

# SAA7133

## Single-chip, multi-standard analog TV video and stereo decoder for PCI applications— North America and Japan

Integrating high-quality, multi-standard TV video (NTSC, PAL, and SECAM) decoding and TV stereo (BTSC with dbx, SAP, and EIAJ) decoding, the Philips SAA7133 gives designers an efficient, low-BOM solution for adding analog TV features to a variety of PCI-based computing and consumer products.



### Key features

- > Fully automatic detection and decoding of worldwide analog TV video formats: PAL, NTSC, and SECAM
- > Automatic standard detection and decoding of TV stereo formats: BTSC (with dbx™ noise reduction), SAP, EIAJ, and FM Radio
- > Supports simultaneous stereo decoding and adaptive 3D comb filtering (to enhance picture quality)
- > Certified three-level Macrovision® detection circuitry
- > Advanced audio feature processing: volume, balance, bass, treble, automatic volume leveling (AVL), and Philips Incredible Sound
- > 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

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On a single chip, the SAA7133 TV video/stereo decoder handles fully automatic detection and decoding of all worldwide analog TV video standards and the TV stereo formats used in North America and Japan. It delivers exceptional picture quality and advanced video features proven in other SAA713x devices: low-noise, high-quality ADCs, an adaptive comb filter, subpixel-accurate scaling, and certified three-level Macrovision detection circuitry.

The SAA7133's flexible design, reusable components, and versatile external interfaces lower BOM and cost and support advanced TV decoder configurations. 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 SAA7133 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 SAA7133 is a space-efficient solution for adding high-quality multi-standard analog TV decoding to a wide variety of computing and consumer products. Its 100% pin compatibility with existing SAA713x decoders enables efficient reuse of existing SAA713x designs for new markets or price points. The SAA7133 is targeted for North American and Japanese markets for products such as desktop and portable PCs, personal video recorders (with time shifting), hybrid (analog/digital) TV sets, hybrid cable, terrestrial, and satellite set-top boxes, and DVD recorders.

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## Analog TV video processing

### Capture

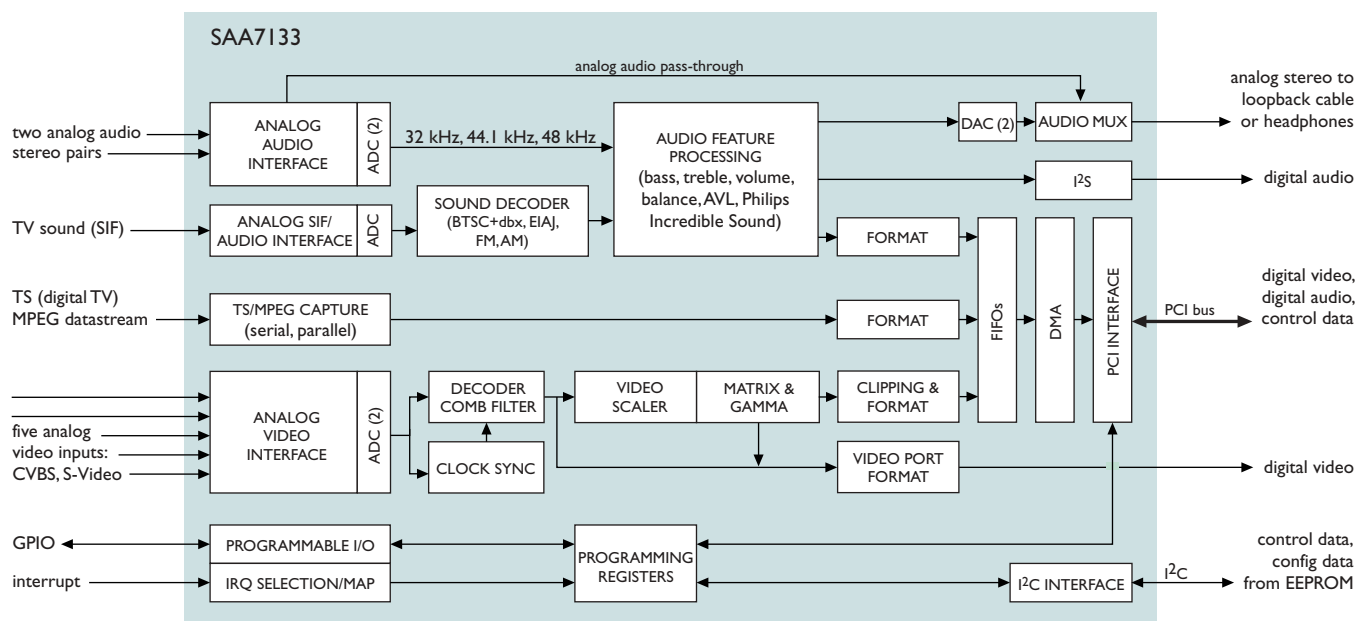
Analog video is sampled through five video inputs, supporting any combination of CVBS and S-Video signals. The SAA7133 automatically detects 50- and 60-Hz field frequencies and all analog video standards (PAL, NTSC, and SECAM) used in TV. Video is digitized by sophisticated, low-noise nine-bit ADCs with built-in white and color peak control, clamping, and programmable gain control. Support for 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), and forced-field toggle (for non-interlaced inputs to avoid VCR 'blue screen').

