High Performance HDMI™/DVI Transmitter

AD9889

FEATURES

- **HDMI/DVI transmitter compatible with HDMI 1.1 and HDCP 1.1**
- **Single 1.8 V power supply**
- **Video/audio inputs are 3.3 V tolerant**
- **80-lead, Pb-free LQFP**
- **Digital video**
  - **80 MHz operation supports all video formats from 480i to 1080i and 720p**
  - **Programmable 2-way color space converter**
  - **Supports RGB, YCbCr, DDR, ITU656 formats**
  - **Auto input video format detection**
- **Digital audio**
  - **Supports standard S/PDIF for stereo or compressed audio up to 192 kHz**
  - **8-channel LPCM I²S audio up to 192 kHz**
- **Special features for easy system design**
  - **On-chip MPU to perform HDCP operations**
  - **On-chip I²C master to handle EDID reading**
  - **5 V tolerant I²C and MPD I/Os, no extra device needed**
  - **No audio master clock needed for S/PDIF support**

APPLICATIONS

- **DVD players and recorders**
- **Digital set-top boxes**
- **AV receivers**
- **Digital cameras and camcorders**

FUNCTIONAL BLOCK DIAGRAM

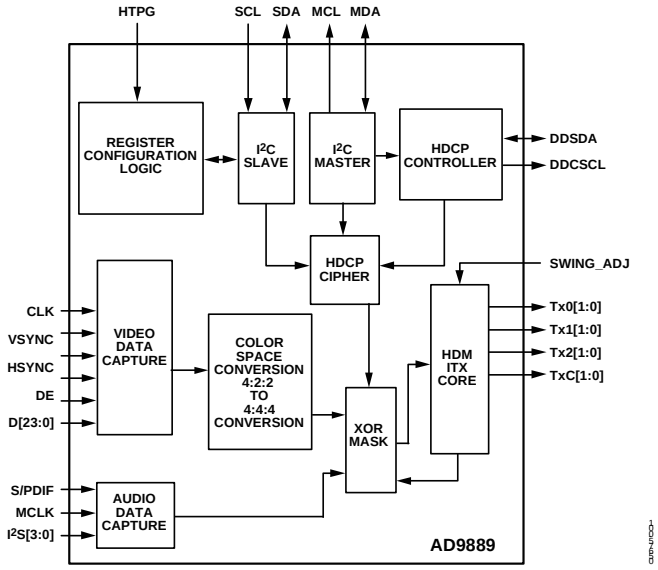

Figure 1.

GENERAL DESCRIPTION

The AD9889 is an 80 MHz, high-definition multimedia interface (HDMI™ 1.1) transmitter. It supports HDTV formats up to 1080i and 720p, and graphic resolutions up to XGA (1024 × 768 @ 75 Hz). With the inclusion of HDCP, the AD9889 allows the secure transmission of protected content as specified by the HDCP 1.1 protocol.

The AD9889 supports both S/PDIF and 8-channel I²S audio. Its high fidelity 8-channel I²S can transmit either stereo or 7.1 surround audio at 192 kHz. The S/PDIF can carry stereo LPCM (linear pulse code modulation) audio or compressed audio including Dolby® Digital, DTS®, and THX®.

The AD9889 helps to reduce system design complexity and cost by incorporating such features as HDCP master, I²C master for EDID reading, a single 1.8 V power supply, and 5 V tolerance on I²C and hot plug detect pins.

Fabricated in an advanced CMOS process, the AD9889 is provided in a space-saving, 80-lead, surface-mount, Pb-free plastic LQFP and is specified over the 0°C to 70°C temperature range.

EVALUATION KITS AND OTHER RESOURCES

Evaluation kits, reference design schematics, software quick start guide, and codes are available from Analog Devices local sales and marketing personnel.

Rev. 0

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REVISION HISTORY

10/05—Revision 0: Initial Version

ELECTRICAL SPECIFICATIONS

Table 1.

Parameter	Temp	Test Level	AD9889KSTZ-80 Min	Typ	Max	Unit
DIGITAL INPUTS						
Input Voltage, High (V_{IH})	Full	VI	1.4			V
Input Voltage, Low (V_{IL})	Full	VI			0.7	V
Input Current, High (V_{IH})	Full	V			−1.0	mA
Input Current, Low (V_{IL})	Full	V			+1.0	mA
Input Capacitance	25°C	V		3		pF
DIGITAL OUTPUTS						
Output Voltage, High (V_{OH})	Full	VI	AV_{DD} − 0.1			V
Output Voltage, Low (V_{OL})	Full	VI			0.4	V
THERMAL CHARACTERISTICS						
θ_{JC} Junction-to-Case Thermal Resistance		V			25	°C/W
θ_{JA} Junction-to-Ambient Thermal Resistance		V			30	°C/W
Ambient Temperature	Full	V	0	25	70	°C
DC SPECIFICATIONS						
Input Leakage Current, I_{IL}	25°C	VI	−10		+10	µA
Input Clamp Voltage (−16 mA)	25°C	V		−0.8		V
Input Clamp Voltage (+16 mA)	25°C	V		+0.8		
Differential High Level Output Voltage		V		AV_{CC}		V
Differential Output Short-Circuit Current		V			10	µA
POWER SUPPLY						
V_{DD} (All) Supply Voltage	Full	IV	1.71	1.8	1.89	V
V_{DD} Supply Voltage Noise	Full	V			50	mV p-p
Complete Power-Down Current (Everything Except I^2C)	25°C	IV		6	13	mA
Quiet Power Down Current (Monitor Detect On)	25°C	VI		7		mA
Transmitter Supply Current (27 MHz Typical Random Pattern)	25°C	VI		165		mA
Transmitter Supply Current (80 MHz Typical Random Pattern)	25°C	IV		185	205	mA
Transmitter Total Power (80 MHz Single Pixel Stripe Pattern; Worst Case Operating Conditions)	Full	VI			430	mW
AC SPECIFICATIONS						
CLK Frequency	25°C	IV	13.5		80	MHz
CLK Duty Cycle	25°C	VI	40%		60%	
Worst Case CLK Input Jitter	Full	VI			1.0	ns
Setup Time to CLK Falling Edge		VI	TBD		TBD	ns
Hold Time to CLK Falling Edge		VI	TBD		TBD	ns
TMDS Differential Swing		VII	800	1000	1200	mV
VSYNC and HSYNC Delay from DE Falling Edge		VI		1		UI
VSYNC and HSYNC Delay to DE Rising Edge		VI		1		UI
DE High Time	25°C	VI			8191	UI
DE Low Time	25°C	VI		138		UI
Differential Output Swing Low-to-High Transition Time	25°C	VII	75		490	ps
Differential Swing Output High-to-Low Transition Time	25°C	VII	75		490	ps

Parameter	Temp	Test Level	AD9889KSTZ-80 Min	Typ	Max	Unit
AUDIO AC TIMING						
Sample Rate (I^2S and S/PDIF)	Full	IV	32		192	kHz
I^2S Cycle Time	25°C	IV			1	UI
I^2S Setup Time	25°C	IV		15		ns
I^2S Hold Time	25°C	IV		0		ns
Audio Pipeline Delay	25°C	IV		75		us

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Digital Inputs	5 V to 0.0 V
Digital Output Current	20 mA
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Maximum Junction Temperature	150°C
Maximum Case Temperature	150°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

EXPLANATION OF TEST LEVELS

Table 3.

Level	Test
I	100% production tested.
II	100% production tested at 25°C and sample tested at specified temperatures.
III	Sample tested only.
IV	Parameter is guaranteed by design and characterization testing.
V	Parameter is a typical value only.
VI	100% production tested at 25°C; guaranteed by design and characterization testing.
VII	Limits defined by HDMI specification.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

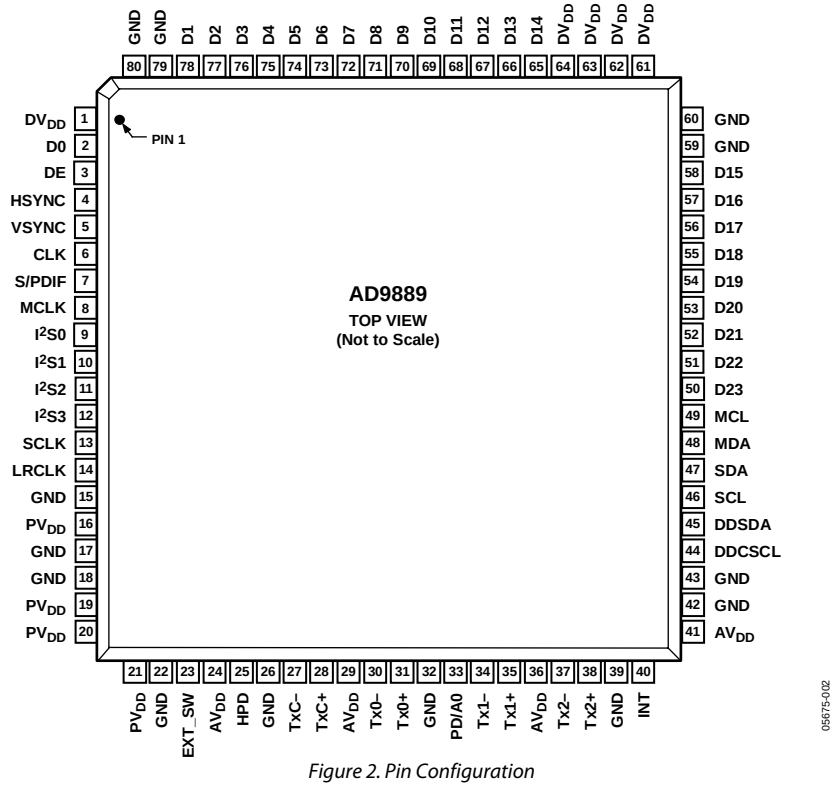


Figure 2. Pin Configuration

Table 4. Complete Pinout List

Pin Type	Pin No.	Mnemonic	Description	Value
INPUTS				
	50 to 58, 65 to 78, 2	D[23:0]	Video Data Input	1.8 V CMOS
	6	CLK	Video Clock Input	1.8 V CMOS
	3	DE	Data Enable Bit for Digital Video	1.8 V CMOS
	4	HSYNC	Horizontal SYNC Input	1.8 V CMOS
	5	VSYNC	Vertical SYNC Input	1.8 V CMOS
	23	EXT_SW	Differential Output Swing Adjustment	1.8 V CMOS
	25	HPD	Hot Plug Detect Signal	1.8 V CMOS
	7	S/PDIF	S/PDIF (Sony/Philips Digital Interface) Audio Input Pin	1.8 V CMOS
	8	MCLK	Audio Reference Clock, 128 × fs or 256 × fs	1.8 V CMOS
	12 to 9	I^2S[3:0]	I^2S Audio Data Inputs	1.8 V CMOS
	13	SCLK	I^2S Audio Clock	1.8 V CMOS
	14	LRCLK	Left/Right Channel Selection	1.8 V CMOS
	33	PD/A0	Power-Down Control	1.8 V CMOS
OUTPUTS				
	28, 27	TxC+	Differential Clock Output	TMDS
		TxC−	Differential Clock Output Complement	
	38, 37	Tx2+	Differential Output Channel 2	TMDS
		Tx2−	Differential Output Channel 2 Complement	
	35, 34	Tx1+	Differential Output Channel 1	TMDS
		Tx1−	Differential Output Channel 1 Complement	
	31, 30	Tx0+	Differential Output Channel 0	TMDS
		Tx0−	Differential Output Channel 0 Complement	
	40	INT	Monitor Sense Connection Status	1.8 V CMOS

Pin Type	Pin No.	Mnemonic	Description	Value
POWER SUPPLY				
	24, 29, 36, 41	AV_{DD}	Output Power Supply	1.8 V
	1, 61, 62, 63, 64	DV_{DD}	Digital and I/O Power Supply	1.8 V
	16, 19, 20, 21	PV_{DD}	PLL Power Supply	1.8 V
	15, 17, 18, 22, 26, 32, 39, 42, 43, 59, 60, 79, 80	GND	Ground	0 V
CONTROL				
	47	SDA	Serial Port Data I/O	3.3 V CMOS
	46	SCL	Serial Port Data Clock (100 kHz Maximum)	3.3 V CMOS
	48	MDA	Serial Port Data I/O to HDCP Keys	3.3 V CMOS
	49	MCL	Serial Port Data Clock to HDCP Keys	3.3 V CMOS
	45	DDSDA	Serial Port Data I/O to Receiver	3.3 V CMOS
	44	DDCSCL	Serial Port Data Clock to Receiver	3.3 V CMOS

Table 5. Pin Function Descriptions

Pin Mnemonic	Description
OUTPUTS	
TxC+	Differential Clock Output at Pixel Clock Rate; Transition Minimized Differential Signaling (TMDS).
TxC−	Differential Clock Output Complement.
Tx2+	Differential Output of the Red Data at 10× the Pixel Clock Rate; TMDS.
Tx2−	Differential Red Output Complement.
Tx1+	Differential Output of the Green Data at 10× the Pixel Clock Rate; TMDS.
Tx1−	Differential Green Output Complement.
Tx0+	Differential Output of the Blue Data at 10× the Pixel Clock Rate; TMDS.
Tx0−	Differential Blue Output Complement.
INT	Monitor Sense.
SERIAL PORT (2-WIRE)	
SDA	Serial Port Data I/O.
SCL	Serial Port Data Clock.
DDSDA	Serial Port Data I/O Master to Receiver.
DDCSCL	Serial Port Data Clock Master to Receiver.
MDA	Serial Port Data I/O Master to HDCP Keys.
MCL	Serial Port Data Clock Master to HDCP Keys.
	For a full description of the 2-wire serial register and how it works, refer to the 2-Wire Serial Control Port section.
INPUTS	
D[23:0]	Digital Input in RGB or YCbCr Format.
CLK	Video Clock Input.
DE	Data Enable for Video Data.
HSYNC	Horizontal Sync Input.
VSYNC	Vertical Sync Input. This is the input for vertical sync.
EXT_SW	Swing Adjust Sets the Differential Output Voltage or Swing. An 887 Ω resistor (1% tolerance) should be placed between this pin and ground.
HPD	Hot Plug Detect. This indicates to the interface whether the receiver is connected.
S/PDIF	S/PDIF Audio Input. This is the audio input from a Sony/Philips Digital Interface.
MCLK	Audio Reference Clock. Set either to 128 × fs or 256 × fs.
I^2S[3:0]	I^2S Audio Inputs. These represent the eight channels of audio (two per input) available through I^2S.
I^2S CLK	I^2S Audio Clock.
LRCLK	Left/Right Channel Selection.
PD/A0	Power Down.

Pin Mnemonic	Description
POWER SUPPLY	
DV_{DD}	Main Power Supply. These pins supply power to the main elements of the circuit. They should be filtered and as quiet as possible.
AV_{DD}	Output Power Supply
PV_{DD}	Clock Generator Power Supply. The most sensitive portion of the AD9889 is the clock generation circuitry. These pins provide power to the clock PLL (phase-locked loop) and help the user design for optimal performance. The designer should provide quiet, noise-free power to these pins.
GND	Ground. The ground return for all circuitry on-chip. It is recommended that the AD9889 be assembled on a single solid ground plane, with careful attention given to ground current paths.

I²C ADDRESSES

The SDA/SCL programming address is 0x72 or 0x7A based on whether A0 is pulled high (10 kΩ resistor = 0x7A) or pulled low (10 kΩ resistor = 0x72).

The MDA/MCL EEPROM address is 0xA0.

The EDID EEPROM on the receiver is expected to have an address of 0xA0.

LIST OF REFERENCE DOCUMENTS

Table 6.

