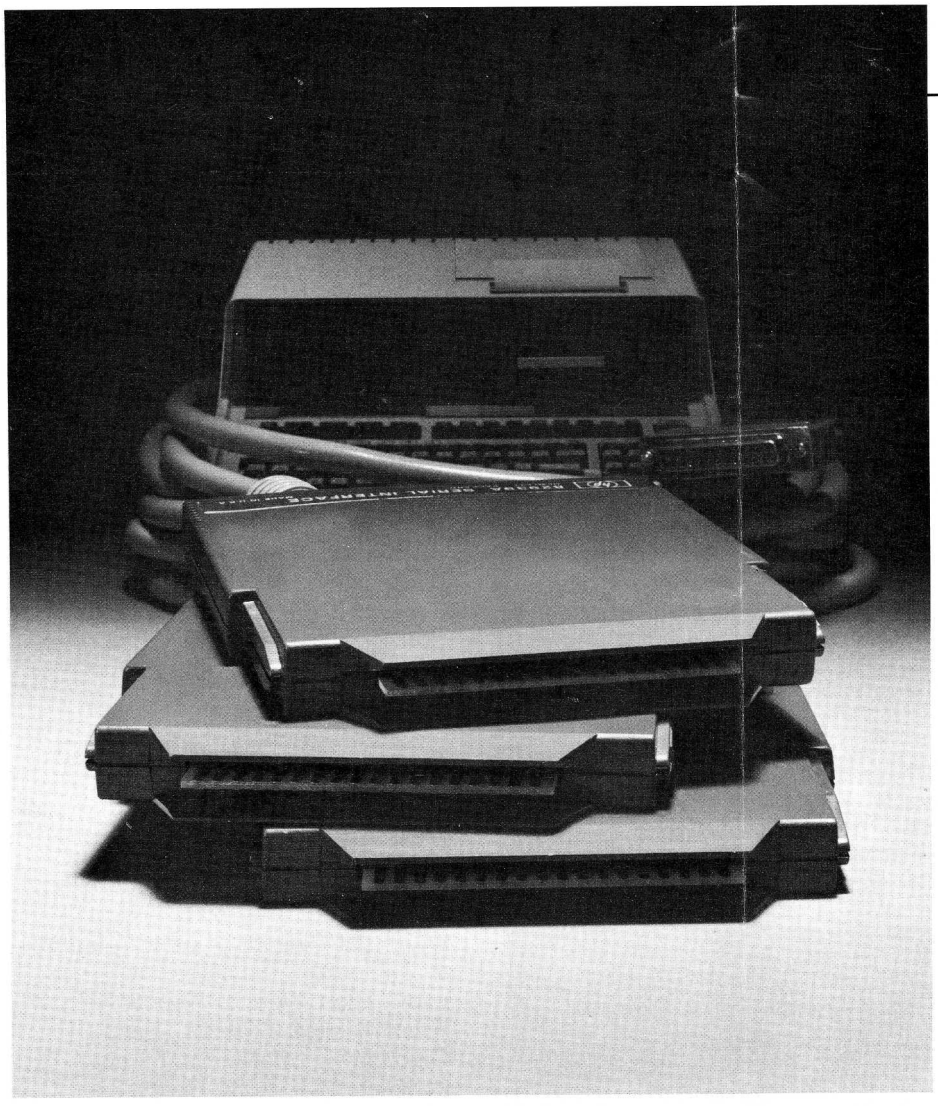
Adding I/O to the HP-85



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A major reason for the popularity of desktop computers is that they are designed to make computing easy for people — human interfacing is optimized.

The HP-85 may be the best example of this concept. It is compact and powerful, yet provides all of the necessary human interface devices (keyboard, CRT display, printer and tape cartridge) for solving a variety of computational problems (see *Keyboard*, Jan/Feb 1980).

For a great many tasks, this self-contained configuration is all that is needed (see Figure). But there are two areas for which this scheme must be altered. Such changes in human interfacing are the reasons for adding external input/output (I/O) to the HP-85.

Augmenting human interfacing

One of these two groups of tasks requires peripheral devices with more powerful characteristics than those inherent to the HP-85, such as a page-width multiple-copy printer, or a full-size graphics plotter with multi-color capabilities. Other applications may require that the HP-85 be able to communicate with other desktop computers, minicomputers or full-size mainframe computers.

Adding external peripherals to supplement internal peripherals augments the ability of the computer to interact with people.

Eliminating human interfacing

A second group of tasks makes elimination of the human interface desirable. In data acquisition applications, some measurement instruments can communicate directly to the computer, eliminating the need for manual data entry through a human interface.

Communicating directly with instruments, not only acquiring and performing data analyses, but also making decisions and providing feedback to modify operation of the system, is the definition of a controller, or I/O computer. This requires a different type of I/O, one not optimized for human interaction.

In order to add I/O capability to the HP-85, two distinct elements are required. First, a piece of hardware known as an interface card is required to provide electrical, mechanical and timing compatibility with the device to be connected to the desktop computer.

Second, a piece of firmware (microprocessor program) known as an I/O ROM is required to add new statements to the BASIC language. These statements give the applications programmer access to the interfaced device.

