Controllers Proliferate as USB Catches On

Most Controllers Use 8051; Plethora of Nonprogrammable Chips Debut, Too

by Jim Turley

The number of peripheral controllers available for the Universal Serial Bus (USB) has grown dramatically in the past few months, advancing prophecies of USB's eventual ubiquity. Starting from Intel's lone 8-bit microcontroller, there are now a dozen different chips from as many vendors.

Prices for this new crop of USB chips are generally $5–$7, which is only a small price premium over equivalent processors without USB. A handful of special-purpose, nonprogrammable controllers for keyboards are even cheaper, leading a number of PC peripheral OEMs to bring out their first USB-compatible keyboard, scanner, or mouse.

Software support from Microsoft for USB still lags, but peripheral OEMs have worked around Windows' present shortcomings by providing their own drivers. Apart from Intel's chips, all the chip vendors have embraced the Open Host Controller Interface (OHCI) model, guaranteeing register-level compatibility among vendors.

Intel Expands Across the Board

Intel started at the host and worked outward. The company's first USB host controller for PCs debuted early in 1996 with the 430VX/HX chip set for Pentium systems *(see* **1002MSB.PDF***)*. Starting with the 430VX/HX, all Intel chip sets include a USB host controller as a matter of course.

Intel's 82930Ax *(see* **1003MSB.PDF***)* was the first CPU with USB and stands as the most popular USB controller in the first wave of peripherals. Based on Intel's 251, a 16-bit upgrade of the paleolithic 8051, the '930A controls peripherals attached as "leaf nodes" in the USB topology.

With the host and end points covered, Intel moved to the middle with a hub chip. The new '930Hx is similar to the '930Ax but adds the capability to act as a USB hub, distributing power and data to three downstream USB ports. The '930Hx is priced at $7, a $1 premium over the '930Ax.

Intel, Opti, and VIA, among others, include USB in their core-logic chip sets, guaranteeing a USB host controller in virtually all PC motherboards by mid-1997. For the upgrade market, CMD Technology offers the 0670, a PCI-to-USB converter that acts as a host controller. The chip, which is also available on a PCI plug-in board, allows retrofitting existing systems for USB support.

Hub Controllers a Popular Target

Philips, Texas Instruments, Thesys, and MultiVideo Labs have all targeted the hub-and-peripheral combination as a potentially lucrative part of the market. With Intel dominating host controllers (i.e., core-logic chip sets) and with leaf controllers too cheap, intermediate hub controllers have the best chance of generating significant revenue.

Philips's hub device, the PDIUSBH11, offers four downstream USB ports, one more than Intel's, as Table 1 shows. Without an internal microprocessor to drive it, the 'H11 relies on a serial-interface engine (SIE) macrocell distributed by Intel and used on both the '930Ax and '930Hx processors. Unlike the '930Hx, the 'H11 includes an extra "internal" port, which is brought out as an I^2C interface. A separate microcontroller can then communicate over USB via this interface.

The Philips approach is a popular one, also appearing on devices from TI and German vendor Thesys. The Thesys hub, dubbed TH6502, has only two downstream ports in addition to its internal port, and it relies on an external microcontroller for intelligence. The internal port appears as an 8-bit parallel interface with generic control signals that work with most microcontrollers.

TI's two hub chips, the TUSB2040 and TUSB2070, are similar to the Philips and Thesys devices. Based on the same SIE logic Philips and Intel use, these chips have four ('2040) or seven ('2070) downstream USB ports. Neither one has an internal microcontroller or even an internal USB port.

An internal port allows the hub chip to control the peripheral in which it is located. Unlike the Intel, Philips, and Thesys parts, the TI chips must use one of their downstream ports for local control. Alternatively, the '2040 and '2070 can be used in standalone USB hub products, unattached to any PC peripheral. CATC (*www.catc.com*) makes such a box, a four-port hub based on its own hub controller.

MultiVideo Labs' W82C620 chip is another nonprogrammable hub controller with four downstream ports and an internal port. The fabless semiconductor company has plans for a future intelligent version based on an 8051 core, similar to Intel's '930Hx.

Part	8x930Hx	H11	TH6502	2040	2070	W82C620
Vendor	Intel	Philips	Thesys	TI	TI	MVL
CPU core	251	SIE	None	SIE	SIE	None
Ports	3 ports	4 ports	2 ports	4 ports	7 ports	4 ports
Internal port?	No	Yes	Yes	No	No	Yes
Package	PLCC-68	DIP-32	DIP-32	DIP-28	PQFP-48	PQFP-48
Availability	1Q97	Now	1Q97	Now	Now	Now
Price	$7	$6	$6	$4	$5	$5

Table 1. The current crop of USB hub- and peripheral controllers includes both intelligent and nonprogrammable parts from a variety of vendors. (Source: vendors)

Ports and Power Provide Differentiation

While support for four downstream ports seems to be the sweet spot, TI believes its seven-port hub will be in demand for home PCs that are used as entertainment systems. At least three ports are already used by the monitor, keyboard, and mouse. The extra ports could be used, for example, to connect multiple joysticks or multiple speakers to the same monitor or keyboard.