Document	Description
EIA/CEA-861B	Describes audio and video infoframes as well as the E-EDID structure for HDMI.
HDMI V1.1	Defining document for HDMI Version 1.1. Can be located at www.hdmi.org.
HDCPv1.0	Defining document for HDCP Version 1.1. Can be located at www.digital-cp.com.
ITU-R BT.656-3	Defining document for BT656.

FORMAT STANDARDS

In this document, data is represented in a variety of ways.

Table 7.

Data Type	Format
0xNN	Hexadecimal (base-16) numbers are represented using the C language notation, preceded by 0x.
0bNN	Binary (base-2) numbers are represented using the C language notation, preceded by 0b.
NN	Decimal (base-10) numbers are represented using no additional prefixes or suffixes.
Bit	Bits are numbered in little-endian format, that is, the least significant bit (LSB) of a byte or word is referred to as Bit 0.

DESIGN GUIDE

GENERAL DESCRIPTION

The AD9889 HDMI transmitter provides a high bandwidth digital content protected (HDCP) digital link between a wide range of digital input formats—both audio and video (see Table 8) and output formats (see Table 9). Video and audio data are captured and prepared for transmission while three separate I^2C buses (two of which are masters) are used to program and provide content protection for the data to be transmitted.

VIDEO DATA CAPTURE

The AD9889 can accept video data from as few as eight pins (YCbCr DDR) representing 8-bit data or as many as 24 pins representing 12-bit data. The AD9889 is capable of detecting all of the 34 video formats defined in the EIA/CEA-861B specification. If video ID (VID) 32, 33, or 34 is present, the user needs to set Register R0x15[0] to 0b1, as these modes have V_{REF} frequencies of 30 Hz or less. The user can read the detected video format at R0x3E[7:2]. Formats outside the EIA/CEA-861B specification can be read in R0x3F[7:5]. Detailed line count differences for 240p and 288p modes can be read from R0x3F[4:3]. In order to distinguish between an aspect ratio of 4:3 and one of 16:9, R0x17[1] should be set accordingly.

Table 8. Input Formats Supported

No. of Bits	Input Format
12	RGB (DDR)
12	YCbCr 4:4:4 (DDR)
24	RGB 4:4:4
24	YCbCr 4:4:4
16	YCbCr 4:2:2 (ITU.601)
20	YCbCr 4:2:2 (ITU.601)
24	YCbCr 4:2:2 (ITU.601)
8	YCbCr (DDR)
10	YCbCr (DDR)
12	YCbCr (DDR)
8	YCbCr 4:2:2 (ITU.656)
10	YCbCr 4:2:2 (ITU.656)
12	YCbCr 4:2:2 (ITU.656)

Table 9. Output Formats Supported

No. of Bits	Output Format
24	RGB 4:4:4
24	YCbCr 4:4:4
16	YCbCr 4:2:2
20	YCbCr 4:2:2
24	YCbCr 4:2:2

INPUT FORMATS

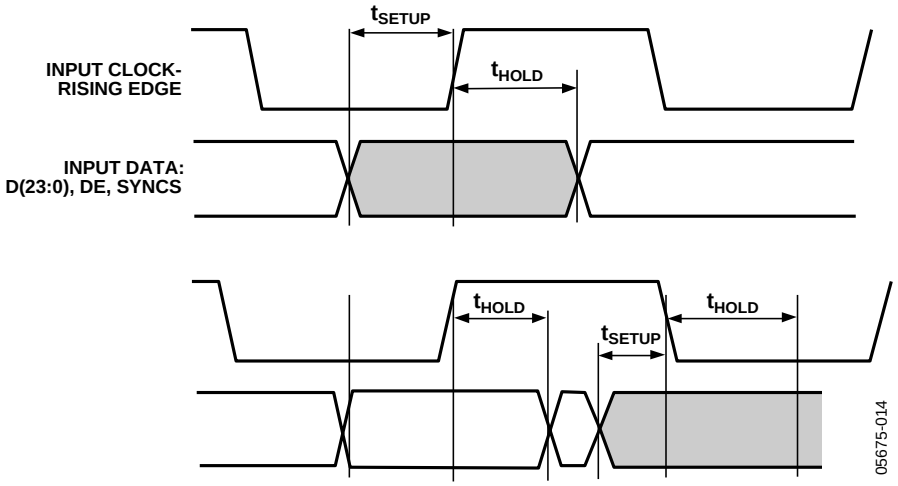


Figure 3. Timing for Data Input

Normal 4:4:4 Input Format (RGB or YCbCr) Input ID = 0

An input format of RGB 4:4:4 or YCbCr 4:4:4 can be selected by setting the input ID (R0x15[3:1]) to 0b000. The input color space (CS) must be selected by setting R0x16[0] to 0b0 for RGB or 0b1 for YCbCr. There is no need to set the input style (R0x16[3:2]).

Table 10.

	Data<23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
RGB 4:4:4	R[7:0]							G[7:0]									B[7:0]							
YCbCr 4:4:4	Cr[7:0]							Y[7:0]									Cb[7:0]							

YCbCr 4:2:2 Formats (24 Bits, 20 Bits, or 16 Bits) with Separate Sync, Input ID = 1

An input with YCbCr 4:2:2 with separate syncs can be selected by setting the Input ID (R0x15[3:1]) to 0b001. The input CS (R0x16[0]) must be set to 0b1 for proper operation. The data bit width (24 bits, 20 bits, or 16 bits) must be set with R0x16[5:4]. The three input pin assignment styles are shown in Table 11. The input style can be set in R0x16[3:2].

Table 11.

	Data <23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Style 1																								
YCbCr 4:2:2 Sep. Sync (24 bit)	Cb[11:4]								Y[11:4]								Cb[3:0]				Y[3:0]			
	Cr[11:4]								Y[11:4]								Cr[3:0]				Y[3:0]			
YCbCr 4:2:2 Sep. Sync (20 bit)	Cb[9:2]								Y[9:2]								Cb[1:0]				Y[1:0]			
	Cr[9:2]								Y[9:2]								Cr[1:0]				Y[1:0]			
YCbCr 4:2:2 Sep. Sync (20 bit)	Cb[7:0]								Y[7:0]															
	Cr[7:0]								Y[7:0]															
Style 2																								
24-bit	Cb[11:0]												Y[11:0]											
	Cr[11:0]												Y[11:0]											
20-bit	Cb[9:0]										Y[9:0]													
	Cr[9:0]										Y[9:0]													
16-bit	Cb[7:0]								Y[7:0]															
	Cr[7:0]								Y[7:0]															
Style 3																								
24-bit	Y[11:0]												Cb[11:0]											
	Y[11:0]												Cr[11:0]											
20-bit	Y[9:0]										Cb[9:0]													
	Y[9:0]										Cr[9:0]													
16-bit	Y[7:0]								Cb[7:0]															
	Y[7:0]								Cr[7:0]															

YCbCr 4:2:2 Formats (24 Bits, 20 Bits, or 16 Bits) with Embedded Syncs, Input ID = 2

An input with YCbCr 4:2:2 with embedded syncs can be selected by setting the input ID (R0x15[3:1]) to 0b010. HS YNC and VSYNC are embedded as Start of Active Video (SAV) and End of Active Video (EAV). The input CS (R0x16[0]) must be set to 0b1 for proper operation. The data bit width (24 = 12 bits, 20 = 10 bits, or 16 = 8 bits) must be set with R0x16[5:4]. The three input pin assignment styles are shown in Table 12. The input style can be set in R0x16[3:2]. The only difference between Input ID 1 and Input ID 2 is that the syncs on ID 2 are embedded in the data much like ITU 656 running at 1× clock and double width.

Table 12.

	Data <23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Style 1																								
YCbCr 4:2:2 Sep. Sync (24 bit)	Cb[11:4]								Y[11:4]								Cb[3:0]				Y[3:0]			
	Cr[11:4]								Y[11:4]								Cr[3:0]				Y[3:0]			
YCbCr 4:2:2 Sep. Sync (20 bit)	Cb[9:2]								Y[9:2]								Cb[1:0]				Y[1:0]			
	Cr[9:2]								Y[9:2]								Cr[1:0]				Y[1:0]			
YCbCr 4:2:2 Sep. Sync (16 bit)	Cb[7:0]								Y[7:0]															
	Cr[7:0]								Y[7:0]															
Style 2																								
24-bit	Cb[11:0]												Y[11:0]											
	Cr[11:0]												Y[11:0]											
20-bit	Cb[9:0]										Y[9:0]													
	Cr[9:0]										Y[9:0]													
16-bit	Cb[7:0]								Y[7:0]															
	Cr[7:0]								Y[7:0]															
Style 3																								
24-bit	Y[11:0]												Cb[11:0]											
	Y[11:0]												Cr[11:0]											
20-bit	Y[9:0]										Cb[9:0]													
	Y[9:0]										Cr[9:0]													
16-bit	Y[7:0]								Cb[7:0]															
	Y[7:0]								Cr[7:0]															

YCbCr 4:2:2 Formats (Double Data Rate) Formats (12, 10, or 8 bits) with Separate Syncs, Input ID = 3

An input with YCbCr 4:2:2 DDR data and separate syncs can be selected by setting the input ID (R0x15[3:1]) to 0b011. The input CS (R0x16 [0]) must be set to 0b1. The data bit width (12 bits, 10 bits, or 8 bits) must be set with R0x16[5:4]. The two input pin assignment styles are shown in Table 13. The input style can be set in R0x16[3:2].

Table 13.

	Data <23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Style 1																								
12-bit									Cb/Y/Cr/Y[11:4]												[3:0]			
10-bit									Cb/Y/Cr/Y[9:2]												[1:0]			
8-bit									Cb/Y/Cr/Y[7:0]															
Style 2																								
12-bit													Cb/Y/Cr/Y[11:0]											
10-bit														Cb/Y/Cr/Y[9:0]										
8-bit																	Cb/Y/Cr/Y[7:0]							

YCbCr 4:2:2 DDR (Double Data Rate) Formats (12 Bits, 10 Bits, or 8 Bits) with Embedded Syncs. Input ID = 4

An input with YCbCr 4:2:2 DDR data and embedded syncs (ITU 656) can be selected by setting the input ID (R0x15[3:1]) to 0b100. The input CS (R0x16[0]) must be set to 0b1. The data bit width (12 bits, 10 bits, or 8 bits) must be set with R0x16[5:4]. The two input pin assignment styles are shown in Table 14. The input style can be set in R0x16[3:2]. The order of data input is the order in the table (for example, 12-bit data is accepted as Cb0, Y0, Cr0, Y1, Cb2, Y2, Cr2, Y3).

Table 14.

	Data <23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Style 1																								
12-bit									Cb/Y/Cr/Y[11:4]												[3:0]			
10-bit									Cb/Y/Cr/Y[9:2]												[1:0]		
8-bit									Cb/Y/Cr/Y[7:0]															
Style 2																								
12-bit													Cb/Y/Cr/Y[11:0]											
10-bit															Cb/Y/Cr/Y[9:0]									
8-bit																	Cb/Y/Cr/Y[7:0]							

Normal 4:4:4 input format (RGB or YCbCr) Clocked at Double Data Rate (DDR), Input ID = 5

An input with YCbCr 4:2:2 DDR data and separate syncs can be selected by setting the input ID (R0x15[3:1]) to 0b011. The input CS (R0x16[0]) must be set to 0b1. The data bit width (12 bits, 10 bits, or 8 bits) must be set with R0x16[5:4]. The three input pin assignment styles are shown in Table 15. The input style can be set in R0x16[3:2].

Table 15.

	Data <23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Style 1																								
RGB 4:4:4 (DDR) (1st edge, 2nd edge)													G[3:0]				B[7:0]							
													R[7:0]								G[7:4]			
YCbCr 4:4:4 (DDR) (1st edge, 2nd edge)													Y[3:0]				Cb[7:0]							
													Cr[7:0]								Y[7:4]			
Style 2																								
RGB 4:4:4 (DDR) (1st edge, 2nd edge)													R[7:0]								G[7:4]			
													G[3:0]				B[7:0]							
YCbCr 4:4:4 (DDR) (1st edge, 2nd edge)													Cr[7:0]								Y[7:4]			
													Y[3:0]				Cb[7:0]							
Style 3																								
YCbCr 4:4:4 (DDR) (1st edge, 2nd edge)													Y[7:0]								Cb[7:4]			
													Cb[3:0]				Cr[7:0]							

YCbCr 4:2:2 Formats (24, 20, or 16 bits) DDR with Separate Sync, Input ID = 6

An input format of YCbCr 4:2:2 DDR can be selected by setting the input ID (R0x15[3:1]) to 0b110. The three different input pin assignment styles are shown in Table 16. The input style can be set in R0x16[3:2]. The input CS (R0x16[0]) must be set to 0b1. The data bit width (12, 10, or 8 bits) must be set to with R0x16[5:4].

The 1st or the 2nd edge may be the rising or falling edge. The data input edge is defined in R0x16[1]. 0b0 = rising edge; 0b1 = falling edge. Pixel 0 is the first pixel of the 4:2:2 word and should be where DE starts.

Table 16.

	Data<23:0>																							
Input Format	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Style 1																								
YCbCr 4:2:2 Sep Syncs (DDR) 12-bit		1st Pixel					2nd Edge		1st Edge				Y[7:4]				Cb[3:0]			Y[3:0]				
													Cb[11:4]							Y[11:8]				
		2nd Pixel											Y[7:4]				Cr[3:0]			Y[3:0]				
													Cr[11:4]							Y[11:8]				
YCbCr 4:2:2 Sep Syncs (DDR) 10-bit													Y[5:4]		Cb[3:0]			Y[3:0]						
													Cb[9:4]					Y[9:6]						
													Y[5:4]		Cr[3:0]			Y[3:0]						
													Cr[9:4]					Y[9:6]						
YCbCr 4:2:2 Sep. Syncs (DDR) 8-bit													Cb[3:0]			Y[3:0]								
													Cb[7:4]			Y[7:4]								
													Cr[3:0]			Y[3:0]								
													Cr[7:4]			Y[7:4]								
Style 2																								
12-bit													Y[11:0]											
													Cb[11:0]											
													Y[11:0]											
													Cr[11:0]											
10-bit													Y[9:0]											
													Cb[9:0]											
													Y[9:0]											
													Cr[9:0]											
8-bit													Y[7:0]											
													Cb[7:0]											
													Y[7:0]											
													Cr[7:0]											
Style 3																								
12-bit													Cb[11:0]											
													Y[11:0]											
													Cr[11:0]											
													Y[11:0]											
10-bit													Cb[9:0]											
													Y[9:0]											
													Cr[9:0]											
													Y[9:0]											
8-bit													Cb[7:0]											
													Y[7:0]											
													Cr[7:0]											
													Y[7:0]											

4:2:2 TO 4:4:4 DATA CONVERSION

The AD9889 has the ability to convert YCbCr video from 4:4:4 to 4:2:2 and 4:2:2 to 4:4:4. To convert from 4:4:4 to 4:2:2, the video data goes through a filter first to remove any artificial downsampling noise. To convert from 4:2:2 to 4:4:4, the AD9889 utilizes either the zero-order upconversion (pixel repetition) or first-order upconversion (linear interpolation). The upconversion and downconversion are used when the video output timing format does not match the video input timing format. The video output format is set by Register R0x16[7:6]. The video input format is set by the video ID (R0x15[3:1]) and video color space (R0x16[0]). The default mode for upconversion is pixel repetition. To use linear interpolation, set Register R0x17[2] to 1.

HORIZONTAL SYNC, VERTICAL SYNC, AND DEGENERATION

When transmitting video data across the TMDS interface, it is necessary to have an HSYNC, VSYNC, and data enable (DE) defined for the image. ITU-656 based sources have start of active video (SAV) and end of active video (EAV) signals built in, but the HSYNC and VSYNC must be generated (the DE is implied by the SAV and EAV signals). Other sources (with separate syncs) have HSYNC, VSYNC, and DE supplied at the same time as the pixel data.

