Universal diskette reader resolves different formats

BILL OTT and JERRY RUOFF, Applied Data Communications Inc.

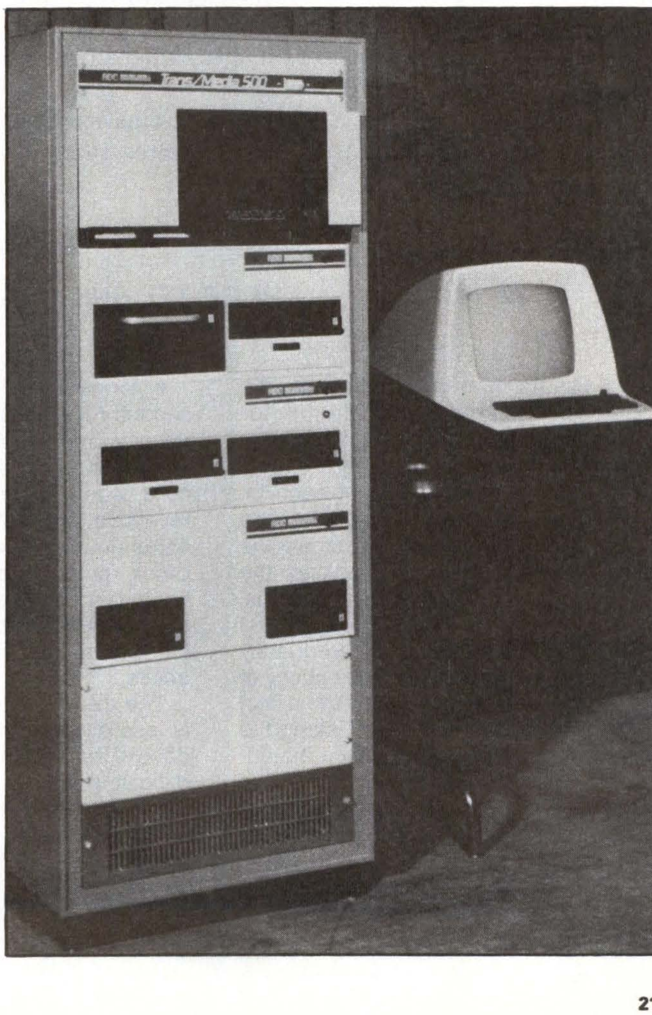
Programs, text and databases can be transported across system boundaries

Different file directories, floppy disk sizes, densities, encoding techniques and timing margins can cause big problems for system integrators and end users who want to use the same floppy disk with different computer systems. New high-capacity disks and uncommon data formats also present logical and physical incompatibilities.

One solution to these problems is the Trans/Media 500 media-translation system from Applied Data Communications Inc. It solves the problem of incompatible media formats by using a Z80A microprocessor and BASIC translation routines to resolve logical format differences. A slave microcontroller translates physical differences between the source and destination diskettes.

Resolving logical differences

The Z80 host processor is bused to 64K bytes of RAM; 4K bytes of EPROM; and controllers for floppy disk drives, magnetic-tape drives, 10M-byte hard disks and line printers. The processor is also linked to four serial asynchronous I/O ports and a fifth port that drives the system keyboard terminal (Fig. 1).



A typical Trans/Media 500 configuration *includes a Cipher Data F880 nine-track, 1600-bpi streaming-tape drive, an 8-in. Memorex 651 floppy disk drive, three 8-in. Shugart 850 drives, a 5¼-in. Shugart 450, a 5¼-in., Micro Peripherals B52 and a Lear Siegler ADM 3A terminal. This configuration is priced at $32,900; the base price of the TM-500 is $15,800.*

The TM-500 is designed for diskette-to-diskette translation, but can also handle as many as four 800- or 1600-bpi tape drives and as many as two 10M-byte hard disks as I/O media. When the system is used as the front end of vendor-integrated turnkey systems (such as phototypesetters, laser printers and computer-output microfilm), the translated output files are sent directly to the host equipment over one of the asynchronous ports.

If the translated data are targeted for systems with floppy disk drives, the TM-500 directs the output to the appropriate disk size. The system accommodates 8-, 5¼- and 3½-in., hard- and soft-sectored, single- and double-sided, single- and double-density, and frequency-modulation, modified-FM and modified-MFM recording diskettes (see "Three techniques for writing a disk," below). Virtually any source/destination combination of floppies, magnetic tape or hard disks is possible.

