C-Cube DoMiNo™ Network Media Processor

Single Chip Multi-Stream and Multi-Format Audio/Video/System Codec

Target Applications

- Interactive, digital set-top boxes
- DVD recorder appliances
- Home media gateways
- Home media servers
- Multi-service network video head-end transraters and transcoders
- Non-linear video editing (NLE) for the broadcast industry, including cable, satellite, and Internet

C-Cube DoMiNo Network Media Processor

Overview

The C-Cube DoMiNo™ Network Media Processor is the industry's first programmable, single chip, multi-stream, multi-format, MPEG audio/video/system codec (encoder/decoder) architecture. This powerful and flexible architecture has been designed to trigger – very much like the domino effect – an endless variety of digital audio-visual products for the consumer, prosumer and professional markets. The C-Cube DoMiNo architecture adds the dimension of networked digital entertainment for the networked home in the Internet Age.

To deliver the industry's best quality 4:2:2 HD and 4:2:0 standard definition TV images, C-Cube DoMiNo uses C-Cube's award winning PerfectView™ MPEG-2 encoding algorithm in combination with its advanced motion compensated noise filtering and de-interlacing algorithms for superior source noise reduction and up-conversion to high-resolution formats, respectively. Moreover, using C-Cube's MPEG-4 (H.263+) encoder, C-Cube DoMiNo brings streaming of sports and movies over the Internet on a wide-screen TV into the living room.

C-Cube DoMiNo is a true system-on-chip architecture, reducing cost, design complexity, power consumption, and time-to-market through its high level of system integration and its C-Ware™ high-level programming environment. C-Cube DoMiNo's true multi-stream and multi-format AV codec capabilities enable unique features on digital set-top boxes and DVD recorders. These include, but are not limited to, dual channel HD decode with picture-in-picture, quad channel live preview for channel selections, digital and analog time-shifting, seamless channel and video clip switching without frame freezes and audio muting, and concurrent execution of multiple tasks, such as recording a TV program while watching a DVD movie.

C-Cube is the industry leader in developing best-of-class integrated circuits, modules, and software for video and audio compression and decompression. C-Cube DoMiNo represents the industry's most powerful, versatile, and advanced single chip audio/video/ system codec. C-Cube DoMiNo brings distributed video over home networks and professional video encoding quality to consumer markets.

The C-Cube DoMiNo Architecture

C-Cube DoMiNo integrates dual 150MIPS RISC processors, an audio DSP, a flexible video and motion estimation processor, DRAM controller, cache and scratch pad memory, IEEE1394 link, transport stream demultiplexers, video and audio I/O, a flexible system bus, and all necessary system I/O, including smart card interfaces.

The dual RISC core provides the necessary horse-power to implement additional graphics and host functions. The VxWorks® RTOS from WindRiver® Systems provide real-time operating system services, while C-Ware provides signal processing specific services and high level, application programming interfaces (APIs) for the development of applications.

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The integrated I/O processor supports dual UARTs, IR receive and transmit, an IDC (inter-device connection) interface, and SPI bus for Flash memory devices like SmartMedia, etc. The smart card interface supports up to two smart cards. C-Cube DoMiNo can support multiple encryption standards, including CPPM, CPRM, CSS, Multi-2, DES, 5C, etc.

The flexible system bus can be configured either as a 32-bit, 66MHz PCI 2.2 compliant bus, or as a16- or 32-bit generic host bus. It either operates in slave mode with an external host processor, or in limited master mode when using the on-chip dual RISC core as the host. This makes C-Cube DoMiNo suitable for use in embedded as well as in PC-based applications.

The integrated DRAM controller supports 8Mbytes to 64Mbytes of single or double data rate (DDR) SDRAM. The 32-bit,148.5MHz memory bus has a bandwidth of 1.2GigaBytes per second with DDR SDRAM to serve the most demanding applications.

