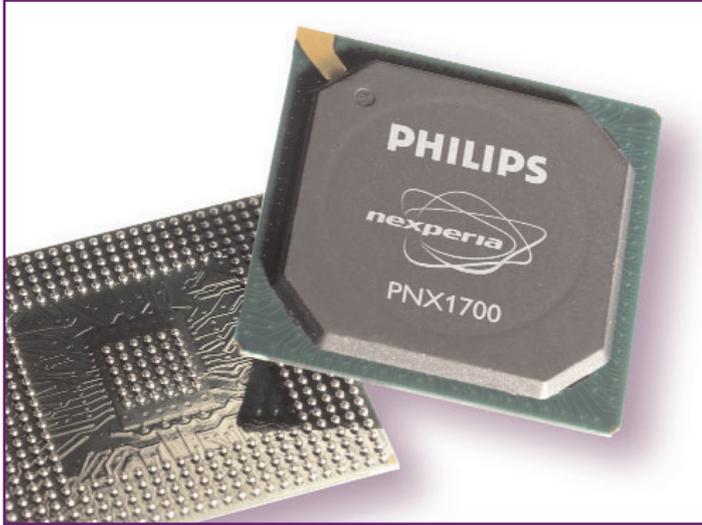


# Nexperia PNX1700

## Connected media processor

With clock speeds of 500 MHz, high-definition (HD) video decoding, MPEG-4 encoding, and PNX1500 pin-compatibility, the Nexperia PNX1700 connected media processor offers a powerful, versatile, cost-effective solution for delivering high-quality digital content in the latest generation of multimedia consumer products.



### Key features

- HD-capable connected media processor delivering a 2X performance improvement over previous Nexperia media processors
- Ideal for IP-STB and digital media adapter products
- 100% pin compatible with PNX1500 for re-use of existing designs
- Advanced, super-pipelined 32-bit 500-MHz TriMedia TM5250 CPU core with powerful multimedia and floating point instructions
- On-chip, independent, DMA I/O and co-processing units perform image scaling, advanced de-interlacing and 2D graphics acceleration
- Encodes/decodes many popular video formats, including H.264, WMV9, MPEG-4 (SP, MVP, ASP), MPEG-2, and DivX
- Decodes HD resolutions of MPEG-2, WMV9, DivX
- Video output up to XGA TFT LCD (1280 x 1024 x 60P) and up to HD video (1920 x 1080 60I)
- Supports up to 256-MB DDR SDRAM memory system at rates up to 400 MHz (total memory bandwidth of 1.6 GB/s)
- Support for Philips V<sup>2</sup>F dynamic power management enables frequency and power consumption to be tailored per application

Semiconductors

Continuing a tradition of low-cost, high-performance, real-time media processors, the Nexperia PNX1700 handles popular video, audio, graphics, and communications standards such as H.264, Windows Media Technology, DivX, MPEG-2, MPEG-4, MP3, Dolby Digital®, TCP I/P, Ethernet, and Universal PnP. Doubling the performance of the PNX1500, the PNX1700 also decodes HD video formats including WMV9, MPEG-2, and DivX-HD. Support for simultaneous encode/decode of MPEG-2 or MPEG-4 formats enables features such as watch/record and time-shifting in PVRs. The PNX1700 maintains 100% pin compatibility with the PNX1500, ensuring design re-use as well as an instant performance boost for existing PNX1500 designs.

The PNX1700 features a TriMedia TM5250 CPU core with an enhanced set of powerful multimedia and floating point instructions. Its on-chip I/O and co-processing units perform high-quality hardware image scaling, advanced de-interlacing, picture enhancements, and complex 2D graphics acceleration. A TFT LCD controller and an Ethernet 10/100 MAC reduce the BOM and support advanced product configurations. Together the CPU and on-chip units make PNX1700 an ideal single-chip solution for delivering exceptional picture quality in a variety of connected multimedia appliances such as digital media adapters, IP STBs, personal media players, and more.

