



# Multiformat SDTV Video Decoder with Fast Switch Overlay Support

## ADV7188

### FEATURES

- Multiformat video decoder supports NTSC (J/M/4.43), PAL (B/D/G/H/I/M/N), SECAM
- Integrates four 54 MHz, Noise Shaped Video (NSV<sup>®</sup>), 12-bit ADCs
- SCART fast blank support
- Clocked from a single 28.63636 MHz crystal
- Line-locked clock-compatible (LLC)
- Adaptive Digital Line Length Tracking (ADLLT<sup>™</sup>), signal processing, and enhanced FIFO management give mini-TBC functionality
- 5-line adaptive comb filters
- Proprietary architecture for locking to weak, noisy, and unstable video sources such as VCRs and tuners
- Subcarrier frequency lock and status information output
- Integrated automatic gain control (AGC) with adaptive peak white mode
- Macrovision<sup>®</sup> copy protection detection
- Chroma transient improvement (CTI)
- Digital noise reduction (DNR)
- Multiple programmable analog input formats
  - CVBS (composite video)
  - Y/C (S-video)
  - YPrPb (component) (VESA, MII, SMPTE, and BETACAM)
- 12 analog video input channels
- Integrated antialiasing filters
- Programmable interrupt request output pin

### GENERAL DESCRIPTION

The ADV7188 integrated video decoder automatically detects and converts standard analog baseband television signals compatible with worldwide NTSC, PAL, and SECAM standards into 4:2:2 component video data compatible with 20-/16-/10-/8-bit CCIR 601/CCIR 656.

The advanced, highly flexible digital output interface enables performance video decoding and conversion in line-locked, clock-based systems. This makes the device ideally suited for a broad range of applications with diverse analog video characteristics, including tape-based sources, broadcast sources, security and surveillance cameras, and professional systems.

The accurate 12-bit ADC provides professional quality video performance and is unmatched. This allows true 10-bit resolution in the 10-bit output mode.

The 12 analog input channels accept standard composite, S-video, and component video signals in an extensive number of combinations.

### Automatic NTSC/PAL/SECAM identification

- Digital output formats (8-bit, 10-bit, 16-bit, or 20-bit)
- ITU-R BT.656 YCrCb 4:2:2 output + HS, VS, and FIELD
- 0.5 V to 1.6 V analog signal input range
- Differential gain: 0.4% typical
- Differential phase: 0.4° typical
- Programmable video controls
  - Peak white/hue/brightness/saturation/contrast
- Integrated on-chip video timing generator
- Free-run mode (generates stable video output with no input)
- VBI decode support for close captioning (including Gemstar<sup>®</sup> 1x/2x (XDS)), WSS, CGMS, teletext, VITC, VPS
- Power-down mode
- 2-wire serial MPU interface (I<sup>2</sup>C<sup>®</sup> compatible)
- 3.3 V analog, 1.8 V digital core, 3.3 V input/output supply
- Industrial temperature grade: -40°C to +85°C
- 80-lead, Pb-free LQFP

### APPLICATIONS

- High end DVD recorders
- Video projectors
- HDD-based PVRs/DVDRs
- LCD TVs
- Set-top boxes
- Professional video products
- AVR receiver

AGC and clamp-restore circuitry allow an input video signal peak-to-peak range of 0.5 V to 1.6 V. Alternatively, these can be bypassed for manual settings.

The fixed 54 MHz clocking of the ADCs and datapath for all modes allows very precise, accurate sampling and digital filtering. The line-locked clock output allows the output data rate, timing signals, and output clock signals to be synchronous, asynchronous, or line locked even with ±5% variation in line length. The output control signals allow glueless interface connections in most applications. The ADV7188 modes are set up over a 2-wire, serial, bidirectional port (I<sup>2</sup>C compatible).

SCART and overlay functionality are enabled by the ability of the ADV7188 to process CVBS and standard definition RGB signals simultaneously. Signal mixing is controlled by the fast blank pin. The ADV7188 is fabricated in a 3.3 V CMOS process. Its monolithic CMOS construction ensures greater functionality with lower power dissipation. It is packaged in a small, Pb-free, 80-lead LQFP.



## TABLE OF CONTENTS

Features .....	1	Global Status Registers .....	23
Applications.....	1	Standard Definition Processor (SDP).....	24
General Description.....	1	SD Luma Path .....	24
Revision History .....	3	SD Chroma Path.....	24
Introduction .....	4	Sync Processing .....	25
Analog Front End.....	4	VBI Data Recovery.....	25
Standard Definition Processor (SDP).....	4	General Setup.....	25
Functional Block Diagram .....	4	Color Controls.....	28
Specifications.....	5	Clamp Operation.....	30
Electrical Characteristics.....	5	Luma Filter .....	31
Video Specifications.....	6	Chroma Filter.....	34
Analog Specifications.....	6	Gain Operation.....	35
Thermal Specifications .....	7	Chroma Transient Improvement (CTI) .....	39
Timing Specifications .....	7	Digital Noise Reduction (DNR) and Luma Peaking Filter ...	39
Timing Diagrams.....	8	Comb Filters.....	40
Absolute Maximum Ratings.....	9	AV Code Insertion and Controls .....	43
Package Thermal Performance.....	9	Synchronization Output Signals.....	45
ESD Caution.....	9	Sync Processing .....	53
Pin Configuration and Function Descriptions.....	10	VBI Data Decode .....	53
Analog Front End .....	12	I <sup>2</sup> C Interface .....	60
Analog Input Muxing .....	13	Standard Detection and Identification.....	62
Manual Input Muxing.....	15	I <sup>2</sup> C Readback Registers.....	64
XTAL Clock Input Pin Functionality.....	16	Pixel Port Configuration .....	79
28.63636 MHz Crystal Operation.....	16	Pixel Port–Related Controls.....	79
Antialiasing Filters .....	16	MPU Port Description.....	80
SCART and Fast Blanking.....	16	Register Accesses .....	81
Fast Blank Control.....	17	Register Programming.....	81
Global Control Registers .....	21	I <sup>2</sup> C Sequencer.....	81
Power-Saving Modes.....	21	I <sup>2</sup> C Programming Examples .....	81
Reset Control .....	21	I <sup>2</sup> C Register Maps .....	82
Global Pin Control .....	21	User Map .....	82



User Sub Map.....	99	Digital Inputs.....	110
PCB Layout Recommendations .....	109	XTAL and Load Capacitor Values Selection .....	110
Analog Interface Inputs.....	109	Typical Circuit Connection .....	111
Power Supply Decoupling.....	109	Outline Dimensions.....	112
PLL .....	109	Ordering Guide .....	112
Digital Outputs (Both Data and Clocks) .....	109		

**REVISION HISTORY**

**1/07—Rev. 0 to Rev. A**

Corrected Register and Bit Names.....	Universal
Changes to Pin Configuration and Function Descriptions Section .....	10
Change to Table 9 .....	14
Change to Table 17 .....	22
Change to VBI Data Recovery Section.....	25
Changes to Table 24 .....	25
Changes to SFL_INV, Address 0x41 [6] Section.....	26
Change to Table 35 .....	31
Change to Table 40 .....	36
Change to LAGT [1:0], Luma Automatic Gain Timing, Address 0x2F [7:6] Section .....	36
Change to NVBIOLCM [1:0], NTSC VBI Odd Field Luma Comb Mode, Address 0xEB [7:6] Section .....	43
Change to NVBIELCM [1:0], NTSC VBI Even Field Luma Comb Mode, Address 0xEB [5:4] Section .....	43
Change to NVBIOCCM [1:0], NTSC VBI Odd Field Chroma Comb Mode, Address 0xEC [7:6] Section .....	43
Change to NVBIECCM [1:0], NTSC VBI Even Field Chroma Comb Mode, Address 0xEC [5:4] Section .....	43
Changes to NEWAVMODE, New AV Mode, Address 0x31 [4] Section.....	47
Change to Table 69 .....	56
Added Standard Detection and Identification Section .....	62
Changes to MPU Port Description Section.....	80
Changes to I <sup>2</sup> C Programming Examples Section.....	81
Change to Table 104.....	82
Changes to Table 105 .....	84
Change to Table 107.....	101

**7/05—Revision 0: Initial Version**



# ADV7188

## INTRODUCTION

The ADV7188 is a high quality, single chip, multiformat video decoder that automatically detects and converts PAL, NTSC, and SECAM standards in the form of composite, S-video, and component video into a digital ITU-R BT.656 format.

