

An originate-only modem converts the logic 1's and 0's to the 1070/1270-Hz tones that are sent over the telephone lines. It cannot, however, receive tones in that frequency range. It can only receive tones in the 2025/2225-Hz tones. Therefore, two originate-only modems cannot talk to each other. This type of modem is the kind that you will probably use with your home computer.

An answer-only modem converts logic 1's and 0's to the 2025/2225-Hz tones, but it cannot receive these tones. It can only receive 1070/1270-Hz tones. Some answer-only modems have the capability to answer the telephone and connect the computer to the telephone line. A modem with answer and originate capabilities can both send and receive data on both tone pairs. That kind of modem can therefore, carry on a conversation with either an originate-only or an answer-only modem.

Synchronous vs. asynchronous transmission

Data is in the form of a stream of logic 1's and 0's, representing letters, numbers, and symbols. As they are transmitted over the telephone lines, some method of synchronization—either synchronous or asynchronous—at the sending and receiving ends is required to maintain the bit code.

Asynchronous transmission involves defining the beginning and end of each individual character or 8-bit byte sent over the lines. The word asynchronous can be misleading since it implies no synchronization. Actually, a begin and end (or start and stop) bit is inserted between each 8-bit word to synchronize the transmitter and receiver; a parity bit is included to detect errors.

THE *MODEL VA3451* direct-connect modem from Racal-Vadic.

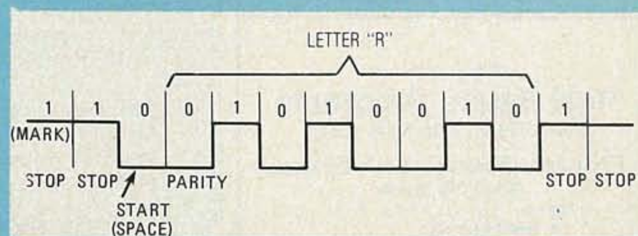


FIG. 10—AN ASYNCHRONOUS TRANSMISSION of the letter "R" with start, stop, and parity bits.

Synchronous transmission does not involve individual timing signals for each character; instead, timing signals are provided for long, lengthy stretches or blocks of data flow. Thus, there are no start and stop bits between characters.

Binary data transmission may be expressed as one of two conditions, mark for a binary 1 and space as binary 0, shown in Fig. 10. In asynchronous transmission, the transmitter rises to a mark condition at the end of each byte and remains at that level until the next byte is heralded by a space; thus, the mark at the end of the byte is the stop bit and the space at the beginning of the byte is the start bit. Those two synchronization bits permit the receiver at the end of the line to lock in or sync with the transmitter. However, an 8-bit byte requires an additional two bits to signal when a byte is arriving and is completed; those bits do not convey data and thus the system is relatively inefficient. The clock or timing signals at the transmitter and receiver are synchonized or locked each time a byte arrives; there may be lengthy periods (in the fast nanosecond world of computers) when bytes are not transmitted. However, as a new byte appears, synchronization will again take place. Asynchronous transmission of the letter "R" with start, parity, and stop bits included, is shown in Fig. 10. If data bits would be sent in a continuous stream, efficiency would be increased. For high-speed data, synchronous transmission is used whereby the transmitter clock triggers the receiver clock and is allowed to run for a lengthy sequence of bytes or blocks of data. Bytes are transmitted in a rapid, steady stream; in the event that gaps occur in the data flow, the transmitter must inject idle-bytes to maintain synchronization. The synchronous transmission system is initiated by a predetermined bit pattern or code sent by the transmitter.

Hard-wired modems vs. acoustic couplers

Modems are available either as hard-wired (sometimes called direct connection) or acoustic coupled. The hard-wired units are connected to the telephone lines directly by means of a plug fitted into the telephone's wall jack. An acoustic coupler, shown in Fig. 11, is designed to accept the telephone handset physically; the analog/digital signals entering and leaving the telephone lines are fed to the modem through tight-fitting, soundproof rubber cups to reduce external noise that might enter and upset transmission. ASCII input (in serial form) from the computer is fed to the modulator which converts logic-0's and 1's to either of two tones, FSK audio signals are converted to logic-1's and 0's by the demodulator to reproduce the ASCII coded information.

