

# EM8400 EM8401

## MPEG-2 Decoder for Set-top, DVD and Streaming Applications

### Description

The EM8400 is a single-chip MPEG audio/video decoder that supports DVD-Video, SVCD, VCD 1.x, VCD 2.0, CD-DA and CD-ROM media formats, with MPEG-1 and MPEG-2 MP@ML video decoding. Audio decoding support includes Dolby® Digital, MPEG-1 Layers 1 and 2 and 16-bit linear PCM. DVD-Video support includes hardware CSS decryption, 16:9 and 4:3 aspect ratios, letterboxing, 3:2 pull-down, multiple angles and sub-picture.

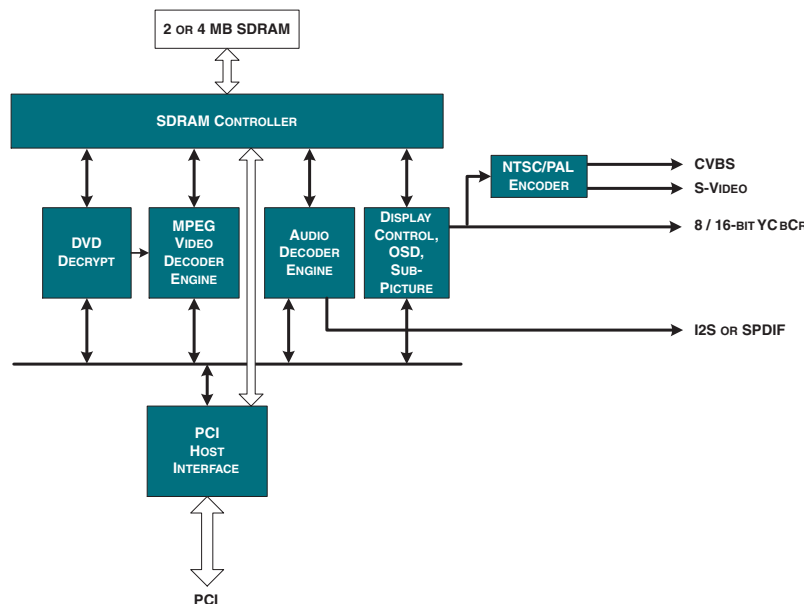
The programmable video output display controller includes high-quality arbitrary scaling and an OSD frame buffer with 16-level alpha blending. It supports interlaced or progressive output resolutions up to 1920x1080 with a refresh rate up to 120 Hz. The provided brightness, contrast and color controls optimize displayed video.

Based on the company's award-winning REALmagic® Video Streaming Technology, the EM8400 provides highly-integrated solutions for high-quality decoding of MPEG-1 and MPEG-2. Positioned as a cost-effective solution for streaming video clients, advanced digital set-top boxes and next-generation interactive DVD players, the EM8400 enables manufacturers to easily incorporate streaming video, progressive DVD playback and video-on-demand into their products.

### Features

- Supports DVD-Video, SVCD, VCD 1.x, VCD 2.0, CD-DA, CD-ROM media formats
- MPEG-1, MPEG-2 MP@ML video decoding
- Dolby Digital, MPEG-1 Layers 1 and 2 and linear PCM audio decoding
- 2-, 4-, 7- or 8-bit OSD with optional run-length compression and 16-level alpha blending
- Programmable display output with scaling up to 1920x1080 resolution, interlaced or progressive, up to 120 Hz refresh

### Block Diagram



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## Bitstream Demultiplexing

The host processor performs MPEG-2 transport and program stream and MPEG-1 system stream demultiplexing. The EM8400 operates as a PCI bus master while audio and video elementary streams are transferred from host system memory to EM8400 memory by the EM8400's DMA engine.

Software drivers for the x86, available from Sigma Designs, include MPEG-2 transport and program stream demultiplex, MPEG-1 system stream demultiplex and DVD-Video/SVCD/VCD stream demultiplex and navigation. Supported operating systems for our x86-based reference designs include Windows® XP Embedded, Windows CE .NET and Linux. For other operating systems and hardware platforms, our Professional Services Group can assist in supporting your requirements.

## DVD-Video Decryption

The EM8400 includes decryption logic and supports DVD-Video CSS procedural specifications. It also fully supports DVD-Video control features including up to 8 language sound tracks, 32 subtitle settings, letterbox, pan and scan, multi-angles and 3:2 pull-down.