The host processor manipulates the formatted data files from the source media for input to the destination media. The format-shuffling routines are written in BASIC. Under control of the format-translation programs, the system translates information in four phases. It reads sectors from the source disk to obtain file-directory information, locates source files and their descriptive parameters, such as length, where the file starts, which sectors it occupies and all other data that define source files, creates a file on the destination disk and reads the source records and replicates them as destination files.

Sectors are read one at a time and buffered in RAM. Before being written to their destinations, records are processed by character- or string-translation routines or by any available programmed routines. Each source/destination pair requires an individual task and a specific BASIC program. A total of 90 programs that translate between the most popular disk, tape and port formats is available. Each TM-500 system includes a user-selectable set of six of these programs.

Custom programs can be written on-site or ordered from the factory. The application programs run under Applied Data Communications' MICRO DOS BASIC and typically can be written within a week.

Translating physical differences between floppies

A "formatter subsystem," based on a machine-language program, resolves the physical differences between input and output media. The subsystem is configured with an 8X300 microcontroller, local RAM, ROM and controllable hardware elements (Fig. 2). The formatter off-loads control data from the host and enables the system to read and write more than 230 data formats. Control information for 20 physical parameters is down-loaded from the host in four blocks. The first block establishes physical format parameters, such as the technique for reading or writing data, the number of holes punched in the disk (if it is hard sectored), the number of sectors to be written per track, the number of bytes per sector, the sizes of gaps

Fig. 1. The media-translation system architecture *includes an 8-bit Z80A microprocessor, 64K bytes of RAM, 4K bytes of EPROM and controllers for a wide variety of I/O devices. These elements are linked via an Applied Data Communications proprietary bus. The Z80A resolves logical differences, and the formatting subsystem handles physical differences between diskettes.* ►

THREE TECHNIQUES FOR WRITING A DISK

• **Frequency modulation** is the earliest successful technique for encoding data. The two rules for FM data recording are that there should be a pulse in the middle of each bit cell that contains a logical ONE and that an additional pulse must mark the start of each bit cell, making the technique self-clocking and, thus, very stable.

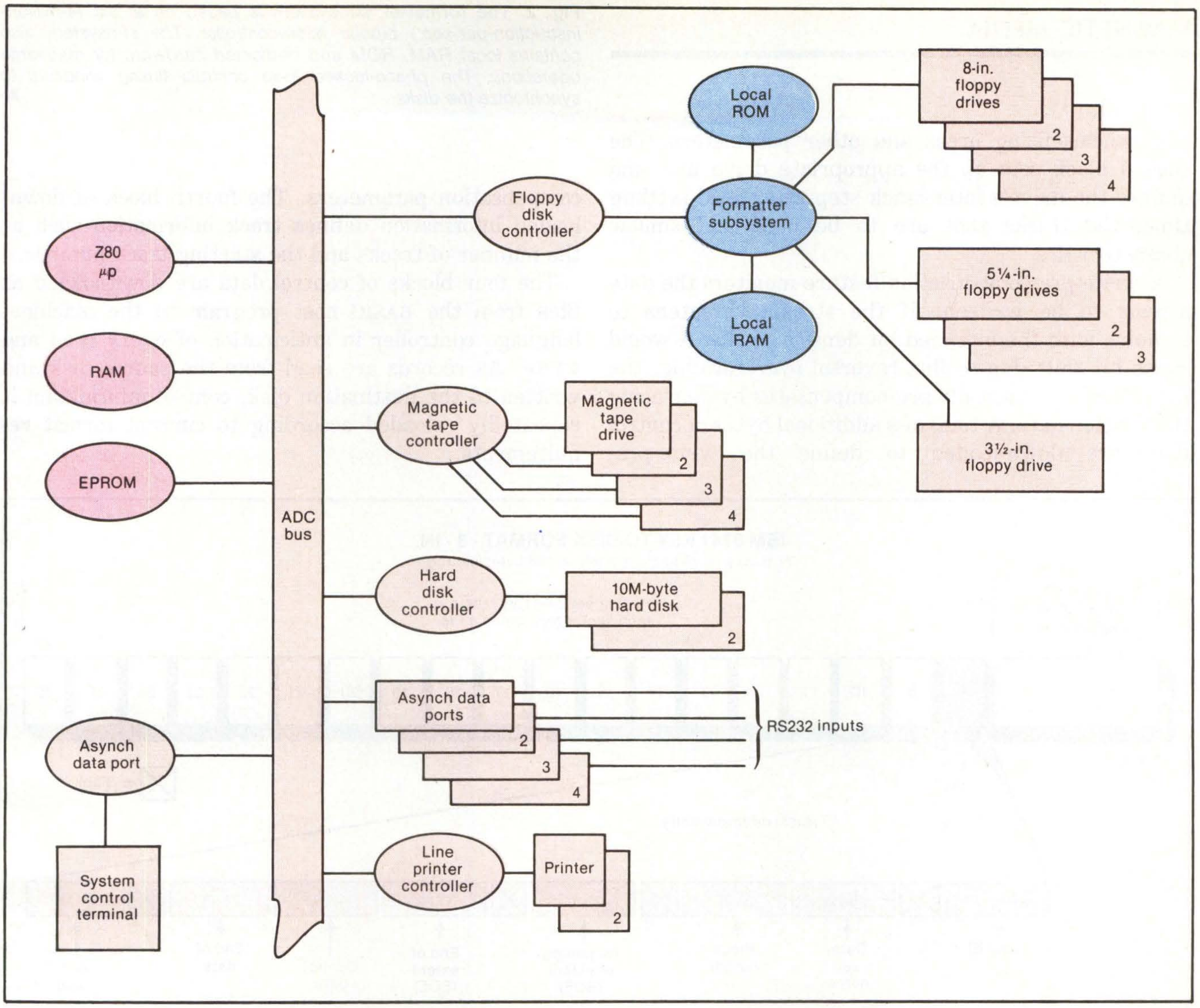
The technique is called "frequency modulation" because the frequency of read pulses is modulated by the mix of ONEs and ZEROs appearing along the recorded track. The primary advantage of FM recording is the stable clocking of the drive's read electronics; the primary disadvantage is an inefficient use of recording space. Disk density is decreased because of the space used by the clock pulses.