DEGENERATION

The AD9889 offers a choice of DE from an external pin, or an internally generated DE. To activate the internal DE generation, set Register R0x17[0] to 1. Register R0x35 to Register R0x3A are used to define the DE. R0x35 and R0x36[7:6] define the number of pixels from the HS leading edge to the DE leading edge. R0x36[5:0] are the number of HSYNCs between the leading edge of VS and DE. R0x37[7:5] defines the difference of HS counts during VS blanking for interlace video. R0x37[4:0] and R0x38[7:1] indicate the width of the DE. R0x39 and R0x3A[7:4] are the number of lines of active video (see Figure 4).

HSYNC AND VSYNC GENERATION

For video with embedded HSYNC and VSYNC, such as EAV and SAV, found in ITU 656 format, it is necessary to reconstruct HSYNC and VSYNC. This is done with Register R0x30 to Register R0x34. R0x30 and R0x31[7:6] specify the number of pixels between the HSYNC leading edge and the trailing edge of DE. Register R0x31[5:0] and Register R0x32[7:4] are the duration of the HSYNC in pixel clocks. R0x32[3:0] and R0x33[7:2] are the number of HS pulses between the trailing edge of the last DE and the leading edge of the VSYNC pulse. Register R0x33[1:0] and Register R0x34[7:0] are the duration of VSYNC in units of HSYNCs. HSYNC and VSYNC polarity can be specified by setting R0x17[6] (for VSYNC) and R0x17[5] (for HSYNC).

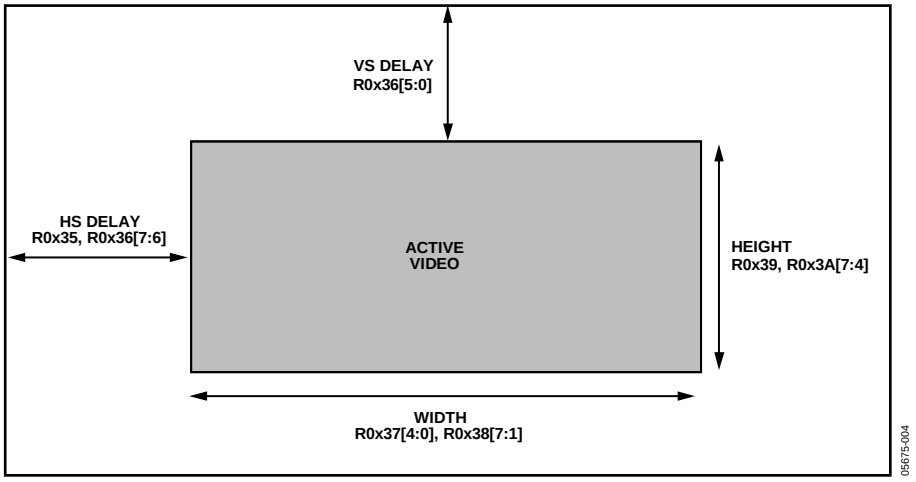


Figure 4. Active Video

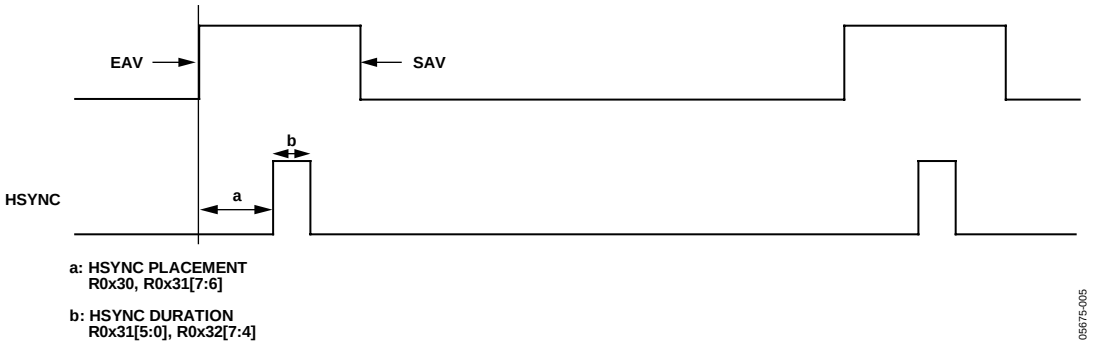


Figure 5. HSYNC Reconstruction

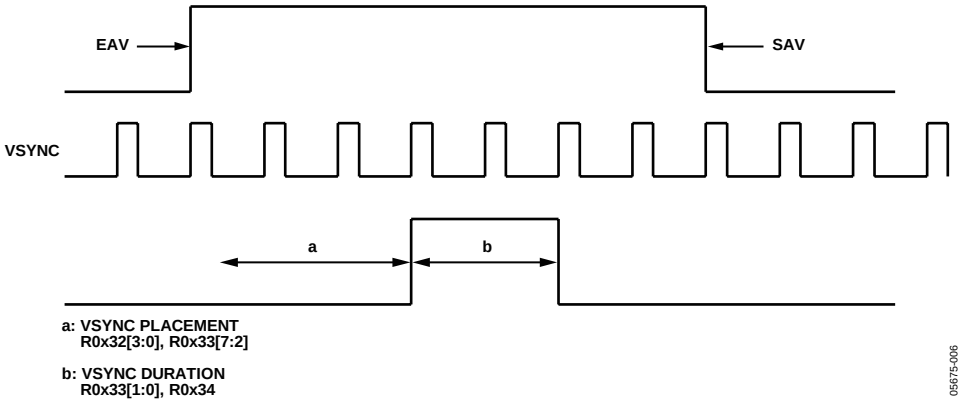


Figure 6. VSYNC Reconstruction

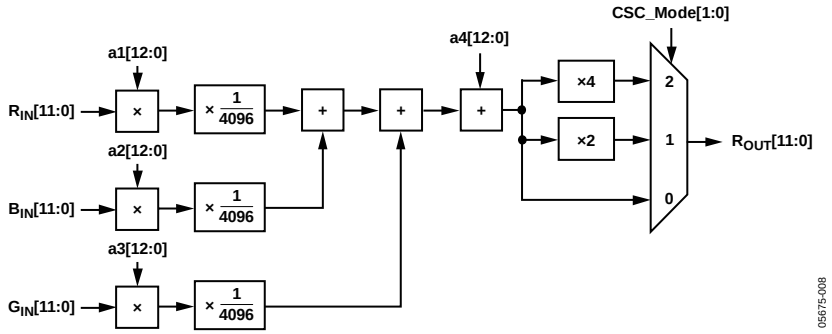


Figure 7. Single CSC Channel

COLOR SPACE CONVERSION MATRIX (CSC)

The color space conversion matrix in the AD9889 consists of three identical processing channels. In each channel, three input values are multiplied by three separate coefficients. Also included are an offset value for each row of the matrix and a scaling multiple for all values. Each value is 13-bit, twos complement resolution to ensure the signal integrity is maintained. The CSC is designed to run at speeds up to 80 MHz supporting resolutions up to 1080i at 60 Hz and UXGA at 60 Hz. With any-to-any color space support, RGB, YUV, YCbCr, and other formats are supported by the CSC.

The main inputs, R_{IN}, G_{IN}, and B_{IN} come from the 8-bit to 12-bit inputs from each channel. These inputs are based on the input format detailed in Table 10 to Table 16. The mapping of these inputs to the CSC inputs is shown in Table 17.

Table 17. CSC Port Mapping

Input Channel	CSC Input Channel
R/Cr	R_{IN}
Gr/Y	G_{IN}
B/Cb	B_{IN}

One of the three channels is represented in Figure 7. In each processing channel the three inputs are multiplied by three separate coefficients marked a1, a2, and a3. These coefficients are divided by 4096 to obtain nominal values ranging from −0.9998 to +0.9998. The variable labeled a4 is used as an offset control. The CSC_Mode setting is the same for all three processing channels. This multiplies all coefficients and offsets by a factor of 2CSC_Mode.

The functional diagram for a single channel of the CSC as per Figure 7 is repeated for the remaining G and B channels. The coefficients for these channels are b1, b2, b3, b4, c1, c2, c3, and c4.

A programming example and register settings for several common conversions are listed in the Color Space Converter (CSC) Common Settings section.

For a detailed functional description and more programming examples, refer to AN-795, *The AD9880 Color Space Converter User's Guide*.

AUDIO DATA CAPTURE

The AD9889 is capable of receiving audio data in either I²S or S/PDIF format for packetization and transmission over the HDMI interface.

I²S AUDIO

The AD9889 can accommodate from two to eight channels of I²S audio at up to a 192 kHz sampling rate. Selection of I²S audio mode (vs. S/PDIF) is set with R0x0A[4] = 0. The detected sampling frequency (from 32 kHz to 192 kHz) can be read in R0x04[7:4]. The output sampling frequency (from 32 kHz to 192 kHz) can be selected with R0x15[7:4]. The number of channels and the specific channels can be selected in R0x0C[5:2] and R0x50[7:5]. If all eight channels (I²S0 to I²S3) are required, setting all bits or R0x0C[5:2] to 1 selects eight channels. If I²S0 only is needed, setting R0x0C[2] to 1 selects this. The placement of these packets with respect to their output can be specified in Register R0x0E to Register R0x11. Default settings place all channels in their respective position (I²S0 left channel in Channel 0 left position, I²S3 right channel in Channel 3 right position), but this mapping is completely programmable.

The AD9889 supports standard I²S, left-justified I²S, and right-justified I²S formats via R0x0C[1:0] and sample word lengths between 16 bits and 24 bits (R0x14[3:0]).

S/PDIF AUDIO

The AD9889 is capable of accepting two channel LPCM and encoded audio up to a 192 kHz sampling rate via the S/PDIF. S/PDIF audio input is selected by setting R0x0A[4] = 1. The AD9889 is capable of accepting S/PDIF with or without an MCLK input. When no MCLK is present, the AD9889 makes the determination of the CTS value (N/CTS determines the MCLK frequency).

CTS GENERATION

Audio data being carried across the HDMI link, which is driven by a TMDS (video) clock only, does not retain the original audio sample clock.

The task of recreating this clock at the sink is called audio clock regeneration. There are a variety of clock regeneration methods that can be implemented in an HDMI sink, each with a different set of performance characteristics. The HDMI specification does not attempt to define exactly how these mechanisms operate. It does, however, present a possible configuration and it does define the data items that the HDMI source supplies to the HDMI sink in order to allow the HDMI sink to adequately regenerate the audio clock. It also defines how that data is generated. In many video source devices, the audio and video clocks are generated from a common clock (coherent clocks). In this situation, there exists a rational (integer divided by integer) relationship between these two clocks. The HDMI clock regeneration architecture can take advantage of this rational relationship and can also work in an environment where there is no such relationship between these two clocks, that is, where the two clocks are truly asynchronous or where their relationship is unknown.

Figure 8 shows the system architecture model used by HDMI for audio clock regeneration. The source determines the fractional relationship between the video clock and an audio reference clock (128 × audio sample rate) and passes the numerator and denominator for that fraction to the sink across the HDMI link. The sink can then recreate the audio clock from the TMDS clock by using a clock divider and a clock multiplier. The exact relationship between the two clocks is

$$128 \times fs = f_{TMDS}\_clock \times N/CTS$$

The source determines the value of the numerator N as stated in Section 7.2.1 of the HDMI specification. Typically, this value N is used in a clock divider to generate an intermediate clock that is slower than the 128 × fs clock by the factor N. The source typically determines the value of the denominator cycle time stamp (CTS) by counting the number of TMDS clocks in each of the 128 × fs/N clocks.

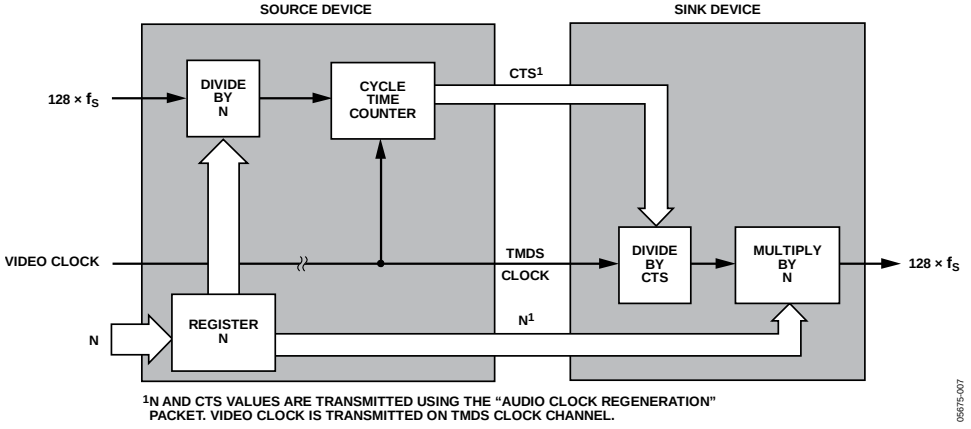


Figure 8. Audio Clock Regeneration

N PARAMETER

N shall be an integer number that meets the following restriction: 128 × fs/1500 Hz ≤ N ≤ 128 × fs/300 Hz with a recommended optimal value of 128 × fs/1000 Hz equals N. For coherent audio and video clock sources, use Table 18 to Table 20 to determine the value of N. For noncoherent sources or sources where coherency is not known, use the equations previously described.

CTS PARAMETER

CTS is an integer number that satisfies the following:

$$(Average\ CTS\ Value) = (f_{TMDS\_clock} \times N)/(128 \times fs)$$

Recommended N and Expected CTS Values

The recommended value of N for several standard pixel clocks is given in Table 18 to Table 20. It is recommended that sources with noncoherent clocks use the values listed for the pixel clock type labeled Other.

Table 18. Recommended N and Expected CTS Values for 32 kHz Audio

	32 kHz	
Pixel Clock (MHz)	**N**	**CTS**
25.1/1.001	4576	28125
25.2	4096	25200
27	4096	27000
27 × 1.001	4096	27027
54	4096	54000
54 × 1.001	4096	54054
74.25/1.001	11648	210937 to 210938[1]
74.25	4096	74250
148.5/1.001	11648	421875
148.5	4096	148500
Other	4096	Measured

[1] This value alternates because of the restriction on N.

Table 19. Recommended N and Expected CTS Values for 44.1 kHz Audio and Multiples

	44.1 kHz		88.2 kHz		176.4 kHz	
Pixel Clock (MHz)	**N**	**CTS**	**N**	**CTS**	**N**	**CTS**
25.1/1.001	7007	31250	14014	31250	28028	31250
25.2	6272	28000	12544	28000	25088	28000
27	6272	3000	12544	30000	25088	30000
27 × 1.001	6272	30030	12544	30030	25088	30030
54	6272	60000	12544	60000	25088	60000
54 × 1.001	6272	60060	12544	60060	25088	60060
74.25/1.001	17836	234375	35672	234375	71344	234375
74.25	6272	82500	12544	82500	25088	82500
148.5/1.001	8918	234975	17836	234375	35672	123375
148.5	6272	165000	12544	16500	25088	162000
Other	6272	Measured	15244	Measured	25088	Measured

Table 20. Recommended N and Expected CTS Values for 48 kHz Audio and Multiples

	44.1 kHz		88.2 kHz		176.4 kHz	
Pixel Clock (MHz)	**N**	**CTS**	**N**	**CTS**	**N**	**CTS**
25.1/1.001	6864	28125	13728	28125	27456	28125
25.2	6144	25200	12288	25200	24576	25200
27	6144	27000	12288	27027	24576	27027
27 × 1.001	6144	27027	12288	27027	24576	27027
54	6144	54000	12288	54000	24576	54000
54 × 1.001	6144	54054	12288	54054	24576	74250
74.25/1.001	11648	140625	23296	140625	46592	140625
74.25	6144	74250	12288	74250	24576	74250
148.5/1.001	5824	140625	11648	140625	23296	140625
148.5	6144	148500	12288	148500	24576	148500
Other	6144	Measured	12288	Measured	24576	Measured

The AD9889 has two modes for CTS generation: manual mode and auto mode. In manual mode, the user can program the CTS number directly into the chip (R0x07 to R0x09) and select this external mode by setting R0x0A[7] to 1. In auto mode, the chip computes the CTS based on the actual audio and video rates. This can be selected by setting R0x0A[7] to 0, and the results can be read from R0x04 to R0x06. Manual mode is good for coherent audio and video, where the audio and video clock are generated from the same crystal; thus CTS should be a fixed number. The auto mode is good for incoherent audio-video, where there is no simple integer ratio between the audio and video clock. A filter is available (R0x0A[6:5]) to stabilize the chip-generated CTS. The 20-bit N value can be programmed into the AD9889 in Register R0x01 to Register R0x03.

