



# SiI9135/SiI9235A HDMI Receiver with Enhanced Audio and Deep Color Outputs

## Data Brief

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## Introduction

The SiI9135/SiI9235A HDMI Receiver with Enhanced Audio and Deep Color Outputs is a second-generation dual-input High Definition Multimedia Interface (HDMI) receiver. It is software-compatible with the SiI9133 receiver, but adds audio support for DTS-HD and Dolby TrueHD. Digital televisions that can display 10- or 12-bit color depth can now provide the highest quality protected digital audio and video over a single cable. The SiI9135 and SiI9135A devices, which are functionally identical, can receive Deep Color video up to 12-bit, 1080p @ 60 Hz. Backward compatibility with the DVI 1.0 specification allows HDMI systems to connect to existing DVI 1.0 hosts, such as HD set-top boxes and PCs. Silicon Image HDMI receivers use the latest generation Transition Minimized Differential Signaling (TMDS) core technology that runs at 25–225 MHz.

The chip comes pre-programmed with High-bandwidth Digital Content Protection (HDCP) keys for receiving protected audio and video content. This set of keys simplifies the manufacturing process and lowers costs while providing the highest level of HDCP key security.

The SiI9135/SiI9135A receiver can send and receive up to eight channels of uncompressed digital audio at 192 kHz and 2-channel digital audio up to 192 kHz. Compressed streams are also supported through either the S/PDIF port or over I<sup>2</sup>S for DTS-HD and Dolby TrueHD. An industry-standard I<sup>2</sup>S port allows direct connection to low-cost audio DACs at up to 192 kHz. An S/PDIF port supports up to 192 kHz audio. The device supports Super Audio Compact Disc (SACD) and provides Direct Stream Digital (DSD) ports that support 44.1 and 88.2-kHz one-bit audio.

A low-power standby feature of the SiI9135/SiI9135A receiver enables flexible power management.

## Digital Video Interface

- Flexible support for many different standard- and high-definition video formats (36-bit RGB / YCbCr 4:4:4, 16/20/24-bit YCbCr 4:2:2, 8/10/12-bit YCbCr 4:2:2 (ITU BT.656))
- 12/15/18-bit Digital Multimedia Output (DMO) RGB/YCbCr 4:4:4 (clocked with rising and falling edges)
- Color Space Conversion for both RGB-to-YCbCr and YCbCr-to-RGB (both 601 and 709)
- True 12-bit accurate data using 14-bit processing
- Auto video mode configuration simplifies system firmware design

## Digital Audio Interface

- DTS-HD and Dolby TrueHD high bit rate audio
- Four I<sup>2</sup>S inputs accept Dolby Digital, DVD-Audio input (2-channel 192 kHz and 8-channel 192 kHz)
- S/PDIF input supports PCM, Dolby Digital, DTS digital audio transmission (32–192 kHz Fs sample rate)
- IEC60958 or IEC61937 compatible
- Flexible, programmable I<sup>2</sup>S channel mapping

## HDCP Decryption

- Pre-programmed HDCP keys provide the highest level of key security, simplify manufacturing, and lower cost
- Full support for HDCP repeaters (up to 16 attached downstream devices)