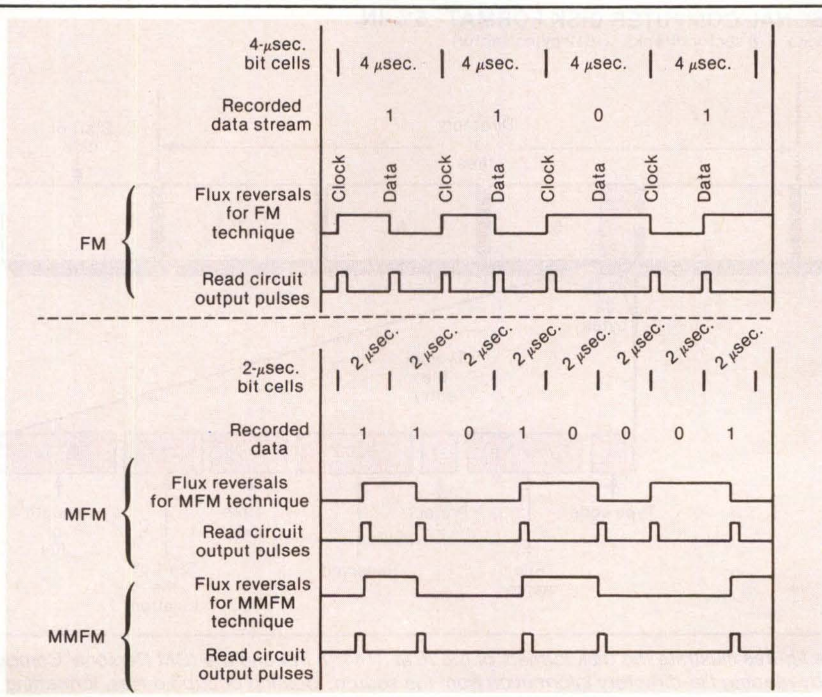
• **Modified FM** modifies FM's second rule to increase the useful bit density on recorded tracks. MFM records clock pulses only between bit cells when there are no data flux reversals within the cell. This eliminates double pulses for each bit cell. Clock pulses appear only at the beginning of cells containing ZEROs that follow other ZEROs. This doubles the information capacity of recorded tracks.

The disadvantage of this technique is less accurate timing control of the drive's read circuits, making it more difficult to decode data properly. This requires more complex timing circuits, which translates into higher cost. However, the benefits of more memory capacity and a higher data rate justify the increased price.

