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TRISCEND REVS UP FOR MOTORS

New Field-Configurable MCUs Aim at Industrial Applications

By Tom R. Halfhill {9/15/03-02}

Trying to ascend above the fray of 32-bit microcontrollers, Triscend is revising its line of ARM7-based field-configurable MCUs. New on-chip peripherals and features will make them more suitable for industrial applications—particularly for motor controllers. The revised parts will supersede the company's current line of ARM7-based MCUs next year.

The new A7V05 family initially has four members, all with ARM7TDMI processor cores running as fast as 70MHz. Rich in on-chip peripherals, they also boast a feature that sets Triscend's MCUs apart from all others: field-programmable logic. Each chip has 512 cells of configurable system logic (CSL), equivalent to 6,400 FPGA gates. This feature allows embedded-system developers to customize the MCUs for specific applications without spinning silicon for an ASIC or SoC. (See *MPR 11/16/98-02*, "Triscend E5 Reconfigures Microcontrollers" and *MPR 9/11/00-03*, "Triscend Rolls Out Configurable SoC.")

Unique Combo of Peripherals

All members of the A7V05 family surround the ARM7 core with useful peripherals, such as an eight-channel DMA controller, a dual-bank SDRAM controller, a flash-memory interface, a serial synchronous interface (SSI), four 32-bit timers, two 16-bit timers, a 32-bit watchdog timer, and a pair of UARTs with FIFO buffers. Triscend's existing A7S04-series MCUs have similar features.

New to the A7V05 family are dual I^2C interfaces; a control-area network CAN2.0B controller; a USB 1.1 transceiver with integrated PHY; one or two 10–100Mb/s Ethernet media-access controllers (MAC); and a 10-bit, eight-channel analog-to-digital converter (ADC). However, not all members of the A7V05 family have all these features, as Table 1 shows.

The top-of-the-line A7VT05 chip is especially interesting, because no other 32-bit MCU combines an ADC, CAN2.0B controller, USB 1.1 transceiver, and dual 10–100Mb/s Ethernet MACs. The CAN controller supports the latest CANopen and DeviceNet protocols. As CANs, USB ports, and local-area networks become more widespread in industrial machinery, Triscend's new MCUs should enjoy an advantage over lesser (albeit less-expensive) MCUs.

The most important distinguishing feature of all Triscend MCUs is their programmable logic, which is implemented in embedded SRAM. This feature goes a step beyond the integrated flash memory that some other ARM-based MCUs rely on to provide an extra degree of configurability at design time or in the field. (See *MPR 5/19/03-01*, "Philips Shows Flashy MCUs.")

By programming the CSL cells with standard Verilog or VDHL tools, developers can add custom-tailored logic blocks for their specific applications. The custom logic can do just about anything that would be possible in 6,400 gates of FPGA logic: for example, developers can add new peripherals or custom function units. The CSL can run as fast as the ARM7 processor core, although the actual speed will vary with the complexity of the custom logic. A high-speed on-chip bus, patented by Triscend, connects the CSL to the ARM7 core. Figure 1 is a block diagram of the MCU.

Using the CSL doesn't necessarily require logic-design expertise. Triscend is also introducing a new version of its FastChip development system, which includes a graphical

Price & Availability

Triscend says engineering samples of the A7V05-series MCUs will be available in October, and production quantities will begin shipping in January 2004. Estimated prices for the chips in 10,000-unit volumes range from $10.40 for the low-end A7VL05 to $13.70 for the high-end A7VT05. For more information, visit *www.triscend.com*.

tool that lets developers choose precompiled function blocks from a library of royalty-free intellectual property (IP). The function blocks include additional timers, UARTs, communications interfaces, math units, comparators, and display interfaces. Even developers with no FPGA experience can use the FastChip tools to configure the MCUs.

Triscend expects the most-popular function block implemented in the CSL to be a pulse-width modulator (PWM), which is critical for motor control and is conspicuously missing from the A7V05 specifications. Virtually all other MCUs designed for motor control have at least one PWM on chip. Triscend says it deliberately omitted this feature because many customers would rather have a customizable PWM. Typically, the PWM connects to an external array of power transistors that amplifies the waveforms to control the speed and torque of the motor. However, the size of the transistor array—which developers usually implement in discrete blocks, often with custom logic—varies according to the size and type of motor. For that reason, Triscend decided to let developers choose from a selection of PWMs in the FastChip IP library or design their own.