The PNX1700 is supported by a comprehensive software development environment, enabling application development entirely in the C or C++ programming languages. Extensive applications libraries, developed by Philips and third parties, improve time-to-market, reduce design cycles, and lower product development costs.

# PHILIPS



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# Nexperia PNXI700

## Connected media processor



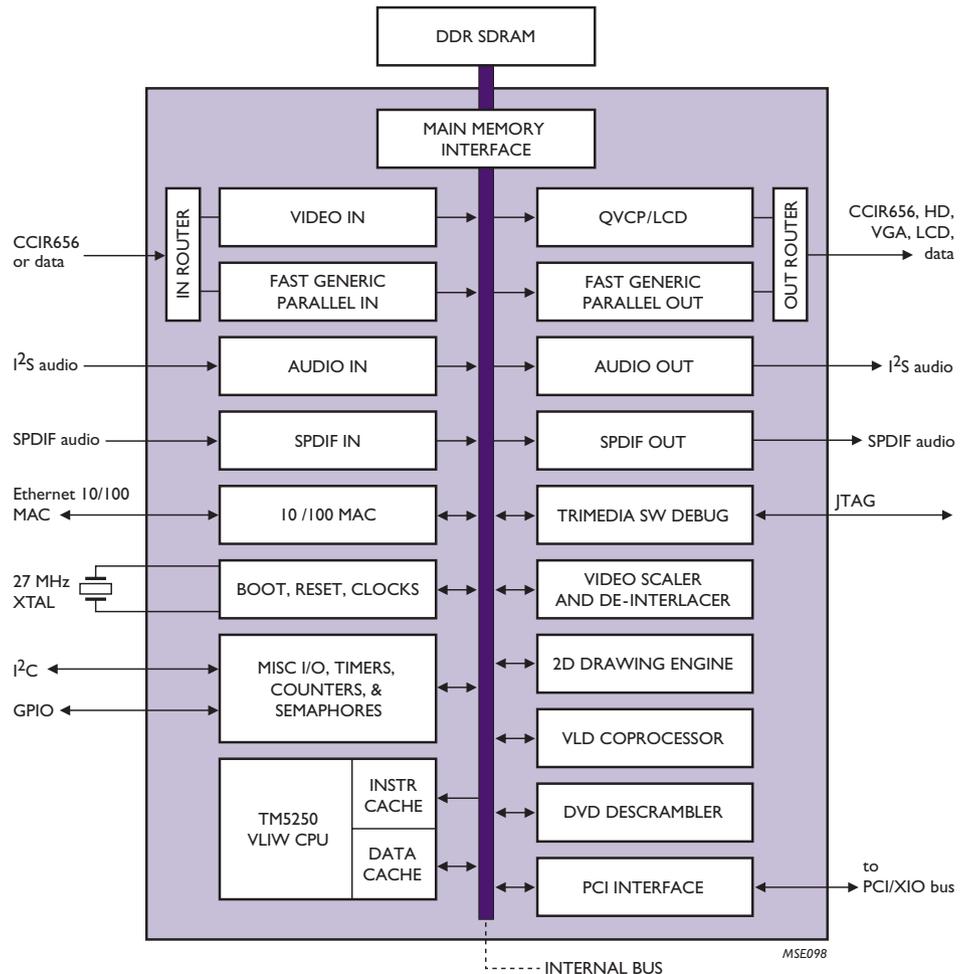
### Architectural overview

The PNXI700 leverages a powerful, redesigned C/C++ programmable TriMedia TM5250 CPU running a small real-time operating system for efficient, predictable response to real-time events. Independent, on-chip, bus-mastering DMA units capture and format datastream I/O and accelerate processing of multimedia algorithms. A sophisticated memory hierarchy manages internal I/O and streamlines access to external memory. The result is a low-cost, programmable media processor proven in stand-alone and hosted multimedia products.