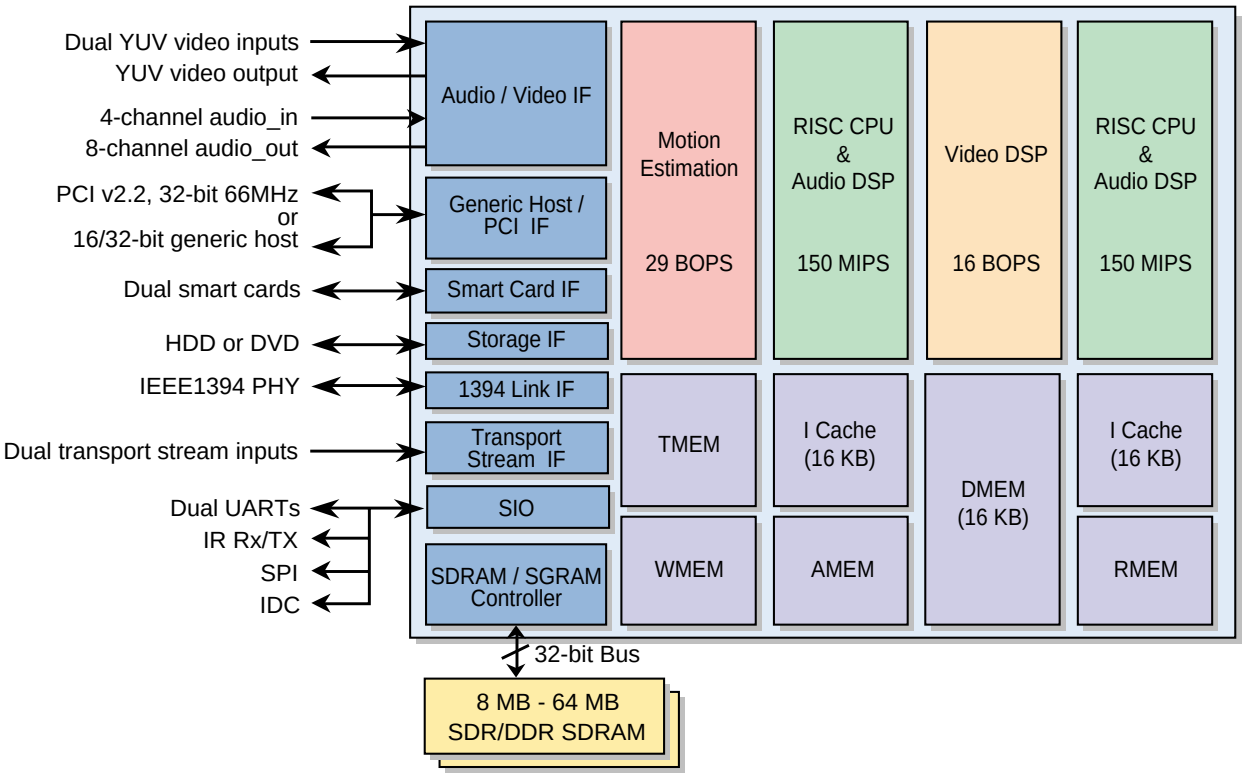
C-Cube DoMiNo's powerful signal processing capabilities support multi-stream, multi-format AV encoding and decoding, transcoding and transrating between different AV formats and bit rates. The integrated motion estimation processor supports Motion Compensated Temporal Filtering (MCTF) and De-Interlacing (MCDI) for source noise reduction and up-conversion to high-resolution display formats, respectively.

The video input interface supports up to two CCIR656 8-bit YUV video inputs, or a single 16-bit YUV video input. The video output supports CCIR656 16-bit YUV or 24-bit RGB video out. The audio input interface supports dual stereo inputs, while the audio output interface supports up to 8 channels of surround sound audio. Dual transport stream demultiplexers are integrated for digital set-top box applications.

Key C-Cube DoMiNo Features

Single Chip System Integration. The integration of audio/video codec, host, graphics, network, and I/O sub systems, enable single chip set-top box, DVD recorder, and video editing/production solutions. The high level of system integration drastically reduces system design complexity, component cost and time-to-market. The reduction of component count greatly increases system reliability, and cuts power consumption significantly.