Even with a customizable PWM, the A7V05 chips—or any other individual MCUs, for that matter—cannot serve the vast range of AC/DC motor-control applications. At the low end are the motors in disk drives and printers and the tiny vibrators in cellphones and pagers; an MCU that delivers one mips of performance is sufficient for those. Large consumer appliances like washing machines and refrigerators need an MCU that delivers about 10 mips. At the high end are powerful industrial motors requiring a high-performance MCU in the range of 400 mips. Triscend is aiming the A7V05 family at what it considers the sweet spot: midrange industrial motors that need an MCU delivering about 50 mips. That also happens to match the performance of the ARM7TDMI core that Triscend has adopted for its 32-bit MCUs.

Of course, the A7V05-series chips are suitable for many applications other than motor control: automotive telematics, client-side networking products, voice-over-Internet-Protocol (VoIP) telephony, and other embedded systems that need 32-bit performance and a rich mix of on-chip peripherals.

Feature	Triscend A7VL05	Triscend A7VE05	Triscend A7VC05	Triscend A7VT05
Processor Core	ARM7TDMI	ARM7TDMI	ARM7TDMI	ARM7TDMI
Clock Frequency*	~70MHz	~70MHz	~70MHz	~70MHz
Unified I/D Cache	8KB, 4-way	8KB, 4-way	8KB, 4-way	8KB, 4-way
Scratchpad RAM	32K x 8 bits	32K x 8 bits	32K x 8 bits	32K x 8 bits
Config Logic (CSL)	512 cells	512 cells	512 cells	512 cells
DMA Controller	8 channels	8 channels	8 channels	8 channels
SDRAM Controller	4GB addr	4GB addr	4GB addr	4GB addr
Flash Interface	Yes	Yes	Yes	Yes
Addr Selectors	16	16	16	16
Timers	4 x 32-bit 2 x 16-bit	4 x 32-bit 2 x 16-bit	4 x 32-bit 2 x 16-bit	4 x 32-bit 2 x 16-bit
Watchdog Timer	32-bit	32-bit	32-bit	32-bit
UARTs	2 w/ FIFOs	2 w/ FIFOs	2 w/ FIFOs	2 w/ FIFOs
Serial Sync I/F	1	1	1	1
I^2C Interface	—	2	2	2
CAN 2.0B	—	—	1	1
USB 1.1 Controller	—	1	—	1
ADC	—	10-bit, 8-channel	10-bit, 8-channel	10-bit, 8-channel
10/100 Ethernet	—	1	1	2
Maximum I/O Pins	74	98	98	98
Voltage (Core-I/O)	1.8V/3.3V	1.8V/3.3V	1.8V/3.3V	1.8V/3.3V
Package	PQFP-208	BGA-324	BGA-324	BGA-324
Samples	Oct 2003	Oct 2003	Oct 2003	Oct 2003
Production	Jan 2004	Jan 2004	Jan 2004	Jan 2004
Est Price (10K)	~$10.40	~$12.20	~$12.20	~$13.70

Table 1. The A7VL05 is the least-endowed member of the new MCU family; it provides a migration path for customers using Triscend's current A7S04-series parts. Only the high-end A7VT05 has all the new on-chip peripherals, controllers, and interfaces. *Triscend expects the fastest chips to run at 70MHz and plans to offer slower parts as well; the exact range of clock frequencies will be determined after Triscend characterizes the early silicon.

Worth the Price?

Rival 32-bit ARM7-based MCUs—even those having generous amounts of embedded flash memory—cost only 33% to 50% as much as Triscend's A7V05-series chips and deliver virtually the same processing power. What sets Triscend's MCUs apart is design-time and field-programmable flexibility, thanks to their configurable logic. They also tend to provide other luxuries not found in competing MCUs, such as Ethernet MACs, CAN controllers, and USB transceivers. Of course, all these features tend to inflate Triscend's manufacturing costs.

The 32-bit configurable microprocessor cores licensed by ARC International, MIPS Technologies, and Tensilica offer much greater design flexibility than Triscend's chips and are equally suitable for MCU applications. The essential difference is that the ARC, MIPS, and Tensilica processors are synthesizable cores, not off-the-shelf chips, so customers must design their own chips and manufacture them at a foundry. Doing that adds one or two years to the development cycle and millions of dollars in up-front licensing fees, nonrecurring engineering (NRE) costs, mask sets, manufacturing costs, and royalty payments. It's a worthwhile endeavor for applications that demand an optimized SoC and can generate enough sales to amortize the development costs, but for low-volume projects, it doesn't make sense.