The advanced, highly flexible digital output interface enables performance video decoding and conversion in line-locked, clock-based systems. This makes the device ideally suited for a broad range of applications with diverse analog video characteristics, including tape-based sources, broadcast sources, security and surveillance cameras, and professional systems.

### ANALOG FRONT END

The ADV7188 analog front end includes four 12-bit NSV ADCs that digitize the analog video signal before applying it to the standard definition processor (SDP). The analog front end uses differential channels for each ADC to ensure high performance in mixed-signal applications.

The front end also includes a 12-channel input mux that enables multiple video signals to be applied to the ADV7188. Current and voltage clamps are positioned in front of each ADC to ensure that the video signal remains within the range of the converter. Fine clamping of the video signals is performed downstream by digital fine clamping within the ADV7188. The ADCs are configured to run in 4x oversampling mode.

The ADV7188 has optional antialiasing filters on each of the four input channels. The filters are designed for standard definition (SD) video with approximately 6 MHz bandwidth.

SCART and overlay functionality are enabled by the ability of the ADV7188 to process CVBS and standard definition RGB signals simultaneously. Signal mixing is controlled by the fast blank (FB) pin.

### STANDARD DEFINITION PROCESSOR (SDP)

The ADV7188 is capable of decoding a large selection of baseband video signals in composite, S-video, and component formats. The video standards that are supported include PAL B/D/I/G/H, PAL 60, PAL M, PAL N, PAL Nc, NTSC M/J, NTSC 4.43, and SECAM B/D/G/K/L. The ADV7188 can automatically detect the video standard and process it accordingly.

The ADV7188 has a 5-line, superadaptive, 2D comb filter that provides superior chrominance and luminance separation when decoding a composite video signal. This highly adaptive filter automatically adjusts its processing mode according to the video standard and signal quality without requiring user intervention. Video user controls such as brightness, contrast, saturation, and hue are also available within the ADV7188.

The ADV7188 implements the patented ADLLT algorithm to track varying video line lengths from sources such as a VCR. ADLLT enables the ADV7188 to track and decode poor quality video sources such as VCRs and noisy sources from tuner outputs, VCD players, and camcorders. The ADV7188 contains a CTI processor that sharpens the edge rate of chroma transitions, resulting in sharper vertical transitions.

The ADV7188 can process a variety of VBI data services, such as closed captioning (CC), wide-screen signaling (WSS), copy generation management system (CGMS), Gemstar® 1x/2x, extended data service (XDS), and teletext. The ADV7188 is fully Macrovision certified; detection circuitry enables Type I, Type II, and Type III protection levels to be identified and reported to the user. The decoder is also fully robust to all Macrovision signal inputs.

## FUNCTIONAL BLOCK DIAGRAM

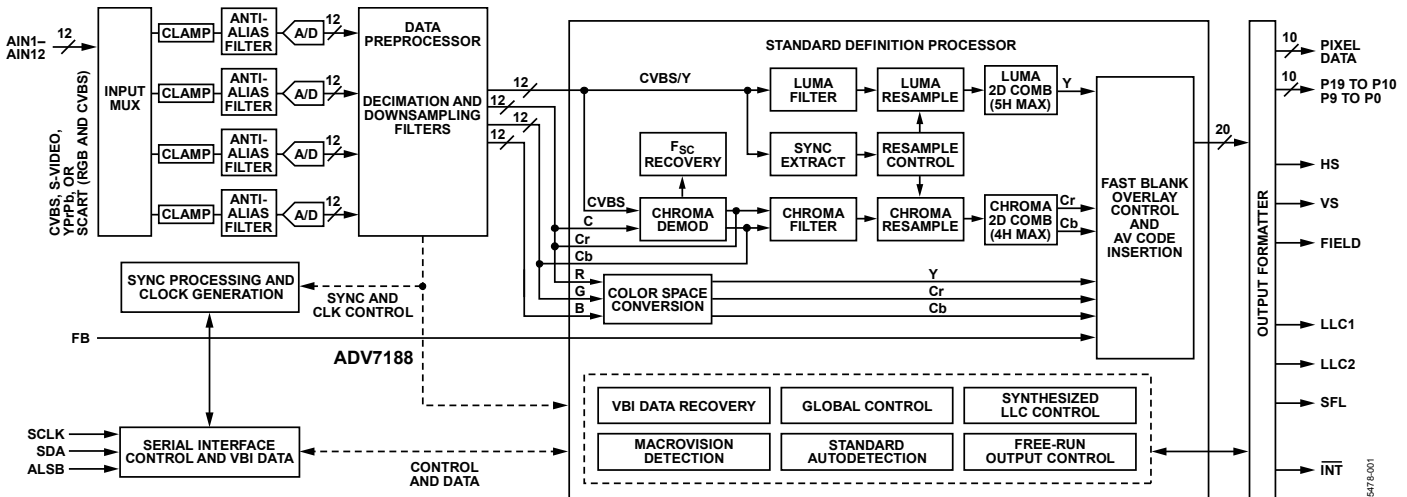


Figure 1.

## SPECIFICATIONS

### ELECTRICAL CHARACTERISTICS

$A_{VDD} = 3.15\text{ V to }3.45\text{ V}$ ,  $D_{VDD} = 1.65\text{ V to }2.0\text{ V}$ ,  $D_{VDDIO} = 3.0\text{ V to }3.6\text{ V}$ ,  $P_{VDD} = 1.71\text{ V to }1.89\text{ V}$ , nominal input range 1.6 V.

Operating temperature range, unless otherwise noted.

Table 1.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
STATIC PERFORMANCE <sup>1, 2, 3</sup>						
Resolution (Each ADC)	N				12	Bits
Integral Nonlinearity	INL	BSL at 54 MHz		-1.5/+2.5	±8	LSB
Differential Nonlinearity	DNL	BSL at 54 MHz		-0.7/+0.7	-0.99/+2.5	LSB
DIGITAL INPUTS						
Input High Voltage <sup>4</sup>	$V_{IH}$		2			V
Input Low Voltage <sup>5</sup>	$V_{IL}$				0.8	V
Input Current <sup>6, 7</sup>	$I_{IN}$		-50		+50	μA
			-10		+10	μA
Input Capacitance <sup>8</sup>	$C_{IN}$				10	pF
DIGITAL OUTPUTS						
Output High Voltage <sup>9</sup>	$V_{OH}$	$I_{SOURCE} = 0.4\text{ mA}$	2.4			V
Output Low Voltage <sup>9</sup>	$V_{OL}$	$I_{SINK} = 3.2\text{ mA}$			0.4	V
High Impedance Leakage Current	$I_{LEAK}$				10	μA
Output Capacitance <sup>8</sup>	$C_{OUT}$				20	pF
POWER REQUIREMENTS <sup>8</sup>						
Digital Core Power Supply	$D_{VDD}$		1.65	1.8	2.0	V
Digital Input/Output Power Supply	$D_{VDDIO}$		3.0	3.3	3.6	V
PLL Power Supply	$P_{VDD}$		1.71	1.8	1.89	V
Analog Power Supply	$A_{VDD}$		3.15	3.3	3.45	V
Digital Core Supply Current	$I_{DVDD}$			105		mA
Digital Input/Output Supply Current	$I_{DVDDIO}$			4		mA
PLL Supply Current	$I_{PVDD}$			11		mA
Analog Supply Current	$I_{AVDD}$			99		mA
		CVBS input <sup>10</sup>		269		mA
		SCART RGB FB input <sup>11</sup>		0.65		mA
Power-Down Current	$I_{PWRDN}$			0.65		mA
Power-Up Time	$t_{PWRUP}$			20		ms

<sup>1</sup> All ADC linearity tests performed with the input range at full scale - 12.5% and at zero scale + 12.5%.