### C/C++ programmable VLIW CPU

The PNXI700 TriMedia TM5250 CPU core delivers top performance through an elegant implementation of a fine-grain parallel very-long instruction word (VLIW) architecture. This core offers an extended instruction set accelerating algorithms such as H.264 and WMV9 decode. It doubles the performance of PNXI500 applications 'out-of-the-box' after only source recompilation; additional performance can be achieved by leveraging the new TM5250 instructions.

*On a single chip, the Nexperia PNXI700 accelerates processing of audio, video, graphics, control, and communications datastreams.*



The CPU's five issue slots enable up to five simultaneous RISC-like operations to be scheduled into only one VLIW instruction. These operations can simultaneously target any five of the CPU's 30 pipelined functional units within one clock cycle.

In addition to a full complement of traditional 32-bit integer and IEEE-754 compliant floating-point microprocessor operations, the TM5250 instruction set includes an extensive set of custom multimedia operations and single instruction multiple data (SIMD)-style operations (ops) for single 32-bit, dual 16-bit or quad 8-bit packed data. By combining multiple simple operations, a single custom op can implement up to 12 traditional microprocessor operations. In this way, up to 40 traditional operations can be executed in a single VLIW instruction. When incorporated into source code, custom ops can dramatically improve performance by taking advantage of the TM5250's highly parallel implementation.

## On-chip I/O and co-processing units

### *Video input processor (VIP)*

The VIP unit captures and processes digital video for use by on-chip units. It accepts up to 10-bit parallel YUV 4:2:2 digital video from any device or component outputting a CCIR656-compliant stream or a YUV stream with separate H and V syncs. During capture of a continuous video stream, the VIP unit can crop, horizontally downscale, or convert the YUV video to one of many standard pixel formats as needed before writing data to memory. When streaming video from TV broadcasts, it can also capture raw VBI data into a separate window in memory. This unit shares its pin interface with a fast generic parallel input unit through an input router.

### *Fast generic parallel input (FGPI)*

An FGPI unit captures unstructured, infinite parallel datastreams, messages, or control signals—any datastream with no YUV processing requirements. When raw mode is enabled, an 8-, 16-, or 32-bit parallel datastream is captured continuously and double buffered into memory to receive, for example, an ATSC transport stream from an external channel decoder.

### *Video scaler and de-interlacer*

A versatile, programmable memory-based scaler unit applies a wide variety of image size, color, and format manipulations to improve video quality and prepare it for display. The unit handles de-interlacing (with optional edge detection/correction), horizontal and vertical scaling, linear and non-linear aspect ratio conversions, anti-flicker filtering, pixel format conversions, and more.

### *Quality video composition processor (QVCP)*

The QVCP unit composites two planes of display data from different sources before output. It supports either two video planes or one video plane and one graphics plane, such as video from DVD playback and graphics from a web browser. Working together with the on-chip 2D engine and the memory-based scaler, QVCP enables the PNX1700 to support many types of multimedia applications at high speeds with few external components.

In addition to two-layer video compositing, the QVCP integrates scaling, a TFT LCD controller and a long list of video quality enhancements including de-indexing or gamma equalization, contrast and brightness control, luminance sharpening, horizontal dynamic peaking, skin tone correction, dithering, and screen timing generation for the target display.

QVCP outputs the resulting video datastream to any of a wide variety of off-chip video subsystems supporting CCIR656, YUV, or RGB formats, progressive or interlaced scan modes, and resolutions up to XGA TFT LCD (1280 × 1024 × 60P) or SD/HD video (up to 1920 × 1080 60I). It shares its pin interface with the fast generic parallel output unit through an output data router.

### *Fast generic parallel output (FPGO)*

The FPGO unit can output any raw datastream with no video post processing requirements, for example, an ATSC bitstream. It can also broadcast unidirectional messages to other PNX1700 processors.

# Nexperia PNX1700

## Connected media processor



### *Audio input (AI) and audio output (AO)*

Highly programmable AI and AO units provide all signals needed to read and write digital audio datastreams from/to most high-quality, low-cost serial audio over-sampling A/D and D/A converters and codecs. Both units connect to off-chip stereo converters through flexible bit-serial I<sup>2</sup>S interfaces. Their high level of programmability provides tremendous flexibility in handling custom datastreams, adapting to custom protocols, and upgrading to future audio standards.