## Package

- 20 mm x 20 mm 144-pin TQFP package with ePad™

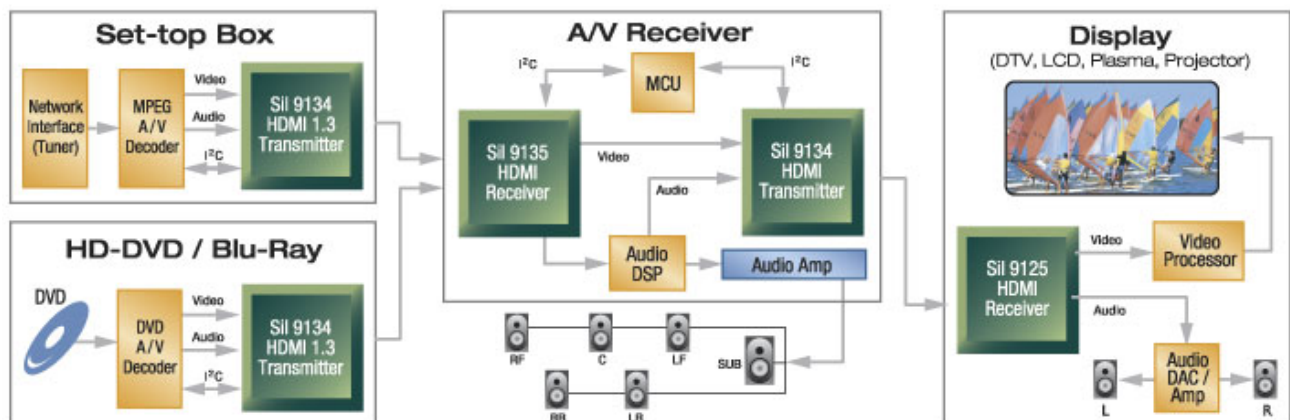


Figure 1. Typical Application of SiI9135/SiI9135A Receiver

## System Applications

The SiI9135/SiI9135A receiver is designed for AV receivers that require support for HDMI Deep Color and the latest audio technologies: DTS-HD and Dolby TrueHD. The receiver allows receiving 10/12-bit color depth up to 1080p resolutions. A single device provides two HDMI input ports. The video output goes to a video processor or HDMI transmitter. Besides DTS-HD and Dolby TrueHD, the device supports full surround sound audio including DVD-Audio and SACD. The audio output can go directly to an audio DAC or an audio digital signal processor for further processing.

## Comparing the SiI9135/SiI9135A Receiver with the SiI9033 and SiI9133 Receivers

Table 1 summarizes the functional differences among the SiI9033, the SiI9133, and the SiI9135/SiI9135A receivers.

Table 1. Summary of New Features

Feature	SiI9033	SiI9133	SiI9135/SiI9135A
<b>HDMI Input Connections</b>			
<b>TMDS Input Ports</b>	2	2	2
<b>Color Depth</b>	8-bit	8/10/12-bit	8/10/12-bit
<b>DDC Input Ports</b>	2	2	2
<b>Maximum TMDS Input Clock</b>	165 MHz	225 MHz	225 MHz
<b>Output Ports</b>			
<b>Digital Video Output Ports</b>	1	1	1
<b>Maximum Output Pixel Clock</b>	165 MHz.	165 MHz.	165 MHz.
<b>Maximum Output Bus Width</b>	24	36	36
<b>Analog Video Output Ports</b>	0	0	0
<b>S/PDIF Output Ports</b>	1	1	1
<b>I<sup>2</sup>S Output</b>	8 channel	8 channel	8 channel
<b>DSD Output</b>	8 channel	8 channel	6 channel
<b>Video Processing</b>			
<b>Color Space Converter</b>	RGB to/from YcbCr	RGB to/from YcbCr	RGB to/from YcbCr
<b>Pixel Clock Divider</b>	0.25, 0.5	0.25, 0.5	0.25, 0.5
<b>Digital Video Bus Mapping</b>	swap Cb, Cr pins	swap Cb, Cr pins	swap Cb, Cr pins
<b>Maximum Audio Sample Rate (Fs)</b>			
<b>2-channel (I<sup>2</sup>S or S/PDIF)</b>	192 kHz	192 kHz	192 kHz
<b>8-channel (I<sup>2</sup>S)</b>	192 kHz	192 kHz	192 kHz
<b>8-channel (DSD)</b>	88.2 kHz	88.2 kHz	88.2 kHz (6 channel)
<b>High Bit Rate Audio Support Compressed DTS-HD and Dolby True-HD</b>	No	No	Yes
<b>Other Features</b>			
<b>MCLK Generation</b>	No external connection required.	No external Connection required	No external connection required.
<b>HDCP Repeater Support</b>	Yes	Yes	Yes
<b>Interlaced Format Detection Pin</b>	Yes	Yes	Yes
<b>TMDS R<sub>EXT_SWING</sub></b>	Not Used	Not Used	Not Used
<b>Package</b>	144-pin TQFP ePad	404-pin BGA w/Heat Slug	144-pin TQFP ePad