Power distribution is another factor separating hubs. In the USB lexicon, hubs are either self-powered (with their own power supply) or bus powered (drawing their current from the upstream device). Either way, the hub is responsible for providing power to all downstream USB connections. Those connections are classified as either high-power (up to 500 mA) or low-power (100 mA or less). Thus, each port on a hub must be able to source as much as 500 mA to each of its downstream devices. To avoid sapping too much current from the USB cable, bus-powered hubs cannot drive high-powered devices and are limited to only four low-powered devices; self-powered hubs can accept any number of high- or low-powered devices *(see* **090501.PDF***)*.

This maze of restrictions makes the monitor the attachment point of choice for PC hubs, because monitors generally have their own AC power supplies.

The Philips, TI, and Thesys chips work as either self-powered or bus-powered hubs. In their self-powered mode, they provide overcurrent protection on their downstream ports, as required by USB, with the help of external MOSFETs or other switching components.

The two TI chips go a bit further, managing port protection either individually or as a group. Group protection is easier to implement and requires fewer external components, but it has the disadvantage of lumping all downstream devices into a single load. If a single downstream device shorts, all downstream devices lose their power. Alternatively, each of the downstream ports can be handled individually, with separate power components for each.

Peripheral Controllers Also Proliferate

Outside of the host or hub market, a number of new peripheral controllers have appeared to handle leaf nodes. Many are keyboard-specific controllers, with a few generic USB converters thrown in.

Angling for keyboard design-ins is CMD's 0678KMp. The 48-pin device includes an 8051 with keyboard-controller firmware. In a unique twist, the 0678 accepts a standard PS/2 mouse connection, which will appear as a USB device to the upstream hub or host controller. The chip even supports hot-swapping the mouse.

Thesys's TH6503 is a simple device that acts as a USB-to-microcontroller bridge. The 16-pin chip carries USB signals on one side and a serial interface on the other. It's useful for adding USB to existing products or designs and could be used, for example, to add a USB interface to an existing keyboard or modem.

Price & Availability

Intel's 8x930Ax is currently in production at $6 in quantity. The 8x930Hx is sampling now for $7. For more information check *www.intel.com/design/usb.*

Philips's PDIUSBH11 hub controller is available for $6 in 10K quantities. The PDIUSBP11 in a 14-pin package costs $0.40. For more information contact Philips (Santa Clara, Calif.) at 800.447.1500, x1347.

Texas Instruments offers the 2040 and the 2070 for $4.10 and $5, respectively, in 1,000-unit quantities. Contact TI (Denver) at 800.477.8924, x5504.

Thesys will begin sampling the 6502 in March; pricing will be in the $4–$5 range. The 6503 is sampling, with pricing set at $1.65 in quantity. Contact Thesys (Erfurt, Germany) at 49.361.427.8100 or visit *www.thesys.de.*

CMD Technology's 0678KMp sells for $4.95. The 0670 is priced at $6.75. CMD Technology (Irvine, Calif.) can be reached at 714.454.0800, or visit *www.cmd.com.*

MultiVideo Labs is sampling its W82C620 controller. Contact MVL (Princeton, New Jersey) at 609.497.1930.

The Cypress CY7C63xxx family begins sampling in February with production in April. Contact Cypress (San Jose, Calif.) at 408.943.6300 or *www.cypress.com.*

Philips complements its hub chip with the PDIUSBP11, a peripheral controller like the TH6503 with a straightforward serial interface for controlling the peripheral device. The 'P11 comes in a 14-pin DIP and sells for about $0.40.

Cypress made its own 8-bit core for the CY7C63xxx controllers. While a standard SIE handles USB, the CPU adds local intelligence. Different version of the 63xxx family provide varying amounts of EPROM, SRAM, and I/O pins.

From Concept to Reality

Keyboards, mice, scanners, and speakers from Logitech, Cherry, KeyTronic, Altec Lansing, and others are now starting to appear on store shelves. With any motherboard based on a new chip set providing USB, the coming year will see this feature move from curiosity to common denominator.

Microsoft's operating systems have been slow to support USB, so silicon vendors have enjoyed a breathing period in which USB was neither in demand nor especially useful. That will change over the course of 1997 as public awareness of USB grows and PCs edge closer to appliance status.

By the end of 1997, USB will be a required feature on keyboards, high-end monitors, mice, and joysticks, at which time it will cease to be a differentiating factor. In the interim, USB provides an opportunity. Rather than just increasing the cost of mundane peripherals, USB can enable new devices, thus opening new markets. Digital speakers, inexpensive modems, and cheap networks are all new possibilities enabled by this new crop of USB microcontrollers. M