PACKET CONFIGURATION

The AD9889 supports all the packets listed in the HDMI 1.1 specification. Each packet can be separately enabled and disabled. Based on the audio and video input, the packets are added to the HDMI link at the earliest time, so that a minimum delay is incurred. Notice the ISRC1 packet has one bit to enable the ISRC2 packet. For the general control packet, remember to clear or reset the bits to avoid system lock-up.

PIXEL REPETITION

Due to HDMI specification and bandwidth requirements, sometimes it is necessary to set clock multiplication by 2× and 4× in order to maintain the minimum TMDS clock frequency. The AD9889 offers three choices for the user to implement this function: auto mode, manual mode, and max mode (R0x3B[6:5]).

For the auto mode (R0x3B[6:5] = 00), based on the input video format (either programmed by user, or chip detection) and audio sampling rate, AD9889 automatically sets the pixel repetition factor (R0x3D[7:6]).

For manual mode (R0x3B[6:5] = 1×), the user programs the pixel repetition factor in R0x3B[4:3].

For max mode (R0x3B[6:5] = 01), based on the input video format, the AD9889 selects the maximum repetition factor. The advantage of the max mode is that it is independent of the audio sampling rate.

Table 21. Pixel Repetition—Valid Pixel Repeat Values for Each Format

Video Code	Video Description	EIA/CEA-861B Pixel Repeat Values	HDMI Pixel Repeat Values
1	640 × 480p @ 60 Hz	No repetition	No repetition
2, 3	720 × 480p @ 59.94/60 Hz	No repetition	No repetition
4	1280 × 720p @ 59.94/60 Hz	No repetition	No repetition
5	1920 × 1080i @ 59.94/60 Hz	No repetition	No repetition
6, 7	720/1440 × 480i @ 59.94/60 Hz	Pixel sent 2 times	Pixel sent 2 times
8, 9	720/1440 × 240p @ 59.94/60 Hz	Pixel sent 2 times	Pixel sent 2 times
10, 11	2880 × 480i @ 59.94/60 Hz	Pixel sent 0 to 10 times	Pixel sent 1 to 10 times
12, 13	2880 × 240p @ 59.94/60 Hz	Pixel sent 1 to 10 times	Pixel sent 1 to 10 times
14, 15	1440 × 480p @ 59.94/60 Hz	No repetition	Pixel sent 1 to 2 times[1]
16	1920 × 1080p @ 59.94/60 Hz	No repetition	No repetition
17, 18	720 × 576p @ 50 Hz	No repetition	No repetition
19	1280 × 720p @ 50 Hz	No repetition	No repetition
20	1920 × 1080i @ 50 Hz	No repetition	No repetition
21, 22	720/1440 × 576i @ 50 Hz	Pixel sent 2 times	Pixel sent 2 times
23, 24	720/1440 × 288p @ 50 Hz	Pixel sent 2 times	Pixel sent 2 times
25, 26	2880 × 576i @ 50 Hz	Pixel sent 1 to 10 times	Pixel sent 1 to 10 times
27, 28	2880 × 288 @ 50 Hz	Pixel sent 1 to 10 times	Pixel sent 1 to 10 times
29, 30	1440 × 576p @ 50 Hz	No repetition	Pixel sent 1 to 2 times[1]
31	1920 × 1080p @ 50 Hz	No repetition	No repetition
32	1920 × 1080p @ 23.97/24 Hz	No repetition	No repetition
33	1920 × 1080p @ 25 Hz	No repetition	No repetition
34	1920 × 1080p @ 29.9/30 Hz	No repetition	No repetition

[1] Denotes change from EIA/CEA-861B valid values. Pixel repetition is required to support some audio formats at 720 × 480p and 720 × 576p video format timings.

HDCP HANDLING

The AD9889 has a built-in microcontroller to handle HDCP transmitter states, including handling downstream HDCP repeaters. To activate HDCP from a system level, the main controller needs to set R0xAF[7] to 1 to inform AD9889 that the video stream should be encrypted. The AD9889 takes control from there and implements all remaining tasks defined by the HDCP 1.1 specification.

The system controller should monitor the status of HDCP by reading Register R0xB8[6] (indicating the HDCP link has been established). There are also some error flags (R0xC5[7] and R0xC8[7:4]) to help debug the system.

The AD9889 also supports AV functions to suspend HDCP temporarily. To set AV mute, clear R0x45[7] and set R0x45[6] to 1. To clear AV mute, clear R0x45[6] and set R0x45[7] to 1. (Note that it is invalid to set the two mute bits at the same time.)

For more information, refer to application note AN-810, *EDID and HDCP Controller User Guide for the AD9889*.

EDID READING

The AD9889 has an I^2C master (DDC Pin 44 and Pin 45) to read the EDID based on system need. It buffers segment 0 once HPD is detected. The system can request other segments by programming Register R0xC4. An interrupt bit (R0x96[2]) indicates the completion of EDID rebuffering.

To read EDID data from the AD9889, use the AD9889 programming bus (Pin 46 and Pin 47) with I^2C Address 0x7E. This is the default address but can be changed by writing the desired address into Register R0x43.

For more information, refer to application note AN-810, *EDID and HDCP Controller User Guide for the AD9889*.

INTERRUPTS

The AD9889 has interrupts to help with the system design: hot plug detection, receiver sense, VS detection, audio FIFO overflow, ITU 656 error, EDID ready, HDCP error, and BKSV ready. Interrupts can be cleared by writing 1 into the interrupt register (R0x96, R0x97). There are read-only registers (R0xC5, R0xC6) to show the state of these signals. Masks (R0x94, R0x95) are available to let the user selectively activate each interrupt. To enable a specific interrupt register, write 1 to the corresponding mask bit.

POWER MANAGEMENT

The AD9889 power-down pin polarity depends on the AD9889's I^2C address selection. To use 0x72, the PD pin is high active. To use 0x7A, the PD pin is low active. At any time, the power-down pin polarity can be verified by reading Register R0x42[7].

The AD9889 can be powered down or reset either by Pin 33 or by Register R0x41[6]. During power-down mode, all the circuits are inactive except the I^2C slave and some circuits related to mode and activity detection. During power-down mode, the chip status can still be read through the I^2C slave. To enter normal power-down mode, either drive Pin 33 to 1, or set R0x41[6] to 1. To further reduce power consumption, disable the receiver sense detection by setting Register R0xA4[2] to 1.

For HDCP security reasons, the I^2C power-down bit is also reset by the power-down pin. Anytime after power down, the user needs to drive the PD pin back to 0 and set R0x41[6] to 0 to activate the chip.

2-WIRE SERIAL REGISTER MAP

The AD9889 is initialized and controlled by a set of registers that determine the operating modes. An external controller is employed to write and read the control registers through the two-line serial interface port.

