

SAA7135

For multi-standard analog and hybrid TVs, the Philips SAA7135 integrates high-quality decoding of all analog video and stereo formats used in TVs worldwide. It gives manufacturers a low-BOM solution for new PCI products, and an efficient upgrade path for adding advanced audio features to existing SAA713x designs.



Key features

- > Fully automatic standard detection and decoding of worldwide analog TV video formats (PAL, NTSC, and SECAM), and worldwide TV stereo formats (A2/Dual-FM, NICAM, BTSC with dbx™, SAP, EIAJ, and FM radio)
- > Advanced audio feature processing including Dolby® Pro Logic™, Virtual Dolby Surround™, Philips Incredible Sound, and more
- > Supports simultaneous stereo decoding and adaptive 3D comb filtering (to enhance picture quality)
- > Certified three-level Macrovision® detection circuitry
- > Captures raw VBI data (for Closed Captioning, Teletext, etc.)
- > Superior subpixel-accurate horizontal and vertical scaling
- > Outputs digital I²S audio and ITU-656 video
- > Captures transport streams from digital TV broadcasts and MPEG datastreams in time-shift applications
- > For PCI (Rev. 2.2, ACPI compliant) and standalone configurations

Single-chip, analog TV video/stereo decoder for worldwide PCI applications—with Dolby Pro Logic

Semiconductors

Like other SAA713x single-chip TV decoders, the SAA7135 offers high-quality detection and decoding of all worldwide analog TV video standards. In addition, it decodes all worldwide TV stereo formats and supports advanced audio features, such as Dolby Pro Logic decoding, and more. The SAA7135's flexible design, reusable components, and versatile external interfaces lower BOM and cost and support advanced TV decoder configurations. It gives manufacturers an ideal solution for adding robust multi-standard analog TV decoding to a wide variety of computing and consumer products. In addition, the SAA7135's 100% pin compatibility with existing SAA713x decoders enables efficient reuse of existing SAA713x designs for more sophisticated markets or price points.

The SAA7135 delivers exceptional picture quality and advanced video features proven in other SAA713x devices: low-noise, high-quality ADCs, an adaptive comb filter, and subpixel-accurate scaling. Certified three-level Macrovision detection circuitry ensures the video content's original analog copy protection remains intact. Capture of transport streams from all digital TV broadcast standards supports hybrid TV designs; capture of MPEG datastreams from MPEG encoders supports time-shift applications. In PCI configurations, the SAA7135 takes full advantage of the streaming capabilities of PCs by outputting decoded video, audio, VBI, and transport streams through DMA bus-mastered writes across the PCI bus.

Target applications

The SAA7135 is targeted for adding multi-standard analog TV decoding with robust audio features to computing and consumer products such as desktop and portable PCs, hybrid TVs or set-top boxes (cable, terrestrial, satellite), personal video recorders (with time shifting), DVD recorders, and more.

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Analog TV video processing

Capture

Analog video is sampled through five video inputs, supporting any combination of CVBS and S-Video signals. The SAA7135 automatically detects 50- and 60-Hz field frequencies and all analog standards (PAL, NTSC, and SECAM) used in TV broadcasts.

Video is digitized by sophisticated, low-noise nine-bit ADCs with built-in white and color peak control, clamping, and programmable gain control. 27-MHz oversampling, twice the ITU-601 standard, ensures an exceptional signal-to-noise ratio for maximum picture clarity. Additional video capture features include:

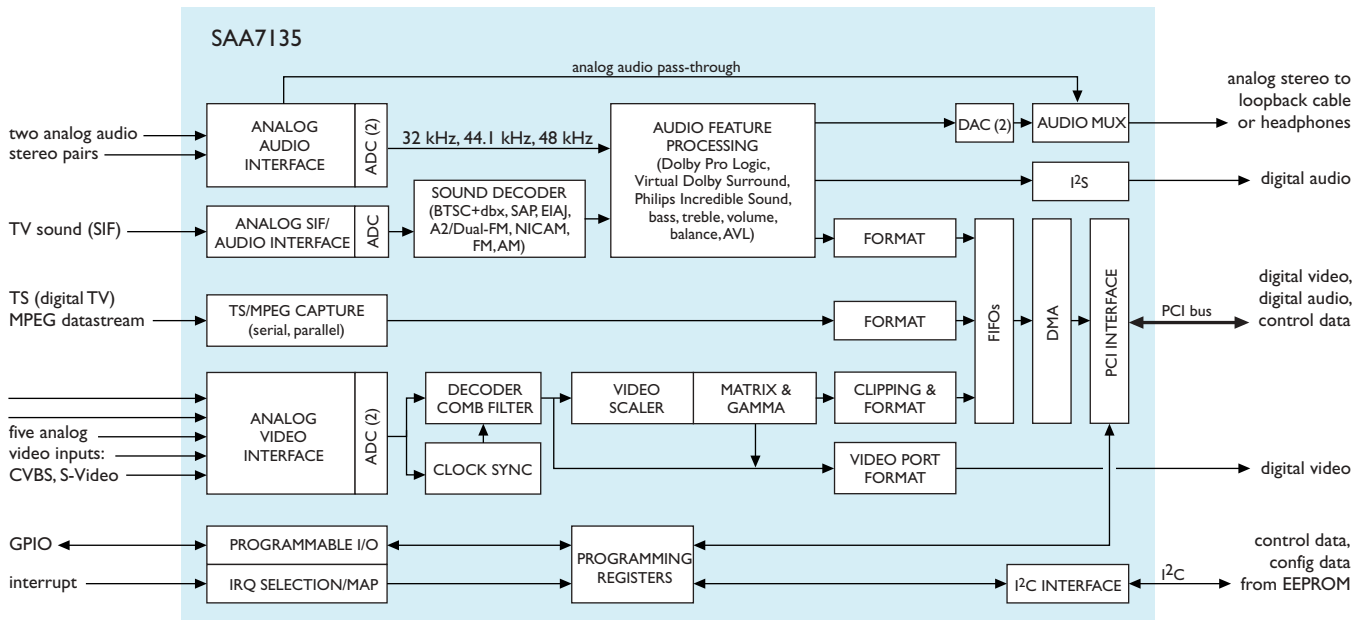
- > single crystal support for all video standards
- > ultra-fast frame lock for fast input-switching in surveillance applications and VCR fast search, shuttle, and freeze frame
- > forced-field toggle for use with non-interlaced inputs to avoid VCR 'blue screen'