In the back of the HP-85 are four slots which allow add-on ROMs, add-on RAM (user read/write memory), and interface cards to be connected to the internal memory bus (see Figure 1). A single ROM

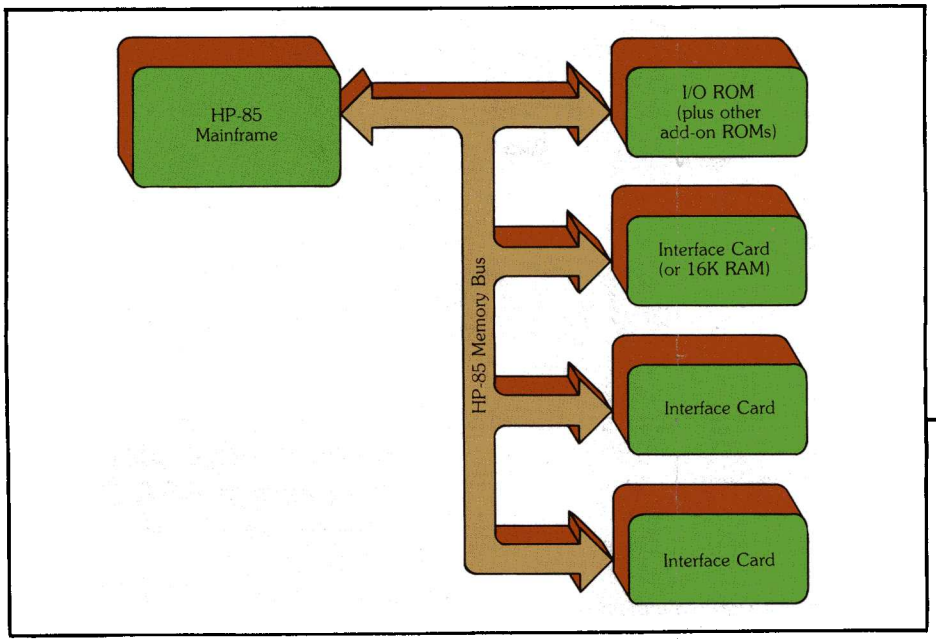

Figure 1.

drawer plugged into one of these slots can contain the I/O ROM and up to five other add-on ROMs. Thus, a typical interfacing configuration can include a ROM drawer and three interface cards or the add-on RAM module and two interface cards.

I/O cards

The most general-purpose interface card is the 16-bit GPIO card (parallel). Sixteen TTL-compatible input lines and 16 open-collector output lines, plus a variety of status, control and handshake lines make this card a workhorse. A variation of the card, with input lines organized into four-bit nibbles, is called the BCD card. It will allow interfacing devices whose data is encoded in binary-coded decimal format.

A third type of interface card is designed to connect the HP-85 to serial I/O devices using either RS-232C or 20 mA current loop configurations. This card will also allow the HP-85 to be connected to terminals, modems or a host computer.

A fourth interface card, and the first to be introduced, is the HP-IB card, the HP-85's implementation of the IEEE-488 instrumentation bus standard. Using this card, the HP-85 may be used to control up to 14 IEEE-488 compatible instruments in data acquisition and control applications. With HP-IB systems, applications such as gathering and analyzing measurement data, production line monitoring, and product testing can be automated easily.

The HP-IB card itself contains an 8049 microprocessor which makes possible a complete and powerful implementation of the bus standard. This card can act as either the controller of all the other HP-IB compatible devices on the bus, or as a non-controller responding to the commands of another controlling device on the bus.

A bidirectional interrupt capability makes it possible not only for the card to interrupt the HP-85 to inform it of events occuring on the bus, but also for the HP-85 to interrupt the card to obtain bus status information or abort a process, even when the card is busy performing bus operations.

I/O ROM

Making the capabilities of the interface cards available to the BASIC language program in the HP-85 is the task of the I/O ROM. The HP-85 itself provides such statements as PRINT, DISP and INPUT for accessing the internal peripherals.

When external peripherals are added, their wider range of capabilities requires more extensive BASIC language statements. The I/O ROM expands the BASIC language by increasing the number of statements and functions that can be recognized and executed.

Almost all computers provide language extensions for the output of data to a device or the input of data from a device. These BASIC language OUTPUT and ENTER statements are usually sufficient for communicating with external peripherals.

Control applications, however, may require other methods of transferring data and control information. This is important where timing is critical and the speed of the external devices and instruments may not be well matched to the speed of the computer.

For example, considerable time may be wasted waiting for data from a slow device. The HP-85 I/O ROM provides a mechanism to interrupt the program when data is available, freeing the computer to perform other tasks.

Typical applications would be the analysis of data from relatively slow activities such as traffic control, chemical titrations, environmental control or production line monitoring.

At the other end of the time scale are applications which require capturing a burst of data from rapidly changing events. Normally, each data point is entered into the computer and converted to the internal format before the next data point is read.

The HP-85 I/O ROM provides a fast read/write mechanism in which a bust of data may be placed in a buffer and the conversion to internal format delayed until the data capture is complete. In burst mode, data may be transferred at rates in excess of 20K bytes per second. Typical applications include examination of data from fast real-time events and waveform analysis.

Thus, the HP-85 makes available for the first time in a low-cost unit the same kinds of powerful interfacing and control capabilities previously found only in more costly desktop computers. K