Table 22. Control Register Map

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x00	Read	[7:0]	00000000	Chip Revision	Revision of the chip, start from 0.
0x01	Read/Write	[3:0]	****0000	N[19:16]	20-bit N used with cycle time stamp (CTS) (see Table 18 to Table 20 for appropriate settings) to regenerate the audio clock in the receiver. For remaining bits, see R0x02 and R0x03. Used only with I²S audio, not S/PDIF.
0x02	Read/Write	[7:0]	00000000	N[15:8]	The middle byte of N.
0x03	Read/Write	[7:0]	00000000	N[7:0]	The lower byte of N.
0x04	Read	[7:4]	0000****	S/PDIF_SF	S/PDIF sampling frequency for S/PDIF audio decoded from hardware. This information is used by both the audio Rx and the pixel repetition. 0011 = 32 kHz. 0000 = 44.1 kHz. 0010 = 48 kHz. 1000 = 88.2 kHz. 1010 = 96 kHz. 1100 = 176.4 kHz. 1110 = 192 kHz. Default = 0x0.
		[3:0]	****0000	CTS_Int[19:16]	CTS measured (internal). This 20-bit value is used in the receiver with the N value to regenerate an audio clock. For remaining bits, see R0x05 and R0x06.
0x05	Read	[7:0]	00000000	CTS_Int[15:8]	Middle byte of measured CTS.
0x06	Read	[7:0]	00000000	CTS_Int[7:0]	Low byte of measured CTS.
0x07	Read/Write	[3:0]	****0000	CTS_Ext[19:16]	CTS (external). This 20-bit value is used in the receiver with the N value to regenerate an audio clock. For remaining bits see R0x08 and R0x09.
0x08	Read/Write	[7:0]	00000000	CTS_Ext[15:8]	Middle byte of external CTS.
0x09	Read/Write	[7:0]	00000000	CTS_Ext[7:0]	Low byte of external CTS.
0x0A	Read/Write	[7]	0*******	CTS_Sel	CTS source select. 0 = internal CTS. 1 = external CTS. Default = 0.
		[6:5]	*10*****	Avg_Mode	CTS filter mode. 00 = no filter. 01 = divide by 4. 10 = divide by 8. 11 = divide by16. Default = 10.
		[4]	***0****	Audio_Sel	Audio type select. 0 = I²S. 1 = S/PDIF. Default = 0.
		[3]	****0***	MCLK_SP	MCLK for S/PDIF. 1 = MCLK active. 0 = MCLK inactive. Default = 0.
		[2]	*****0**	MCLK_I²S	MCLK for I²S. 1 = I²S MCLK active. 0 = I²S MCLK inactive. Default = 0.
		[1:0]	******01	MCLK_Ratio	MCLK ratio.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
					00 = × 128 fs. 01 = × 256 fs. 10 = × 384 fs. 11 = × 512 fs. Default = 01.
0x0B	Read/Write	[6]	*0******	MCLK_Pol	MCLK polarity. 0 = rising edge. 1 = falling edge. Default = 0.
		[5]	**0*****	Flat_Line	Flat line. 1 = flat line audio (audio sample not valid). 0 = normal. Default = 0.
		[4:0]	****0111	Test bits	Must be set to 0x7 for proper operation.
0x0C	Read/Write	[5:2]	**1111**	I^2S enable	I^2S enable for the four I^2S pins (active). 0001 = I^2S0. 0010 = I^2S1. 0100 = I^2S2. 1000 = I^2S3. Default = 1111 for all.
		[1:0]	******00	I^2S Format	I^2S format. 00 = standard I^2S mode. 01 = right-justified I^2S mode. 10 = left-justified I^2S mode. 11 = raw IEC60958 mode. Default = 0.
0x0D	Read/Write	[4:0]	***11000	I^2S_bit_width	I^2S bit width. For right justified audio only. Default is 24. Not valid for widths greater than 24.
0x0E	Read/Write	[5:3]	**000***	SUBPKT0_L_src	Registers 0x0E-0x11 should be set based on the speaker mapping information obtained from EDID Source of sub packet 0, left channel. Default = 000.
		[2:0]	*****001	SUBPKT0_R_src	Source of sub packet 0, right channel. Default = 001.
0x0F	Read/Write	[5:3]	**010***	SUBPKT1_L_src	Source of sub packet 1, left channel. Default = 010.
		[2:0]	*****011	SUBPKT1_R_src	Source of sub packet 1, right channel. Default = 011.
0x10	Read/Write	[5:3]	**100***	SUBPKT2_L_src	Source of sub packet 2, left channel. Default = 100.
		[2:0]	*****101	SUBPKT2_R_src	Source of sub packet 2, right channel. Default = 101.
0x11	Read/Write	[5:3]	**110***	SUBPKT3_L_src	Source of sub packet 3, left channel. Default = 110.
		[2:0]	*****111	SUBPKT3_R_src	Source of sub packet 3, right channel. Default = 111.
0x12	Read/Write	[5]	**0*****	CR_bit	Copyright bit. 0 = copyright. 1 = not copyright protected.
		[4:2]	***000**	a_info	Additional information for channel status bits. 000 = 2 audio channels without pre-emphasis. 100 = 2 audio channels with 50/15 µs pre-emphasis. 010 = reserved. 110 = reserved. Default = 000.
		[1:0]	******00	Clk_Acc	Clock accuracy. 00 = Level II, normal accuracy $\pm 1000 \times 10^{-6}$. 01 = Level III, variable pitch shifted clock. 10 = Level I, high accuracy $\pm 50 \times 10^{-6}$. 11 = reserved. Default = 00.
0x13	Read/Write	[7:0]	00000000	Category Code	Category code for audio infoframe; see IEC 60958.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x14	Read/Write	[7:4]	0000****	Source Number	Source number.
		[3:0]	****0000	Word Length	Audio word length. 0000 = not specified. 0100 = 16 bits. 0011 = 17 bits. 0010 = 18 bits. 0001 = 19 bits. 0101 = 20 bits. 1000 = not specified. 1100 = 20 bits. 1011 = 21 bits. 1010 = 22 bits. 1001 = 23 bits. 1101 = 24 bits. Default = 0x0.
0x15	Read/Write	[7:4]	0000****	I^2S_SF	Sampling frequency for I^2S audio. This information is used by both the audio Rx and the pixel repetition. 0011 = 32 kHz. 0000 = 44.1 kHz. 0010 = 48 kHz. 1000 = 88.2 kHz. 1010 = 96 kHz. 1100 = 176.4 kHz. 1110 = 192 kHz. Default = 0x0.
		[3:1]	****000*	VFE_input_id	Input video format. 000 = RGB and YCbCr 4:4:4 (Y on Green). 001 = YCbCr 4:2:2; 16, 20, and 24 bit. 010 = Same as 001 with HS and VS embedded as SAV and EAV. 011 = ITU656 with separated syncs. 100 = ITU656 with embedded syncs. 101 = DDR RGB 4:4:4 or YCbCr 4:4:4. 110 = DDR YCbCr 4:2:2. 111 = undefined. Default = 000.
		[0]	*******0	low_frq_video	Video refresh rate. 0 = V_{REF} > 30 Hz. 1 = V_{REF} ≤ 30 Hz refresh rate video. Default = 0.
0x16	Read/Write	[7:6]	00******	VFE_out_fmt	Video output format. This should be written along with R0x45[5:4]. 00 = RGB 4:4:4. 01 = YCbCr 4:4:4. 1x = YCbCr 4:2:2. Default = 00.
		[5:4]	**00****	VFE_422_width	4:2:2 input, could be either 8 bit, 10 bit, or 12 bit. x0 = 12 bits. 01 = 10 bits. 11 = 8 bits. Default = 00.
		[3:2]	****00**	VFE_input_style	Styles refer to the input pin assignments. See Table 23 to Table 28. x0 = Style 1. 01 = Style 2. 11 = Style 3.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
		[1]	******0*	VFE_input_edge	Video data input edge. Defines the first clock edge of video word clocked. 0 = rising edge. 1 = falling edge. Default = 0 (in reference to DDR).
		[0]	*******0	VFE_input_cs	Video input color space. 0 = RGB. 1 = YCbCr. Default = 0.
0x17	Read/Write	[7]	0*******	itu_error_correct_en	ITU656 error correction. This must be enabled if using ITU656 format. 0 = disable. 1 = enable. Default = 0.
		[6]	*0******	itu_vsync_pol	VS polarity from regenerated ITU 656 input. 0 = high polarity. 1 = low polarity. Default = 0.
		[5]	**0*****	itu_hsync_pol	HS polarity from regenerated ITU 656 input. 0 = high polarity. 1 = low polarity. Default = 0.
		[4:3]	***00***	csc_mode	Sets the fixed point position of the CSC coefficients, including the a4, b4, and c4 offsets. 00 = ±1.0, −4096<−>4095. 01 = ±2.0, −8192<−>8190. 1× = ±4.0, −16384<−>16380. Default = 000.
		[2]	*****0**	gen_444_en	4:2:2 to 4:4:4 upconversion mode. 1 = uses interpolation. 0 = no interpolation. Default = 0.
		[1]	******0*	ASP_ratio	Aspect ratio of input video. 0 = 4:3. 1 = 16:9. Default = 0.
		[0]	*******0	deGen_en	Enable DE generator. The DE generator should be enabled when a DE input is not provided. 1 = enable DE generator. Default = 0 (see Register 0x30 to Register 0x3A).
0x18	Read/Write	[4:0]	***00110	CSC_A1_MSB	MSB of R0x19.
0x19	Read/Write	[7:0]	01100010	CSC_A1_LSB	Color space converter (CSC) coefficient for equation: $R_{OUT} = (\mathbf{a1} \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x1A	Read/Write	[4:0]	***00100	CSC_A2_MSB	MSB of R0x1B.
0x1B	Read/Write	[7:0]	10101000	CSC_A2_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (\mathbf{a2} \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x1C	Read/Write	[4:0]	***00000	CSC_A3_MSB	MSB of R0x1D.
0x1D	Read/Write	[7:0]	00000000	CSC_A3_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (\mathbf{a3} \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x1E	Read/Write	[4:0]	***11100	CSC_A4_MSB	MSB of R0x1F.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x1F	Read/Write	[7:0]	10000100	CSC_A4_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + \mathbf{a4}$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x20	Read/Write	[4:0]	***11100	CSC_B1_MSB	MSB of R0x21.
0x21	Read/Write	[7:0]	10111111	CSC_B1_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (\mathbf{b1} \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN} + c4$
0x22	Read/Write	[4:0]	***00100	CSC_B2_MSB	MSB of R0x23.
0x23	Read/Write	[7:0]	10101000	CSC_B2_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (\mathbf{b2} \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x24	Read/Write	[4:0]	***11110	CSC_B3_MSB	MSB of R0x25.
0x25	Read/Write	[7:0]	01110000	CSC_B3_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (\mathbf{b3} \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x26	Read/Write	[4:0]	***00010	CSC_B4_MSB	MSB of R0x27.
0x27	Read/Write	[7:0]	00011110	CSC_B4_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + \mathbf{b4}$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x28	Read/Write	[4:0]	***00000	CDC_C1_MSB	MSB of R0x29.
0x29	Read/Write	[7:0]	00000000	CSC_C1_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (\mathbf{c1} \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x2A	Read/Write	[4:0]	***00100	CSC_C2_MSB	MSB of R0x2B.
0x2B	Read/Write	[7:0]	10101000	CSC_C2_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (\mathbf{c2} \times G_{IN}) + (c3 \times B_{IN}) + c4$
0x2C	Read/Write	[4:0]	***01000	CSC_C3_MSB	MSB of R0x2D.
0x2D	Read/Write	[7:0]	00010010	CSC_C3_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (\mathbf{c3} \times B_{IN}) + c4$
0x2E	Read/Write	[4:0]	***11011	CSC_C4_MSB	MSB of R0x2F.
0x2F	Read/Write	[7:0]	10101100	CSC_C4_LSB	CSC coefficient for equation: $R_{OUT} = (a1 \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$ $G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$ $B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + \mathbf{c4}$
0x30	Read/Write	[7:0]	00000000	VFE_hs_pla_MSB	Most significant 8 bits for HSYNC placement for ITU 656 HSYNC regeneration.
0x31	Read/Write	[7:6]	00******	VFE_hs_pla_LSB	HSYNC placement lower 2 bits (see R0x30).
		[5:0]	**000000	VFE_hs_dur_MSB	Most significant 6 bits for HSYNC duration.
0x32	Read/Write	[7:4]	0000****	VFE_hs_dur_LSB	HSYNC duration lower 4 bits (see R0x31).
		[3:0]	****0000	VFE_vs_pla_MSB	Most significant 4 bits for VSYNC placement for ITU 656 VSYNC regeneration.
0x33	Read/Write	[7:2]	000000**	VFE_vs_pla_LSB	VSYNC placement lower 6 bits (see R0x32).
		[1:0]	******00	VFE_vs_dur_MSB	Most significant 2 bits for VSYNC duration.
0x34	Read/Write	[7:0]	00000000	VFE_vs_dur_LSB	VSYNC duration lower 8 bits (see R0x33).
0x35	Read/Write	[7:0]	00000000	VFE_hsDelayIn_MSB	Most significant 8 bits for HSYNC delay in for ITU 656 HSYNC regeneration.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x36	Read/Write	[7:6]	00******	VFE_hsDelayIn_LSB	HSYNC delay in lower 2 bits (see R0x35).
		[5:0]	**000000	VFE_vsDelayIn	VSYNC delay in for DE generation.
0x37	Read/Write	[7:5]	000*****	Interlace Offset	Sets the difference (in HSYNCs) in field length between Field 0 and Field 1.
		[4:0]	***00000	VFE_width_MSB	Most significant 5 bits for frame width.
0x38	Read/Write	[7:1]	0000000*	VFE_width	Lower 7 bits for frame width (see R0x37).
0x39	Read/Write	[7:0]	00000000	VFE_height_MSB	Most significant 8 bits for frame height.
0x3A	Read/Write	[7:4]	0000****	VFE_height	Lower 4 bits for frame height (see R0x39).
0x3B	Read/Write	[7]	1*******	ext_audioSF_sel	Audio sampling frequency select. valid when using SPDIF input 0 = Fs extracted from SPDIF 1 = Fs set via R0x15[7:4] Default = 1 (only used during pixel repetition mode).
		[6:5]	*00*****	pr_mode	Pixel repetition mode selection. Set to b00 unless non-standard video is supported. 00 = auto mode. 01 = max mode. 1x = manual mode (see R0x3B Bits [4:3]). Default = 00.
		[4:3]	***00***	ext_PLL_pr	External value for PLL pixel repetition. 00 = ×1. 01 = ×2. 10 = ×4. 11 = ×4. Default = 00.
		[2:1]	*****00*	ext_target_pr	User programmed pixel repetition number to send to RX. Default = 00.
		[0]	*******0	csc_en	CSC enable. 0 = no CSC. 1 = enable CSC. Default = 0.
0x3C	Read/Write	[5:0]	**000000	ext_VID_to_Rx	User programmed VID to send to Rx. See Table 24 for full VID formats. Default = 0x00.
0x3D	Read	[7:6]	00******	pr_to_Rx	The actual pixel repetition sent to Rx.
		[5:0]	**000000	VID_to_Rx	The actual VID sent to HDMI Rx (see Table 24).
0x3E	Read	[7:2]	000000**	VFE_fmt_VID	VID detected by video FE (see Table 24).
0x3F	Read	[7:5]	000*****	VFE_aux_vid	This register is for video input formats that are not inside the 861B table. 000 = 480i not active. 001 = 240p not active. 010 = 576i not active. 011 = 288p not active. 100 = 480i active. 101 = 240p active. 110 = 576i active. 111 = 288p active. Default = 000.
		[4:3]	***00***	VFE_prog_mode	Information about 240p and 288p. 240p – 01 = 262 lines. 240p – 10 = 263 lines. 288p – 01 = 312 lines. 288p – 10 = 313 lines. 288p – 11 = 314 lines. Default = 00.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x40	Read/Write	[7]	0*******	GC_pkt_en	1 = enable General Control packet. Default = 0.
		[6]	*0******	SPD_pkt_en	1 = enable Source Product Descriptor packet. Default = 0.
		[5]	**0*****	MPEG_pkt_en	1 = enable MPEG packet. Default = 0.
		[4]	***0****	ACP_pkt_en	1 = enable ACP packet. Default = 0.
		[3]	****0***	ISRC_pkt_en	1 = enable ISRC packet. Default = 0.
0x41	Read/Write	[6]	*1******	system_PD	0 = all circuits powered up. 1 = power down the whole chip, except I²C, HPD interrupt and MSEN interrupt. Default = 1.
		[5]	**0*****	Test bit	Must be set to 0.
		[4]	***1****	INTR_pol	Interrupt polarity. 0 = low active interrupt. 1 = high active interrupt. Default = 1.
		[3]	****0***	initiate_scan	1 = initiate scan. Default = 1.
0x42	Read	[7]	1*******	PD_pol	Polarity for power-down pin. 0 = low active. 1 = high active.
		[6]	*0******	HPD_state	State of the hot plug detection. 0 = hot plug detect inactive. 1 = hot plug active.
		[5]	**0*****	MSEN_state	State of the monitor connection. 0 = HDMI clock termination not detected. 1 = HDMI clock termination detected.
0x43	Read/Write	[7:0]	01111110	EDID_ID	The I²C address for EDID memory. Default = R0x7E.
0x44	Read/Write	[7]	0*******	spdif_en	1 = enable S/PDIF receiver. Default = 0.
		[6]	*1******	N_CTS_pkt_en	1 = enable N_CTS packet. Default = 1.
		[5]	**1*****	audio_sample_pkt_en	1 = enable audio sample packet. Default = 1.
		[4]	***1****	aviIF_pkt_en	1 = enable avi info frame. Default = 1.
		[3]	****1***	audioIF_pkt_en	1 = enable audio info frame. Default = 1.
0x45	Read/Write	[7]	0*******	clear_avmute	1 = clear av mute. Default = 0.
		[6]	*0******	set_avmute	1 = set av mute. Default = 0.
		[5:4]	**00****	Y1Y0	Output format, should be written when R0x16[7:6] is written. 00 = RGB. 01 = YCbCr 4:2:2. 10 = YCbCr 4:4:4. 11 = reserved. Default = 00.
		[3]	****0***	Active Format Information Status	Active format information present. 0 = no data. 1 = active format information valid. Default = 0.
		[2:1]	*****00*	Bar Information	B[1:0]. 00 = no bar information. 01 = horizontal bar information valid. 10 = vertical bar information valid. 11 = horizontal and Vertical bar information valid. Default = 00.
0x46	Read/Write	[7:6]	00******	Scan Information	S[1:0]. 00 = no information. 01 = overscanned (television). 10 = underscanned (computer). 11 = undefined. Default = 00.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
		[5:4]	**00****	Colorimetry	C[1:0]. 00 = no data. 01 = SMPTE 170M, ITU601. 10 = ITU709. 11 = undefined. Default = 00.
		[3:2]	****00**	Picture Aspect Ratio	M[1:0]. 00 = no data. 01 = 4:3. 10 = 16:9. 11 = undefined. Default = 00.
		[1:0]	******00	Nonuniform Picture Scaling	SC[1:0]. 00 = No known nonuniform scaling. 01 = picture has been scaled horizontally. 10 = picture has been scaled vertically. 11 = picture has been scaled horizontally and vertically. Default = 00.
0x47	Read/Write	[7:4]	0000****	Active Format Aspect Ratio	R[3:0]. 1000 = same as picture aspect ratio. 1001 = 4:3 (center). 1010 = 16:9 (center). 1011 = 14:9 (center). Default = 0x0.
0x48	Read/Write	[7:0]	00000000	Active Line Start LSB	This represents the line number at the end of the top horizontal bar. If 0, there is no horizontal bar.
0x49	Read/Write	[7:0]	00000000	Active Line Start MSB	
0x4A	Read/Write	[7:0]	00000000	Active Line End LSB	This represents the line number at the beginning of a lower horizontal bar. If greater than the number of active video lines, there is no lower horizontal bar..
0x4B	Read/Write	[7:0]	00000000	Active Line End MSB	
0x4C	Read/Write	[7:0]	00000000	Active Pixel Start LSB	This represents the last pixel in a vertical pillar bar at the left side of the picture. If 0, there is no left bar.
0x4D	Read/Write	[7:0]	00000000	Active Pixel Start MSB	
0x4E	Read/Write	[7:0]	00000000	Active Pixel End LSB	This represents the first horizontal pixel in a vertical pillar bar at the right side of the picture. If greater than the maximum number of horizontal pixels, there is no vertical bar.
0x4F	Read/Write	[7:0]	00000000	Active Pixel End MSB	
0x50	Read/Write	[7:5]	000*****	audio_IF_CC	Channel count. 000 = refer to stream header. 001 = 2 channels. 010 = 3 channels. … 111 = 8 channels. Default = 000.
		[4]	***0****	audio_IF_DM_INH	Down-mix inhibit. 0 = permitted or no information about this. 1 = prohibited. Default = 0.
		[3:0]	****0000	Level Shift	LSV[3:0]. Level Shift Values with attenuation information. 0000 = 0 dB attenuation. 0001 = 1 dB attenuation. … 1111 = 15 dB attenuation. Default = 0x0.
0x51	Read/Write	[7:0]	00000000	Speaker Mapping	CA[7:0]. Speaker mapping or placement for up to 8 channels (see Table 24). Default = 0x00.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x52	Read/Write	[7:0]	00000000	Source Product Description Infoframe Byte 1. (SPD_B1)	Vendor name character 1 (VN1).
0x53	Read/Write	[7:0]	00000000	SPD_B2	VN2.
0x54	Read/Write	[7:0]	00000000	SPD_B3	VN3.
0x55	Read/Write	[7:0]	00000000	SPD_B4	VN4.
0x56	Read/Write	[7:0]	00000000	SPD_B5	VN5.
0x57	Read/Write	[7:0]	00000000	SPD_B6	VN6.
0x58	Read/Write	[7:0]	00000000	SPD_B7	VN7.
0x59	Read/Write	[7:0]	00000000	SPD_B8	VN8.
0x5A	Read/Write	[7:0]	00000000	SPD_B9	Product description character 1 (PD1).
0x5B	Read/Write	[7:0]	00000000	SPD_B10	PD2.
0x5C	Read/Write	[7:0]	00000000	SPD_B11	PD3.
0x5D	Read/Write	[7:0]	00000000	SPD_B12	PD4.
0x5E	Read/Write	[7:0]	00000000	SPD_B13	PD5.
0x5F	Read/Write	[7:0]	00000000	SPD_B14	PD6.
0x60	Read/Write	[7:0]	00000000	SPD_B15	PD7.
0x61	Read/Write	[7:0]	00000000	SPD_B16	PD8.
0x62	Read/Write	[7:0]	00000000	SPD_B17	PD9.
0x63	Read/Write	[7:0]	00000000	SPD_B18	PD10.
0x64	Read/Write	[7:0]	00000000	SPD_B19	PD11.
0x65	Read/Write	[7:0]	00000000	SPD_B20	PD12.
0x66	Read/Write	[7:0]	00000000	SPD_B21	PD13.
0x67	Read/Write	[7:0]	00000000	SPD_B22	PD14.
0x68	Read/Write	[7:0]	00000000	SPD_B23	PD15.
0x69	Read/Write	[7:0]	00000000	SPD_B24	PD16.
0x6A	Read/Write	[7:0]	00000000	SPD_B25	Source device information code. Code defines source, such as DVD or STB. Default = 0x00.
0x6B	Read/Write	[7:0]	00000000	MPEG_B0	MB[0]. Lower byte of MPEG bit rate: Hz. This is the lower 8 bits of 32 bits (4 bytes) that specify the MPEG bit rate in Hz.
0x6C	Read/Write	[7:0]	00000000	MPEG_B1	MB[1].
0x6D	Read/Write	[7:0]	00000000	MPEG_B2	MB[2].
0x6E	Read/Write	[7:0]	00000000	MPEG_B3	MB[3] (upper byte).
0x6F	Read/Write	[7]	0*******	MPEG_FR	FR indicates new picture or repeat. 0 = new field or picture. 1 = repeated field. Default = 0.
0x70	Read/Write	[6:5]	*00*****	MPEG_MF	MPEG frame indicator. MF[1:0] identifies whether frame is an I, B, or P picture. 00 = unknown. 01 = I picture. 10 = B picture. 11 = P picture. Default = 00.
0x71	Read/Write	[7:0]	00000000	Audio Content Protection Packet (ACP) Type	ACP type. 0 = generic audio. 1 = IEC 60958-identified audio. 2 = DVD audio. 3 = reserved for SACD. Default = 0x00.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x72	Read/Write	[7:0]	00000000	ACP_byte1	Audio content protection. [7:6] audio_copy_permission. [5:3] audio_copy_number. [2:1] quality. [0] transaction.
0x73	Read/Write	[7]	0*******	ISRC1 Continued	International standard recording code continued (ISRC1). Indicates an ISRC2 packet is being transmitted. 1 = the 2nd ISRC packet is needed. Default = 0.
		[6]	*0******	ISRC1_valid	0 = ISRC1 status bits and PBs not valid. 1 = ISRC1 status bits and PBs valid. Default = 0.
		[5:3]	**000***	ISRC1 Status	These bits indicate beginning, middle, and end of a track. 001 = start. 010 = middle. 100 = end. Default = 000.
0x74	Read/Write	[7:0]	00000000	ISRC1_PB0	ISRC1 Packet Byte 0.
0x75	Read/Write	[7:0]	00000000	ISRC1_PB1	ISRC1 Packet Byte 1.
0x76	Read/Write	[7:0]	00000000	ISRC1_PB2	ISRC1 Packet Byte 2.
0x77	Read/Write	[7:0]	00000000	ISRC1_ PB3	ISRC1 Packet Byte 3.
0x78	Read/Write	[7:0]	00000000	ISRC1_ PB4	ISRC1 Packet Byte 4.
0x79	Read/Write	[7:0]	00000000	ISRC1_ PB5	ISRC1 Packet Byte 5.
0x7A	Read/Write	[7:0]	00000000	ISRC1_ PB6	ISRC1 Packet Byte 6.
0x7B	Read/Write	[7:0]	00000000	ISRC1_ PB7	ISRC1 Packet Byte 7.
0x7C	Read/Write	[7:0]	00000000	ISRC1_ PB8	ISRC1 Packet Byte 8.
0x7D	Read/Write	[7:0]	00000000	ISRC1_ PB9	ISRC1 Packet Byte 9.
0x7E	Read/Write	[7:0]	00000000	ISRC1_ PB10	ISRC1 Packet Byte 10.
0x7F	Read/Write	[7:0]	00000000	ISRC1_ PB11	ISRC1 Packet Byte 11.
0x80	Read/Write	[7:0]	00000000	ISRC1_ PB12	ISRC1 Packet Byte 12.
0x81	Read/Write	[7:0]	00000000	ISRC1_ PB13	ISRC1 Packet Byte 13.
0x82	Read/Write	[7:0]	00000000	ISRC1_ PB14	ISRC1 Packet Byte 14.
0x83	Read/Write	[7:0]	00000000	ISRC1_ PB15	ISRC1 Packet Byte 15.
0x84	Read/Write	[7:0]	00000000	ISRC2_ PB0	ISRC2 Packet Byte 0.
0x85	Read/Write	[7:0]	00000000	ISRC2_ PB1	ISRC2 Packet Byte 1.
0x86	Read/Write	[7:0]	00000000	ISRC2_ PB2	ISRC2 Packet Byte 2.
0x87	Read/Write	[7:0]	00000000	ISRC2_ PB3	ISRC2 Packet Byte 3.
0x88	Read/Write	[7:0]	00000000	ISRC2_ PB4	ISRC2 Packet Byte 4.
0x89	Read/Write	[7:0]	00000000	ISRC2_ PB5	ISRC2 Packet Byte 5.
0x8A	Read/Write	[7:0]	00000000	ISRC2_ PB6	ISRC2 Packet Byte 6.
0x8B	Read/Write	[7:0]	00000000	ISRC2_ PB7	ISRC2 Packet Byte 7.
0x8C	Read/Write	[7:0]	00000000	ISRC2_ PB8	ISRC2 Packet Byte 8.
0x8D	Read/Write	[7:0]	00000000	ISRC2_ PB9	ISRC2 Packet Byte 9.
0x8E	Read/Write	[7:0]	00000000	ISRC2_ PB10	ISRC2 Packet Byte 10.
0x8F	Read/Write	[7:0]	00000000	ISRC2_ PB11	ISRC2 Packet Byte 11.
0x90	Read/Write	[7:0]	00000000	ISRC2_ PB12	ISRC2 Packet Byte 12.
0x91	Read/Write	[7:0]	00000000	ISRC2_ PB13	ISRC2 Packet Byte 13.
0x92	Read/Write	[7:0]	00000000	ISRC2_ PB14	ISRC2 Packet Byte 14.
0x93	Read/Write	[7:0]	00000000	ISRC2_ PB15	ISRC2 Packet Byte 15.
0x94	Read/Write	[7:0]	11000000	mask1	Mask for Interrupt Group1 (R0x96).

