

The TEC-86 16-Bit Computer System

by Chris Terry

The TEC-86 computer system, manufactured by TecMar Inc., is a general-purpose microcomputer system using the new Intel 8086 16-bit microprocessor. The rugged metal enclosure houses a heavy-duty power supply, an S-100 motherboard with twelve slots, and two Shugart SA800 8" floppy disk drives. The basic system is supplied with:

- CPU board equipped with an Intel 8086 microprocessor running at 5 MHz (4 or 8 MHz options available), an 8259A priority interrupt chip, and power-on jump circuitry;

- 32K of 300nS static RAM on two 16K boards, expandable to 1 Megabyte; available as an option is a single 64K dynamic RAM board at the same price as four 16K boards.

- PROM I/O board equipped with two 8251A serial ports capable of handling synchronous or asynchronous RS-232 data links at transmission speeds of up to 19,200 baud, an 8255 chip that provides 24 lines of parallel I/O, and sockets for 2K x 16 of PROM;

- Microbyte single/dual density disk controller, based on the NEC 765 LSI controller chip and capable of supporting up to four drives.

The price for the basic system is \$3990; additional 16K memory boards are available at \$395 each.

Hardware Documentation

The manuals supplied by TecMar for each board in the system are very good. They supply complete logic diagrams which, though reduced to half the original size, are clean and readable, as regards both lettering and layout. They are also split into convenient one page chunks, each of which contains one or more complete functions; connections that have to cross page boundaries are brought to the left or right edge of the diagram and are plainly visible. Pin connections and cabling to the outside world are clear and have text clarifications where necessary. On-board jumpers to select options are similar to those found on disk drives—contact pins which are connected together by jumper connectors in plastic covers. The placement of jumpers is both described and illustrated

for each option, and the user should have no difficulty in setting up or changing the jumpers correctly. Switch settings are defined as "Open" or "Closed" according to the marking on the switches, and there are clear statements as to whether a switch closure represents a 1 or a 0 on the associated line.

The theory sections contain enough detail to clue in a person who already has a fair amount of hardware experience, and are enhanced by simplified logic diagrams of functions that might otherwise be difficult to understand. This is a most welcome change from so many other manuals where highly detailed and dense descriptions refer to equally dense fold-outs, with no clue as to where in the drawing to look.

TecMar is to be congratulated on these manuals. They have obviously hired professional writers and given them reasonable time and budget to do a first class job. The language is just informal enough to be readable without losing exactness, and clarity has been made a prime goal.

I found only one typographic error (the notorious "intergrated" chips, which conjures up visions of elves diligently grating cheese into the inter-chip spaces). And only one factual error—which in any case is not calamitous—the I/O board manual calls out RS232 signal levels as +5 to +15 volts for a Mark (1) and -5 to -15 volts for a Space (0). In fact, the RS232-C spec defines the signal level limits as 3 volts to 25 volts in either direction relative to signal ground; the positive level is a SPACE (0) for a data line and ON for a control line, whereas the negative level is a MARK (1) for a data line and OFF for a control line.

The Software

Software to support the TEC-86 consists of CP/M-86 from Digital Research, Inc., and Basic-86 from Microsoft, Inc. TecMar also has Pascal/M-86 from Sorcim available as an option. Mention is made in the PROM I/O board manual of a system monitor for which the PROM sockets are intended, but this does not appear on the current price list. The PROM in the evaluation system contains the CP/M-86 bootstrap and disk primitives, but no monitor accessible to the programmer. It would not be necessary,

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since the CP/M-86 DDT is perfectly adequate for this purpose.

CP/M-86

This operating system is functionally equivalent to CP/M Version 2.X for the 8080/Z80 systems. The differences are due mainly to the use of separate memory segments for code, data, and stack, and the addition of function calls—CP/M-86 has 59 function codes, compared to the 36 of CP/M-80 Version 2.X. Page 0 is used for the same purposes as in CP/M-80, but the operating system is usually loaded at 400H, directly above the interrupt locations. You can, however, change this location. Relocatable transient programs load above the operating system, starting at 2A00H. Unlike CP/M-80, CP/M-86 does not use absolute locations for system entry or default variables; instead, entry to BDOS takes place through a software interrupt, and entry to BIOS is by a new function call. Most of the new function calls are related to the allocation or releasing of memory.