<sup>2</sup> Maximum INL and DNL specifications obtained with the part configured for component video input.

<sup>3</sup> Temperature range  $T_{MIN}$  to  $T_{MAX}$ , -40°C to +85°C. The minimum/maximum specifications are guaranteed over this range.

<sup>4</sup> To obtain specified  $V_{IH}$  level on Pin 29, Register 0x13 (write only) must be programmed with Value 0x04. If Register 0x13 is programmed with Value 0x00, then  $V_{IH}$  on Pin 29 is 1.2 V.

<sup>5</sup> To obtain specified  $V_{IL}$  level on Pin 29, Register 0x13 (write only) must be programmed with Value 0x04. If Register 0x13 is programmed with Value 0x00, then  $V_{IL}$  on Pin 29 is 0.4 V.

<sup>6</sup> Pins 36, 64, 79.

<sup>7</sup> Excluding all TEST pins (TEST0 to TEST8)

<sup>8</sup>  $V_{OH}$  and  $V_{OL}$  levels obtained using default drive strength value (0x05) in Register 0xF4.

<sup>9</sup> Guaranteed by characterization.

<sup>10</sup> Only ADC0 is powered on.

<sup>11</sup> All four ADCs powered on.



# ADV7188

## VIDEO SPECIFICATIONS

At  $A_{VDD} = 3.15\text{ V to }3.45\text{ V}$ ,  $D_{VDD} = 1.65\text{ V to }2.0\text{ V}$ ,  $D_{VDDIO} = 3.0\text{ V to }3.6\text{ V}$ ,  $P_{VDD} = 1.71\text{ V to }1.89\text{ V}$  (operating temperature range, unless otherwise noted).

**Table 2.**

Parameter <sup>1,2</sup>	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>NONLINEAR SPECIFICATIONS</b>						
Differential Phase	DP	CVBS input, modulate five steps		0.4	0.6	Degree
Differential Gain	DG	CVBS input, modulate five steps		0.4	0.6	%
Luma Nonlinearity	LNL	CVBS input, five steps		0.4	0.7	%
<b>NOISE SPECIFICATIONS</b>						
SNR Unweighted		Luma ramp	61	63		dB
		Luma flat field	63	65		dB
Analog Front End Crosstalk				60		dB
<b>LOCK TIME SPECIFICATIONS</b>						
Horizontal Lock Range			-5		+5	%
Vertical Lock Range			40		70	Hz
$F_{SC}$ Subcarrier Lock Range				$\pm 1.3$		Hz
Color Lock-In Time				60		Lines
Sync Depth Range <sup>3</sup>			20		200	%
Color Burst Range			5		200	%
Vertical Lock Time				2		Fields
Autodetection Switch Speed				100		Lines
<b>CHROMA SPECIFICATIONS</b>						
Hue Accuracy	HUE			1		Degree
Color Saturation Accuracy	CL_AC			1		%
Color AGC Range			5		400	%
Chroma Amplitude Error				0.4		%
Chroma Phase Error				0.3		Degree
Chroma Luma Intermodulation				0.1		%
<b>LUMA SPECIFICATIONS</b>						
Luma Brightness Accuracy		CVBS, 1 V input		1		%
Luma Contrast Accuracy		CVBS, 1 V input		1		%

<sup>1</sup> Temperature range  $T_{MIN}$  to  $T_{MAX}$  is  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . The minimum/maximum specifications are guaranteed over this range.

<sup>2</sup> Guaranteed by characterization.

<sup>3</sup> Nominal sync depth is 300 mV at 100% sync depth range.

## ANALOG SPECIFICATIONS

At  $A_{VDD} = 3.15\text{ V to }3.45\text{ V}$ ,  $D_{VDD} = 1.65\text{ V to }2.0\text{ V}$ ,  $D_{VDDIO} = 3.0\text{ V to }3.6\text{ V}$ ,  $P_{VDD} = 1.71\text{ V to }1.89\text{ V}$  (operating temperature range, unless otherwise noted). Recommended analog input video signal range is 0.5 V to 1.6 V, typically 1 V p-p.

**Table 3.**

Parameter <sup>1,2</sup>	Symbol	Test Condition	Min	Typ	Max	Unit
<b>CLAMP CIRCUITRY</b>						
External Clamp Capacitor		Clamps switched off		0.1		$\mu\text{F}$
Input Impedance <sup>3</sup>			10		$\text{M}\Omega$	
Input Impedance of Pin 40 (FB)			20		$\text{k}\Omega$	
Large-Clamp Source Current			0.75		mA	
Large-Clamp Sink Current			0.75		mA	
Fine-Clamp Source Current			60		$\mu\text{A}$	
Fine-Clamp Sink Current			60		$\mu\text{A}$	

<sup>1</sup> Temperature range  $T_{MIN}$  to  $T_{MAX}$  is  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . The minimum/maximum specifications are guaranteed over this range.

<sup>2</sup> Guaranteed by characterization.

<sup>3</sup> Except Pin 40 (FB).



**THERMAL SPECIFICATIONS**

Table 4.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Junction-to-Case Thermal Resistance	$\theta_{JC}$	4-layer PCB with solid ground plane		7.6		°C/W
Junction-to-Ambient Thermal Resistance (Still Air)	$\theta_{JA}$	4-layer PCB with solid ground plane		38.1		°C/W

**TIMING SPECIFICATIONS**

$A_{VDD} = 3.15\text{ V to }3.45\text{ V}$ ,  $D_{VDD} = 1.65\text{ V to }2.0\text{ V}$ ,  $D_{VDDIO} = 3.0\text{ V to }3.6\text{ V}$ ,  $P_{VDD} = 1.71\text{ V to }1.89\text{ V}$  (operating temperature range, unless otherwise noted).

Table 5.

Parameter <sup>1,2</sup>	Symbol	Test Conditions	Min	Typ	Max	Unit
SYSTEM CLOCK AND CRYSTAL						
Nominal Frequency				28.63636		MHz
Frequency Stability					±50	ppm
I <sup>2</sup> C PORT <sup>3</sup>						
SCLK Frequency					400	kHz
SCLK Minimum Pulse Width High	$t_1$		0.6			µs
SCLK Minimum Pulse Width Low	$t_2$		1.3			µs
Hold Time (Start Condition)	$t_3$		0.6			µs
Setup Time (Start Condition)	$t_4$		0.6			µs
SDA Setup Time	$t_5$		100			ns
SCLK and SDA Rise Time	$t_6$				300	ns
SCLK and SDA Fall Time	$t_7$				300	ns
Setup Time for Stop Condition	$t_8$			0.6		µs
RESET FEATURE						
Reset Pulse Width			5			ms
CLOCK OUTPUTS						
LLC1 Mark-Space Ratio	$t_9:t_{10}$		45:55		55:45	% duty cycle
LLC1 Rising to LLC2 Rising	$t_{11}$			1		ns
LLC1 Rising to LLC2 Falling	$t_{12}$			1		ns
DATA AND CONTROL OUTPUTS						
Data Output Transitional Time <sup>4</sup>	$t_{13}$	Negative clock edge to start of valid data ( $t_{ACCESS} = t_{10} - t_{13}$ )			3.6	ns
Data Output Transitional Time <sup>4</sup>	$t_{14}$	End of valid data to negative clock edge ( $t_{HOLD} = t_9 + t_{14}$ )			2.4	ns
Propagation Delay to Hi-Z	$t_{15}$			6		ns
Max Output Enable Access Time	$t_{16}$			7		ns
Min Output Enable Access Time	$t_{17}$			4		ns

<sup>1</sup> Temperature range  $T_{MIN}$  to  $T_{MAX}$  is  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . The minimum/maximum specifications are guaranteed over this range.