The AI unit supports capture of up to eight channels of stereo audio. In raw mode, it captures any quantity of bits from the programmable frame. The AO unit outputs up to eight channels and directly drives up to four external stereo I<sup>2</sup>S or similar D/A converters or highly integrated PC codecs. Software support for decode and output of Dolby Pro Logic<sup>®</sup> and Dolby AC-3 is provided through optional application library modules.

### *S/PDIF input and output*

An SPDIF (Sony/Philips Digital Interface) input unit connects to external sources of digital audio, such as a DVD player, to receive audio datastreams a variety of formats, including stereo PCM data, 5.1-channel Dolby Digital data (per IEC-1937), and more. An SPDIF output unit outputs a high-speed serial datastream. Primarily used to transmit digital S/PDIF-formatted audio data to external audio equipment, it can also be used to output two-channel linear PCM audio from an internal audio mix or captured, compressed multi-channel audio streams such as Dolby Digital or AAC (per Project 1937). Software-decoded audio can be mixed with other audio before output.

Both SPDIF input and output units have independent, programmable sample rates guaranteeing synchronization to any system time reference. Datastream content is software generated and software controlled.

### *2D drawing engine (2D DE)*

An on-chip 2D rendering and DMA engine accelerates high-speed 2D graphics operations including solid fills, lines, three-operand bitblts, and color expansion of monochrome data to any supported pixel format. A full 256-level alpha bitblt blends source and destination images together.

### *Variable length decoder (VLD)*

A VLD coprocessor offloads the CPU during decoding or transcoding of Huffman-encoded MPEG-2 and MPEG-1 datastreams. It outputs a decoded stream to memory that is optimized for MPEG decompression software.

### *DVD descrambler*

An on-chip DVD descrambler unit handles DVD authentication and descrambling tasks, enabling PNX1700 to integrate complete DVD datastream playback. An IDE DVD drive can be attached directly to the PCI/XIO interface.

### **Memory system**

The PNX1700 couples main memory to substantial on-chip caches through a glueless main memory interface and internal bus system.

### *Glueless main memory interface (MMI)*

The MMI acts as the main memory controller and programmable central arbiter, allocating memory bandwidth for on-chip unit activities. The MMI provides a 16- or 32-bit DDR SDRAM interface. The 32-bit interface is equivalent to a 64-bit SDR SDRAM interface running at 200 MHz, resulting in theoretical maximum bandwidth of up to 1.6 GB/s. Programmable memory timing parameters enable the MMI memory controller to support most DDR SDRAM devices. Memory clock speed is programmable and independent of the PNX1700 CPU clock, eliminating the top-speed limitations of fixed memory/CPU clock ratios. Flexible memory configurations from eight to 256 MB enable a wide variety of products to be built.

#### *Dedicated instruction and data caches*

The CPU is supported by separate, dedicated on-chip data and instruction caches employing a variety of techniques to improve cache hit ratios and CPU performance. A 16-KB L1, four-way, set-associative data cache supports a copyback write and allocate on write policy, thus cache misses and CPU cache accesses can be handled simultaneously. Additional early restart techniques reduce read-miss latency. A 128-KB L2, eight-way, set-associative data cache further reduces the CPU stalls cycles by prefetching and holding relevant data before the L1 data cache misses.

A 64 KB 8-way set-associative instruction cache provides several hundreds of bits of instructions every clock cycle. To reduce internal bus bandwidth requirements, instructions in main memory and cache use a compressed format.

#### *High-speed internal bus*

The PNX1700 CPU and processing units access external memory through an internal bus system comprising separate 64-bit data and 32-bit address buses. Arbitrated by the MMI unit, the internal buses maintain real-time responsiveness in a variety of applications.

