

# ANCHOR CHIPS INCORPORATES THE DESIGNWARE DW8051 TO CREATE AWARD-WINNING EZ-USB CONTROLLER

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IC Design Manager



Anchor Chips, a newcomer in the highly competitive personal computer market, needed to significantly reduce the development time of its EZ-USB™ controller—without compromising on performance. With the easy to use DesignWare® DW8051™ MacroCell Solution, Anchor Chips was able to meet both its performance requirements and tight schedule. EZ-USB was named an *EDN* "Hot Product" and was awarded the "Cool Product of the Month" by *Multimedia System Design* magazine.

## INNOVATIVE SOLUTIONS FOR CONNECTING PERIPHERAL DEVICES

As the number and type of PC peripheral devices grows, connecting them becomes a challenge. Anchor Chips, located in San Diego, California, specializes in providing innovative interface solutions for high-performance PC buses with products that address the system-on-a-chip requirements of today's PC peripheral manufacturers.

In late 1996, Anchor Chips set out to build the industry's first Universal Serial Bus (USB) controller. Leading PC and telecom companies had developed the USB peripheral bus standard to enable plug-and-play connection of computer peripherals outside the box, eliminating the need to install cards into dedicated computer slots and to reconfigure the system. When Anchor Chips started the EZ-USB project, the USB bus standard was relatively new and there was no stable commercial USB core available. By developing its own USB controller interface, Anchor Chips gained a competitive advantage over its rivals. Anchor then devoted its attention to creating an architecture for allowing in-system programmability in its USB devices.

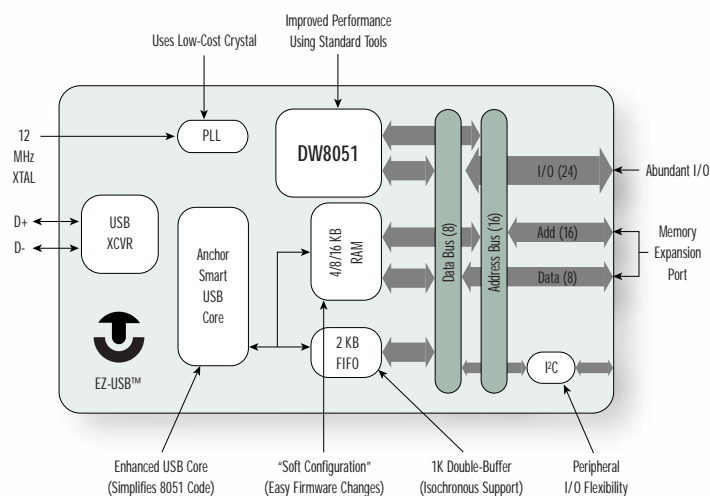
To produce the USB device controller, Steven Larky, IC Design Manager for Anchor Chips, determined that he would need a USB interface, a microcontroller, and an onboard memory. His design team architected a system consisting of a 0.5mm standard cell chip integrating two major intellectual property (IP) blocks — a USB interface and 8051 microprocessor — in addition to two memory blocks. The 8051 was selected because of the broad array of existing development and debugging tools, and in-circuit emulation (ICE). Incorporating an 8051 would also enable Anchor Chips' customers to reprogram the chip to meet

### DESIGN TOOL SUITE

- DW8051™
- Design Compiler™
- Test Compiler™
- Verilog-XL

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***By incorporating the high-performance DW8051, the EZ-USB chip requires only 10% of the CPU processing bandwidth and can pass along the remaining 90% to its customers.***

their individual specifications. “From our perspective, as well as the end user, there was a higher comfort level with the 8051,” says Larky.

Anchor Chips next decided how best to leverage its resources, adding value where they had expertise. The company focused its design resources on the USB portion of the design and turned to Synopsys for the 8051 core solution. Developing its own embedded controller would have consumed valuable resources and significantly increased time-to-market—time that Anchor Chips didn’t have. Anchor Chips chose to buy, rather than build the microcontroller, seeking a third-party vendor that could provide an 8051 core solution they could trust.