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0x95	Read/Write	[7:6]	00******	mask2	Mask for Interrupt Group 2 (R0x97[7:6]. [7] for HDCP error. [6] for BKSV flag.
0x96	Read/Write	[7]	0*******	HPD_INT	Interrupt for hot plug detect (HPD).
		[6]	*0******	MSEN_INT	Interrupt for monitor connection (MSEN).
		[5]	**0*****	VS_INT	Interrupt for active VS edge.
		[4]	***0****	AUD_FIFO_FULL_INT	Interrupt for audio FIFO overflow.
		[3]	****0***	ITU656_ERR_INT	Interrupt for ITU656 error.
		[2]	*****0**	EDID_RDY_INT	Interrupt for EDID Ready.
0x97	Read/Write	[7]	0*******	HDCP_ERR_INT	Interrupt bit from HDCP master.
		[6]	*0******	BKSV_flag	Set to 1 to instruct the MPU to read the BKSV or the EDID MEM for revocation list checking.
		[2]	*****0**	Test bit	Must be written to 1 for proper operation.
0x98	Read/Write	[7]	0******	Test bit	Must be written to 0 for proper operation.
		[3:0]	****0010		Must be written to 0x2 for proper operation.
0x9C	Read/Write	[7:0]		Test bits	Must be written to 0x3A for proper operation.
0x9D	Read/Write	[3:0]	****0***	Test bits	Must be written to 1 for proper operation.
0xA2	Read/Write	[7:0]		Test bits	Must be written to 0x87 for proper operation.
0xA3	Read/Write	[7:0]		Test bits	Must be written to 0x87 for proper operation.
0xAF	Read/Write	[7]	0*******	HDCP_desired	HDCP encryption. 0 = input AV content not to be encrypted. 1 = the input A/V content should be encrypted. Default = 0.
		[4]	***1****	frame_enc	Frame encryption. 0 = the current frame should not be encrypted. 1 = the current frame should be encrypted. Default = 1.
		[1]	******0*	ext_HDMI_MODE	HDMI mode. 0 = DVI. 1 = HDMI. Default = 0.
0xB0	Read	[7:0]	00000000	An_0	Byte 0 of An.
0xB1	Read	[7:0]	00000000	An_1	Byte 1 of An.
0xB2	Read	[7:0]	00000000	An_2	Byte 2 of An.
0xB3	Read	[7:0]	00000000	An_3	Byte 3 of An.
0xB4	Read	[7:0]	00000000	An_4	Byte 4 of An.
0xB5	Read	[7:0]	00000000	An_5	Byte 5 of An.
0xB6	Read	[7:0]	00000000	An_6	Byte 6 of An.
0xB7	Read	[7:0]	00000000	An_7	Byte 7 of An.
		[6]	*0******	ENC_on	1 = the AV content is being encrypted. 0 = not encrypted. Default = 0.
		[5]	**0*****	int_HDMI_MODE	Digital mode. 1 = HDMI mode. 0 = DVI mode.
		[4]	***0****	keys_read_error	1 = HDCP key reading error.
0xBA	Read/Write	[7:5]	000*****	clk_delay	Edge select for input video clock. 011 = positive edge capture. 111 = negative edge capture. Default = 000.
		[4]	***0****		Must be written to 0 for proper operation.

Hex Address	Read/Write or Read Only	Bits	Default Value	Register Name	Description
0xBE	Read	[7]	0*** ****	BCAPS	HDMI reserved.
		[6]	*0** ****	Repeater	HDCP repeater. 0 = HDCP receiver is not repeater capable. 1 = HDCP receiver is repeater capable.
		[5]	**0* ****	KSV ready	KSV FIFO ready. 1 = HDCP receiver has compiled list of attached KSVs.
		[4]	***0 ****	Test bit	Must be written to 0 for proper operation.
		[3:2]	**** 00**	Test bit	Reserved.
		[1]	**** **0*	HDCP support	HDCP 1.1 features support. 0 = HDCP receiver does not support v. 1.1 features. 1 = HDCP receiver supports 1.1 features such as enhanced encryption status signaling (EESS).
		[0]	**** ***0	Fast HDCP	Fast authentication. 0 = HDCP Receiver not capable of fast authentication. 1 = HDCP Receiver capable of receiving unencrypted video during the session re-authentication.
0xBF	Read	[7:0]	00000000	Bksv1	Bksv read from Rx by the HDCP controller 40 bits (5 bytes).
0xC0	Read	[7:0]	00000000	Bksv2	
0xC1	Read	[7:0]	00000000	Bksv3	
0xC2	Read	[7:0]	00000000	Bksv4	
0xC3	Read	[7:0]	00000000	Bksv5	
0xC4	Read/Write	[7:0]	00000000	EDID Segment	Sets the E-DDC segment used by the EDID fetch routine.
0xC5	Read	[7]	0*******	Error Flag	Error flag interrupt.
		[6]	*0******	AN Stop	AN stop interrupt.
		[5]	**0*****	HDCP Enabled	HDCP enabled interrupt.
		[4]	***0****	EDID Ready Flag	EDID ready interrupt.
		[3]	****0***	I^2C Interrupt	I^2C interrupt.
		[2]	*****0**	RI Flag	RI interrupt.
		[1]	******0*	BKSV Update Flag	BKSV update interrupt.
		[0]	*******0	PJ Flag	PJ interrupt.
0xC6	Read	[4]	***0****	HDMI Mode	HDMI interrupt.
		[3]	****0***	HDCP Requested	HDCP requested interrupt.
		[2]	*****0**	Rx Sense	Rx sense interrupt.
		[1]	******0*	EEPROM Read OK	EEPROM read interrupt.
		[0]	*******0	TMDS Output Enabled	TMDS output enabled interrupt.
0xC7	Read/Write	[7]	0*******	BKSV Flag	BKSV flag.
		[6:0]	*0000000	BKSV Count	BKSV count.
0xC8	Read	[7:4]	0000****	HDCP Controller Error	HDCP controller error (see Table 28).
		[3:0]	****0000	HDCP Controller State	HDCP controller state.
0xC9	Read/Write	[3:0]	****0011	EDID Tries	Number of times that the EDID is read if unsuccessful. Default = 0x3.

2-WIRE SERIAL CONTROL REGISTER DETAIL CHIP IDENTIFICATION

0x00—Bits[7:0] Chip Revision

An 8-bit register that represents the silicon revision.

0x01—Bits[3:0] N[19:16]

These are the most significant four bits of a 20-bit word used along with the 20-bit CTS term in the receiver to regenerate the audio clock.

0x02—Bits[7:0] N[15-8]

0x03—Bits[7:0] [(7-0]

0x04—Bits[3:0] CTS_Int[19:16]

These are the most significant four bits of a 20-bit word used along with the 20-bit N term in the receiver to regenerate the audio clock. This is the measured or internal CTS. The internal or external CTS can be selected via R0x0A Bit 7.

0x05—Bits[7:0] CTS_Int[15:8]

0x06—Bits[7:0] CTS_In[7:0]

0x07—Bits[3:0] CT_Ext[19:16])

These are the most significant four bits of a 20-bit word used along with the 20-bit N term in the receiver to regenerate the audio clock. This is the external CTS. The internal or external CTS can be selected via R0x0A Bit 7.

0x08—Bits[7:0] CTS_Ext[15:8]

0x09—Bits[7:0] CTS_Ext[7:0]

0x0A—Bits[7] CTS_Sel

When internal CTS is selected, the CTS is calculated by the AD9889.

0 = internal CTS
1 = external CTS

0x0A—Bits[6:5] Avg_Mode

00 = no filter
01 = divide by 4
10 = divide by 8
11 = divide by 16
Default = 10

0x0A—Bit[4] Audio_Sel

0 = I^2S
1 = S/PDIF
Default = 0

0x0A—Bit[3] MCLK_SP

If MCLK is available for S/PDIF, it is used for bit recovery; otherwise, internal circuitry is used.

1 = MCLK active
0 = MCLK inactive
Default = 0

0x0A—Bit[2] MCLK_I²S

1 = I^2S MCLK active
0 = I^2S MCLK inactive
Default = 0

If MCLK is available for I^2S, it is used for bit recovery; otherwise, internal circuitry is used.

0x0A—Bits[1:0] MCLK_Ratio

00 = ×128 fs
01 = ×256 fs
10 = ×384 fs
11 = ×512 fs
Default = 01

0x0B—Bit[6] MCLK_ Pol

0 = rising edge
1 = falling edge
Default = 0

0x0B—Bit[5] Flat_Line

1 = flat line audio (audio sample not valid)
0 = normal
Default = 0

0x0C—Bits[5:2] I²S enable

0001 = I^2S0
0010 = I^2S1
0100 = I^2S2
1000 = I^2S3
Default = 1111 for all

0x0C—Bits[1:0] I²S Format

00 = standard I^2S mode
01 = right-justified I^2S mode
10 = left-justified I^2S mode
11 = raw IEC60958 mode
Default = 00

0x0D—Bits[4:0] I²S bit width

For right-justified audio only. Default is 11000 (24). Not valid for widths greater than 24.

0x0E—Bits[5:3] SUBPKT0_L_src

Source of audio subpacket 0 (left channel) data. Default is 000.

Table 23. Source of Subpacket Audio

Field Code	Channel (0 to 3) and Left/Right
000	Channel 0 Left
001	Channel 0 Right
010	Channel 1 Left
011	Channel 1 Right
100	Channel 2 Left
101	Channel 2 Right
110	Channel 3 Left
111	Channel 3 Right

0x0E—Bits[2:0] SUBPKT0_R_src

Default is 001 (see Table 27).

0x0F—Bits[5:3] SUBPKT1_L_src

Default is 010 (see Table 27).

0x0F—Bits[2:0] SUBPKT1_R_src

Default is 011 (see Table 27).

0x10—Bits[5:3] SUBPKT2_L_src

Default is 100 (see Table 27).

0x10—Bits[2:0] SUBPKT2_R_src

Default is 101 (see Table 27).

0x11—Bits[5:3] SUBPKT3_L_src

Default is 110 (see Table 27).

0x11—Bits[2:0] SUBPKT3_R_src

Default is 111 (see Table 27).

0x18—Bits[4:0] CSC_A1_MSB

These five bits form the 5 MSBs of the Color Space Conversion coefficient a1. Combined with the 8 LSBs of the following register, they form a 13-bit, twos complement coefficient that is user programmable. The equation takes the form of

$R_{OUT} = (\mathbf{a1} \times R_{IN}) + (a2 \times G_{IN}) + (a3 \times B_{IN}) + a4$
$G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$
$B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$

The default value for the 13-bit, a1 coefficient is 0x0662.

0x19—Bits[7:0] CSC_A1_LSB

See Register 0x18.