<sup>2</sup> Guaranteed by characterization.

<sup>3</sup> TTL input values are 0 V to 3 V, with rise/fall times  $\leq 3\text{ ns}$ , measured between the 10% and 90% points.

<sup>4</sup> SDP timing figures obtained using default drive strength value (0xD5) in Register 0xF4.



# ADV7188

## TIMING DIAGRAMS

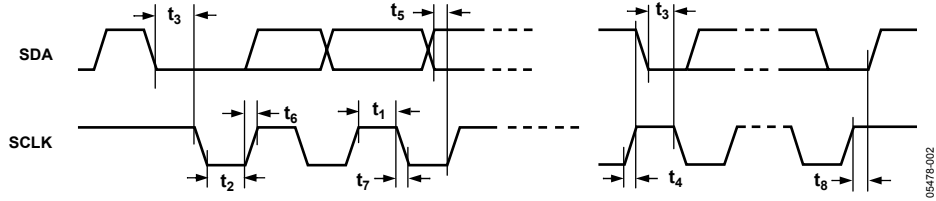


Figure 2. I<sup>2</sup>C Timing

054778-002

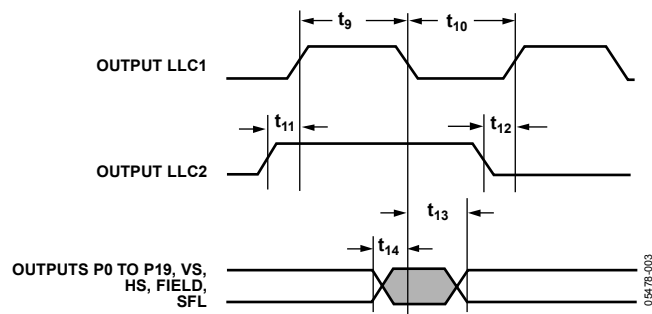


Figure 3. Pixel Port and Control Output Timing

054778-003

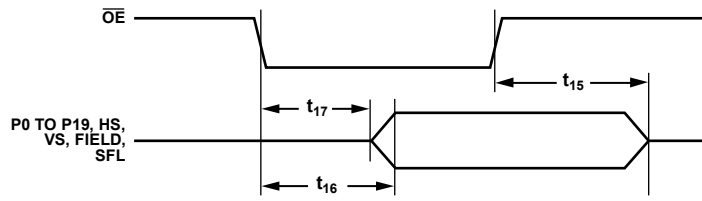


Figure 4.  $\overline{OE}$  Timing

054778-004





## ABSOLUTE MAXIMUM RATINGS

Table 6.

Parameter	Rating
$A_{VDD}$ to AGND	4 V
$D_{VDD}$ to DGND	2.2 V
$P_{VDD}$ to AGND	2.2 V
$D_{VDDIO}$ to DGND	4 V
$D_{VDDIO}$ to $A_{VDD}$	-0.3 V to +0.3 V
$P_{VDD}$ to $D_{VDD}$	-0.3 V to +0.3 V
$D_{VDDIO}$ to $P_{VDD}$	-0.3 V to +2 V
$D_{VDDIO}$ to $D_{VDD}$	-0.3 V to +2 V
$A_{VDD}$ to $P_{VDD}$	-0.3 V to +2 V
$A_{VDD}$ to $D_{VDD}$	-0.3 V to +2 V
Digital Inputs Voltage to DGND	-0.3 V to $D_{VDDIO} + 0.3$ V
Digital Output Voltage to DGND	-0.3 V to $D_{VDDIO} + 0.3$ V
Analog Inputs to AGND	AGND - 0.3 V to $A_{VDD} + 0.3$ V
Maximum Junction Temperature ( $T_J$ max)	125°C
Storage Temperature Range	-65°C to +150°C
Infrared Reflow Soldering (20 sec)	260°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.

### PACKAGE THERMAL PERFORMANCE

To reduce power consumption the user is advised to turn off any unused ADCs when using the part.

The junction temperature must always stay below the maximum junction temperature ( $T_J$  max) of 125°C. Use the following equation to calculate the junction temperature:

$$T_J = T_{A\max} + (\theta_{JA} \times W_{\max})$$

where:

$$T_{A\max} = 85^\circ\text{C}.$$

$$\theta_{JA} = 30^\circ\text{C}/\text{W}.$$

$$W_{\max} = ((A_{VDD} \times I_{AVDD}) + (D_{VDD} \times I_{DVDD}) + (D_{VDDIO} \times I_{DVDDIO}) + (P_{VDD} \times I_{PVDD})).$$

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

# ADV7188

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

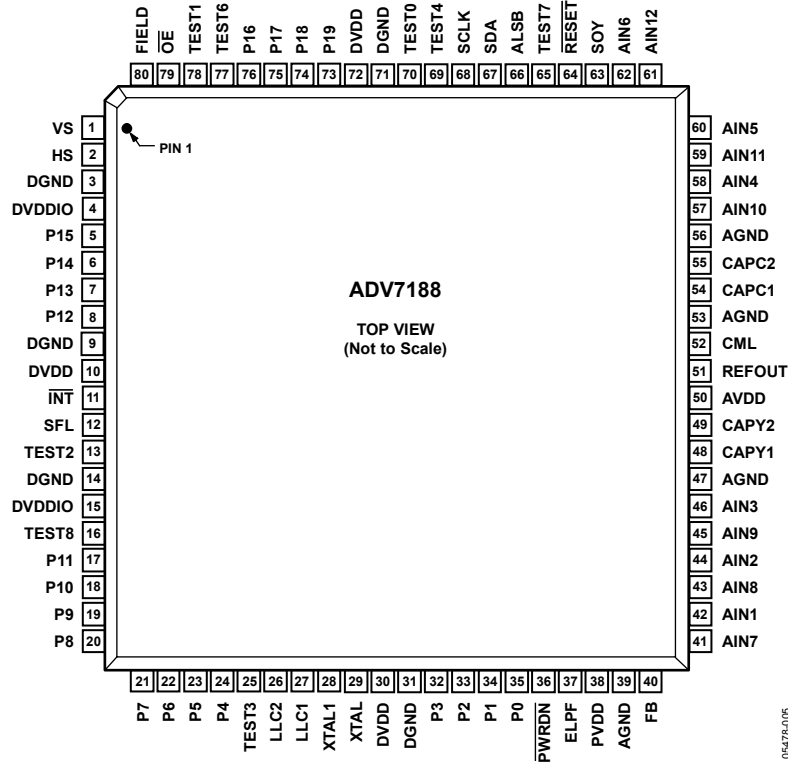


Figure 5. 80-Lead LQFP Pin Configuration

Table 7. Pin Function Descriptions

Pin No.	Mnemonic	Type	Description
3, 9, 14, 31, 71	DGND	G	Digital Ground.
39, 47, 53, 56	AGND	G	Analog Ground.
4, 15	DVDDIO	P	Digital I/O Supply Voltage (3.3 V).
10, 30, 72	DVDD	P	Digital Core Supply Voltage (1.8 V).
50	AVDD	P	Analog Supply Voltage (3.3 V).
38	PVDD	P	PLL Supply Voltage (1.8 V).
42, 44, 46, 58, 60, 62, 41, 43, 45, 57, 59, 61	AIN1 to AIN12	I	Analog Video Input Channels.
11	INT	O	Interrupt Request Output. An interrupt occurs when certain signals are detected on the input video. See the User Sub Map register details in Table 107.
40	FB	I	Fast Blank. FB is a fast switch overlay input that switches between CVBS and RGB analog signals.
70, 78, 13, 25, 69	TEST0 to TEST4		Leave these pins unconnected.
77, 65	TEST6 to TEST7		Tie to AGND.
16	TEST8		Tie to DVDDIO.
35 to 32, 24 to 17, 8 to 5, 76 to 73	P0 to P19	O	Video Pixel Output Ports.
2	HS	O	Horizontal Synchronization Output Signal.
1	VS	O	Vertical Synchronization Output Signal.
80	FIELD	O	Field Synchronization Output Signal.
67	SDA	I/O	I <sup>2</sup> C Port Serial Data Input/Output.