## **SELECTING THE RIGHT 8051 CORE**

The EZ-USB engineering team weighed a number of factors in considering 8051 core solutions from various vendors. Was it easy to evaluate? Did it deliver high performance? Was it flexible? Was it easy to integrate with other components? Did it offer easy, full-scan test insertion? Was it available in Verilog? Anchor Chips considered a number of 8051 core suppliers and selected Synopsys because its DW8051 met all of the company’s requirements and provided the highest level of confidence and performance. The lower performance 8051 cores offered by the other suppliers severely restricted configurability, and the ability to add test. Portability was also limited with other 8051 solutions.

“One supplier provided a Verilog version that malfunctioned the very first time it ran,” says Larky. “Another supplier provided HDL source that had been converted at a very low level from VHDL to Verilog, but the Verilog didn’t look like Verilog. All the signal names were missing and it was impossible to read or understand.” Anchor Chips was concerned that the lack of detail would make debugging of the overall chip nearly impossible.

### DW8051 Advantages

Anchor Chips evaluated solutions from several vendors. In addition to the technical requirements that the core had to meet, they were also looking for the following features:

- Easy to use — drop it into the design.
- Well documented — complete and intuitive, with no ambiguity or lack of detail.
- Easy to integrate with other elements of the design.
- Easy to configure and synthesize.

The Synopsys DW8051 design solution met all of the criteria. In addition to superior features, performance and an accelerated chip development schedule, the Synopsys solution gave Anchor Chips confidence. “We got a warm and fuzzy feeling that Synopsys knew what they were doing. We had real confidence in them as a vendor,” says Larky. “When we were evaluating the part, Synopsys provided us with synthesis results within hours, based on the specific configuration and manufacturing technology library we were using. The results helped us determine whether timing, performance, and area goals would be met. Synopsys made it easy for us to evaluate their IP. They set up several examples to demonstrate speed and the depth of the paths and signal names, which increased our comfort level,” says Larky. “In contrast, sample synthesis paths from one of the other two vendors we evaluated were nearly incomprehensible.”

### High Performance

Compared to a standard Intel 8051, Synopsys’ design is fully binary-compatible, but has a higher-performance architecture. The DW8051’s four clocks per instruction, compared to the standard 12 clocks per instruction, offers a 2.5 times performance advantage on average and put it in the domain of some 16-bit microcontrollers, but with only an 8-bit memory requirement. As a result of the DW8051, Anchor Chips’ EZ-USB requires only 10 percent of the CPU processing bandwidth and can pass along the remaining 90 percent to its customers.

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• Steven Larky, Anchor Chips  
IC Design Manager

## Flexibility

“The Synopsys DesignWare DW8051 MacroCell offered a number of real advantages,” said Larky. The DW8051 is a complete solution, including verification, and is highly configurable and fully featured. Changing the number of timers, serial ports, or the number of interrupts, for example, is as simple as changing one number in a table. This eliminates the need to “hack” the RTL code or synthesis scripts to meet performance or function needs.

Anchor Chips’ EZ-USB uses only some of the DW8051 resources and processing bandwidth so they are able to pass the unused part to their end-customers. Anchor Chips chose to use two DW8051 serial ports, enabling Anchor Chips’ customers to use one for debugging and another for the application. USB communication manufacturers such as ISDN, ADSL and POTS modem linked the two UARTS. This design provided flexibility and more options for the end product.

