BA20

PipelineZero 32-bit Embedded Processor

The BA20 is a small, ultra-low-power, and very efficient 32-bit processor. It is an excellent step up from the 8051 and other 8- and 16-bit microcontrollers, and ideal for energy-sensitive deeply embedded applications such as wearable electronics, Internet of Things (IoT) sensors, wireless communication, and other mixed-signal ICs.

Thanks to its PipelineZero™ architecture, the BA20 core delivers a surprisingly high processing efficiency with a tiny silicon footprint. True single-cycle instruction execution of the BA2 ISA, zero-delay branches, no pipeline-stalling overheads, and an optional hardware multiply unit enable the BA20 to operate with efficiency as high as 3.48 CoreMarks/MHz. With no pipeline stages in the instruction execution path, the BA20 uses a minimal number of flip-flops and a simplified CPU control, so its processing efficiency comes without a silicon area penalty. These advantages plus advanced power management features and the extreme code density of the BA2™ instruction set, make the BA20 the most energy-efficient 32-bit processor currently available.

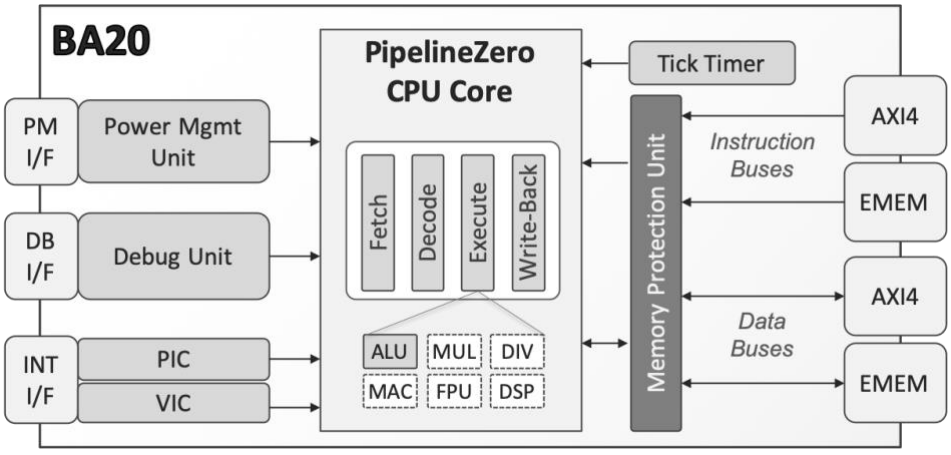
The BA20's capabilities can be enhanced with options including a single-precision floating-point unit, a multiply-accumulate unit, and a unit accelerating the DSP extensions of the BA2 instruction set. Interrupt response time can be optimized further with a vectored interrupt controller, and an optional memory protection unit can be used to protect application code and/or data from corruption.

The core's system interface uses two AMBA® AXI4™ or optionally two AHB-Lite™ buses, one for data and one for instructions. Two tightly-coupled embedded memory (EMEM) buses allow fast access for time-critical code and data and can be used for inter-core communication in a multi-core architecture.

The BA20 supports the variable instruction length BA2 instruction set, benefits from its extreme code density, and is binary compatible with other members of the BA2x processor family. Programming is facilitated with the included C/C++ tool chain, Beyond Studio™ IDE, architectural simulator, and ported C libraries. Advanced debugging capabilities and off-the-shelf development boards can further ease software development. Additional peripherals and bus infrastructure cores or complete subsystems can be ordered with the processor core to simplify SoC integration.

Part of the royalty-free BA2x family, the BA20 processor core has been designed for easy reuse and integration, has been rigorously verified, and is production proven.

