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BEST MEDIA PROCESSOR: TRIMEDIA TM5250

Philips Updates a Classic, Achieves High Benchmark Scores

By Tom R. Halfhill {2/9/04-14}

We have chosen the **Philips TriMedia TM5250** for the *Microprocessor Report* Analysts' Choice Award as the **Best Media Processor** of 2003. We believe the TM5250 deserves the award for proving that smart design work can keep a 10-year-old media-processor architecture competitive against newer, more-extreme architectures without sacrificing software compatibility. This achievement is particularly impressive in a field that attracts exotic designs that often aren't bound by past architectural decisions and installed bases of software.

With 29 function units at its disposal, the TM5250 is a very wide machine—appropriate for a descendant of the first VLIW architecture ever implemented as a microprocessor. To improve the performance of a synthesizable core that lacks the efficiency of a full-custom layout, Philips has extended the TM5250's simple-integer pipeline to 11 stages. In contrast, the TriMedia processor it supersedes has only a five-stage simple-integer pipeline. For some floating-point operations, the TM5250's pipeline runs as deep as 16 stages.

Each VLIW instruction bundle in the TM5250 may contain up to five operations, including as many as three branches. To avoid the deeper-pipeline penalty of taking a branch, the TM5250 is the first TriMedia processor that has dynamic branch prediction. It predicts which cache way holds the branch-target code, saving two clock cycles for each correctly predicted taken branch. As with previous TriMedia processors, conditional instructions can reduce the incidence of explicit branches in program code.

Another valuable new feature—especially for a media processor that must handle many different data types—is the TM5250's ability to read and write unaligned data in memory without paying a penalty in extra clock cycles. The load/store unit can read and write aligned or unaligned data at the same speed, and a single 32-bit load instruction can fetch four consecutive elements of 8-bit video data on any byte alignment in memory. Other CPU architectures can fetch unaligned data, of course, but they often require multiple instructions.

EEMBC Scores Confirm Performance

Philips had enough confidence in the TM5250 to subject it to the EEMBC benchmarking and certification process and publicly report the results—the only vendor among our five media-processor nominees to do so.

Using a Quickturn machine, Philips ran the EEMBC consumer suite on a cycle-accurate simulation of the TM5250. After obtaining unoptimized "out-of-the-box" scores, Philips ran another round of tests, using partially optimized code to obtain the "full-fury" scores. Then Philips ran its own MediaStone benchmarks on the TM5250 for comparison with its Nexperia PNX1300 processor, which is also based on the TriMedia architecture. Table 1 compares all these scores with those posted by the fastest processors in the EEMBC consumer suite.

What's notable about the EEMBC and MediaStone scores is that Philips didn't optimize the benchmark code to use any new features of the TM5250. (EEMBC rules allow vendors to modify the benchmark programs when measuring

	TriMedia TM5250	TriMedia TM1300	Nexperia PNX1300	Tensilica Xtensa V	Tensilica Xtensa III	Motorola MPC7447	ARC ARCtangent-A4	SuperH SH-4
Clock Speed*	500MHz	166MHz	200MHz	260MHz	200MHz	1.3GHz	150MHz	202MHz
Implementation	Simulation	Chip	Chip	Simulation	Simulation	Chip	Simulation	Simulation
EEMBC Consumer Suite (Out of the Box)**								
Compress JPEG	20.0	11.5	—	12.5	7.9	—	6.5	10.1
Decompress JPEG	40.0	14.3	—	17.8	9.9	—	7.7	12.1
Gray-Scale Filter	275.0	115.9	—	117.4	46.2	—	27.3	70.7
RGB to CMYK	255.0	125.2	—	130.7	76.6	—	63.3	117.2
RGB to YIQ	320.0	146.7	—	88.0	37.2	—	24.5	34.3
ConsumerMark	**51.3**	**23.3**	—	**22.6**	**11.5**	—	**8.4**	**14.7**
EEMBC Consumer Suite (Optimized)**								
Compress JPEG	125.5	65.2	—	57.2	7.9	85.3	6.8	34.3
Decompress JPEG	137.0	76.9	—	83.2	9.9	103.9	8.0	40.4
Gray-Scale Filter	2,125.0	759.4	—	7,014.8	4,884.0	907.3	4,768.1	179.8
RGB to CMYK	1,765.0	482.3	—	6,762.6	5,202.0	992.0	3,904.1	181.8
RGB to YIQ	1,465.0	444.2	—	9,014.2	6,936.0	960.1	5,198.7	135.3
ConsumerMark	**284.6**	**110.0**	—	**525.9**	**193.6**	**172.2**	**159.3**	**41.4**
Philips MediaStone Benchmark								
Composite	**425**	—	**200**	—	—	—	—	—

Table 1. The TriMedia TM5250's ConsumerMark scores beat every other processor but Tensilica's customized Xtensa V. *Clock speeds for processors running in simulation are the vendors' target clock frequencies. ***MPR* extrapolated the EEMBC scores by multiplying the vendor's target clock frequency by the raw 1MHz simulator scores certified by EEMBC Certification Labs (ECL).

the optimized "full-fury" scores, and Philips typically recompiles its MediaStone code for the target processor.) Of course, some features in the TM5250—like the larger L1 instruction cache and all-new L2 data cache—don't require modifications to software. But Philips didn't rewrite or recompile the benchmark code to take advantage of other improvements, such as the unaligned load/store instructions, new MPEG-4/H.264 instructions, and an enhanced prefetching mechanism. Instead, Philips simply ran the benchmark code compiled for the older PNX1300. Therefore, the EEMBC and MediaStone scores shown in Table 1 probably represent the lower range of the TM5250's future performance while confirming the processor's compatibility with existing software.

The target clock frequency of 500MHz in a standard 0.13-micron fabrication process is a conservative estimate. Philips thinks the TM5250 could reach 700MHz in such a process. In a higher-performance 0.13-micron or 90nm process, Philips says the TM5250 might attain 900MHz, an impressive clock speed for a synthesizable media-processor core. The other media processors nominated for a *Microprocessor Report* Analysts' Choice Award this year run at speeds ranging from 150MHz to 400MHz.

More important than raw clock rates are the TM5250's well-thought-out improvements, its stellar benchmarks, its compatibility with existing TriMedia software, and the likelihood of even better performance to come. The TM5250 is a worthy media processor in the TriMedia tradition.