#### **PCI/XIO bus interface**

A PCI/XIO interface connects the CPU and on-chip units to a variety of board-level memory components and off-chip devices. It allows simultaneous connection of 32-bit PCI master/slave devices as well as separate address/data-style 8- and 16-bit microprocessor slave peripherals, standard (NOR) or disk-type (NAND) Flash memories, or an IDE disk interface.

#### **Control and connectivity**

The PNX1700's versatile interfaces and control options support many advanced product configurations.

#### *I<sup>2</sup>C interface*

An I<sup>2</sup>C master/slave external interface operates in both standard (100 kHz) and fast (400 kHz) modes. It can connect to an optional EEPROM for boot and can be used to control a variety of I<sup>2</sup>C board-level devices.

#### *I/O/100 Ethernet MAC*

The PNX1700 incorporates an Ethernet MAC sub-layer of the IEEE 802.3 standard, enabling an external PHY chip to be attached through a standard media independent interface (MII) or reduced MII interface (RMII). It implements dual-transmit descriptor buffers, supporting both real-time and non-real-time traffic. Quality of Service (QoS) is ensured through low- and high-priority transmit queues.

#### *Timers*

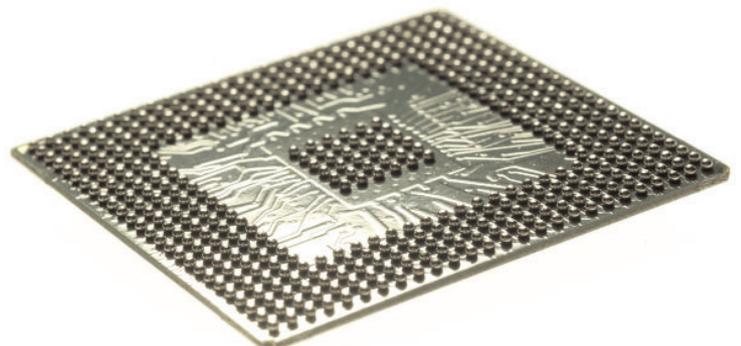
Eight 32-bit general-purpose timers can be used for performance analysis, real-time interrupt generation and/or system event counting.

#### **TriMedia software debug (TMDBG) unit/JTAG port**

Remote debugging of software running on the CPU core can be performed using the TriMedia interactive source debugger. The PNX1700 JTAG port connects a PC (running the debugger) to the TMDBG unit, enabling full support for interactive debugging features. The JTAG port is also used for boundary scan.

#### **General purpose I/O (GPIO) and flexible serial interface**

The PNX1700 supports 16 dedicated GPIO I/O pins for software I/O, external interrupt input, universal Remote Control Blaster transmission, and signal sampling and pattern generation for emulating high-speed serial protocols.



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### IR remote control, receive and transmit

The PNX1700 uses the GPIO pin event sequence time-stamping mechanism and software event interpretation to execute remote control (RC) commands. This approach supports a wide variety of RC protocols including Philips RC-5, RC-6, and RC-MM.

### Dynamic power management

Philips V<sup>2</sup>F power management enables devices to conserve power by tailoring frequency and core voltage to application requirements. When PNX1700 is configured with an external, programmable core voltage regulator, its software-programmable clocks enable the CPU to run at lower speeds, reducing power consumption during less cycle-consuming tasks. For example, decoding an MP3 audio stream requires less than 30 MHz of CPU cycles. Power is conserved, by adjusting the clock speed and the external voltage to service this lower cycle requirement.

### Robust software development environment

The PNX1700 is supported by a full suite of system software tools to compile and debug code, analyze and optimize performance, and simulate execution of its TriMedia CPU core. This comprehensive software development environment dramatically lowers development costs and reduces time-to-market by enabling development of multimedia applications entirely in the C and C++ programming languages.

Nexperia PNX1700 processors preserve investments in software development through compatibility between PNX1700 family members at the source code level. Powerful, optimizing compilers ensure that programmers never need to resort to non-portable assembler programming. As evolutionary hardware and software enhancements are incorporated into newer PNX processors, increased performance can be achieved by simply recompiling application software.