## Pin Diagrams

Figure 2 shows the SiI9135/SiI9135A pin assignments of the receiver. Pin names are generalized by type for this document. The list below the diagram describes the purpose of each type. The package is a 20 mm x 20 mm 144-pin TQFP with an ePad.

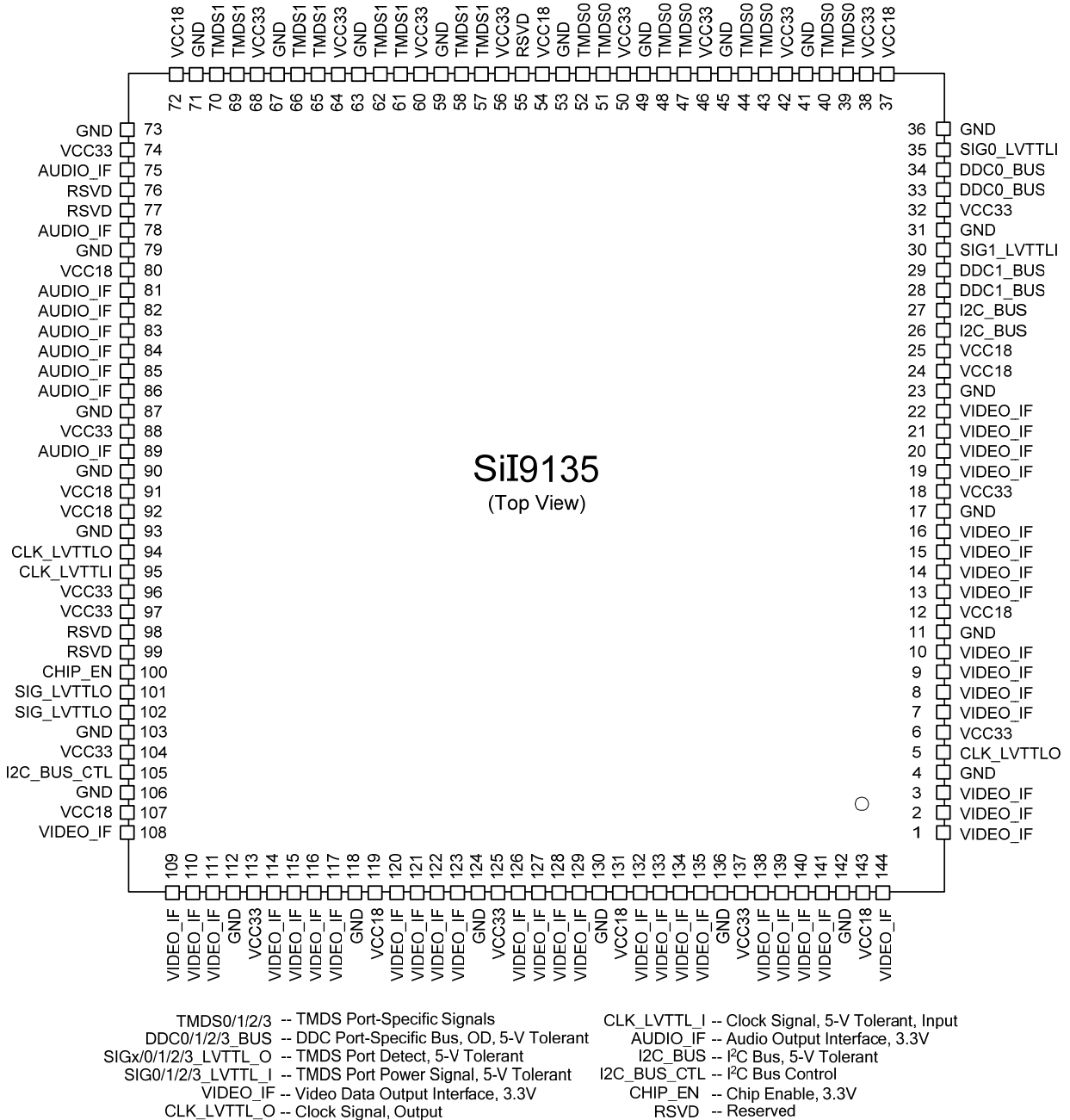
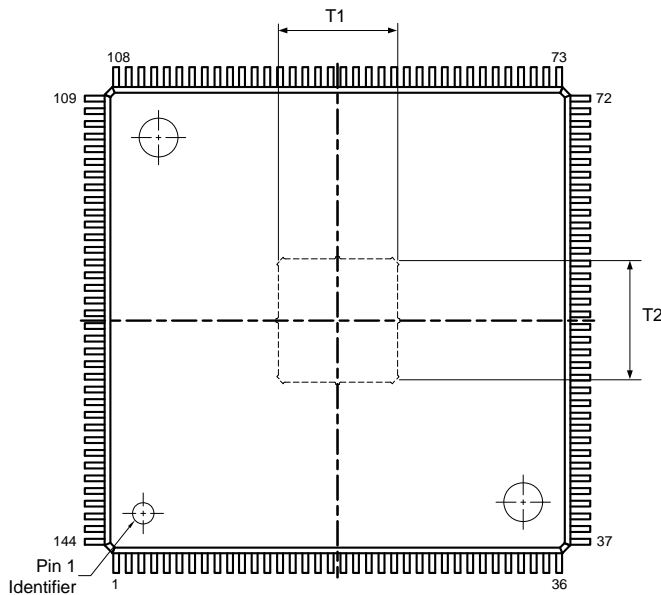