### Decode

The SAA7133 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 SAA7133 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.

SAA7133 Conceptual Block Diagram



### SAA713x Family Audio Feature Comparison

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

#### Scaling, matrix, clipping

The SAA7133 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.

#### VBI capture

The SAA7133 captures raw VBI samples to memory, making them available to software components for decoding. 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.

### Stereo decoding and audio processing

#### Capture and decoding

The SAA7133 handles capture and on-chip decoding of stereo formats used in North American (BTSC with dbx noise reduction, and SAP) and Japanese (EIAJ) TV broadcasts. After capture from the TV tuner through a Sound Intermediate Frequency (SIF) port, TV stereo 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. An 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 SAA7133 incorporates advanced on-chip audio-feature processing to improve user control and perceived audio quality. 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 an I<sup>2</sup>S port. Alternatively, it can be reconverted to analog (by on-chip stereo DACs) and rerouted through the loop-back cable to a sound card.

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## Digital TV transport stream capture

For low-cost hybrid TVs, the SAA7133 supports transport stream capture from digital TV (ATSC or BS-Digital) broadcasts. After capture, the transport stream is written to memory across the PCI bus for demux and program stream decoding, typically by software running on the system CPU.

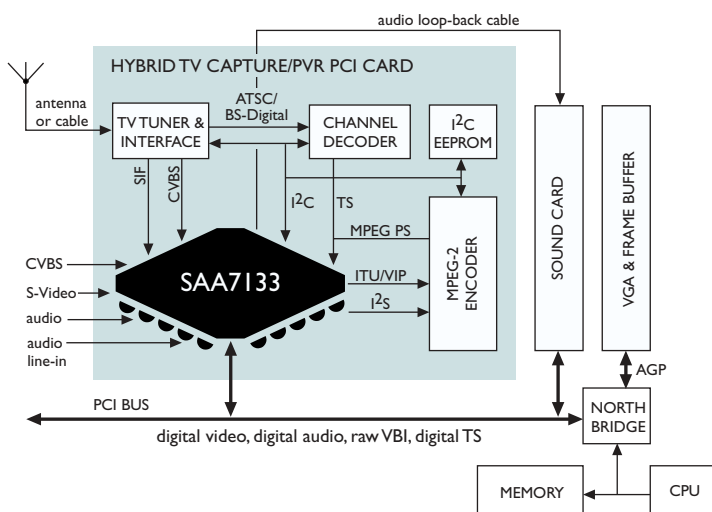
## Time-shifting and digital video recording support

In time-shift recording or personal video recording applications, the SAA7133 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 SAA7133's flexible design, reusable components, and versatile external interfaces lower BOM and cost 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:

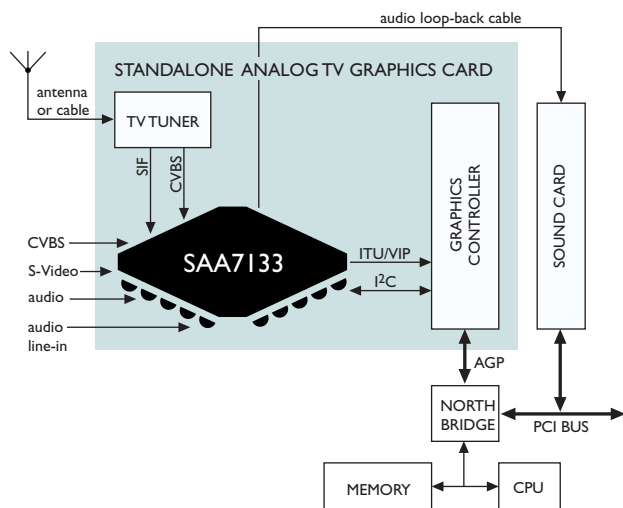
- > a digital video port
- > transport stream capture from a digital TV channel decoder
- > MPEG datastream capture from an MPEG encoder
- > an I<sup>2</sup>S digital audio output port
- > peripheral interrupt input.



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 SAA7133 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 per DMA channel allows system designers to tailor and balance the latency behavior for each channel in a given application, adapting to actual conditions.



Typical SAA7133 configurations for a PCI add-in card for hybrid TV capture (top) and a graphics card for analog TV capture (bottom).

## Comprehensive software support and reference design

The SAA7133 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.

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 SAA7133 WDM driver is WHQL validated and is supported for Windows® 98/ME/2000/XP. The SAA7133 Vfw driver is available for Windows 95/NT4. A BDA-compliant driver is included for digital TV applications. The SAA7133 also provides a custom API enabling development of specialized applications when the published Windows APIs (WDM or Vfw) are insufficient.

A comprehensive SAA713x Reference Design Kit enables system designers and hardware manufacturers to quickly evaluate SAA7133 features and develop cost effective single, half-size PCI designs for hybrid TV receivers. The Kit includes:

- > a reference PCI card with SAA7133 decoder, analog TV tuner, 32.11-MHz quartz crystal, I<sup>2</sup>C 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 SAA7133 SDK and DDK
- > installation and user guides
- > board design, schematics, and Gerber files
- > video cables.



## Technical specifications

### PHYSICAL

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

### STANDARD COMPLIANCE/CERTIFICATION

<b>PC</b>	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

<b>Input</b>	Five (5) analog input ports supporting any combination of CVBS (NTSC, PAL, SECAM), S-Video
<b>ADCs</b>	Two (2) 9-bit CMOS ADCs, 27-MHz oversampling
<b>Output</b>	<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)
<b>Sample rate</b>	720 pixels/line (ITU 601)
<b>XTAL reference</b>	32.11 or 24.576 MHz, supports all video standards
<b>Comb filter</b>	NTSC/PAL adaptive 4-line Y-C separation for all sources including broadcast and VCR
<b>Scaling</b>	Downscaling: horizontal, vertical, and by field rate Scalable from 10 taps H (for ratios close to 1:1) to 74 taps (icon-sized video)
<b>VBI</b>	<i>supported 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
<b>Macrovision</b>	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

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

### DIGITAL TV SUPPORT

<b>TS input</b>	(GPIO) serial or parallel TS (from a channel decoder)
<b>MPEG input</b>	(GPIO) parallel MPEG datastream (from MPEG encoder)

### GENERAL PURPOSE I/O

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

### I<sup>2</sup>C INTERFACE

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

### PCI BUS INTERFACE

<b>Compliance</b>	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
<b>DMA channels</b>	Six (6) master-write DMA channels sharing 1-kB configurable FIFO
<b>Data types</b>	<i>digital</i> video, audio, raw VBI, TS (ATSC/BS-Digital), and elementary MPEG datastream

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