

Input/Output (I/O) Interfaces and On-Chip Features

I/O Interfaces

An I/O interface is a physical port that provides a way to get data into and out of the microcontroller.

Both parallel and serial buses are provided on most products.

Parallel buses permit interfacing to external RAM or ROM if needed as well as other circuits and devices.

The I/O may be programmed or memory mapped.

Serial buses now predominate because they cut pin count to a minimum and address the growing number of external devices served by serial I/O.

Parallel Buses

Some 8-bit controllers have standard data and address buses like a microprocessor to add external memory or I/O interfaces.

The data bus is usually 8-bits.

The address bus is 16-bits allowing $2^{16} = 65,536$ (64kB) external memory locations or I/O ports to be addressed.

A general purpose I/O (GPIO) bus, a bidirectional parallel port with 4 or 8-bits, is commonly available.

Miscellaneous input and output control lines called the control bus are also available.

Serial I/O Interfaces

Serial interfaces are preferred in most controller chips as they require fewer pins to implement, usually a data line and a clock line in addition to ground.

A UART or serial data port is usually available on most versions. This port implements the long popular but slowly fading RS-232 serial data interface.

Other common serial interfaces are I²C, serial peripheral interface (SPI), and controller area network (CAN).

I²C is a simple 3-wire serial 10 kbps to 400 kbps interface made for controlling or monitoring other nearby chips.

Serial peripheral interface (SPI) is another 3-wire serial port offering speeds to 20 Mbps.

Controller area network (CAN) is a serial interface used to link multiple micros together in a small network. It is widely used in automotive electronics and industrial control.

Common Micro I/O Features

Counter/timers are counters that can be programmed to up or down count. Counter values can be inserted or read under program control. They are useful for timing and pulse forming.

Pulse width modulation (PWM) is an output that can be duty cycle modulated by special instructions for external control purposes.

An 8, 10, 12 or 16-bit analog-to-digital converter (ADC) is common on many 8 and 16-bit controllers. This makes them useful in working with analog inputs from sensors, etc.

Sleep mode is a mode in which most of the 8051 circuits automatically turn off to save power when the device is not being used. It turns on if I/O activity is detected or needed.

Test your knowledge

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