Figure 2. Pin Diagram

# Packaging

## ePad Enhancement

The SiI9135/SiI9135A receiver is packaged in a 144-pin TQFP package with an ePad™. The ePad dimensions are shown in Figure 3.



Silicon Image recommends that the ePad be soldered to the PCB and electrically grounded on the PCB. The ePad must not be connected to any other voltage level.

Figure 3. ePad Diagram

### ePad Dimensions: Amkor and SPIL

Item	Description	Typ	Max
T1	ePad height	4.60	4.64
T2	ePad width	5.20	5.24

### ePad Dimensions: ASE

Item	Description	Typ	Max
T1	ePad height	5.25	5.29
T2	ePad width	5.25	5.29

All dimensions are in millimeters.

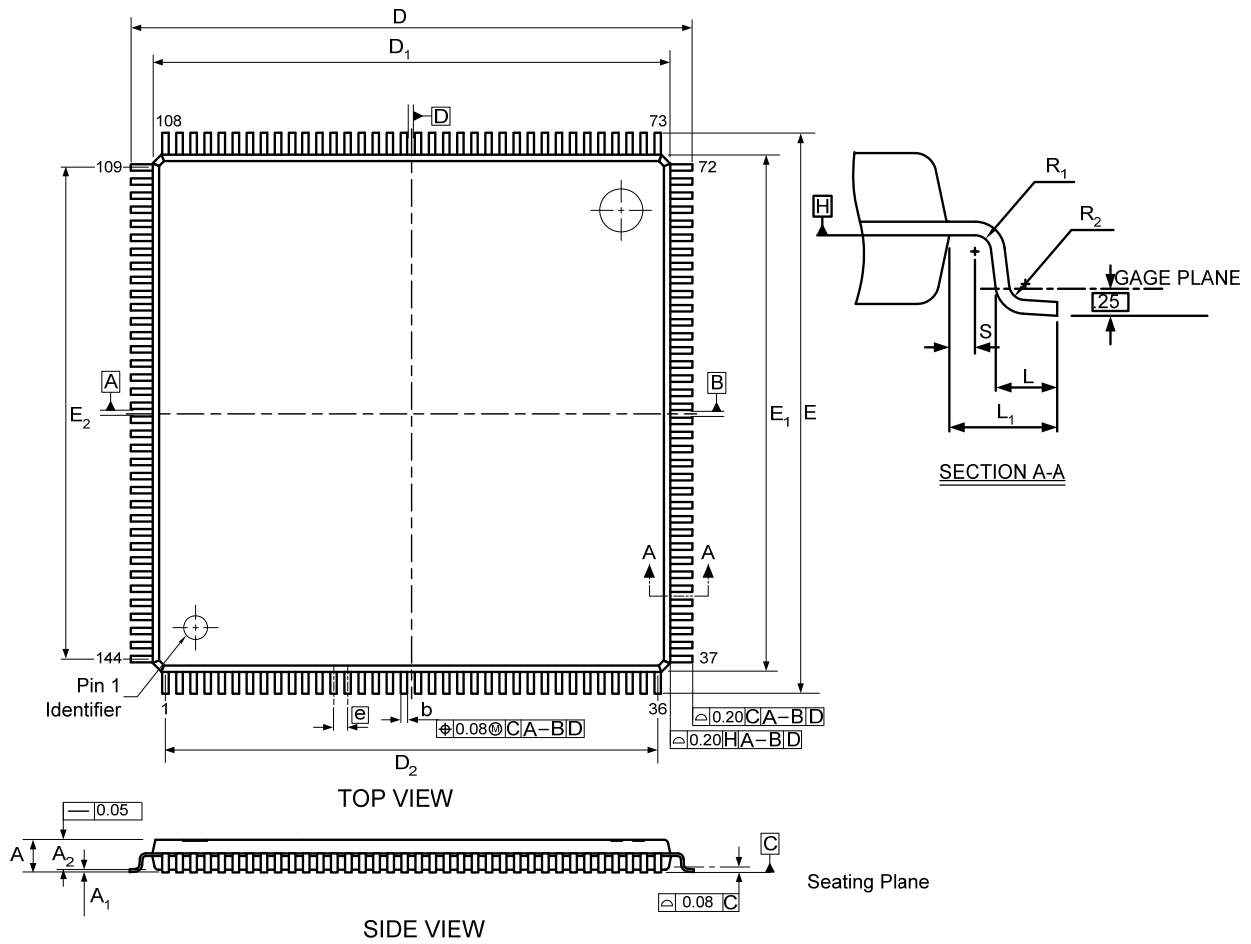
The ePad is centered on the package center lines. The measurement tolerance is  $\pm 0.04$  mm for all manufacturers. The ePad tab dimensions may vary.

A clearance of at least 0.25 mm should be provided on the PCB between the edge of the ePad and the inner edges of the lead pads to avoid the possibility of electrical shorts.

## PCB Layout Guidelines

PCB layout designers should refer to Silicon Image application note *PCB Layout Guidelines: Designing with Exposed Pads* for basic design guidelines when designing with thermally enhanced packages using the Exposed Pad.