Pin No.	Mnemonic	Type	Description
68	SCLK	I	I <sup>2</sup> C Port Serial Clock Input. Maximum clock rate of 400 kHz.
66	ALSB	I	This pin selects the I <sup>2</sup> C address for the ADV7188. ALSB set to Logic 0 sets the address for a write to 0x40; set to Logic 1 sets the address to 0x42.
64	$\overline{\text{RESET}}$	I	System Reset Input (active low). A minimum low reset pulse width of 5 ms is required to reset the ADV7188 circuitry.
27	LLC1	O	Line-Locked Clock 1. This is a line-locked output clock for the pixel data output by the ADV7188. Nominally 27 MHz, but varies according to video line length.
26	LLC2	O	Line-Locked Clock 2. This is a divide-by-2 version of the LLC1 output clock for the pixel data output by the ADV7188. Nominally 13.5 MHz, but varies according to video line length.
29	XTAL	I	Crystal Input. This is the input pin for the 28.63636 MHz crystal, or it can be overdriven by an external 3.3 V, 28.63636 MHz clock oscillator source. In crystal mode, the crystal must be a fundamental crystal.
28	XTAL1	O	This pin should be connected to the 28.63636 MHz crystal or left as a no connect if an external 3.3 V, 28.63636 MHz clock oscillator source is used to clock the ADV7188. In crystal mode, the crystal must be a fundamental crystal.
36	$\overline{\text{PWRDN}}$	I	Logic 0 on this pin places the ADV7188 in a power-down mode. Refer to the I <sup>2</sup> C Register Maps section for more options on power-down modes for the ADV7188.
79	$\overline{\text{OE}}$	I	When set to Logic 0, $\overline{\text{OE}}$ enables the pixel output bus, P19 to P0 of the ADV7188. Logic 1 on the $\overline{\text{OE}}$ pin places P19 to P0, HS, VS, and SFL into a high impedance state.
37	ELPF	I	The recommended external loop filter must be connected to this ELPF pin, as shown in Figure 52.
12	SFL	O	Subcarrier Frequency Lock. This pin contains a serial output stream that can be used to lock the subcarrier frequency when this decoder is connected to any Analog Devices, Inc., digital video encoder.
63	SOY	I	SYNC on Y. This input pin should only be used with the standard detection and identification function (see the Standard Detection and Identification section). This pin should be connected to the Y signal of a component input for standard identification function.
51	REFOUT	O	Internal Voltage Reference Output. Refer to Figure 52 for a recommended capacitor network for this pin.
52	CML	O	Common-Mode Level. The CML pin is a common-mode level for the internal ADCs. Refer to Figure 52 for a recommended capacitor network for this pin.
48, 49	CAPY1, CAPY2	I	ADC Capacitor Network. Refer to Figure 52 for a recommended capacitor network for this pin.
54, 55	CAPC1, CAPC2	I	ADC Capacitor Network. Refer to Figure 52 for a recommended capacitor network for this pin.



ANALOG FRONT END

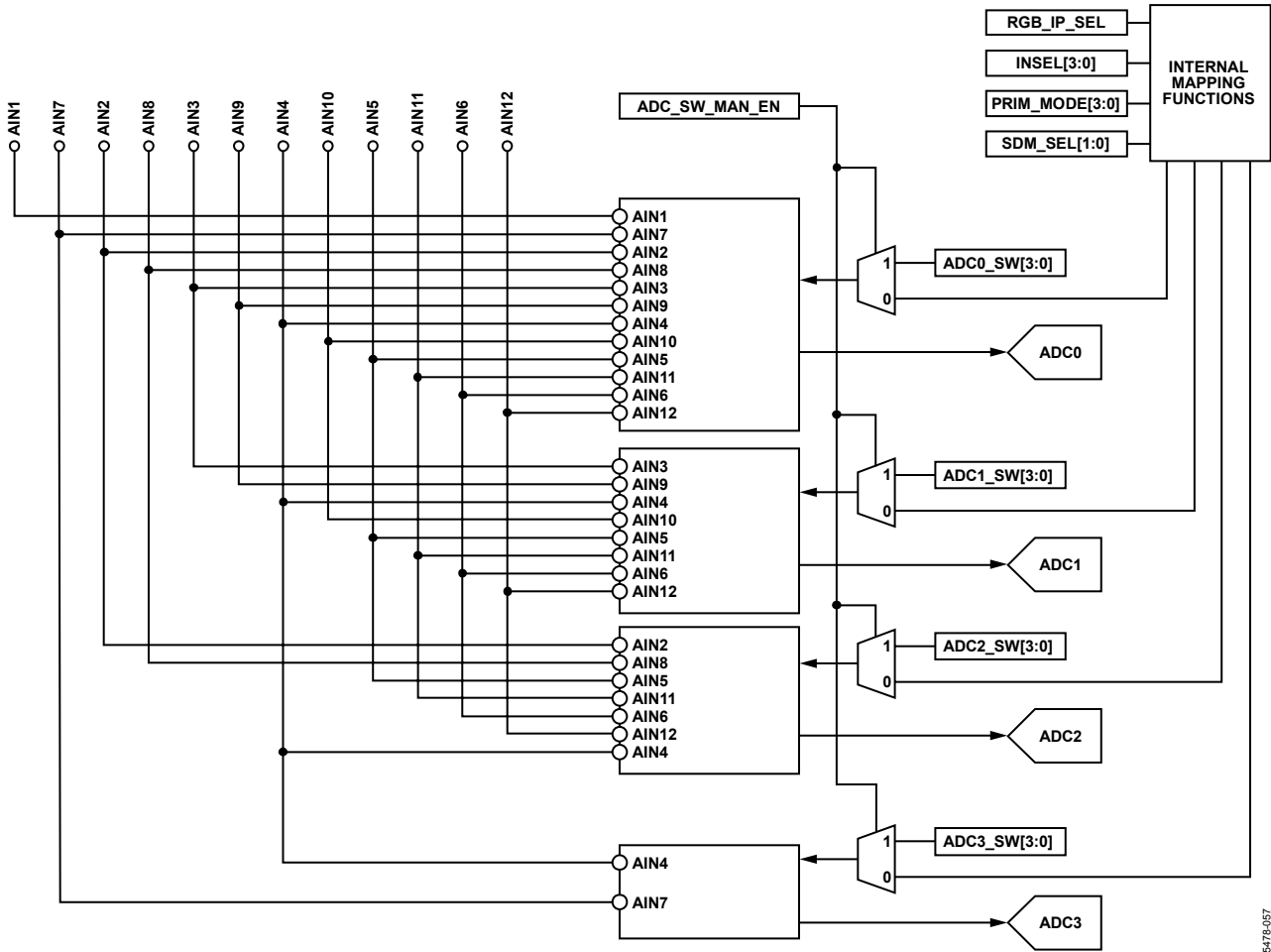


Figure 6. Internal Pin Connections

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### ANALOG INPUT MUXING

The ADV7188 has an integrated analog muxing section that allows connecting more than one source of video signal to the decoder. Figure 6 outlines the overall structure of the input muxing provided in the ADV7188.