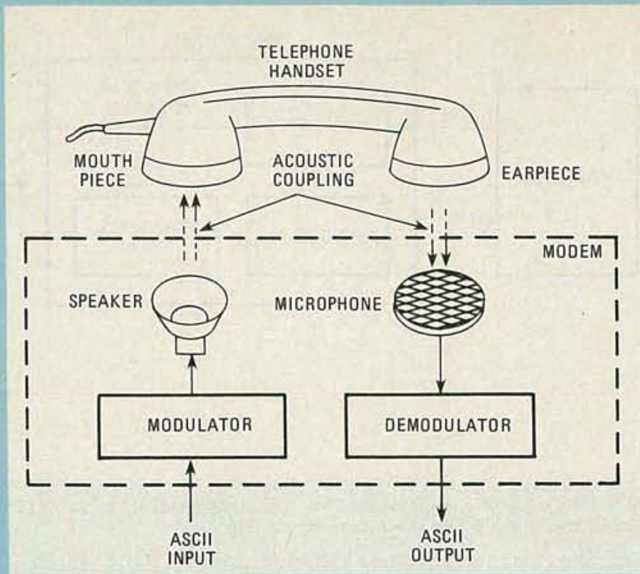


FIG. 11—AN ACCOUSTIC COUPLER is designed to pass and receive information through a telephone's handset.

tightly pressed against the mouthpiece of the telephone handset; the audio tones are then transmitted along the phone lines. Assuming that a full-duplex system is used, incoming audio tones reach the earpiece of the handset, which is closely coupled to a microphone. The two-tone FSK audio signals are converted to logic 1's and 0's by the demodulator to produce the ASCII coded information sent by the distant computer or terminal.

Hard-wired modems are generally more expensive than acoustic coupled types; however, they are not susceptible to external noise interference. A list of manufacturers supplying modems is shown in Table 2. **R-E**

TABLE 2—DIRECTORY OF MODEM MANUFACTURERS

To receive information from the manufacturers listed below, circle No. 99 on the Free Information Card inside the back cover.

APF ELECTRONICS, INC.
1501 Broadway
New York, NY 10036

ATARI, INC.
1265 Boregas Avenue
Sunnyvale, CA 94086

BIZCOMP
Box 7498
Menlo Park, CA 94025

HAYES MICROCOMPUTER PRODUCTS
5385 Peachtree Corners East
Norcross, GA 30092

HEATH COMPANY
Benton Harbor, MI 49022

LEXICON CORPORATION OF MIAMI
1541 NW 65th Avenue
Plantation, FL 33313

LIVERMORE DATA SYSTEMS
2050 151st Place NE
Redmond, WA 98952

THE MICROPERIPHERAL CORP.
2643 151st Place NE
Redmond, WA 98052

MULTI-TECH SYSTEMS, INC.
82 Second Avenue SE
New Brighton, MN 55112

NOVATION
18664 Oxnard St.
Tarzana, CA 91356

OHIO SCIENTIFIC
1333 South Chillicothe Road
Aurora, OH 44202

QUEST ELECTRONICS
P.O. Box 4430E
Santa Clara, CA 95054

RACAL-VADIC INC.
222 Caspian Drive
Sunnyvale, CA 94086

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

TNW CORP.
3351 Hancock St.
San Diego, CA 92110

US ROBOTICS
203 N. Wabash, Suite 718
Chicago, IL 60601

UNIVERSAL DATA SYSTEMS
5000 Bradford Drive
Huntsville, AL 35805

SETTING UP A SYSTEM

Choosing a computer system is very much like getting married—it pays to give it a lot of thought first. Consider these points when making your choice.

WELL, THAT FATEFUL DAY HAS FINALLY ARRIVED: YOU'VE gotten up your courage and decided to go out and buy a home computer system. Just one problem remains—what do you do first? The answer is simple: Ask questions!

Ask questions about the system you intend to buy; ask questions about any dealer that you may do business with; ask *any* question that may help you make an intelligent choice, but most important, ask those questions and get them answered *before* you spend the first dollar.

What questions should you ask? That all depends on your requirements, but the ones listed in "Before you Buy A Computer" elsewhere in this article can serve as a good starting point. Use those questions as a checklist for some of the basic things to consider before making your purchase.

One more point: When you think you know what it is you intend to do with your computer, define your requirements in as much detail as you can. Simply saying that you want your computer to help you with your business is not enough. The more information you can provide a good computer salesman regarding your needs (For example: If you're going to be using it to keep an inventory, how many different items and categories will be involved?), the better he will be able to help you find the system best suited to you.

Putting your system together

Of course there's more to a computer system than just a computer. What's more, the peripherals, software, and incidentals that make up a system can often cost more than the computer itself. The most important thing to keep in mind when you are putting your system together is that the peripherals must be compatible with your computer—otherwise they are worse than useless!

Don't always believe what you're told at the store about compatibility; although most computer salesmen are knowledgeable, there are a few who probably know less than you do. Also, just because a manufacturer says that his product is compatible with a particular system does not necessarily mean that it is.