## 144-pin TQFP Package Dimensions



### JEDEC Package Code MS-026-AFB

Item	Description	Min	Typ	Max
A	Thickness	1.00	1.10	1.20
A1	Stand-off	0.05	0.10	0.15
A2	Body thickness	0.95	1.00	1.05
D	Footprint	22.00 BSC		
E	Footprint	22.00 BSC		
D <sub>1</sub>	Body size	20.00 BSC		
E <sub>1</sub>	Body size	20.00 BSC		
D <sub>2</sub>	Lead Row Width	17.5 BSC		
E <sub>2</sub>	Lead Row Width	17.5 BSC		

Item	Description	Min	Typ	Max
b	Lead width	0.17	0.22	0.27
C	Lead thickness	0.09	—	0.20
e	Lead pitch	0.50 BSC		
L	Lead foot length	0.45	0.60	0.75
L <sub>1</sub>	Total lead length	1.00 REF		
R <sub>1</sub>	Lead radius, inside	0.08	—	—
R <sub>2</sub>	Lead radius, outside	0.08	—	0.20
S	Lead horizontal run	0.20	—	—

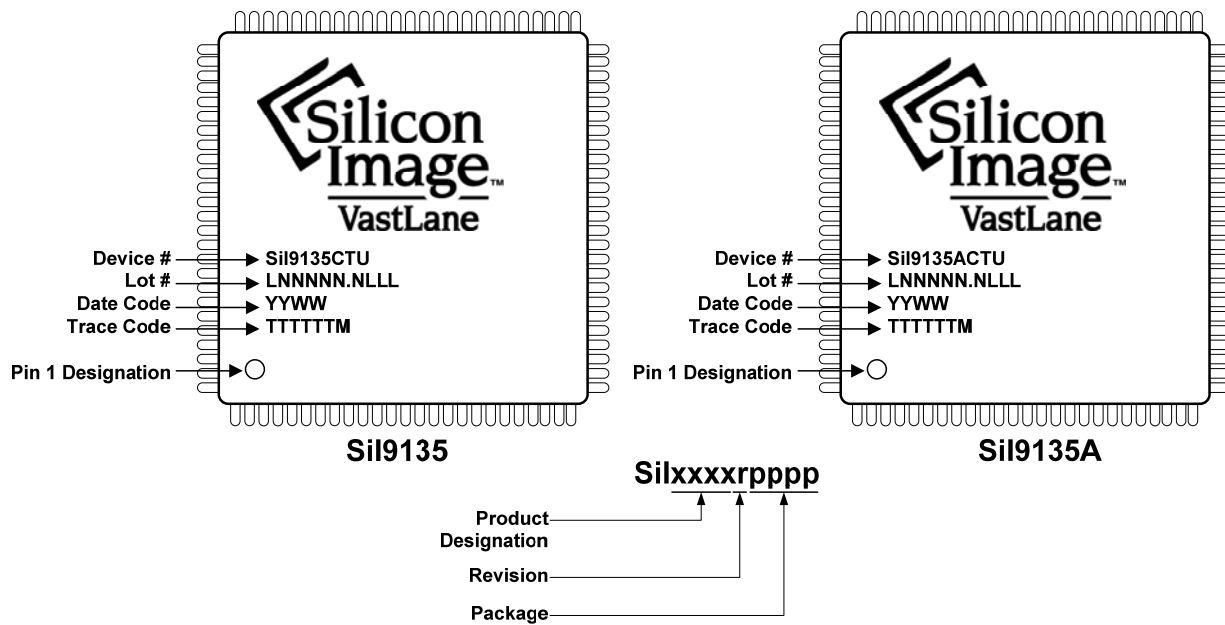
Dimensions in millimeters.

Overall thickness A = A1 + A2.

Figure 4. Package Diagram

## Marking Specification

Drawing is not to scale and pin count shown is representative. Refer to specifics in [Figure 4](#) on page 5.



Legend	Description
LNNNNN.NLLL	Lot number
YY	Year of manufacture
WW	Week of manufacture
TTTTTT	Trace code
M	Maturity code

**Figure 5. Marking Diagram**

The universal package may be used in lead-free and ordinary process lines

## Ordering Information

Production Part Numbers:

TMDS Input Clock Range	Part Number
25–225 MHz	SiI9135CTU
25–225 MHz	SiI9135ACTU



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