0x1A—Bits[4:0] CSC_A2_MSB

These five bits form the 5 MSBs of the Color Space Conversion coefficient a2. This combined with the 8 LSBs of the following register form a 13-bit, twos complement coefficient that is user programmable. The equation takes the form of

$R_{OUT} = (a1 \times R_{IN}) + (\mathbf{a2} \times G_{IN}) + (a3 \times B_{IN}) + a4$
$G_{OUT} = (b1 \times R_{IN}) + (b2 \times G_{IN}) + (b3 \times B_{IN}) + b4$
$B_{OUT} = (c1 \times R_{IN}) + (c2 \times G_{IN}) + (c3 \times B_{IN}) + c4$

The default value for the 13-bit a2 coefficient is 0x04A8.

0x1B—Bits[7:0] CSC_A2_LSB

See Register 0x1A.

0x1C—Bits[4:0] CSC_A3_MSB

The default value for the 13-bit a3 is 0x0000.

0x1D—Bits[7:0] CSC_A3_LSB
0x1E—Bits[4:0] CSC_A4_MSB

The default value for the 13-bit a4 is 0x1C84.

0x1F—Bits[7:0] CSC_A4_LSB
0x20—Bits[4:0] CSC_B1_MSB

The default value for the 13-bit b1 is 0x1CBF.

0x21—Bits[7:0] CSC_B1_LSB
0x22—Bits[4:0] CSC_B2_MSB

The default value for the 13-bit b2 is 0x04A8.

0x23—Bits[7:0] CSC_B2_LSB
0x24—Bits[4:0] CSC_B3_MSB

The default value for the 13-bit b3 is 0x1E70.

0x25—Bits[7:0] CSC_B3_LSB
0x26—Bits[4:0] CSC_B4_MSB

The default value for the 13-bit b4 is 0x021E.

0x27—Bits[7:0] CSC_B4_LSB
0x28—Bits[4:0] CSC_C1_MSB

The default value for the 13-bit c1 is 0x0000.

0x29—Bits[7:0] CSC_C1_LSB
0x2A—Bits[4:0] CSC_C2_MSB

The default value for the 13-bit c2 is 0x04A8.

0x2B—Bits[7:0] CSC_C2_LSB
0x2C—Bits[4:0] CSC_C3_MSB

The default value for the 13-bit c3 is 0x0812.

0x2D—Bits[7:0] CSC_C3_LSB
0x2E—Bits[4:0] CSC_C4_MSB

The default value for the 13-bit c4 is 0x1BAC.

0x2F—Bits[7:0] CSC_C4_LSB

0x3C—Bits[5:0] ext_VID_to_Rx

Table 24.

VID	Format	Vertical Refresh
1	480p	~60 Hz[1]
2	480p	~60 Hz
3	480p	~60 Hz
4	720p	~60 Hz
5	1080i	~60 Hz
6	480i	~60 Hz
7	480i	~60 Hz
8	240p	~60 Hz
9	240p	~60 Hz
10	480i	~60 Hz
11	480i	~60 Hz
12	240p	~60 Hz
13	240p	~60 Hz
14	480p	~60 Hz
15	480p	~60 Hz
16	1080p	~60 Hz
17	576p	~50 Hz[2]
18	576p	~50 Hz
19	720p	~50 Hz
20	1080i	~50 Hz
21	576i	~50 Hz
22	576i	~50 Hz
23	288p	~50 Hz
24	288p	~50 Hz
25	576i	~50 Hz
26	576i	~50 Hz
27	288p	~50 Hz
28	288p	~50 Hz
29	576p	~50 Hz
30	576p	~50 Hz
31	1080p	~50 Hz
32	1080p	24 Hz to 30 Hz
33	1080p	24 Hz to 30 Hz
34	1080p	24 Hz to 30 Hz

[1] V_{REF} can range from 59.826 Hz to 60.115 Hz.
[2] V_{REF} can range from 49.761 Hz to 50.080 Hz.

0x3D—Bits[7:6] pr_to_Rx

0x43—Bits[7:0] EDID Read Address

This is a programmable I²C address from which the EDID information (1 to 256 segment) can be read. Default is 0x7E.

0x48—Bits[7:0] Active Line Start LSB

Combined with the MSB in Register 0x49, these bits indicate the beginning line of active video. All lines before this comprise a top horizontal bar. This is used in letter-box modes. If the 2-byte value is 0x00, there is no horizontal bar.

0x49—Bits[7:0] Active Line Start MSB

See Register 0x48.

0x4A—Bits[7:0] Active Line End LSB

Combined with the MSB in Register 0x4B, the bits indicate the last line of active video. All lines past this comprise a lower horizontal bar. This is used in letter-box modes. If the 2-byte value is greater than the number of lines in the display, there is no lower horizontal bar.

0x4B—Bits[7:0] Active Line End MSB

See Register 0x4A.

0x4C—Bits[7:0] Active Pixel Start LSB

Combined with the MSB in Register 0x4D, these bits indicate the first pixel in the display that is active video. All pixels before this comprise a left vertical bar. If the 2-byte value is 0x00, there is no left bar.

0x4D—Bits[7:0] Active Pixel Start MSB

See Register 0x4C.

0x4E—Bits[7:0] Active Pixel End LSB

Combined with the MSB in Register 0x4F, these bits indicate the last active video pixel in the display. All pixels past this comprise a right vertical bar. If the 2-byte value is greater than the number of pixels in the display, there is no vertical bar.

0x4F—Bits[7:0] Active Pixel End MSB

See Register 0x4E.

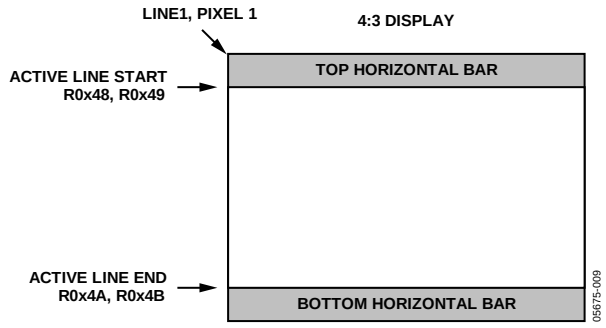


Figure 9. Horizontal Bars

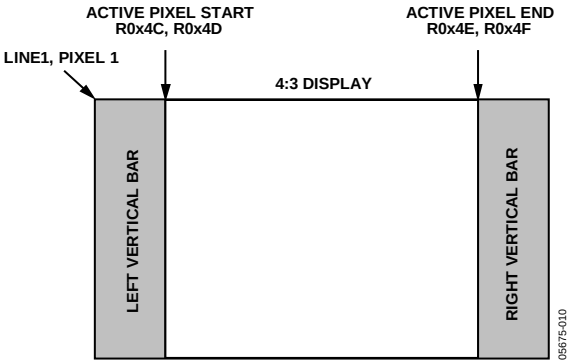


Figure 10. Vertical Bars

0x50—Bits[7:5] audio_IF_cc

000 = refer to stream header
001 = 2 channels
010 = 3 channels
…
111 = 8 channels

0x50—Bits[4] audi_IF_DM_INH

0x50—Bits[3:0] Level Shift

LSV[3:0] – Level Shift Values with attenuation information.
0000 = 0 dB attenuation
0001 = 1 dB attenuation
…
1111 = 15 dB attenuation
Default = 0x0

0x51—Bits[7:0] Speaker Mapping

These bits define the suggested placement of speakers.

Table 25.

CA					Channel Number							
Bit 4	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	**Bit 8**	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**
0	0	0	0	0					-	-	FR	FL
0	0	0	0	1					-	LFE	FR	FL
0	0	0	1	0					FC	-	FR	FL
0	0	0	1	1					FC	LFE	FR	FL
0	0	1	0	0				RC	-	-	FR	FL
0	0	1	0	1				RC	-	LFE	FR	FL
0	0	1	1	0				RC	FC	-	FR	FL
0	0	1	1	1				RC	FC	LFE	FR	FL
0	1	0	0	0			RR	RL	-	-	FR	FL
0	1	0	0	1			RR	RL	-	LFE	FR	FL
0	1	0	1	0			RR	RL	FC	-	FR	FL
0	1	0	1	1	-	-	RR	RL	FC	LFE	FR	FL
0	1	1	0	0	-	RC	RR	RL	-	-	FR	FL
0	1	1	0	1	-	RC	RR	RL	-	LFE	FR	FL
0	1	1	1	0	-	RC	RR	RL	FC	-	FR	FL
0	1	1	1	1	-	RC	RR	RL	FC	LFE	FR	FL
1	0	0	0	0	RRC	RLC	RR	RL	-	-	FR	FL
1	0	0	0	1	RRC	RLC	RR	RL	-	LFE	FR	FL
1	0	0	1	0	RRC	RLC	RR	RL	FC	-	FR	FL
1	0	0	1	1	RRC	RLC	RR	RL	FC	LFE	FR	FL
1	0	1	0	0	FRC	FLC	-	-	-	-	FR	FL
1	0	1	0	1	FRC	FLC	-	-	-	LFE	FR	FL
1	0	1	1	0	FRC	FLC	-	-	FC	-	FR	FL
1	0	1	1	1	FRC	FLC	-	-	FC	LFE	FR	FL
1	1	0	0	0	FRC	FLC	-	RC	-	-	FR	FL
1	1	0	0	1	FRC	FLC	-	RC	-	LFE	FR	FL
1	1	0	1	0	FRC	FLC	-	RC	FC	-	FR	FL
1	1	0	1	1	FRC	FLC	-	RC	FC	LFE	FR	FL
1	1	1	0	0	FRC	FLC	RR	RL	-	-	FR	FL
1	1	1	0	1	FRC	FLC	RR	RL	-	LFE	FR	FL
1	1	1	1	0	FRC	FLC	RR	RL	FC	-	FR	FL
1	1	1	1	1	FRC	FLC	RR	RL	FC	LFE	FR	FL

SOURCE PRODUCT DESCRIPTION (SPD) INFOFRAME

0x52—Bits[7:0] SPD_B1

This is the first character in eight (VN1-VN8) that is the name of the company that appears on the product. The data characters are 7-bit ASCII code.

0x53—Bits[7:0] SPD_B 2 (VN2)
0x54—Bits[7:0] SPD_B 3(VN3)
0x55—Bits[7:0] SPD_B 4(VN4)
0x56—Bits[7:0] SPD_B 5(VN5)
0x57—Bits[7:0] SPD_B 6(VN6)
0x58—Bits[7:0] SPD_B 7(VN7)
0x59—Bits[7:0] SPD_B 8(VN8)
0x5A—Bits[7:0] SBD_B9

Product Description Character 1 (PD1)

This is the first character of 16 that contains the model number and a short description of the product. The data characters are 7-bit ASCII code.

0x5B—Bits[7:0] SBD_B10(PD2)
0x5C—Bits[7:0] SBD_B11(PD3)
0x5D—Bits[7:0] SBD_B12(PD4)
0x5E—Bits[7:0] SBD_B13(PD5)
0x5F—Bits[7:0] SBD_B14(PD6)
0x60—Bits[7:0] SBD_B15(PD7)
0x61—Bits[7:0] SBD_B16(PD8)
0x62—Bits[7:0] SBD_B17(PD9)
0x63—Bits[7:0] SBD_B18(PD10)
0x64—Bits[7:0] SBD_B19(PD11)
0x65—Bits[7:0] SBD_B20(PD12)
0x66—Bits[7:0] SBD_B21(PD13)
0x67—Bits[7:0] SBD_B22(PD14)
0x68—Bits[7:0] SBD_B23(PD15)
0x69—Bits[7:0] SBD_B24(PD16)

0x6A—Bits[7:0] Source Device Information Code

These bytes classify the source device.

Table 26.

SDI Code	Source
0x00	Unknown
0x01	Digital STB
0x02	DVD
0x03	D-VHS
0x04	HDD Video
0x05	DVC
0x06	DSC
0x07	Video CD
0x08	Game
0x09	PC general
0x0A to 0xFF	Reserved

0x6B—Bits[7:0] MPEG_B0

This is the lower 8 bits of 32 bits that specify the MPEG bit rate in Hz.

0x6C—Bits[7:0] MPEG_B1
0x6D—Bits[7:0] MPEG_B2
0x6E—Bits[7:0] MPEG_B3
0x73—Bits[7] ISRC1 Continued

This bit indicates that a continuation of the 16 ISRC1 packet bytes (an ISRC2 packet) is being transmitted.

0x73—Bit[6] ISRC1 Valid

This bit indicates whether ISRC1 packet bytes are valid.

Table 27.

ISRC1	Valid
0	ISRC1 Status bits and PBs not valid
1	ISRC1 Status bits and PBs valid

0x73—Bits[5:3] ISRC1 Status

These bits define where the samples are in the ISRC track: at least two transmissions of 001 occur at the beginning of the track; continuous transmission of 010 occurs in the middle of the track, followed by at least two transmissions of 100 near the end of the track.

0x74—Bits[7:0] ISRC1_PB0
0x75—Bits[7:0] ISRC1_PB1
0x76—Bits[7:0] ISRC1_PB2
0x77—Bits[7:0] ISRC1_PB3
0x78—Bits[7:0] ISRC1_PB4
0x79—Bits[7:0] ISRC1_PB5
0x7A—Bits[7:0] ISRC1_PB6
0x7B—Bits[7:0] ISRC1_PB7
0x7C—Bits[7:0] ISRC1_PB8
0x7D—Bits[7:0] ISRC1_PB9
0x7E—Bits[7:0] ISRC1_PB10
0x7F—Bits[7:0] ISRC1_PB11
0x80—Bits[7:0] ISRC1_PB12
0x81—Bits[7:0] ISRC1_PB13
0x82—Bits[7:0] ISRC1_PB14
0x83—Bits[7:0] ISRC1_PB15

0x84—Bits[7:0] ISRC2_PB0

This is transmitted only when the ISRC continue bit (Register 0x73 Bit 7) is set to 1.

0x85—Bits[7:0] ISRC2_PB1
0x86—Bits[7:0] ISRC2_PB2
0x87—Bits[7:0] ISRC2_PB3
0x88—Bits[7:0] ISRC2_PB4
0x89—Bits[7:0] ISRC2_PB5
0x8A—Bits[7:0] ISRC2_PB6
0x8B—Bits[7:0] ISRC2_PB7
0x8C—Bits[7:0] ISRC2_PB8
0x8D—Bits[7:0] ISRC2_PB9
0x8E—Bits[7:0] ISRC2_PB10
0x8F—Bits[7:0] ISRC2_PB11
0x90—Bits[7:0] ISRC2_PB12
0x91—Bits[7:0] ISRC2_PB13
0x92—Bits[7:0] ISRC2_PB14
0x93—Bits[7:0] ISRC2_PB15
0x94—Bits[7:0] mask1
0x95—Bits[7:6] mask2
0x96—Bit[7] HPD_INT
0x96—Bit[6] MSEN_INT
0x96—Bit[5] VS_INT
0x96—Bit[4]AUD_FIFO_FULL_INT
0x96—Bit[3] ITU656_ERR_INT
0x96—Bit[2] EDID_RDY_INT
0x97—Bit[7] HDCP_ERR_INT
0x97—Bit[6] BKSV_flag
0x97—Bit[2]
0x98—Bit[7]
0x98—Bits[3:0]
0x9C—Bits[7:0]
0x9D—Bits[3:0]
0xA2—Bits[7:0]
0xA3—Bits[7:0]
0xAF—Bit[7] HDCP_desired
0xAF—Bit[4] frame_enc
0xAF—Bit[1] ext_HDMI_MODE
0xB0—Bits[7:0] An_0
0xB1—Bits[7:0] An_1
0xB2—Bits[7:0] An_2
0xB3—Bits[7:0] An_3
0xB4—Bits[7:0] An_4
0xB5—Bits[7:0] An_5
0xB6—Bits[7:0] An_6
0xB7—Bits[7:0] An_7
0xB7—Bit[6] ENC_on
0xB7—Bit[5] int_HDMI_MODE
0xB7—Bit[4] keys_read_error
0xBA—Bits[7:5] clk_delay
0xBA—Bit[4] clk_delay
0xBE—Bit[7] BCAPS
0xBE—Bit[6]
0xBE—Bit[5]
0xBE—Bit[4]
0xBE—Bits[3:2]
0xBE—Bit[1]
0xBE—Bit[0]
0xBF—Bits[7:0] Bksv1
0xC0—Bits[7:0] Bksv Byte2
0xC1—Bits[7:0] Bksv3
0xC2—Bits[7:0] Bksv4
0xC3—Bits[7:0] Bksv5
0xC4—Bits[7:0] EDID Segment

These bits support up to 256 EDID segments that can be addressed. The requested segment address is written here before initiation of the read.