As can be seen in Figure 6, the analog input muxes can be controlled in two ways:

- By the functional register (INSEL). Using INSEL [3:0] simplifies the setup of the muxes and minimizes crosstalk between channels by preassigning the input channels. This is referred to as the recommended input muxing.
- By an I<sup>2</sup>C manual override (ADC\_SW\_MAN\_EN, ADC0\_SW, ADC1\_SW, ADC2\_SW, and ADC3\_SW). This is provided for applications with special requirements, such as number/combinations of signals that are not served by the preassigned input connections. This is referred to as manual input muxing.

Figure 7 shows an overview of the two methods of controlling input muxing.

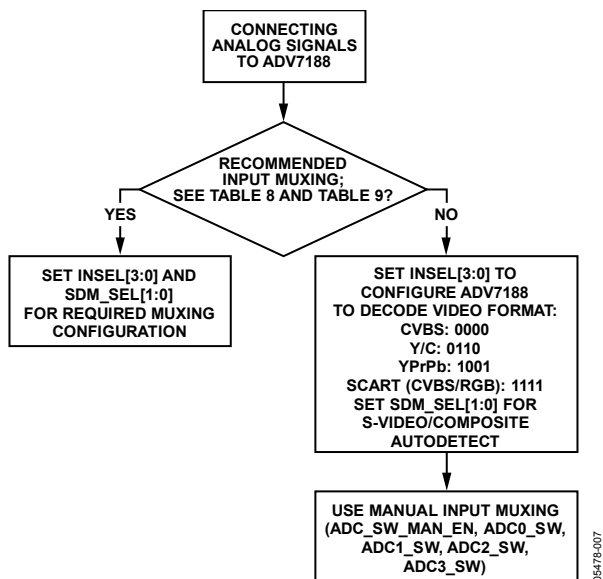


Figure 7. Input Muxing Overview

### Recommended Input Muxing

A maximum of 12 CVBS inputs can be connected and decoded by the ADV7188, meaning that the sources must be connected to adjacent pins on the IC, as seen in Figure 5. This calls for a careful design of the PCB layout, for example, placing ground shielding between all signals routed through tracks that are physically close together.

### SDM\_SEL [1:0], Y/C and CVBS Autodetect Mode Select, Address 0x69 [1:0]

The SDM\_SEL bits decide on input routing and whether INSEL [3:0] is used to govern input routing decisions.

The S-video/composite autodetection feature is enabled using SDM\_SEL = 11.

Table 8. SDM\_SEL [1:0]

SDM_SEL [1:0]	Mode	Analog Video Inputs
00	As per INSEL [3:0]	As per INSEL [3:0]
01	CVBS	AIN11
10	Y/C	Y = AIN10 C = AIN12
11	S-video/composite autodetection	CVBS = AIN11 Y = AIN11 C = AIN12



# ADV7188

## INSEL [3:0], Input Selection, Address 0x00 [3:0]

The INSEL bits allow the user to select the input channel and format. Depending on the PCB connections, only a subset of the INSEL modes is valid. INSEL [3:0] not only switches the analog input muxing, but also configures the ADV7188 to process composite (CVBS), S-video (Y/C), or component (YPbPr) format signals.

The recommended input muxing is designed to minimize crosstalk between signal channels and to obtain the highest level of signal integrity. Table 10 summarizes how the PCB layout should connect analog video signals to the ADV7188.

It is strongly recommended that users connect any unused analog input pins to AGND to act as a shield.

Connect the AIN7 to AIN11 inputs to AGND when only six input channels are used. This improves the quality of the sampling due to better isolation between the channels.

AIN12 is not controlled by INSEL [3:0]. It can be routed to ADC0/ADC1/ADC2 only by manual muxing. See Table 11 for details.

Table 9. Input Channel Switching Using INSEL [3:0]

INSEL [3:0]	Description	
	Analog Input Pins	Video Format
0000 (default)	CVBS1 = AIN1 B = AIN4 or AIN7 <sup>1</sup> R = AIN5 or AIN8 <sup>1</sup> G = AIN6 or AIN9 <sup>1</sup>	SCART (CVBS and R, G, B)
0001	CVBS2 = AIN2 B = AIN4 or AIN7 <sup>1</sup> R = AIN5 or AIN8 <sup>1</sup> G = AIN6 or AIN9 <sup>1</sup>	SCART (CVBS and R, G, B)
0010	CVBS3 = AIN3 B = AIN4 or AIN7 <sup>1</sup> R = AIN5 or AIN8 <sup>1</sup> G = AIN6 or AIN9 <sup>1</sup>	SCART (CVBS and R, G, B)
0011	CVBS4 = AIN4 B = AIN7 R = AIN8 G = AIN9	SCART (CVBS and R, G, B)
0100	CVBS1 = AIN5 B = AIN4 R = AIN5 G = AIN6	SCART (CVBS and R, G, B)
0101	CVBS1 = AIN1 B = AIN4 R = AIN5 G = AIN6	SCART (CVBS and R, G, B)
0110	Y1 = AIN1 C1 = AIN4	Y/C
0111	Y2 = AIN2 C2 = AIN5	Y/C
1000	Y3 = AIN3 C3 = AIN6	Y/C
1001	Y1 = AIN1 PB1 = AIN4 PR1 = AIN5	YPrPb
1010	Y2 = AIN2 PB2 = AIN3 PR2 = AIN6	YPrPb
1011	CVBS7 = AIN7 B = AIN4 R = AIN5 G = AIN6	SCART (CVBS and R, G, B)
1100	CVBS8 = AIN8 B = AIN4 R = AIN5 G = AIN6	SCART (CVBS and R, G, B)
1101	CVBS9 = AIN9 B = AIN4 R = AIN5 G = AIN6	SCART (CVBS and R, G, B)
1110	CVBS10 = AIN10 B = AIN4 or AIN7 <sup>1</sup> R = AIN5 or AIN8 <sup>1</sup> G = AIN6 or AIN9 <sup>1</sup>	SCART (CVBS and R, G, B)
1111	CVBS11 = AIN11 B = AIN4 or AIN7 <sup>1</sup> R = AIN5 or AIN8 <sup>1</sup> G = AIN6 or AIN9 <sup>1</sup>	SCART (CVBS and R, G, B)

<sup>1</sup> Selectable via RGB\_IP\_SEL.