## Audio Output Interfaces

The audio decoding block supports the following audio bitstream formats:

- Dolby Digital with conformance to Group A (20-bit)
- MPEG-1 Layers 1 and 2
- 16-bit linear PCM data
- Compressed Dolby Digital and DTS® digital output via S/PDIF

## I2S Digital Audio Output

The I2S serial audio output block receives either 2-channel down-mixed decoded Dolby Digital audio, decoded MPEG-1 audio or PCM audio data. It then converts this data into a serial bitstream compatible with the I2S specification. The  $256 \times F_s$  serial clock must be generated by an external clock source.

## S/PDIF Digital Audio Output

In addition to receiving the same audio data as the I2S digital audio output block, the S/PDIF output block can receive compressed DTS and compressed Dolby Digital audio data. It then converts this data into a serial bitstream compatible with the S/PDIF specification.

Although both I2S and S/PDIF digital audio outputs are available, they are not available simultaneously.

## Features

- 80 MHz digital video output interface: 8- or 16-bit CCIR 601 / 656 YCbCr
- NTSC/PAL composite and s-video outputs with optional Macrovision v7.1 protection (10-bit DACs)
- Digital audio output interface: I2S for PCM or S/PDIF (IEC 60958) for PCM, compressed Dolby Digital and compressed DTS
- PCI v2.1 bus master / slave interface supports read operations
- 2.5V core with 3.3V I/O (5V tolerant) for low power operation
- Package: 208 PQFP

## Applications

- Consumer products needing playback of video-on-demand (VOD), streaming video, progressive DVD
- Set-top boxes, media/home gateways, video end points, convergence appliances

## Video Display Controller

The display controller reads picture data from DRAM and displays it with proper format, timing and synchronization signals. This is a real-time process driven by the video clock.

The display controller operates in one of four modes:

- Master mode -- the display controller generates HSYNC and VSYNC using an internal or external video clock up to 80 MHz
- Slave mode -- the display controller receives HSYNC and VSYNC using an internal or external video clock up to 80 MHz

The video display timing can be set for interlaced or non-interlaced (progressive) video output up to 120 Hz.

## Sub-Pictures

Sub-pictures are compressed bit maps overlaid on decoded MPEG video which can be scrolled up and down and faded in and out. The area, content, color and contrast in every video field can be changed. These modifications produce special effects such as highlighting.

## OSD (On-Screen Display)

The OSD enables simple full screen graphical menus to be displayed and blended with the MPEG decoded video and sub-picture. It supports 4 palletized color depths: 4 colors (2 bits per pixel), 16 colors (4 bits per pixel), 128 colors (7 bits per pixel) and 256 colors (8 bits per pixel). The bit map can be compressed using Run-Length Coding (RLC) in 2-, 4- and 7-bit per pixel modes. A 256x32 color look-up table (CLUT) is provided to convert the 2-, 4-, 7- or 8-bit code into a 24-bit YCbCr color and 16 levels of alpha blending. The highlight function is supported in 2-, 4- and 7-bit per pixel modes.

## Letterbox Display

Letterbox mode provides vertical downscaling; 16:9 pictures can be displayed in a letterbox fashion on a traditional 4:3 display.

## Pan and Scan Display

Pan and scan mode expands the video image to 16:9. A section of the image can be displayed at full height on a 4:3 TV display.

## Alpha Blending

Alpha blending provides two layers of blending: sub-picture over the MPEG video and OSD over both the sub-picture and MPEG video. Up to 16 levels of blending are available.

## Video Output Interfaces

Video output ports provide digital YCbCr outputs and include an integrated NTSC/PAL video encoder and video DACs for composite and s-video analog outputs.

## VBI Support

NTSC closed captioning on lines 21 and 284 is supported.

## Digital Video Output

The digital video output, controlled by the video display controller, supports 8- / 16-bit CCIR 601 / 656 4:2:2 YCbCr data. It may be operated as a timing master or slave at rates up to 80 MHz (160 MBps) and resolutions up to 720p or 1080i.

## TV Encoder - Composite and S-Video Output

A high-quality NTSC/PAL encoder (with optional Macrovision v7.1 protection) that supports the NTSC, PAL, PAL-60 and PAL-M video standards is available. It features three 10-bit video DACs to generate simultaneous composite and s-video outputs. The analog video outputs are capable of driving a doubly-terminated 75-ohm load.