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Feature	Intel				Dallas DS80C320	DesignWare DW8051
	8031	8051	80C32	80C52		
Clocks Per Instruction Cycle	12	12	12	12	4	4
Internal ROM (1)	–	4KB	–	8KB	–	Up to 64KB
Internal RAM (1)	128 bytes	128 bytes	256 bytes	256 bytes	256 bytes	128 bytes or 256 bytes
Data Pointers	1	1	1	1	2	2
Serial Ports	1	1	1	1	2	0, 1, or 2
16-bit Timers	2	2	3	3	3	2 or 3
Interrupt Sources (total of int. and ext.)	5	5	6	6	13	6 or 13
Stretch Memory Cycle	No	No	No	No	Yes	Yes

(1) Internal ROM and RAM are located outside of DW8051\_core.

*The DW8051 is easy to configure for any application.*

## Easy to Integrate

Synopsys provides the DW8051 in pure-core form for deeply embedded applications, and with standard 8051 port functionality for applications requiring a standard 8051 pinout. Anchor Chips provided their customers with a standard pinout version for greater accessibility to the 8051. DW8051 users add their

logic to either the simple memory interface or the standard Special Function Register (SFR) bus. Anchor Chips used the standard memory interface in order to maintain flexibility and speed the time to market.

### Easy Test Insertion

Anchor's engineers found the Synopsys solution offered true advantages over the other products when it came to ease of synthesis and test insertion. Adding full-scan test, for example, was sometimes difficult or impossible with other vendors' 8051 cores. The Synopsys solution, however, offered a totally automatic manufacturing test insertion with Test Compiler, yielding greater than 98 percent fault coverage.

### Complete Verification Environment

Synopsys provides a complete simulation/verification environment with the DW8051, including the ability to run 8051 software executables in simulation. Test programs for all 8051 instructions, internal peripherals, and special functions are provided in Intel hex format. Synopsys also provides automated testbench configuration and execution, and conversion of the test programs to Verilog .mem format for Verilog users. The testbench is well designed, easy to understand, and extensible to support testing of a custom DW8051 implementation with application-specific peripherals.

### Portability and Reuse

As Anchor Chips gains new customers for its EZ-USB device controller, the issue of porting to new technologies will become important. As the demands of the marketplace cause Anchor Chips to develop new generations of the controller core in the future, Anchor Chips plans on reusing as much of the design as possible. The Synopsys DW8051 MacroCell will enable Anchor Chips engineers to automatically synthesize to new technology processes without having to change the RTL source or synthesis scripts.

### GETTING GOOD RESULTS

"We were really surprised at the speed and ease with which our engineers were able to get the DW8051 core up and running," recalls Larky. "We received the Verilog code on Thursday, and on Friday we were running 8051 software code. Just eight weeks later we taped out the whole chip."

The comprehensive DW8051 documentation enabled Anchor Chips to resolve nearly every issue internally. Total support required throughout the entire design process consisted of just five e-mails between Anchor Chips and Synopsys. "When we did need assistance, technical support was very responsive. I generally got e-mail replies within several hours, and sometimes within minutes," says Larky.

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*Anchor Chips introduced EZ-Link™, a USB networking product containing the EZ-USB, at Spring Comdex 1998 where it was PCWeek's "Best of Comdex New Technology" award winner.*

Getting a fast start, and finishing early was important to Anchor Chips. With millions of PCs sold each year, the potential size of the USB market is attracting many competitors. With the help of the DW8051, Anchor Chips' overall design cycle was shortened significantly. "We probably saved at least a month over using another 8051 IP, and several months over designing it internally," estimates Larky. "And the high quality of the DW8051 gave us confidence in our ability to meet the tight schedule." Anchor Chips is pleased to have the Synopsys DW8051 in its EZ-USB device controller and projects wide acceptance in the marketplace. "Synopsys is a real plus for us and our customers," says Larky. "And because we used Synopsys software, end customers have increased confidence in the chip as well."

#### MORE INFORMATION

For details on the EZ-USB solution or the EZ-Link, visit the Anchor Chips Web site at <http://www.anchorchips.com>. For more information on the Synopsys DesignWare DW8051 MacroCell Solution, visit our Web site at <http://www.synopsys.com> or contact your local Synopsys sales office.

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