THE 8031/8731 MICROCONTROLLER

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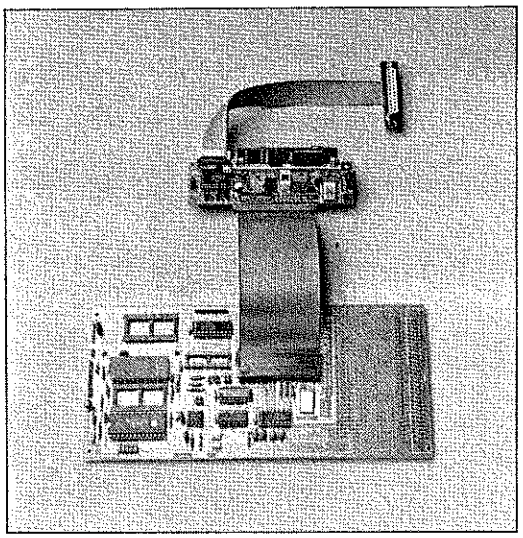
The single-chip micro seldom appears in hobbyist and amateur electronics projects in its true minimum form. The primary reason for this is the difficulty of developing code for the projects without specialist equipment, that is, the high cost of an ICE (In Circuit Emulator). Projects based on the 8031 microcontroller appear fairly regularly, but normally the 8031 is configured to run in its expanded memory mode. The amateur may not have encountered these terms before, and a brief description of the 8031 will, therefore, be given together with that of the EPROM version of the processor—the 8731.

The 8031 is a classic 8-bit microcontroller, with 64 Kbytes of external memory. The memory may be doubled to 128 K if the Harvard architecture is used. A Harvard architecture is defined as a separate data and program memory. The processor has an additional 128 bytes of internal memory and a variety of useful peripheral devices. The EPROM version of the processor incorporates some of the external program memory internally, starting at address 0, which is the power-up address.

If the on-chip EPROM memory (2 K, 4 K, 8 K, or 16 K, depending on part number and manufacturer) is adequate for the target application code and 128 bytes is sufficient for all the variables, program sub-routine stack, and the interrupt stack, the processor can be used in single-chip mode. As a consequence of this, the pins that were used to drive the address and data bus for controlling the external RAM and EPROM can now be used as parallel ports, that is, as general-purpose input/output. In single-chip mode, all of the parallel ports may be used, although some pins are multi-functional, i.e., timer inputs, serial receiver, serial transmitter, interrupt pins, etc. When the processor is used with external RAM or EPROM, the processor is said to be operating in expanded mode.

The average amateur application requires digital I/O, a timer, RAM and EPROM. Armed with these tools, he can tackle most controller applications. It therefore makes sense to consider the microcontroller with on-board EPROM. To build a minimum stand-alone system, a crystal, a PCB or hand-wired board, decoupling capacitors and some tie-up resistors are the only devices required. One Time Programmable—OTP—devices are standard EPROM-based microcontrollers with no quartz window, since that is used to erase the on-chip EPROM. The quartz package is expensive, but OTP devices offer low cost for low-volume production runs, prototypes and amateur applications.



Given all of the above advantages, why are there no single-chip micro projects? Simple: code development!

To develop code for single-chip micros, there are several budget related routes. The route opted by the professional is to rent or purchase an ICE. Typically, this may cost between £1,000 and £5,000, well beyond the means of the poor, old amateur.

The low-cost option is to purchase an EPROM device with quartz window. The code is written, compiled or assembled, downloaded to an EPROM programmer (additional investment may be required for the programmer) and the microcontroller EPROM programmed. The typical one-off cost of a quartz window EPROM microcontroller is £30 to £80, depending on the size of the EPROM. If a single device is purchased (minimum cost solution), when the code fails—as it surely will—the microcontroller EPROM must be erased. The EPROM erasure time (additional cost for the eraser!) will typically take 20 minutes, resulting in a minimum turn-around time of about half an hour at best.

The next problem is testing. To debug the minimum cost route, the processor is programmed, inserted into the target PCB and the power is applied. If the system works: eureka; otherwise go back to the software listing and start guessing. No real debugging information is available. The on-chip serial port can be used to provide diagnostic data, but only when the code to drive the serial port has been debugged. To configure the serial port, the baud rate, stop bits, start bits, et al, have to be initialized with the use of the 8031 special function registers, which are controlled by the timer rate register, timer mode register, serial mode register, and so on. To get all these configured correctly is for the newcomer an extremely daunting task, especially of no suitable tools are available.

Another route is to buy a version of the processor with the on-chip EPROM connected to a socket mounted piggy-back on the processor. An EPROM emulator can then be used to download the code into the PC. The cost of this route is, of course, higher, but the turn-around time is significantly shorter. The feasibility of this route is governed by the manufacturer and the company's policy on producing piggy-back devices.

The professional's life, however, is considerably simpler. To learn how to program the microcontroller, small example routines may be cobbled together, loaded into the ICE and executed. If the code fails, it can be re-executed one line at a time using a single-step instruction. By observing the memory and register contents, the action of the code may be monitored. The turn-around time for the professional is minutes. As such, learning by experimentation is positively encouraged, and the learning curve is reduced.

Dallas Semiconductor manufacture a range of 8031 microcontrollers with a difference. These devices have 8 K/32 K of

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