Because of the additional BDOS functions and a larger BIOS, CP/M-86 is too large to fit on two single-density tracks, though it fits comfortably on two double-density tracks. If single-density is used, the bootstrap loads only the cold-start loader; this in turn loads CP/M-86 from the file area (not the system tracks). A warm start is somewhat simpler than in CP/M-80, since you are not required to reload the CCP and BDOS. Further, relocation of the system is somewhat simpler because relocatable code is used. Thus, there is no MOVCPM utility; the only change is to the cold boot, telling it where to start loading the operating system.

The standard system supplied by TecMar is configured to run in a 64Kbyte memory; however, the distribution disk also contains systems to run in 32K or 96K.

CP/M-86 Documentation

As the Duke of Gloucester remarked when presented with Volume 4 of *The Decline & Fall of the Roman Empire*: "Another damned thick, square, book! Always scribble, scribble, scribble! Eh! Mr. Gibbon?" The TecMar system documentation consists of a six page leaflet describing how to boot up the system (simplicity itself—turn on power, hit RESET, put the disk in the A drive, and close the door!), how to format disks for single or double density, and how to copy the system tracks, for which TecMar has provided utilities to suit the Microbyte controller and formats.

Digital Research has been (necessarily) more lavish. In addition to the *Introduction to CP/M Features and Facilities*, *The CP/M 2.2 User's Guide*, and *The Ed User's Manual*, which are standard for all versions, there is a huge amount of completely new material. *The CP/M-86 Reference Guide* has 138 pages, *The ASM-86 User's Guide* has 75 pages, and *The DDT-86 User's Manual* has 19 pages. *The CP/M-86 Reference Guide* is, like most Digital Research manuals, a tough nut to crack. All the required information is there, but it's not always easy to find. The definitions of BIOS routines and BDOS function calls are easy—they are presented in order, concisely, and reasonably clearly. It's the mass of other information that causes me trouble. I wish I knew why. I cannot complain that the manuals are badly written or disorgan-

ized. Individual sentences are perfectly clear, and there is organization. But it always takes me more time than I like to find what I am looking for. What is frustrating is that I cannot think of just how the manual could be better organized. I suppose you just have to read and read and read until you know it almost by heart, and then your brain goes "Click!" and the pieces drop into the places in your brain from which you can most easily retrieve them. Perhaps an index would help?

Performance

For me, the TecMar system has behaved in an exemplary way. I unpacked it, spent three or four hours with the manuals, plugged it in, connected a Lear-Siegler ADM-3A terminal set for 19,200 baud (as instructed), booted up, and away we went. Operationally, the instructions were clear and simple. Except for copying single-density Basic-86 to a double-density working disk, which gave me a little trouble at first, it's just like running CP/M 2.2 and Basic-80.

I have not yet found a huge increase in speed, but that is because I have not yet gotten to any real number-crunching in A86. Basic-80, as I understand, is a simple translation of the interpreter from 8080 language to 8086 language, without optimization to make use of the special features of the 8086 CPU and architecture. Thus, when I loaded my Basic program for testing sorting routines, the interpreter (which runs on a 5-MHz clock) executed Bubble, Heap, Shell-Metzner, and Quick sorts in a shade less than half the time it takes on my 2 MHz 8080 machine using Basic-80. For 200 random numbers, the Bubble sort took 148 seconds instead of 310, Heap took 32 instead of 67, Shell-Metzner took 34 instead of 71, and Quick took 17 instead of 34 (average of three runs each). But I suspect that a Z80 running at 4 MHz would have done nearly as well.

However, I am sure that the speed advantages will be seen when there is more software around that is optimized for the 8086. A nice screen editor like Wordmaster, for example. ED is for the birds unless you still have a Teletype, and I am thankful to hear that impending CP/M-80 Version 3.X will have a screen editor. If an 8086 version also appears that uses the magnificent string handling capability of the 8086, it will probably be a joy to use.

Conclusions

The TEC-86 is rugged, easy to get going, has given me no hardware problems and only minor software puzzlement (I didn't read the manual carefully enough to start with). A price tag of \$4600 (which includes 64K of RAM, CP/M-86 and Basic-86) is probably too much for the average hobbyist. But for a small business or a professional user it will be extremely good value, once the software starts being available. And don't forget that there is much more available right now than you might think—you can run any existing Basic-80 program on the 8086, provided that you save it on a single-density disk as ASCII source code. As you may have gathered, I like TecMar's product and their hardware manuals. I wish I could afford it for myself!

Available from: TecMar, Inc., 23600 Mercantile Rd.,
Cleveland, OH 44122, (216)382-7599.