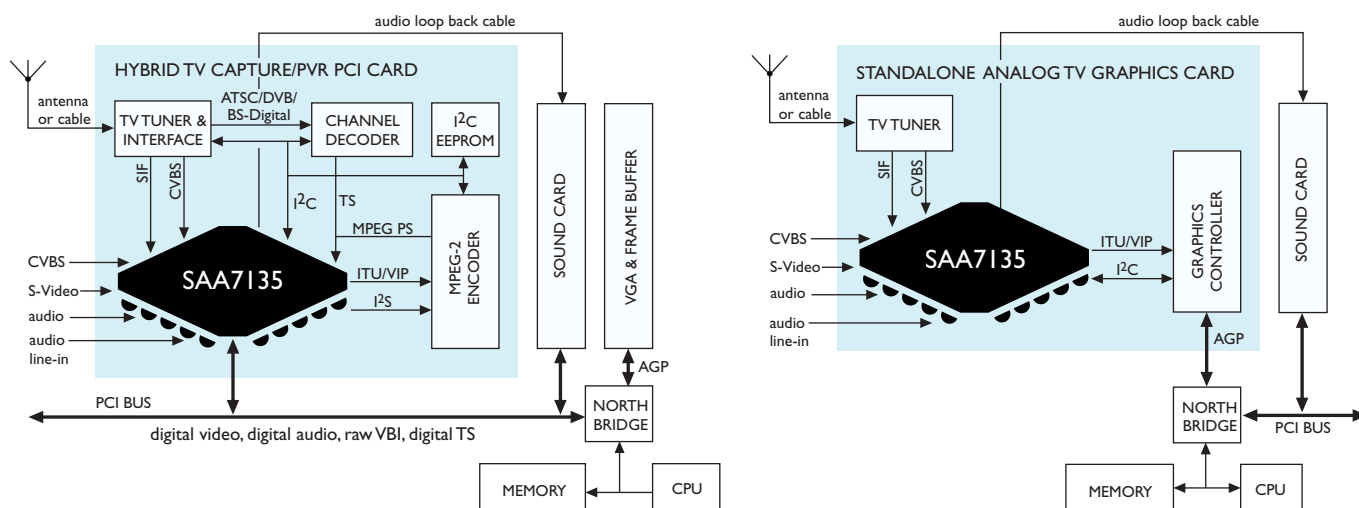
Decode

The SAA7135 decodes composite video into ITU-601 compatible component color values. Its high-quality multi-standard adaptive four-line comb filter performs best-in-class luma/chroma separation of CVBS signals from all sources, significantly reducing dot crawl and enhancing image resolution and detail. The decoder integrates separate brightness-contrast-saturation circuitry for CVBS, S-Video, and raw VBI samples, and hue control for CVBS and S-Video signals.

The SAA7135 supports fully automatic, three-level hardware Macrovision detection with active-status interrupt. By ensuring the content's original analog copy protection is still intact, Macrovision prevents unauthorized recording of copyrighted material transmitted through analog video outputs in applications such as time-shift or archive recording or large screen display.

SAA7135 Conceptual Block Diagram





Typical SAA7135 configurations: a PCI add-in card for capture of live analog and digital TV video and audio (left), and a graphics card for analog TV capture (right).

Scaling, matrix, clipping

The SAA7135 incorporates an adaptive filter and circuitry to crop, scale, and reduce frame rate. It can perform horizontal or vertical video down scaling or zooming to support playback windows of any size. Two alternating settings for active video scaling support independent capture and preview definition. Adaptive anti-alias filters reduce board space, system costs, and external components.

Optional YUV-to-RGB and RGB-to-YUV matrices and a color lookup table can be used to normalize ITU-standard color values to the full RGB range and apply gamma correction as needed to optimize screen contrast and color. A clipping unit allows definition of overlay rectangles (for Video for Windows (VfW) legacy requirements) or assignment of alpha values to video pixels.

Output

Decoded, scaled video can be output in various YUV or RGB formats, including packed and planar, gamma-compensated or black-stretched. The video stream is transmitted through DMA writes across the PCI bus or through a digital video output port in standalone configurations.

Stereo decoding and audio processing

Capture and decoding

The SAA7135 handles capture and on-chip decoding of stereo formats used in analog TV including: BTSC with dbx noise reduction and SAP (North America), EIAJ (Japan), and NICAM and A2/Dual-FM (Europe). After capture from the TV tuner through a Sound Intermediate Frequency (SIF) port, the TV sound signal is digitized and FM or AM demodulated. The audio standard is automatically detected, the pilot tone is investigated (mono, stereo, dual), and the signal is decoded.

Two 16-bit audio ADCs support capture of audio signals from nonstandard sources such as video cameras, VCRs, and AM (mono) or FM (stereo) radio through two stereo line-in inputs. The SAA7135's analog audio pass-through enables an incoming audio signal to be rerouted without processing through an external loop-back cable to a sound card. A field-locked audio clock samples a constant number of audio clocks per video field, guaranteeing synchronization between audio and video streams.