**Table 10. Input Channel Assignments**

Input Channel	Pin	Recommended Input Muxing Control—INSEL [3:0]			
AIN7	41	CVBS7			SCART1-B
AIN1	42	CVBS1	YC1-Y	YPrPb1-Y	SCART2-CVBS
AIN8	43	CVBS8			SCART1-R
AIN2	44	CVBS2	YC2-Y	YPrPb2-Y	
AIN9	45	CVBS9			SCART1-G
AIN3	46	CVBS3	YC3-Y	YPrPb2-Pb	
AIN10	57	CVBS10			
AIN4	58	CVBS4	YC1-C	YPrPb1-Pb	SCART2-B
AIN11	59	CVBS11			SCART1-CVBS
AIN5	60	CVBS5	YC2-C	YPrPb1-Pr	SCART2-R
AIN12	61	Not available			
AIN6	62	CVBS6	YC3-C	YPrPb2-Pr	SCART2-G

**Table 11. Manual Mux Settings for All ADCs (Set ADC\_SW\_MAN\_EN to 1)**

ADC0_SW [3:0]	ADC0 Connected To	ADC1_SW [3:0]	ADC1 Connected To	ADC2_SW [3:0]	ADC2 Connected To	ADC3_SW [3:0]	ADC3 Connected To
0000	No connection	0000	No connection	0000	No connection	0000	No connection
0001	AIN1	0001	No connection	0001	No connection	0001	No connection
0010	AIN2	0010	No connection	0010	AIN2	0010	No connection
0011	AIN3	0011	AIN3	0011	No connection	0011	No connection
0100	AIN4	0100	AIN4	0100	No connection	0100	AIN4
0101	AIN5	0101	AIN5	0101	AIN5	0101	No connection
0110	AIN6	0110	AIN6	0110	AIN6	0110	No connection
0111	No connection	0111	No connection	0111	No connection	0111	No connection
1000	No connection	1000	No connection	1000	No connection	1000	No connection
1001	AIN7	1001	No connection	1001	No connection	1001	AIN7
1010	AIN8	1010	No connection	1010	AIN8	1010	No connection
1011	AIN9	1011	AIN9	1011	No connection	1011	No connection
1100	AIN10	1100	AIN10	1100	No connection	1100	No connection
1101	AIN11	1101	AIN11	1101	AIN11	1101	No connection
1110	AIN12	1110	AIN12	1110	AIN12	1110	No connection
1111	No connection	1111	No connection	1111	No connection	1111	No connection

**RGB\_IP\_SEL, Address 0xF1 [0]**

For SCART input, R, G, and B signals can be input either on AIN4, AIN5, and AIN6 or on AIN7, AIN8, and AIN9.

0 (default)—B is input on AIN4, R is input on AIN5, and G is input on AIN6.

1—B is input on AIN7, R is input on AIN8, and G is input on AIN9.

**MANUAL INPUT MUXING**

By accessing a set of manual override muxing registers, the analog input muxes of the ADV7188 can be controlled directly. This is referred to as manual input muxing. Manual input muxing overrides other input muxing control bits, including INSEL and SDM\_SEL.

Manual muxing is activated by setting the ADC\_SW\_MAN\_EN bit. It only affects the analog switches in front of the ADCs.

Therefore, if the settings of INSEL and the manual input muxing bits (ADC0\_SW/ADC1\_SW/ADC2\_SW/ADC3\_SW) contradict each other, the ADC0\_SW/ADC1\_SW/ADC2\_SW/ADC3\_SW settings apply and INSEL and SDM\_SEL are ignored.

Manual input muxing controls only the analog input muxes. For the follow-on blocks to process video data in the correct format, however, INSEL must still be used to indicate whether the input signal is of YPbPr, Y/C, or CVBS format.

Restrictions in the channel routing are imposed by the analog signal routing inside the IC; each input pin cannot be routed to each ADC. Refer to Figure 6 for an overview on the routing capabilities inside the chip. The four mux sections can be controlled by the reserved control signal buses, ADC0\_SW [3:0], ADC1\_SW [3:0], ADC2\_SW [3:0], and ADC3\_SW [3:0]. Table 11 explains the control words used.



# ADV7188

**ADC\_SW\_MAN\_EN, Manual Input Muxing Enable, Address 0xC4 [7]**

**ADC0\_SW [3:0], ADC0 Mux Configuration, Address 0xC3 [3:0]**

**ADC1\_SW [3:0], ADC1 Mux Configuration, Address 0xC3 [7:4]**

**ADC2\_SW [3:0], ADC2 Mux Configuration, Address 0xC4 [3:0]**

**ADC3\_SW [3:0], ADC3 Mux Configuration, Address 0xF3 [7:4]**

See Table 11.

## XTAL CLOCK INPUT PIN FUNCTIONALITY

**XTAL\_TTL\_SEL, Address 0x13 [2]**

The crystal pad is normally part of the crystal oscillator circuit, powered from a 1.8 V supply. For optimal clock generation, the slice level of the input buffer of this circuit is at approximately half the supply voltage, making it incompatible with TTL level signals.

0 (default)—A crystal is used to generate the ADV7188 clock.

1—An external TTL level clock is supplied. A different input buffer can be selected that slices at TTL-compatible levels. This inhibits operation of the crystal oscillator and therefore can only be used when a clock signal is applied.

## 28.63636 MHz CRYSTAL OPERATION

**EN28XTAL, Address 0x1D [6]**

The ADV7188 can operate on two different base crystal frequencies. Selecting one over the other may be desirable in systems in which board crosstalk between different components leads to undesirable interference between video signals. It is recommended to use a crystal of frequency 28.63636 MHz to clock the ADV7188.

0 (default)—The crystal frequency is 27 MHz.

1—The crystal frequency is 28.63636 MHz.

## ANTI\_ALIASING FILTERS

The ADV7188 has optional antialiasing filters on each of the four input channels. The filters are designed for SD video with approximately 6 MHz bandwidth.

A plot of the filter response is shown in Figure 8. The filters can be individually enabled via I<sup>2</sup>C under the control of AA\_FILT\_EN [3:0].

**AA\_FILT\_EN [0], Address 0xF3 [0]**

0 (default)—The filter on Channel 0 is disabled.

1—The filter on Channel 0 is enabled.

**AA\_FILT\_EN [1], Address 0xF3 [1]**

0 (default)—The filter on Channel 1 is disabled.

1—The filter on Channel 1 is enabled.

**AA\_FILT\_EN [2], Address 0xF3 [2]**

0 (default)—The filter on Channel 2 is disabled.

1—The filter on Channel 2 is enabled.

**AA\_FILT\_EN [3], Address 0xF3 [3]**

0 (default)—The filter on Channel 3 is disabled.

1—The filter on Channel 3 is enabled.

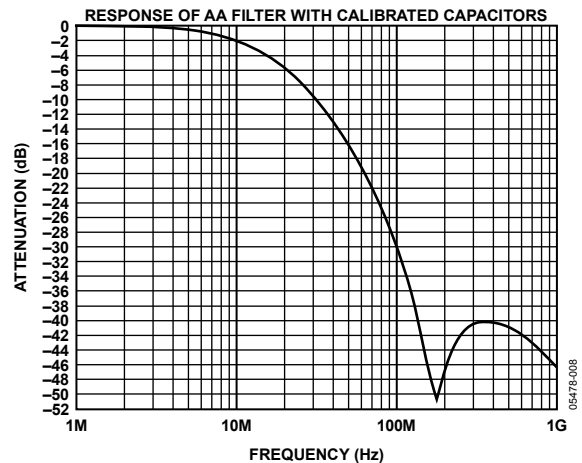


Figure 8. Frequency Response of Internal ADV7188 Antialiasing Filters

## SCART AND FAST BLANKING

The ADV7188 can support simultaneous processing of CVBS and RGB standard definition signals to enable SCART compatibility and overlay functionality.

This function is available when INSEL [3:0] is set appropriately (see Table 9). Timing extraction is always performed by the ADV7188 on the CVBS signal. However, a combination of the CVBS and RGB inputs can be mixed and output under the control of the I<sup>2</sup>C registers and the FB pin.

Four basic modes are supported:

- **Static Switch Mode.** The FB pin is not used. The timing is extracted from the CVBS signal, and either the CVBS content or RGB content can be output under the control of CVBS\_RGB\_SEL. This mode allows the selection of a full-screen picture from either source. Overlay is not possible in static switch mode.
- **Fixed Alpha Blending.** The FB pin is not used. The timing is extracted from the CVBS signal, and an alpha blended combination of the video from the CVBS and RGB sources is output. This alpha blending is applied to the full screen. The alpha blend factor is selected with the I<sup>2</sup>C signal





MAN\_ALPHA\_VAL [6:0]. Overlay is not possible in fixed alpha blending mode.