Block Diagram



FEATURES

Ultra-Low Power

- PipelineZero architecture for high performance and efficiency in a tiny silicon footprint
  - 3.48 Coremarks/MHz
  - From 6,000 sq. um (~8K gates) in a typical 28 nm process
  - More than 300 MHz in TSMC 28nm HPM
- BA2 ISA allows extreme code density for fewer instruction fetches and lower energy usage
- Advanced power management
  - Dynamic clock gating and power shut-off of unused units
  - Software- and hardware-controlled clock frequency
  - Wake-up on tick timer or external interrupt

Optional Processor Units

- Programmable Vectored Interrupt Controller Unit
- Memory Protection Unit
- Timer Unit
- Debug Unit
- ROM Patching Unit
- Hardware Multiplier and/or Divider
- Multiply-Accumulate Unit
- Floating Point Unit
- DSP Instructions Acceleration Unit

Advanced Debug Capability

- Non-intrusive debug/trace for both CPU and system
- Complex chained watchpoint and breakpoint conditions
- Standard JTAG and proprietary Two-Wire Debug interface

Pre-Integrated Platforms

- Available microcontroller peripherals include GPIO, UART, Real-Time Clock, Timers, I2C, and SPI
- Memory controllers, interconnects, and more from the CAST IP line

Easy Software Development

- Beyond Studio™ IDE for Windows & Linux
- C /C++ compiler, debugger, linker, assembler, and utilities
- Architectural simulator
- Ported libraries and RTOS

Ready for Evaluation

- Talos-BA2x Evaluation Kit includes a debug key, FPGA board with reference design, drivers and software

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Engineered by BEYOND SEMICONDUCTOR

The BA2 Instruction Set

The BA2 instruction set provides extreme code density without compromising performance, ease of use, or scalability. It features:

- A linear, 32-bit address space
- Variable length instructions: 16, 24, 32, or 48 bits
- Simple memory addressing modes
- 12 to 32 general purpose registers
- Efficient flow-control, arithmetic, and load/store instructions
- Floating point and DSP extensions

Software Development

The core is delivered with Beyond Studio, a complete Integrated Development Environment (IDE) for Windows and Linux under Eclipse. Beyond Studio includes a highly featured source code editor, supports graphical source-level debugging and GUI based configuration, and can be extended with a collection of available or custom plug-ins.

The IDE integrates an Instruction level simulator and a GNU cross-compiling tool chain. The GNU Compiler Collection (GCC), includes front ends for C, C++, Objective-C, Fortran, Java, and Ada; libraries for these languages (e.g. libstdc++, libgcj, etc) are provided. The tool chain also includes the GNU Binutils collection of binary tools, and the GNU Project Debugger (GDB).

Extensive support of libraries enables easy application development for Linux and Android. Finally, hardware targets can be interfaced with the cost effective Beyond Debug Key, which in addition to standard JTAG (IEEE 1149.1 and IEEE 1149.7) also supports proprietary One Wire Debug and Two Wire Debug protocols.

Support and Services

The core as delivered is warranted against defects for 90 days from purchase. Thirty days of phone and email technical support are included, starting with the first interaction. Additional maintenance and support options are available.

IP Integration Services are also available to help minimize time to market for BA20-based systems. The processor core can be delivered pre-integrated with bus infrastructure cores, typical microcontroller peripherals, memory controllers, and interconnect IP cores. Contact CAST Sales for details.

Deliverables

The core is available for ASICs in synthesizable Verilog source code or for FPGAs in optimized netlists. It includes everything required for successful implementation: extensive documentation, a testbench, a sample SoC design, sample synthesis and simulation scripts, and the Beyond Studio Eclipse-based software development IDE for Windows and Linux.

Reference designs on FPGA boards are also available; contact CAST Sales for information.

Related Products

The BA2x Processor Family

The BA2™ Processor Family includes a set of royalty-free, pre-configured products intended for different applications:

- **BA21 32-bit Low-Power Deeply Embedded Processor**, a dual-pipeline low-power processor that delivers better performance than most processors its size.
- **BA22-DE 32-bit Deeply Embedded Processor**, a flexible and efficient processor with 4- or 5 pipeline stages that delivers the processing power required for demanding deeply embedded applications.
- **BA22-CE 32-bit Cache-Enabled Embedded Processor**, a 4- or 5-stage pipelined processor, with instruction and data caches.
- **BA22-AP Basic Application Processor**, a 5-stage pipelined, cache- and MMU-enabled processor.
- **BA25 Application Processor**, a 7/12-stage pipelined, out of order, cache- and MMU-enabled processor.