

# 68328 to Power Handheld Organizer

## Motorola's DragonBall Developed for Samsung

by James L. Turley

Motorola has unveiled yet another member of its growing 68300 family of embedded microprocessors with the announcement of the 68328. DragonBall, as the chip is more familiarly known, is a low-cost integrated chip with PCMCIA and LCD display support, a first for Motorola. The chip will first appear in a new electronic organizer product due out from Samsung in 1Q96, although other OEMs have committed to use the part as well.

The chip is based on the time-tested 68EC000 core, making it one of the slower 68300-family chips available. Yet, amazingly, the Samsung organizer will use handwriting recognition as a primary form of user input. The unit uses character-recognition software that can be trained to recognize Chinese, Japanese, Korean, or printed Roman (English) characters.

### New Chip from a New Operation

The 68328 is the first publicly disclosed chip from Motorola's Portable Systems Operation, a new organization within the company's embedded systems division, which has responsibility for both 68000 and embedded PowerPC development. The new operation's goal is to develop embedded microprocessors for portable consumer communications products.

The new chip combines a static 16-MHz 68EC000 core, two 16-bit timers, a serial peripheral interface (SPI), a UART, a pulse-width modulation (PWM) output, an LCD controller, and a 16-bit bus interface. The

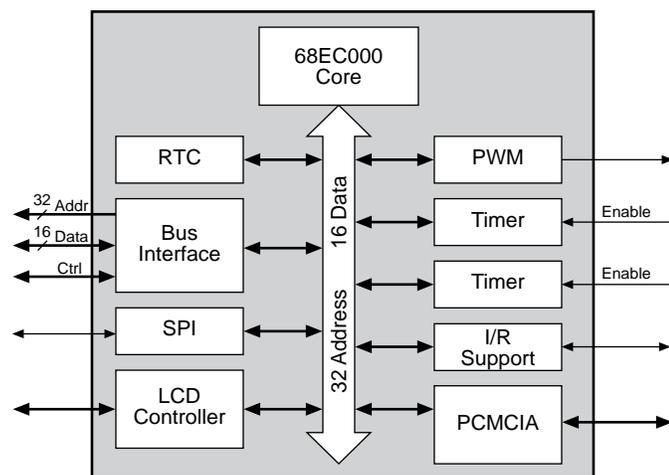


Figure 1. The 68328 DragonBall controller is the first integrated chip from Motorola to include an LCD controller.

modules are all logically connected to the core's 32-bit address and data buses, as Figure 1 shows. Although the 68328 has no cache or on-chip memory, the 68EC000 core's four-cycle instruction-access time and multicycle instruction execution leave ample time for fetching code from moderately priced memory subsystems. With 100-ns SRAMs or ROMs, the 16-MHz processor peaks at 2–3 MIPS on Dhrystone 2.1. While this level of performance hardly makes DragonBall a fire-breather, it is sufficient for handheld units that provide more communication than processing.

### Integrated LCD Controller a Motorola First

The LCD controller is the first one to appear in a Motorola microprocessor. Theoretically, it supports resolutions up to 1024 × 1024 pixels with four shades of gray, although practical considerations will limit that considerably. The 68328 does not maintain a separate frame buffer, relying instead on the chip's main memory to store code, data, and graphics. Beyond one-quarter VGA resolution (320 × 240), bandwidth limitations of the 68328's external bus may begin to impact processor performance.

The 68328's peripherals are fully synthesized, unlike other 68300 chips, which use a modular, physical building-block approach. In the large quantities Samsung anticipates, the more space-efficient approach was prudent. The overall size of the die is about 36 mm<sup>2</sup> in Motorola's 0.65-micron three-layer-metal process. This yields an estimated manufacturing cost of \$9, providing a comfortable margin at the chip's \$15 quantity price.

While DragonBall may appear anemic compared to the ARM610 powering Newtons, it fits well in a simple organizer that doesn't require extensive processing. More important, Motorola has created a good mix of peripheral functions around the core that make such handheld products easy to design. Replacing the 68EC000 with a faster core—possibly including the organization's own PowerPC designs—would make an enticing controller for costlier PDAs, handheld games, and portable instruments. ♦

### Price & Availability

The 16-MHz 3.3-V 68328 is sampling now, with production scheduled to begin in November. In 10,000-unit quantities, the part is priced at \$15. For more information, contact Motorola at 512.891.2000.