• **Modified MFM** was developed to decrease bit shift due to flux reversal overcrowding, which occurs when overcrowded bits on a magnetic media begin to push themselves out of position. This phenomenon is largely a result of high linear bit density. In MMFM recording, FM's first rule—a pulse in the middle of a bit cell defines a ONE—remains the same, but the second rule is modified to reduce the incidence of overhead clock pulses. If three ZEROs appear in a row, a clock pulse is recorded only at the beginning of the second bit cell.

Timing diagrams for three recording techniques *illustrate the advantages of MFM over FM recording—twice the data density and fewer read-circuit pulses. The slight advantage of MMFM over MFM recording does not justify the added cost.*





The intent of MMFM was to improve the read margins for still more density, but the use of MMFM became a moot point when IBM Corp. adopted MFM and established it as a de facto standard. MMFM's additional data capacity and lower error rate were not cost-justified.

In addition, semiconductor firms entered the market by introducing integrated-circuit controller chips that are programmable for FM and MFM, but not for MMFM. MMFM technique has fallen into disuse because of costly drive electronics, stress on the read circuits, the availability of off-the-shelf ICs for FM and MFM and IBM's de facto standard.

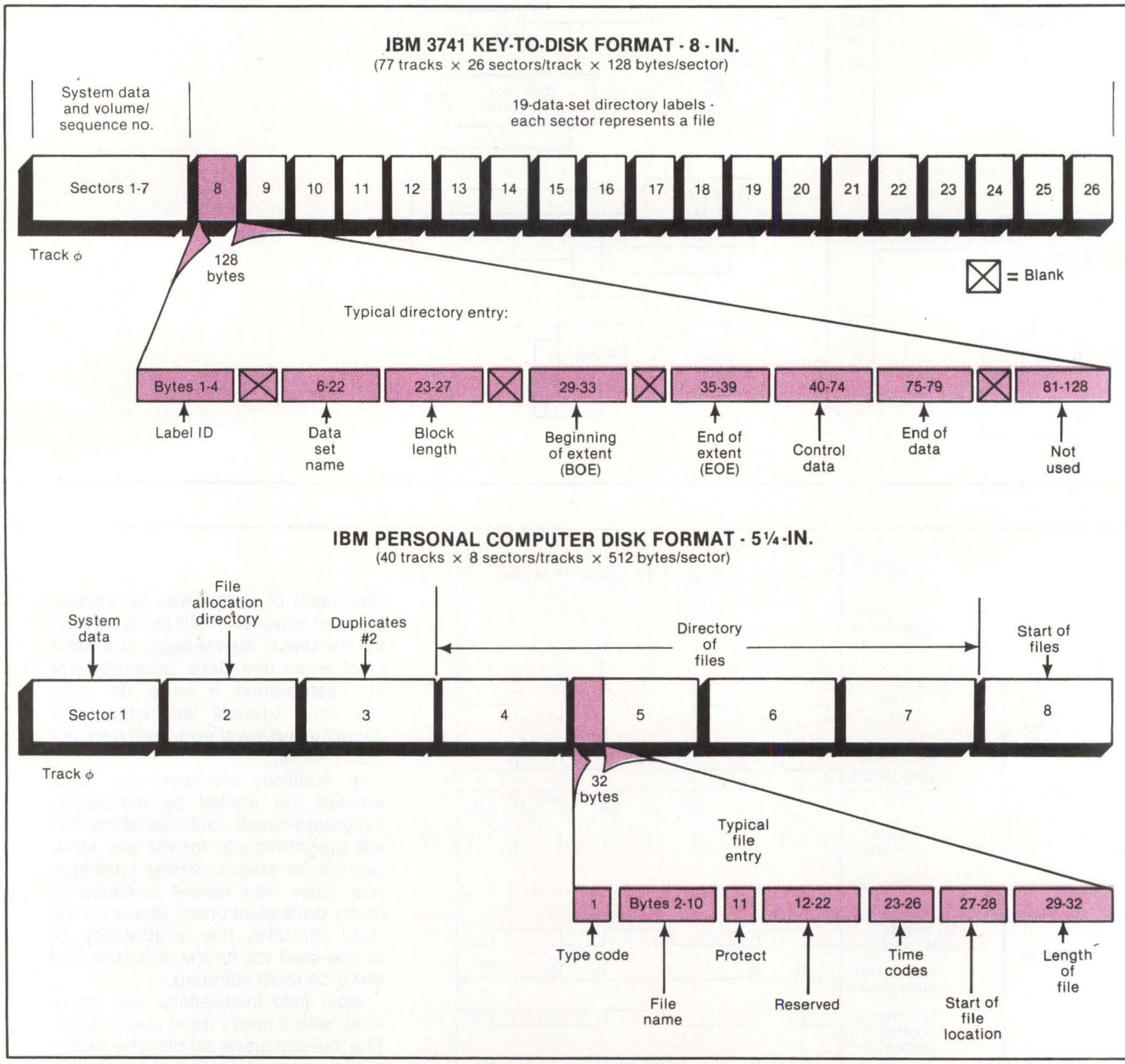
Most field installations use FM or MFM, with a heavy trend toward MFM. The TM-500 universal diskette reader can accommodate all three recording techniques.