Advanced audio feature processing

The SAA7135's advanced, on-chip audio-feature processing improves user control and perceived audio quality. A Dolby Pro Logic decoder 'unfolds' four-channel Dolby Surround audio when it is present in VHS movies and TV broadcasts. A Virtual Dolby

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Surround algorithm emulates true surround sound formats and effects when only two speakers are available. Philips Incredible Mono™ adds stereo-like sound impression to monaural audio signals. Philips Incredible Stereo™ widens the stereo image, immersing the listener in the screen action. Additional on-chip audio features include volume, balance, bass/treble controls, and automatic volume leveling (AVL).

Output

Decoded digital audio is streamed across the PCI bus or output through the I²S port. Alternatively, it can be reconverted to analog (by on-chip stereo DACs) and rerouted through the loop-back cable to a sound card.

VBI capture

The SAA7135 captures raw VBI samples to memory, making them available for decoding by software components. The VBI sampling rate can be adjusted as needed by the data slicing software. Supported VBI formats include Closed Captioning, Teletext, WST, NABST, CGMS, and WSS.

Digital TV transport stream capture

For hybrid TV applications, the SAA7135 supports capture of transport streams from digital TV broadcasts (ATSC, DVB or BS-Digital). After capture, transport streams are written to memory across the PCI bus for demux and program stream decoding, typically by software running on the system CPU.

Time-shifting and digital video recording support

In time-shift recording or personal video recording applications, the SAA7135 supports capture of MPEG datastreams through a glueless interface to a hardware MPEG encoder. Captured MPEG streams are written to system memory or a storage device.

Versatile external interface

The SAA7135's flexible design, reusable components, and versatile external interfaces lower BOM and support advanced decoder configurations. Such flexibility is made possible, in part, through a set of 28 general purpose I/O (GPIO) pins, initially dedicated to interface with key onboard components to provide:

- > a digital video port
- > transport stream capture from a digital TV channel decoder
- > MPEG datastream capture from an MPEG encoder
- > an I²S digital audio output port
- > peripheral interrupt input.

GPIO pins can be reassigned if dedicated functions are not needed in a specific product configuration. In addition, unassigned pins can be utilized for GPIO under direct software control.

DMA and configurable FIFOs

In PCI configurations, the SAA7135 uses DMA bus-mastered writes to output captured video, audio, VBI, and digital TV transport streams. Seven DMA channels share a common one-kB FIFO. The ability to define optimal burst length and FIFO capacity

	audio loop-back	audio bus mastering	mono	FM-radio	A2/Dual-FM	NICAM	BTSC (+ dbx)	SAP	EIAJ	Incredible Mono Incredible Stereo	Dolby Pro Logic	Virtual Dolby Surround
SAA7130	•											
SAA7133	•	•	•	•			•	•	•	•		
SAA7134	•	•	•		•	•						
SAA7135	•	•	•	•	•	•	•	•	•	•	•	•

SAA713x Family Audio Feature Comparison

per DMA channel allows system designers to tailor and balance the latency behavior for each channel in a given application, adapting to actual conditions.

Comprehensive software support and reference design

The SAA7135 software development kit (SDK) supports a common code base for Vfw and Windows Driver Model (WDM) architectures, reducing software maintenance and protecting software investments. The SDK is based on a Component Object Model (COM) interface; it includes sample code in Visual Basic and C++ and a description of the interface.

SAA7135 WDM driver support is provided for all DirectShow®-based applications. A WDM device driver kit (DDK) includes a plug-and-play driver, capture-driver installations, and documentation. The SAA7135 WDM driver is WHQL validated and is supported for Windows® 98/ME/2000/XP. The SAA7135 Vfw driver is available for Windows 95/NT4. A BDA-compliant driver is included for digital TV applications. The SAA7135 also provides a custom API enabling development of specialized applications when published Windows APIs (WDM or Vfw) are insufficient.