0xC5—Bit[7] ErrorFlag Interrupt
0xC5—Bit[6] AN Stop Interrupt
0xC5—Bit[5] HDCP Enabled Interrupt
0xC5—Bit[4] EDID Ready Interrupt
0xC5—Bit[3] I^2C Interrupt
0xC5—Bit[2] RI Interrupt
0xC5—Bit[1] BKSV Update Interrupt
0xC5—Bit[0] PJ Interrupt
0xC6—Bit[4] HDMI Mode Interrupt
0xC6—Bit[3] HDCP Requested Interrupt
0xC6—Bit[2] Rx Sense Interrupt
0xC6—Bit[1] EEPROM Read Interrupt
0xC7—Bit[7] BKSV Flag
0xC7—Bits[6:0] BKSV Count

0xC8—Bits[7:4] HDCP Controller Error

When an error occurs in the HDCP flow, it is reported here after setting the error flag (0xC5[7]).

Table 28.

Error Code	Error Condition
0000	No error
0001	Bad receiver BKSV
0010	Ri mismatch
0011	Pj mismatch
0100	I^2C error (usually a no acknowledge)
0101	Timed out waiting for downstream repeater
0110	Maximum cascade of repeaters exceeded
0111	SHA-1 hash check of BKSV list failed
1000	Too many devices connected to repeater tree

0xC8—Bits[3:0] HDCP Controller State

This information is used in troubleshooting the HDCP controller.

0xC9—Bits[3:0] EDID Read Tries

These bits define the number of times the EDID attempts to be read if unsuccessful.

2-WIRE SERIAL CONTROL PORT

A 2-wire serial interface is provided. Up to two AD9889 devices can be connected to the 2-wire serial interface, with each device having a unique address.

The 2-wire serial interface comprises a clock (SCL) and a bidirectional data (SDA) pin. The analog flat panel interface acts as a slave for receiving and transmitting data over the serial interface. When the serial interface is not active, the logic levels on SCL and SDA are pulled high by external pull-up resistors.

Data received or transmitted on the SDA line must be stable for the duration of the positive going SCL pulse. Data on SDA must change only when SCL is low. If SDA changes state while SCL is high, the serial interface interprets that action as a start or stop sequence.

There are five components to serial bus operation:

- Start signal
- Slave address byte
- Base register address byte
- Data byte to read or write
- Stop signal

When the serial interface is inactive (SCL and SDA are high) communications are initiated by sending a start signal. The start signal is a high-to-low transition on SDA while SCL is high. This signal alerts all slave devices that a data transfer sequence is coming.

The first 8 bits of data transferred after a start signal comprise a 7-bit slave address (the first 7 bits) and a single R/$\overline{W}$ bit (the eighth bit). The R/$\overline{W}$ bit indicates the direction of data transfer, read from (1) or write to (0) the slave device. If the transmitted slave address matches the address of the device, the AD9889 acknowledges by bringing SDA low on the ninth SCL pulse. If the addresses do not match, the AD9889 does not acknowledge.

Table 29. Serial Port Addresses

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
A_6 (MSB)	A_5	A_4	A_3	A_2	A_1	A_0
0	1	1	1	0	0	0
0	1	1	1	0	0	1

DATA TRANSFER VIA SERIAL INTERFACE

For each byte of data read or written, the MSB is the first bit of the sequence.

If the AD9889 does not acknowledge the master device during a write sequence, the SDA remains high so the master can generate a stop signal. If the master device does not acknowledge the AD9889 during a read sequence, the AD9889 interprets this as the end of data. The SDA remains high so the master can generate a stop signal.

Writing data to specific control registers of the AD9889 requires that the 8-bit address of the control register of interest be written to after the slave address has been established. This control register address is the base address for subsequent write operations. The base address auto-increments by one for each byte of data written after the data byte intended for the base address.

Data is read from the control registers of the AD9889 in a similar manner. Reading requires two data transfer operations:

- The base address must be written with the R/$\overline{W}$ bit of the slave address byte low to set up a sequential read operation.
- Reading (the R/$\overline{W}$ bit of the slave address byte high) begins at the previously established base address. The address of the read register auto-increments after each byte is transferred.

To terminate a read/write sequence to the AD9889, a stop signal must be sent. A stop signal comprises a low-to-high transition of SDA while SCL is high.

A repeated start signal occurs when the master device driving the serial interface generates a start signal without first generating a stop signal to terminate the current communication. This is used to change the mode of communication (read, write) between the slave and master without releasing the serial interface lines.

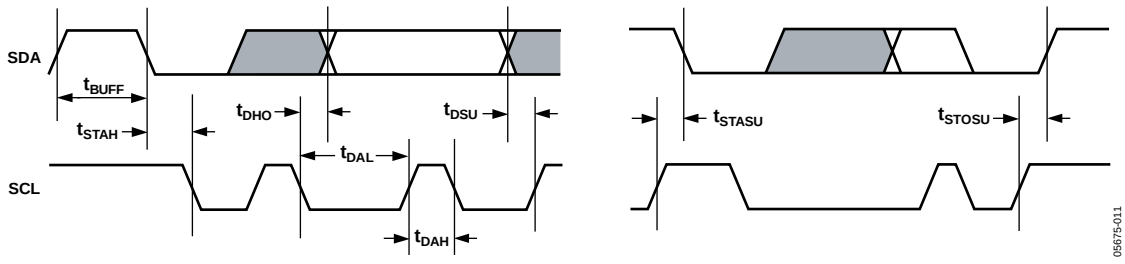


Figure 11. Serial Port Read/Write Timing

SERIAL INTERFACE READ/WRITE EXAMPLES

Write to one control register:

- Start signal
- Slave address byte (R/$\overline{W}$ bit = low)
- Base address byte
- Data byte to base address
- Stop signal

- Write to four consecutive control registers
- Start signal
- Slave address byte (R/$\overline{W}$ bit = low)
- Base address byte
- Data byte to base address
- Data byte to (base address + 1)
- Data byte to (base address + 2)
- Data byte to (base address + 3)
- Stop signal

Read from one control register:

- Start signal
- Slave address byte (R/$\overline{W}$ bit = low)
- Base address byte
- Start signal
- Slave address byte (R/$\overline{W}$ bit = high)
- Data byte from base address
- Stop signal

Read from four consecutive control registers:

- Start signal
- Slave address byte (R/$\overline{W}$ bit = low)
- Base address byte
- Start signal
- Slave address byte (R/$\overline{W}$ bit = high)
- Data byte from base address
- Data byte from (base address + 1)
- Data byte from (base address + 2)
- Data byte from (base address + 3)
- Stop signal

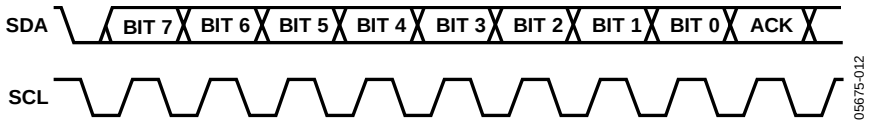


Figure 12. Serial Interface—Typical Byte Transfer

PCB LAYOUT RECOMMENDATIONS

The AD9889 is a high precision, high speed analog device. As such, to get the maximum performance out of the part, it is important to have a well laid out board. The following is a guide for designing a board using the AD9889.

POWER SUPPLY BYPASSING

It is recommended to bypass each power supply pin with a 0.1 µF capacitor. The exception is when two or more supply pins are adjacent to each other. For these groupings of powers/grounds, it is necessary to have only one bypass capacitor. The fundamental idea is to have a bypass capacitor within about 0.5 cm of each power pin. Also, avoid placing the capacitor on the opposite side of the PC board from the AD9889, as that interposes resistive vias in the path.

The bypass capacitors should be physically located between the power plane and the power pin. Current should flow from the power plane to the capacitor to the power pin. Do not make the power connection between the capacitor and the power pin. Placing a via underneath the capacitor pads, down to the power plane, is generally the best approach.

It is particularly important to maintain low noise and good stability of PV_D (the clock generator supply). Abrupt changes in PV_D can result in similarly abrupt changes in sampling clock phase and frequency. This can be avoided by careful attention to regulation, filtering, and bypassing. It is highly desirable to provide separate regulated supplies for each of the analog circuitry groups (V_D and PV_D).

Some graphic controllers use substantially different levels of power when active (during active picture time) and when idle (during horizontal and vertical sync periods). This can result in a measurable change in the voltage supplied to the analog supply regulator, which can in turn produce changes in the regulated analog supply voltage. This can be mitigated by regulating the analog supply, or at least PV_D, from a different, cleaner power source (for example, from a 12 V supply).

It is also recommended to use a single ground plane for the entire board. Experience has shown repeatedly that noise performance is the same or better with a single ground plane. Using multiple ground planes can be detrimental because each separate ground plane is smaller, and long ground loops can result.

In some cases, using separate ground planes is unavoidable, so it is recommended to place a single ground plane under the AD9889. The location of the split should be at the receiver of the digital outputs. For this case, it is even more important to place components wisely because the current loops are much longer (current takes the path of least resistance). Figure 13 shows an example of a current loop.

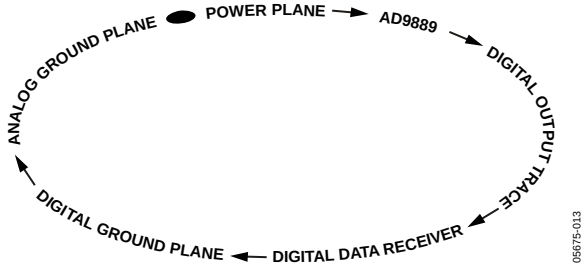


Figure 13. Current Loop

DIGITAL INPUTS

The digital inputs on the AD9889 were designed to work with 1.8 V signals but are tolerant of 3.3 V signals. Therefore, no extra components need to be added if using 3.3 V logic.

Any noise that gets onto the HSYNC input trace adds jitter to the system. Therefore, minimize the trace length and do not run any digital or other high frequency traces near it.

COLOR SPACE CONVERTER (CSC) COMMON SETTINGS

Table 30. HDTV YCbCr (0 to 255) to RGB (0 to 255) (Default Setting for AD9889)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x0C	0x52	0x08	0x00	0x00	0x00	0x19	0xD7
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x1C	0x54	0x08	0x00	0x3E	0x89	0x02	0x91
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x00	0x00	0x08	0x00	0x0E	0x87	0x18	0xBD

Table 31. HDTV YCbCr (16 to 235) to RGB (0 to 255)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x47	0x2C	0x04	0xA8	0x00	0x00	0x1C	0x1F
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x1D	0xDD	0x04	0xA8	0x1F	0x26	0x01	0x34
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x00	0x00	0x04	0xA8	0x08	0x 75	0x1B	0x7B

Table 32. SDTV YCbCr (0 to 255) to RGB (0 to 255)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x2A	0xF8	0x08	0x00	0x00	0x00	0x1A	0x84
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x1A	0x6A	0x08	0x00	0x1D	0x50	0x04	0x23
Register	**Blue/Cb Coeff. 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x00	0x00	0x08	0x00	0x0D	0xDB	0x19	0x12

Table 33. SDTV YCbCr (16 to 235) to RGB (0 to 255)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x46	0x63	0x04	0xA8	0x00	0x00	0x1C	0x84
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x1C	0xC0	0x04	0xA8	0x1E	0x6F	0x02	0x1E
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x00	0x00	0x04	0xA8	0x08	0x11	0x1B	0xAD

Table 34. RGB (0 to 255) to HDTV YCbCr (0 to 255)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x08	0x2D	0x18	0x93	0x1F	0x3F	0x08	0x00
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x03	0x68	0x0B	0x71	0x01	0x27	0x00	0x00
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x1E	0x21	0x19	0xB2	0x08	0x2D	0x08	0x00

Table 35. RGB (0 to 255) to HDTV YCbCr (16 to 235)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x07	0x06	0x19	0xA0	0x1F	0x5B	0x08	0x00
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x02	0xED	0x09	0xD3	0x00	0xFD	0x01	0x00
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x1E	0x64	0x1A	0x96	0x07	0x06	0x08	0x00

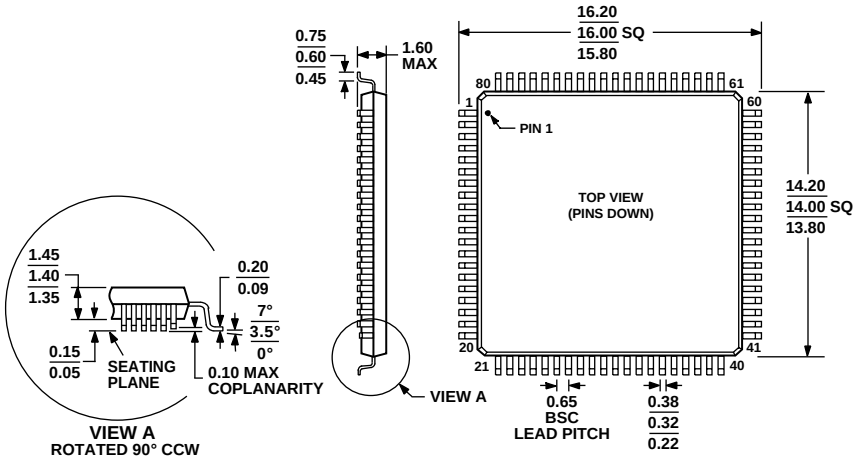
Table 36. RGB (0 to 255) to SDTV YCbCr (0 to 255)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x08	0x2D	0x19	0x27	0x1E	0xAC	0x08	0x00
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x04	0xC9	0x09	0x64	0x01	0xD3	0x00	0x00
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x1D	0x3F	0x1A	0x93	0x08	0x2D	0x08	0x00

Table 37. RGB (0 to 255) to SDTV YCbCr (16 to 235)

Register	Red/Cr Coeff 1		Red/Cr Coeff 2		Red/Cr Coeff 3		Red/Cr Offset	
Address	0x18	0x19	0x1A	0x1B	0x1C	0x1D	0x1E	0x1F
Value	0x07	0x06	0x1A	0x1E	0x1E	0xDC	0x08	0x00
Register	**Green/Y Coeff 1**		**Green/Y Coeff 2**		**Green/Y Coeff 3**		**Green/Y Offset**	
Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Value	0x04	0x1C	0x08	0x11	0x01	0x91	0x01	0x00
Register	**Blue/Cb Coeff 1**		**Blue/Cb Coeff 2**		**Blue/Cb Coeff 3**		**Blue/Cb Offset**	
Address	0x28	0x29	0x2A	0x2B	0x2C	0x2D	0x2E	0x2F
Value	0x1D	0xA3	0x1B	0x57	0x07	0x06	0x08	0x00

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-026-BEC

Figure 14. 80-Lead Low Profile Quad Flat Package [LQFP]
(ST-80-2)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD9889KSTZ-80[1]	0°C to 70°C	80-Lead Low Profile Quad Flat Package (LQFP)	ST-80-2
AD9889/PCB		Evaluation Board	

[1] Z = Pb-free part.

Notes

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