Fig. 2. The formatter subsystem *is based on a fast (4-million-instruction-per-sec.) bipolar microcontroller. The subsystem also contains local RAM, ROM and dedicated hardware for read/write operations. The phase-locked loop controls timing windows to synchronize the disks.* ➤

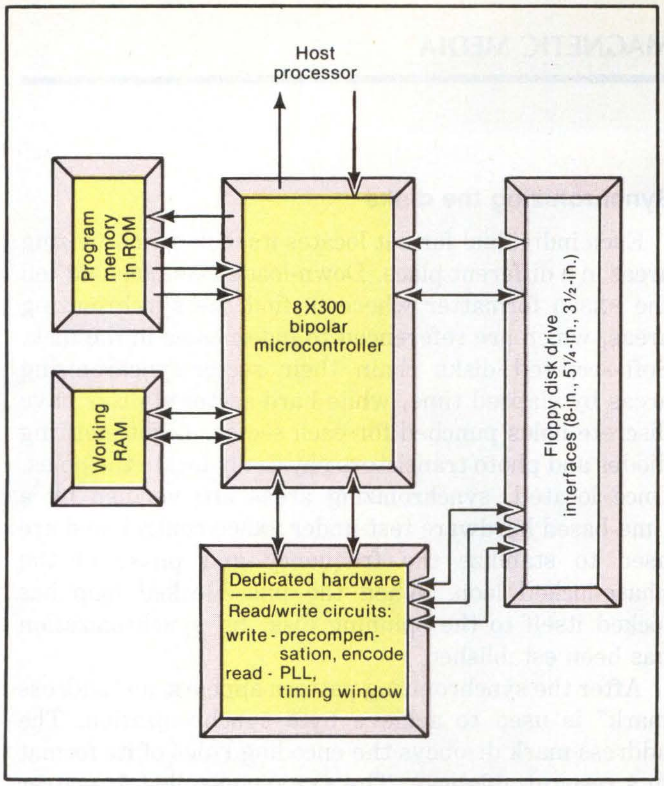
and synchronizing areas and other parameters. The second block sets up the appropriate drive unit and defines the drive's inter-track step rate, head settling time, the tracks that are to be used and similar characteristics.

A write-pre-compensation feature monitors the data stream to be written. If the stream threatens to combine with the intended bit density so that it would cause bit shift due to flux-reversal overcrowding, the formatter automatically pre-compensates by displacing the written data. A total of 8 additional bytes of control data are down-loaded to define the write-pre-compensation parameters. The fourth block of down-loaded information defines track information such as the number of tracks and the starting track number.

The four blocks of control data are down-loaded as files from the BASIC host program to the machine-language controller in anticipation of every read and write. As records are read from the source disk and written to the destination disk, control information is repeatedly reloaded according to current format requirements.



Formats vary widely, even within IBM. *The above figures illustrate the disk formats of the IBM 3741 (8 in.) and the IBM Personal Computer (5¼ in.). The TM-500 resolves the different formats by reading file-directory information from the source, locating occupied files, formatting the destination disk and transferring the source records to the destination disk.*