A comprehensive SAA713x Reference Design Kit enables system designers and hardware manufacturers to quickly evaluate SAA7135 features and develop single, half-size PCI designs for hybrid TV receivers. The Kit includes:

- > a reference PCI card with SAA7135 decoder, analog TV tuner, 32.111-MHz quartz crystal, I²C EEPROM
- > a board connector plate with TV connector, CVBS and S-Video inputs, audio input (line-in) and output (line-out)
- > an optional voltage regulator for improved video performance
- > the SAA7135 SDK and DDK
- > installation and user guides
- > board design, schematics, and Gerber files
- > video cables



Technical specifications

PHYSICAL

Package	Rectangular LQFP128; 128 pins
Power	<i>supply</i> 3.3 V <i>consumption</i> 1.35 W (typical application)
Temperature	0 to 70 °C

STANDARD COMPLIANCE/CERTIFICATION

PC	Meets Microsoft/Intel requirements for PC Design Guides 98/99 and 2001 PCI 2.2 and ACPI compliance (all 4 states)
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ANALOG VIDEO SUBSYSTEM

Input	Five (5) analog input ports supporting any combination of CVBS (NTSC, PAL, SECAM), S-Video
ADCs	Two (2) 9-bit CMOS ADCs, 27-MHz oversampling
Output	<i>via PCI</i> YCbCr or RGB including packet and planar, gamma-compensated, or black stretched <i>via digital video port (GPIO)</i> ITU-656, YUV-VMI (8-bit), VIP 1.1 or VIP 2.0 (8- or 16-bit), ZV (16-bit), ITU-601 (16-bit)
Sample rate	720 pixels/line (ITU 601)
XTAL reference	32.11 or 24.576 MHz, supports all video standards
Comb filter	NTSC/PAL adaptive 4-line Y-C separation for all sources including broadcast and VCR
Scaling	Downscaling: horizontal, vertical, and by field rate Scalable from 10 taps H (for ratios close to 1:1) to 74 taps (icon-sized video)
VBI	<i>formats</i> Closed Captioning, Teletext, NABST, CGMS, WST, and WSS <i>PCI output</i> DMA writes to memory; dedicated channel with independent sample rate, adjustable by slicing algorithm
Macrovision	3-level with active status interrupt; complies with Macrovision's Copy Protection Detect Specification, Revision 1.00

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Technical specifications (continued)

AUDIO SUBSYSTEM

Input	One (1) analog SIF port Two pairs (2) analog stereo baseband inputs
Output	<i>analog</i> One (1) analog stereo port (for loop-back to sound card or local headphones) <i>digital</i> PCI bus or 2 I ² S ports (GPIO) (up to 4 channels)
Decode formats	NICAM, A2/Dual-FM, BTSC (with dbx), SAP, EIAJ
Sample rates	32 kHz, 44.1 kHz, 48 kHz
Clocks	Selectable: 768*fs, 512*fs, 384*fs or 256*fs 24.576 MHz to external audio reference clock Locked to video frame rate
ADCs	Two (2) 16-bit baseband audio One (1) 8-bit SIF, 24.576 MHz
Audio features	Dolby Pro Logic decoding, Virtual Dolby Surround, Philips Incredible Stereo, Philips Incredible Mono, volume, balance, bass, treble, and AVL

GENERAL PURPOSE I/O

Total pins	28
Dedicated	Digital video output Serial or parallel TS from a channel decoder Peripheral interrupts Two (2) I ² S ports

DIGITAL TV SUPPORT

TS input	(GPIO) serial or parallel TS (from a channel decoder) for all digital TV broadcast standards
MPEG input	(GPIO) parallel MPEG datastream (from MPEG encoder)

I²C INTERFACE

Modes	Bus-master interface, multi-master capable Slave interface
Power	3.3 V and 5 V signal-level compatible Includes peripheral reset and power-down control
Rates	100 kHz and 400 kHz

PCI BUS INTERFACE

Compliance	PCI specification, Rev. 2.2, 3.3-V signaling, 5-V tolerant Power Management Interface Specification, Rev. 1 including full Windows ACPI power down specification
DMA channels	Six (6) master-write DMA channels sharing 1-kB configurable FIFO
Data types	<i>digital</i> video, audio, raw VBI, TS (ATSC/DVB/BS-Digital), and MPEG datastream

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