Built-in Audio/Video Networking. The integrated IEEE1394 link interface makes it easy for developers to add networking to consumer electronic devices, such as DV camcorders. The integrated transport stream demultiplexers provide connectivity with multi-service networks, such as digital cable and satellite, in combination with return channels implemented either via the integrated UARTs, or the flexible system bus.



C-Cube DoMiNo Network Media Processor Architecture

Flexible System Bus. The flexible system bus supports both 32-bit, 66MHz PCI and 16- or 32-bit generic host bus protocols in master or slave configurations. Various system configurations are therefore possible, giving designers the flexibility they need to optimize and expand system performance and functionality.

Large Memory Bandwidth. The integrated memory controller supports 8Mbytes to 64Mbytes of single and double data rate (DDR) SDRAM. The 32-bit, 148.5MHz bus has a maximum bandwidth of 1.2Gbytes, able to meet even the most demanding applications such as time-shifting on DVD-RAM, or dual stream HD decoding.

Integrated Graphics Processor. The integrated graphics engine can handle 24-bit RGB and 8-bit alpha blending. Up to 4 graphic planes are possible for support of OSD (On Screen Display), backgrounds and other applications. A flicker filter reduces flicker on interlaced TV screens for viewing Web sites. A video scaler properly scales 16:9 aspect ratio formats to letterbox format for viewing in a 4:3 aspect ratio.

Multi-Stream, Multi-Format Audio-Video Codec. The programmable audio DSP and flexible video processor, together with the RISC instruction set extensions make it possible to handle a multiplicity of video and audio encoding formats, including:

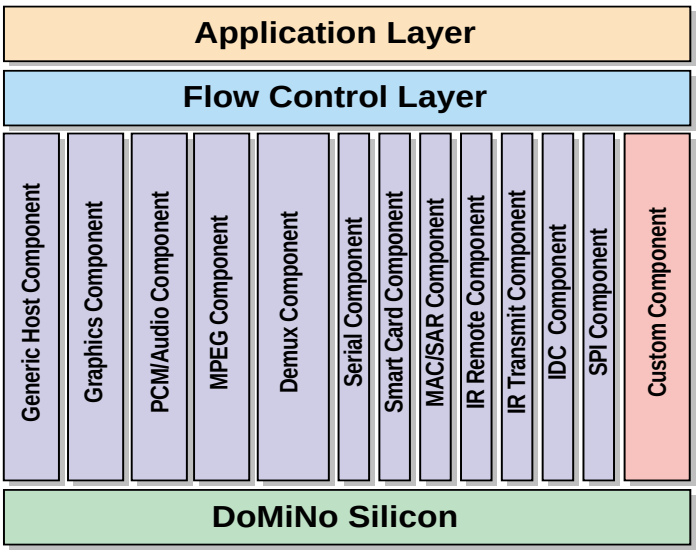
- MPEG-2 MP@ML (4:2:0) and MP@HL (4:2:2)
- MPEG-1
- MPEG-4 (H.263+ with AAC audio and interlaced video support)
- DV
- DVD-Audio with Meridian Lossless Packing (MLP) and LPCM decoding
- MPEG-1 Layer I, MPEG-1 Layer 2, MPEG-1 Layer 3 (MP3), AC-3, DDCE, DTS, etc.

The sophisticated signal processing capabilities also support all the ATSC display formats and conversions between them. Through deployment of C-Cube's proprietary Motion Compensated De-Interlacing up-conversions from 480i to 480p or higher, resolutions result in sharper than usual images, especially for sports scenes and slow motion.

The multi-stream AV codec enables a host of unique applications, such as time-shifting – or personal TV – simultaneous preview of up to four standard definition TV channels or decoding of two HDTV streams on digital set-top boxes, and handling several streams simultaneously in DVD recorder video editing applications.

Another unique feature is seamless switching between audio-video streams, without the usual, annoying frame freezes and audio muting. Examples are switching channels on a set-top box, switching between alternative angle and main screen, or switching between video clips on a DVD recorder.