## PCI Host Interface

The PCI interface is the main conduit between the EM8400 and the host processor. It is designed for master reads and is PCI v2.1 compliant. The PCI interface supports 3.3V and 5V operation and ACPI power management from the PCI v2.2 specification.

## Additional Software Available

### VOD Client Software (MPEG-2)

VOD client software for the x86 is available that supports select MPEG-2 video servers, including:

- Cisco's IPTV family
- Concurrent's MediaHawk
- InfoValue's MediaQuick
- Kasenna's MediaBase
- nCUBE's NVS
- Streaming21's Media Server
- Thirdspace's OVS (Oracle Video Server)

For the latest list, please check with your local sales representative.

## IP Multicasting Client Software

IP multicasting client software for the x86 is available.

## Memory Requirements

The mode of operation determines the amount of 100 MHz SDRAM required as shown in Table 1.

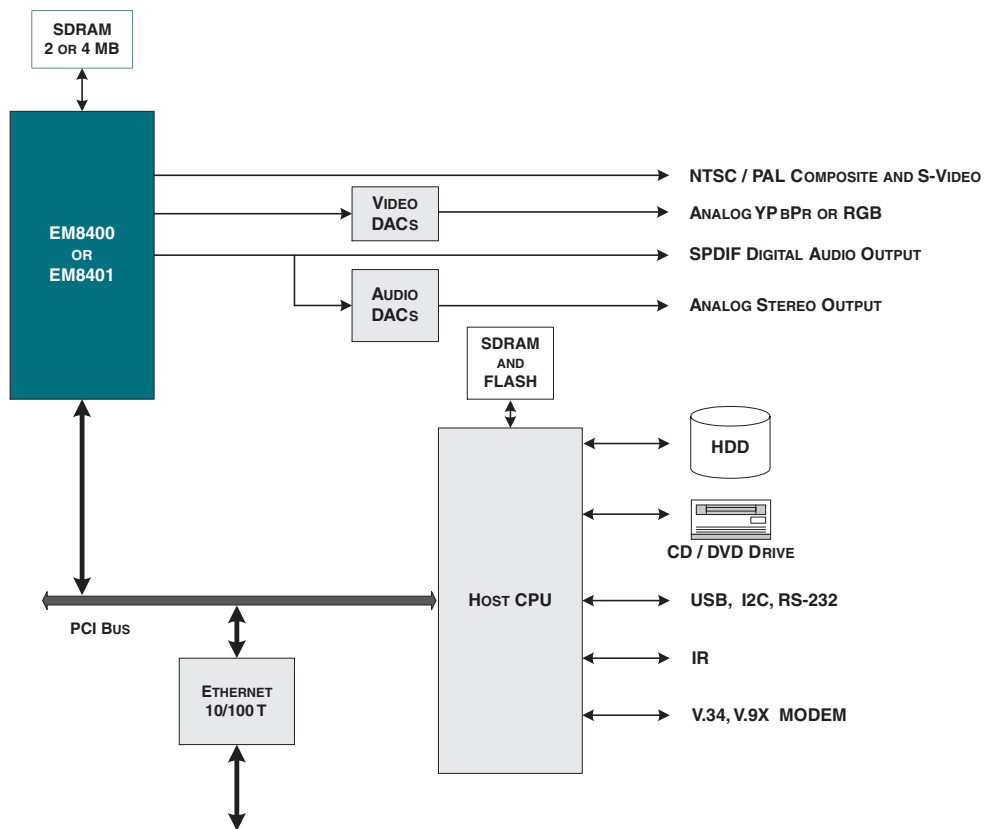
Mode of Operation	Minimum SDRAM Configuration		
	1M x 16	512K x 32	1M x 32
MPEG-2 interlaced SDTV output with no OSD	x	x	x
MPEG-2 interlaced SDTV output with OSD		x	x
MPEG-2 progressive SDTV output with no OSD		x	x
MPEG-2 progressive SDTV output with OSD			x
MPEG-2 HDTV digital output			x

**Table 1. SDRAM Configurations.**

## Application Example: Streaming Set-top Box with DVD-Video Playback

The streaming set-top box example below also supports DVD-Video playback. System integration requires very little external logic since the EM8400 provides most of the features including:

- Streaming video or video-on-demand (VOD) playback
- Progressive DVD-Video playback
- NTSC / PAL composite and s-video outputs
- S/PDIF audio output



### Hardware vs. Software MPEG Decoding

Use hardware-based MPEG decoding when:

- Delivery of audio and video to a television is the primary function of the system. Standard consumer-oriented connectors for audio and video must be used, instead of PC-oriented break-out cables and mini jacks. (Example: set-top box.)
- Home theater quality audio and video (such as 6-channel audio analog outputs, component YPbPr or RGB analog video outputs and a SPDIF digital audio output) are required. Although specifications for audio and video solutions for the PC market look good on paper, the products themselves rarely meet consumer expectations.
- A relatively slow CPU, such as an embedded processor, is used to lower system costs. Slower CPUs also reduce power consumption and eliminate noisy fans. Decoding MPEG-4 requires a 1 GHz CPU, which is currently far too costly for low-cost set-top boxes to employ.
- Multiple video streams must be decoded simultaneously to support picture-in-picture (PIP).
- Ancillary data processing, such as copy protection, closed captioning (multiple languages), teletext (multiple languages), v-chip (multiple regions) and widescreen signaling must be performed for each active video stream displayed. Widescreen processing must be able to handle anamorphic and letterboxed content for either 4:3 or 16:9 televisions. These are typically overlooked in software-based solutions.
- Alpha blending is required when overlaying text and graphics (such as closed captioning, teletext, EPG, OSD, etc.) over video to avoid artifacts (such as flicker) when displayed on a television. Such artifacts are caused by the limited-bandwidth video connection between the set-top box and television. It is typically implemented using anti-aliased fonts and graphics.
- High quality video scaling is required for large television screen sizes. Artifacts not noticeable on a small VGA monitor are magnified on a large television.

Use software-based MPEG decoding when:

- MPEG decoding is a secondary, rather than a primary function of the system. (Example: PC.)
- MPEG decoding is used in a single-tasking environment. Since MPEG decoding requires substantial CPU resources, using other applications usually affects playback quality.
- A fast CPU is already available on the platform.
- Only standard stereo audio and video (composite or VGA) outputs are needed.

## General Specifications

### Media Formats

- DVD-Video, SVCD, VCD 1.x, VCD 2.0, CD-DA, CD-ROM
- 15 Mbps sustained input data rate

### Video Decoding Standards

- MPEG-1, MPEG-2 MP@ML
- DVD-Video
  - CSS decryption
  - 16:9 and 4:3 playback, letterbox, 3:2 pull-down
  - Multiple angles and sub-picture
  - DVD-Video navigation software

### Video Processing

- Brightness, color, contrast controls
- Advanced scaling up to 1920x1080 pixels
- Interlaced or non-interlaced output up to 120 Hz
- 2-, 4-, 7- or 8-bit OSD with optional run-length compression and alpha blending

### Video Interfaces

- 80 MHz 8- / 16-bit CCIR 656 / 601 YCbCr video output port
- NTSC/PAL composite and s-video analog outputs with optional Macrovision v7.1 protection (10-bit DACs)

### Audio Decoding Standards

- 16-bit linear PCM
- MPEG-1 Layers 1 and 2
- Dolby Digital down-mixed to 2 channels

### Audio Interfaces

- I2S serial digital output for PCM
- S/PDIF (IEC 60958) serial digital output for PCM, compressed Dolby Digital and compressed DTS

### Host Interface

- PCI v2.1 bus master for reads

### Power Management

- 2.5V core with 3.3V I/O (5V tolerant) provides low-power operation
- Typical power dissipation:
  - Analog video outputs off: 700 mW
  - Analog video outputs on: 900 mW

### Package

- 208-pin PQFP

## Product Selection Guide

Feature	EM8400 <sup>1</sup>	EM8401 <sup>2</sup>
Media Formats DVD-Video, SVCD, VCD 1.x, VCD 2.0, CD-DA, CD-ROM	yes	yes
Video Decoding MPEG-1, MPEG-2 MP@ML	yes	yes
Audio Decoding Dolby Digital MPEG-1 Layers 1 and 2	yes yes	yes yes
Digital Video Outputs 8- / 16-bit CCIR 601 / 656 YCbCr (80 MHz)	yes	yes
NTSC/PAL Composite and S-video Outputs Macrovision v7.1 protection	yes yes	yes -
Audio Inputs and Outputs I2S or S/PDIF digital output	yes	yes
Package	208 PQFP	208 PQFP
Power Supply	2.5v / 3.3v	2.5v / 3.3v

<sup>1</sup>May be sampled or sold only to companies that are both Macrovision and Dolby licensed.

<sup>2</sup>May be sampled or sold only to companies that are Dolby licensed.

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