### TriMedia application libraries

Many application libraries are available from Philips and third-party suppliers. These C-callable routines are optimized for top performance on the TriMedia CPU and include modules for functions such as:

- H.264 encode/decode
- MPEG-4 (SP, MVP, ASP) encode/decode
- MPEG-2 encode/decode
- MPEG-1 encode/decode
- WMV9 720P decode
- MPEG-2 HD decode
- DivX-HD decode
- DivX-3, -4, -5, -6 decode
- DV decode
- H.32x encode/decode
- H.263 encode/decode
- Dolby Pro Logic or Dolby AC-3 decode
- MP3 encode/decode
- AAC encode/decode
- TCP/IP, Ethernet, Universal PnP protocols
- more.

## Technical specifications

### PHYSICAL

<b>Process</b>	0.13- $\mu$ m CMOS
<b>Package</b>	456 BGA
<b>Power</b>	<i>supply</i> core 1.2 V, DDR 2.5 V, I/O 3.3 V (5 V tolerant) <i>consumption</i> 2 W typical at 466 MHz
<b>Case temp.</b>	0 to 85°C

### CENTRAL PROCESSING UNIT

<b>Type</b>	TriMedia TM5250
<b>Clock speeds</b>	450 MHz, 500 MHz
<b>Issue slots</b>	5
<b>Address space</b>	32-bit, linear
<b>Instruction set</b>	Arithmetic and logical, load/store, custom multimedia and DSP, IEEE-754 compliant floating point
<b>Data types</b>	Boolean, 8-, 16- and 32-bit signed and unsigned integer, 32-bit IEEE floats
<b>Functional units</b>	30 pipelined: integer and floating-point arithmetic units, data-parallel DSP-like units
<b>Registers</b>	128 fully general purpose, 32 bits wide, non-banked
<b>Interrupts</b>	64 auto-vectoring, 8 programmable priority levels
<b>Byte order</b>	Big or little endian

### CACHES

<b>Access</b>	<i>data</i> 8-, 16-, or 32-bit words <i>instruction</i> 128 bytes
<b>Associativity</b>	4- and 8-way set-associative with hierarchical LRU replacement
<b>Block size</b>	64 bytes, 128 bytes
<b>Size</b>	<i>L1 instruction cache</i> 64 KB <i>L1 data cache</i> 16 KB <i>L2 data cache</i> 128 KB

### VIDEO INPUT PROCESSOR UNIT (VIP)

<b>Ext. interface</b>	36 pins: 32 data, 2 clock, and 2 validity signals
<b>Formats</b>	CCIR 601/656: 10-bit video (up to 40.5 Mpix/sec); HD video (using 20-bit YUV input mode)
<b>Clock rate</b>	Up to 81 MHz pixel clock
<b>Functions</b>	Programmable on-the-fly horizontal scaling
<b>VBI formats</b>	Closed Captioning, Teletext, NABST, CGMS, and WSS

### FAST GENERIC PARALLEL INPUT UNIT (FGPI)

<b>Data rate</b>	Up to 100 MHz for 8-, 16- or 32-bit parallel data and messages, aggregate input bandwidth up to 400 MB/s
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### VIDEO SCALER & DE-INTERLACER UNIT (MBS)

<b>Scaling</b>	Simultaneous vertical and horizontal scaling with linear and non-linear aspect-ratio conversion
<b>De-interlacing</b>	Simple median, majority-selection (i.e. selects best case out of 3 different algorithms), simple field insertion and line doubling, or high-end, Philips edge-dependent de-interlacing (EDDI) algorithm
<b>Filtering</b>	Programmable up to 6-tap polyphase filters
<b>Color/Formats</b>	Variable color space conversion; conversions between 4:2:0, 4:2:2 and 4:4:4; color-key and alpha processing
<b>Performance</b>	Up to 120 Mpix/s