Another alternative is to implement a custom MCU wholly in an FPGA. The ARC, MIPS, and Tensilica processor cores are suitable for this purpose, and the leading FPGA vendors offer their own synthesizable processor cores—and even prehardened CPU cores integrated with the programmable logic. The falling prices of FPGAs make them increasingly attractive for low-volume products, but they require more development effort than buying a configurable MCU from Triscend. On the other hand, true FPGAs offer much more programmable logic than Triscend does.

For example, a Xilinx Spartan-3 XC3S50 FPGA has 50,000 gates and 1,728 logic cells—nearly eight times the gates and more than three times the cells that Triscend offers—and will cost less than $3 by the time the A7V05 family ships next year. Of course, the A7V05 devices are full-featured, ready-to-run MCUs, whereas the Spartan-3 is a blank slate that requires significant development work. An FPGA developer couldn't come close to duplicating all the Triscend features in only 50,000 gates.

A one-million-gate Spartan-3 FPGA might allow a developer to implement a subset of A7V05 features needed for a specific application, but that FPGA costs almost $20, about 46% more than Triscend's high-end A7T05 part. A better alternative might be to pair an $8 conventional MCU with the $3 FPGA if custom logic or field-programmability is desired. That combo would cost about the same as Triscend's lowest-priced A7VL05 part and have more programmable gates, although it would require more board space and design effort.

Triscend's configurable MCUs fill a market niche not quite matched by rivals. If it's a small niche, at least it's a huge market: according to Drive Research Corp., worldwide demand for electronic motor drives (motor controllers) was 12.6 billion units in 2000 and is expected to reach 31.6 billion units in 2005. Triscend's challenge is to find those customers needing the unique mix of built-in features and dynamic configurability that only its new MCUs offer. ◇

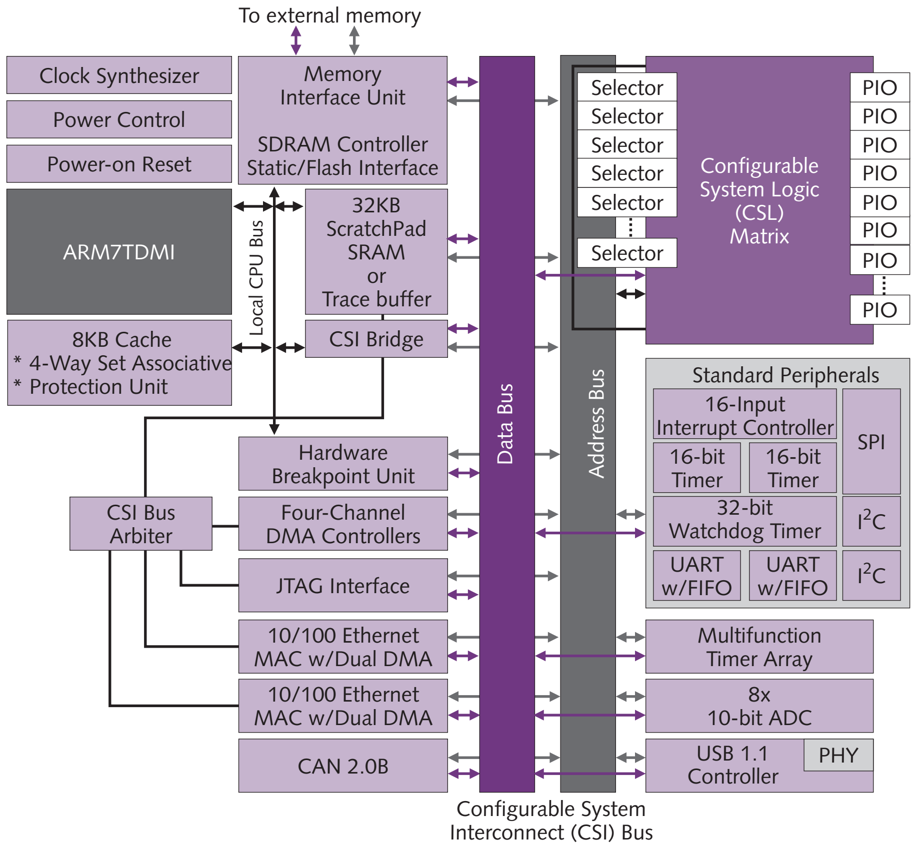

Figure 1. Triscend's Configurable System Interconnect (CSI) bus tightly couples the configurable system logic (CSL) to the 32-bit processor core and on-chip peripherals. This block diagram illustrates the new high-end A7VT05 MCU. As Table 1 indicates, other MCUs in the A7V05 series do not have all the on-chip peripherals shown here.