There are many instances where ambiguous specifications or sudden hardware or software changes have crossed up the best of intentions. If you want to play it safe, insist on seeing a demonstration of all the components of the system you intend to purchase working together. By the way, the same advice holds true for the computer itself—if the computer is delivered in a factory-sealed box, *don't accept it!* All too often, a computer is damaged in transit, so, unless the idea of bringing that bulky box back to the store (and waiting for repair or a replacement) doesn't bother you, it is advisable to have the salesman open the box and make sure the computer is working properly before you take it home.

What you'll need

Let's look at some of the peripherals that you'll need to get the best use out of your computer. For instance, unless you purchase a computer with an integral video monitor (such as the *PET*), you'll need some way to view your programs and their results.

Using your television set is one solution, and that is what is done in many cases. There are some limitations to that approach however, the most serious of which is that the bandwidth of most TV receivers restricts the display size to lines of about 40 characters. If that's all you'll need, fine; otherwise you'll have to obtain a video monitor. With some systems you may require a terminal, which combines a video monitor with a keyboard. Also, if color graphics are important to you, be certain that the monitor you choose is appropriate.

What about disk drives? If you need them, it's best to buy the kind that are already assembled and need only to be plugged in. Unless you are experienced in computer electronics, the do-it-yourself units can be more trouble than they are worth.

A printer is a necessity if you're going to require "hard copy" from your computer. There are two types of printer interfaces: serial and parallel. They differ in the way that they accept information from the computer. A serial printer is recommended if the unit is going to be located more than a few feet from the computer, but it requires an RS-232 interface. Some computers have an RS-232 interface built in, and if yours does, you're all set; if yours doesn't, that is another accessory that you are going to need.

An RS-232 interface is also required if you intend to use your computer with a modem, to communicate with other computers over the telephone.

Everything that we've discussed so far has one thing in common—it all has to be plugged into a 117-volt source... which also means that in the event of a power failure, it will all stop working. If you are in an area where power failures are common, or if your computer system is going to be in continuous use, consider getting a battery-powered backup supply. It can keep things going for about 15 minutes, enough time to shut everything down in an orderly fashion without losing any data. Also, if the power lines in your area are subject to electrical-spike noise, a transient filter would be a good investment.

While we're on the subject of power, you should take care not to overload your computer's power supply. Some computers can accept plug-in boards such as disk controllers, additional memory, communications interfaces, etc. It is possible, in some cases, to plug in a combination of boards that will draw more current than the computer's power supply is designed for. The result is erratic operation at best, and total failure at worst.

Software and incidentals

What we said earlier about peripherals also holds true for software: Make sure it's compatible with your system and that it does everything you expect it to! Have the dealer demonstrate the package in the store and put it through its paces. (Taking this step can also save you some of the time and effort it would take to figure out how it works by yourself.) And when setting up your system, don't forget the incidentals such as paper; disks or cassette tapes, and a place to store them, and the like.

While much of what we've discussed here is simple common sense, in the excitement of buying a computer many people tend to overlook the simple things that are really important. Don't be timid—if you are unsure of anything, ask about it before you buy. Bear in mind what you've just read and you'll greatly increase the chances of making the right decisions. Happy computing! R-E

BEFORE YOU BUY A COMPUTER

Below are some basic questions that you should have the answers to before you purchase any personal computer. Use them as a starting point and add any that are pertinent to your special requirements.

Questions about your computer

1. Is the software you require available for the computer or would you be required to write it yourself?
2. Is the computer supported by software from outside vendors or would you be required to buy it from the manufacturer?
3. Is the manufacturer's documentation (manuals) reasonably complete?
4. Will the dealer and/or manufacturer assist you if you run into problems?
5. Is there a user's group for that particular computer in your local area?
6. Are many manufacturers producing compatible hardware for that computer?
7. What has the hobby press said about the computer?
8. Does that computer have a history of user problems?
9. Is the display's line length long enough? If it isn't, can it be extended?
10. Can the computer grow with your needs? Can additional memory, disk drives, etc. be added as the need arises?
11. If graphics are important, can the computer support them?
12. If color is important, can the computer support it?
13. Does the computer have a standard typewriter keyboard?
14. Does the computer support upper and lower case characters? If not, are accessories available that will enable it to?
15. Does the computer have all the interfaces that you will require, and if not, are they available at a reasonable price?

Questions about your dealer

1. What is his reputation? Will he give you a list of satisfied customers that you can check out?
2. Has he been in business long?
3. Is he responsive to customer needs?
4. Does he have the technical expertise to assist you if trouble should arise?
5. Does he have an in-store service facility?
6. Can he offer a service contract that offers fast response and includes use of a loaner system if yours should go down for more than a day?
7. Does he have a wide selection of software and does he know how to use it?
8. Does he offer training classes?