Video and Audio Streaming. C-Cube DoMiNo's flexible architecture provides support for MPEG-4 and MP3 streaming applications over broadband Internet connections. With C-Cube's MPEG-4 (H.263+) implementation, C-Cube DoMiNo is capable of VHS quality for streaming movies and sports programs at 1.3Mbps or lower on a 35" TV.



C-Ware Component and Flow Controller Architecture

Transcoding and Transrating. The powerful signal processing capabilities of C-Cube DoMiNo include the ability to transcode and transrate between different encoding formats and bit rates, respectively, at faster than real-time speeds (high-speed dubbing). Transcoding enables a set of unique features, including, but not limited to:

- *Digital time-shifting on set-top boxes.*
  Transcoding is required from MPEG-2 MP@HL (4:2:2) to MPEG-2 MP@ML (4:2:0), or even MPEG-4 at 1.3Mbps or lower.
- *Recording from or to DV camcorders for editing, archival, or video-mailing purposes.*
  Transcoding is required from DV to MPEG-2 or MPEG-1, or even MPEG-4, or vice versa.
- *Recording digital music in MP3 format for playback with portable MP3 players.*
  This requires transcoding from the original digital format to MP3 format.

Transrating similarly enables a set of unique features, such as the ability to make trade-offs between picture quality and storage requirements. Applications include, but are not limited to, video-mail, archiving, storage and space optimization.

Variable and Constant Bit Rate Control. C-Cube DoMiNo supports both variable and constant bit rate MPEG video encoding to provide image and storage optimizations for a variety of applications:

- Constant bit rate (CBR) encoding for DVD recorder and time-shift applications on both DVD recorders and set-top boxes.
- Advanced single-pass and multi-pass variable bit rate (VBR) encoding for video quality optimizations in DVD video and DVD recordable applications.
- Statistical multiplexing for multi-channel broadcast applications.

Programmability. C-Cube DoMiNo's support for C-Ware™ firmware architecture provides abstraction of hardware and signal processing flow dependencies through the use of components and flow controllers, respectively. This makes it easy for developers to build applications and maintain portability across C-Cube DoMiNo and other C-Cube-based products. C-Ware's implementation in standard ANSI C, its object-oriented programming model, and its standardized set of application programming interfaces (APIs) promotes application portability and code re-use. Furthermore, C-Ware's rich set of components and flow controllers drastically reduces firmware development schedules.

Summary of Specifications

AV Codec	Dual stream , full duplex, SD/HDTV audio and video codec
Encode/Decode Formats	MPEG-2 MP@ML(4:2:0), MP@HL(4:2:2), MPEG-1, MPEG-4 (H.263+), DV, AC-3, DDCE, MLP, AAC
File System Support	DVD-VR (RTRW), DVD-V, UDE
Display Formats	Vertical: NTSC (480) and PAL (576) interlaced and progressive Horizontal: 1080i, 720p, 480p, 480i
Encryption/Decryption	CPPM, CPRM, CSS, DES, Multi-2, C5, etc.
Video I/O	Dual CCIR 656 YUV inputs, CCIR 656 YUV or RGB output
Audio I/O	Quad channel I²S compatible inputs, 8 channel I²S compatible outputs
Video Networking	Dual transport stream demultiplexers, IEEE1394 Link
Graphics	32-bit RGBA with 8-bit alpha blending, multi-plane 2D graphics with OSD, flicker filter, video scaler
Memory Controller	8M-64MB SDR or DDR SDRAM, 32-bit, 148.5MHz, 1.2Gbytes/second
System Expansion Bus	32-bit, 66MHz PCI 2.2 or 16-/32-bit generic host bus, master or slave
System I/O	IDC, SPI, IR Tx/Rx, dual UARTs, dual smart card interfaces ATAPI/IDE and DVD
JTAG	IEEE1149.1 compliant boundary scan and PCB assembly testing
Input Voltages	3.3V (5V tolerant) I/O, 3.3V DRAM, 1.8V core
System Clock	13.5MHz or 27MHz
Package	388-pin or 308-pin BGA

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