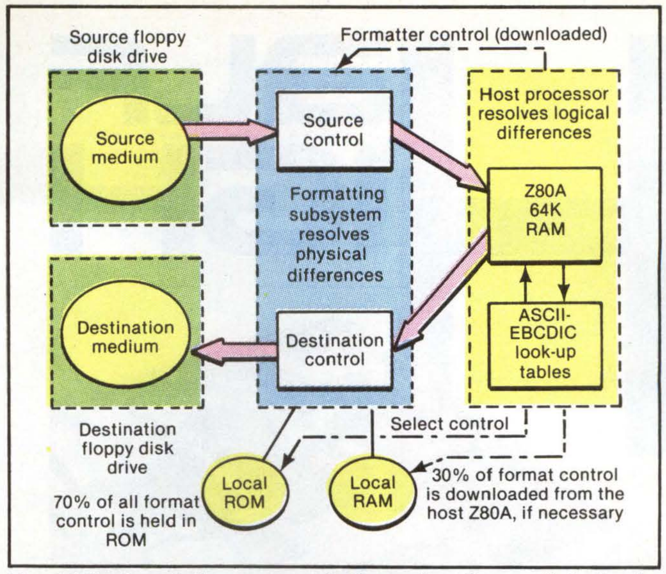


Fig. 3. The translation process between two floppy disks *begins with the formatting subsystem reading the file directory information from the source medium. Formatter control information is downloaded from the host. Source records are buffered and manipulated in the Z80A under control of BASIC translation programs. Records are then written to the destination medium via the formatting subsystem according to physical requirements.*

Control files down-loaded to the microcontroller's RAM evoke subroutines stored in ROM. About 70 percent of all formatting control is held in this firmware; the balance is down-loaded from the host's BASIC program when needed and is executed directly from RAM (Fig. 3).

Read/write control is exercised at the drive level by dedicated hardware in the formatter subsystem designed around a phase-locked loop that is time-locked to a synchronizing pattern on the disk in use.

The phase-locked loop controls the timing windows through which valid ONEs and ZEROs are read from the disk in use.

CP/M machine	Tracks per in.	Recording technique: FM	Recording technique: MFM	Disk size (in. diameter)	No. of tracks	Sectors per tracks	Bytes per sector	Sector interface scheme*	Directory location (track no.)	Directory size (bytes)
Digital Research (original)	48	•		8	77	26	128	n = 5	2	2048
IBM - double side	48		•	8	77	8	1024	3	2	8192
IBM - single side	48		•	8	77	8	1024	2	2	4096
Intertec Superbrain	48		•	5¼	35	10	512	1	2	2048
Osborne I	48	•		5¼	40	10	256	1	3	1024
North Star	48		•	5¼	35	10	512	4	2	2048
Televideo - double side	48		•	5¼	40	18	256	0	2	2048
Xerox 820	48	•		5¼	40	18	128	10	3	1024
DEC personal computer	48		•	5¼	40	9	512	4	2	2048

* Logically adjacent sectors separated by (n) physical sectors to reduce the effects of latency time.

All CP/Ms are not created equal. *Applied Data Communications' newest announcement is a selection of off-the-shelf software packages that resolve the differences in CP/M operating systems as implemented in the above computers. Prices range from $500 to $1000.*

Synchronizing the disks

Each individual format locates its disk-synchronizing areas in a different place. Down-loaded control data tell the 8X300 formatter where to find the synchronizing areas, which are referenced to index holes in the disk. Soft-sectored disks chain their sector-synchronizing areas by elapsed time, while hard-sectored disks have discrete holes punched for each sector. Light-emitting diodes and photo transistors physically locate the holes. Once located, synchronizing areas are verified by a time-based hardware test under 8X300 control, and are used to stabilize the frequency and phase of the phase-locked loop. When the phase-locked loop has locked itself to the spinning disk, bit synchronization has been established.

After the synchronizing pattern appears, an "address mark" is used to achieve byte synchronization. The address mark disobeys the encoding rules of its format in a recognizable way. The 8X300-controlled formatter seeks the address mark and begins reading the source records as meaningful data.

When writing output data to the destination disk, the TM-500 operates in reverse, constructing the new format according to specifications established by the sponsoring firm. The BASIC program in the system's Z80 host down-loads control data to the formatter subsystem to locate synchronizing areas, address marks and other elements of the required destination format. No modifications are made to the software in transit. □

Bill Ott is vice president of transmedia products and **Jerry Ruoff** is vice president of engineering at Applied Data Communications Inc., Tustin, Calif.

NEXT MONTH IN MMS

The October issue of Mini-Micro Systems spotlights memory systems. MMS will cover both main (semiconductor) memory and external magnetic storage devices, concentrating on new memory management architectures and small Winchesters.

Other editorial features will include:

- A survey article, complete with extensive charts of manufacturers' offerings will address memory including disk emulators and printer buffers.
- A look at Shugart's new optical disk drive, which packs 1G byte onto a 12-inch disk.