### VIDEO OUTPUT UNIT (QVCP)

<b>Data formats</b>	24- or 30-bit full parallel RGB or YUV, 16- or 20-bit Y and U/V multiplexed data, 8- or 10-bit 656 (full DI, 4:2:2 YUV), 8- or 10-bit 4:4:4 format in 656-style with RGB or YUV
<b>Resolutions</b>	TFT LCD XGA (1280 x 1024 at 60P), SD/HD video up to 1920 x 1080 60I
<b>Clock rates</b>	Up to 136 MHz
<b>Functions</b>	2-layer compositing, picture quality improvements, gamma correction, horizontal 10-tap scaling, genlock mode

### FAST GENERIC PARALLEL OUTPUT (FGPO)

<b>Data rate</b>	Up to 100 MHz for 8-, 16- or 32-bit parallel data and messages, aggregate output bandwidth up to 400 MB/s
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### AUDIO INPUT & OUTPUT UNITS (AI & AO)

<b>Sample size</b>	8 channels, 16- or 32-bit samples per channel
<b>Sample rates</b>	Programmable with 0.001 Hz resolution; maximum sample rate is application dependent
<b>Data formats</b>	16-bit (mono and stereo), 32-bit (mono and stereo), PC standard memory data format
<b>Clock source</b>	Internal or external
<b>Native protocol</b>	I <sup>2</sup> S over serial 6-wire protocols

### SPDIF INPUT & OUTPUT UNITS (SPDI & SPDO)

<b>Sample size</b>	6 channels, 16 or 24 bits per channel
<b>Bit rate</b>	Up to 40 Mb/s in raw mode
<b>Native protocol</b>	IEC-958, 1 wire

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### Technical specifications (continued)

#### 2D DRAWING ENGINE

<b>Functions</b>	Solid fills, 3-operand bitblt, lines, monochrome data expansion, 256-level alpha bitblt (to blend 2 images), anti-aliased lines and fonts
<b>Formats</b>	8-, 16-, and 32-bit/pixel

#### VARIABLE LENGTH DECODER UNIT (VLD)

<b>Functions</b>	Parses MPEG-1 and MPEG-2 elementary bitstreams generating run-level pairs and filling macroblock headers
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#### DVD DESCRAMBLER UNIT (DVDD)

<b>Functions</b>	Authentication, descrambling
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#### I<sup>2</sup>C INTERFACE

<b>Modes</b>	Master and slave
<b>Addressing</b>	Up to 10-bit
<b>Operating modes</b>	<i>standard</i> 100 kHz <i>fast</i> 400 kHz

#### ETHERNET MAC

<b>Interface</b>	10/100 IEEE 802.3, MII, and RMII
<b>Functions</b>	Real-time traffic, QoS

#### PCI/XIO BUS INTERFACE

<b>Width</b>	32-bit data, 32-bit address space
<b>Speed</b>	33-MHz PCI 2.2 interface with integrated PCI bus arbiter up to 4 masters
<b>Voltage</b>	3.3 V (5 V tolerant)
<b>Functions</b>	PCI master and slave 8-, and 16-bit NAND or NOR Flash memories IDE controller

#### MEMORY SYSTEM

<b>Speed</b>	Up to 200 MHz (1.6 GB/s)
<b>Memory size</b>	8 to 256 MB
<b>Supported types</b>	64 to 512 Mbit DDR SDRAM devices
<b>Width</b>	16- or 32-bit bus
<b>Signal levels</b>	2.5 V SSTL-II

#### TIMERS

<b>Number</b>	8
<b>Sources</b>	(prescaled) CPU clock, data or instruction breakpoints, cache events, video I/O clocks, audio in/out word strobe

#### GPIO

<b>Dedicated pins</b>	16
<b>Functions</b>	Software I/O, external interrupt, universal RC blaster, clock source/gate for system event timers/counters, emulating high-speed serial protocols

<sup>1</sup> Use of this product in any manner that complies with the MPEG-2 Standard is expressly prohibited without a license under applicable patents in the MPEG-2 patent portfolio, which license is available from MPEG LA, L.L.C., 250 Steele Street, Suite 300, Denver, Colorado 80206.

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