- **Dynamic Switching (Fast Mux).** The FB pin can be used to select the source. This enables dynamic multiplexing between the CVBS and RGB sources. With default settings, when Logic 1 is applied to the FB pin, the RGB source is selected; when Logic 0 is applied to the FB pin, the CVBS source is selected. This mode is suitable for the overlay of subtitles, teletext, or other material. Typically, the CVBS source carries the main picture, and the RGB source has the overlay data.
- **Dynamic Switching with Edge Enhancement.** This provides the same functionality as the dynamic switching mode, but with the benefit of Analog Devices' proprietary edge-enhancement algorithms, which improve the visual appearance of transitions for signals from a wide variety of sources.

### System Diagram

A block diagram of the ADV7188 fast blanking configuration is shown in Figure 9.

The CVBS signal is processed by the ADV7188 and converted to YPrPb. The RGB signals are processed by a color space converter (CSC), and samples are converted to YPrPb. Both sets of YPrPb signals are input to the subpixel blender, which can be configured to operate in any of the four modes previously outlined in this section.

The fast blank position resolver determines the time position of the FB pin accurately (<1 ns). This position information is then used by the subpixel blender in dynamic switching modes, enabling the ADV7188 to implement high performance multiplexing between the CVBS and RGB sources even when the RGB data source is completely asynchronous to the sampling crystal reference.

An antialiasing filter is required on all four data channels (R, G, B, and CVBS). The order of this filter is reduced because all signals are sampled at 54 MHz.

The switched or blended data is output from the ADV7188 in the standard output formats (see Table 102).

### FAST BLANK CONTROL

#### FB\_MODE [1:0], Address 0xED [1:0]

FB\_MODE controls which fast blank mode is selected.

**Table 12. FB\_MODE [1:0] Function**

FB_MODE [1:0]	Description
00 (default)	Static switch mode
01	Fixed alpha blending
10	Dynamic switching (fast mux)
11	Dynamic switching with edge enhancement

### Static Mux Selection Control

#### CVBS\_RGB\_SEL, Address 0xED [2]

CVBS\_RGB\_SEL controls whether the video from the CVBS or RGB source is selected for output from the ADV7188.

0 (default)—Data from the CVBS source is selected for output.

1—Data from the RGB source is selected for output.

### Alpha Blend Coefficient

#### MAN\_ALPHA\_VAL [6:0], Address 0xEE [6:0]

When fixed alpha blending is selected (FB\_MODE [1:0] = 01), MAN\_ALPHA\_VAL [6:0] determines the proportion in which the video from the CVBS and RGB sources are blended. Equation 1 shows how these bits affect the video output.

$$Video_{out} = Video_{CVBS} \times \left( 1 - \frac{MAN\_ALPHA\_VAL [6:0]}{64} \right) + Video_{RGB} \times \frac{MAN\_ALPHA\_VAL [6:0]}{64} \quad (1)$$

The maximum valid value for MAN\_ALPHA\_VAL [6:0] is 1000000, such that the alpha blender coefficients remain between 0 and 1. The default value for MAN\_ALPHA\_VAL [6:0] is 0000000.



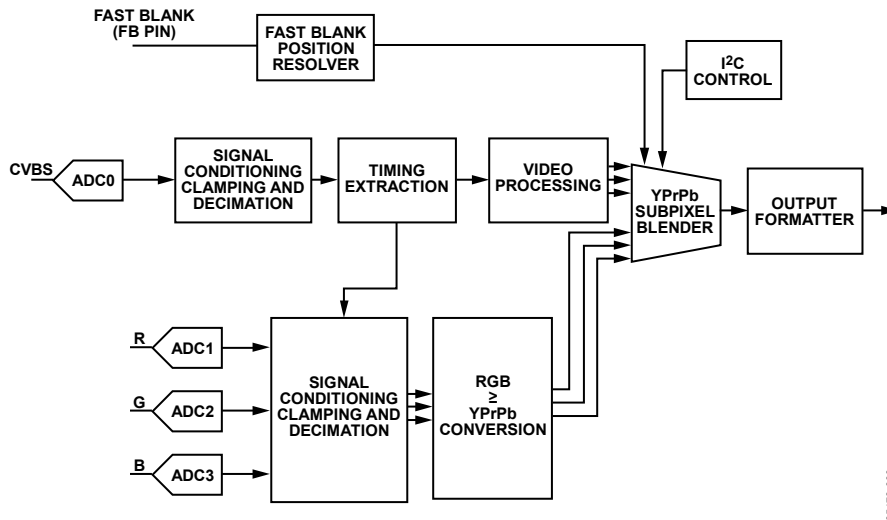


Figure 9. Fast Blanking Configuration

### Fast Blank Edge Shaping

#### FB\_EDGE\_SHAPE [2:0], Address 0xEF [2:0]

To improve the picture transition for high speed fast blank switching, an edge-shaping mode is available on the ADV7188. Depending on the format of the RGB inputs, it may be advantageous to apply different levels of edge shaping. The levels are selected via the FB\_EDGE\_SHAPE [2:0] bits. Users are advised to try each of the settings and select the setting that is most visually pleasing on their system.

Table 13. FB\_EDGE\_SHAPE [2:0] Function

FB_EDGE_SHAPE [2:0]	Description
000	No edge shaping
001	Level 1 edge shaping
010 (default)	Level 2 edge shaping
011	Level 3 edge shaping
100	Level 4 edge shaping
101 to 111	Not valid

### Contrast Reduction

For overlay applications, text can be more readable if the contrast of the video directly behind the text is reduced. To enable the definition of a window of reduced contrast behind inserted text, the signal applied to the FB pin can be interpreted as a trilevel signal, as shown in Figure 10.

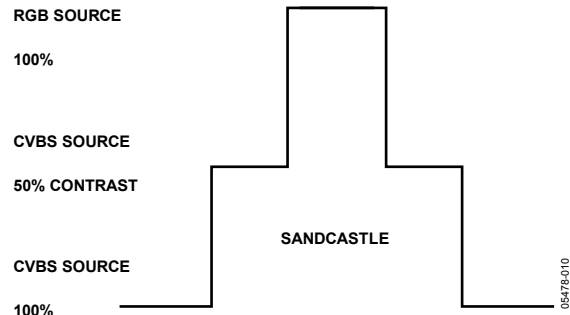


Figure 10. Fast Blank Signal Representation with Contrast Reduction Enabled

### Contrast Reduction Enable

#### CNTR\_ENABLE, Address 0xEF [3]

This bit enables the contrast reduction feature and changes the meaning of the signal applied to the FB pin.

0 (default)—The contrast reduction feature is disabled, and the fast blank signal is interpreted as a bilevel signal.

1—The contrast reduction feature is enabled, and the fast blank signal is interpreted as a trilevel signal.

### Contrast Mode

#### CNTR\_MODE [1:0], Address 0xF1 [3:2]

The contrast level in the selected contrast reduction box is selected using the CNTR\_MODE [1:0] bits.

Table 14. CNTR\_MODE [1:0] Function

CNTR_MODE [1:0]	Description
00 (default)	25%
01	50%
10	75%
11	100%



**Fast Blank and Contrast Reduction Programmable Thresholds**

The internal fast blank and contrast reduction signals are resolved from the trilevel FB signal using two comparators, as shown in Figure 11. To facilitate compliance with different input level standards, the reference level to these comparators is programmable via FB\_LEVEL [1:0] and CNTR\_LEVEL [1:0]. The resulting thresholds are given in Table 15.

**FB\_LEVEL [1:0], Address 0xF1 [5:4]**

These bits control the reference level for the fast blank comparator.

**CNTR\_LEVEL [1:0], Address 0xF1 [7:6]**

These bits control the reference level for the contrast reduction comparator.

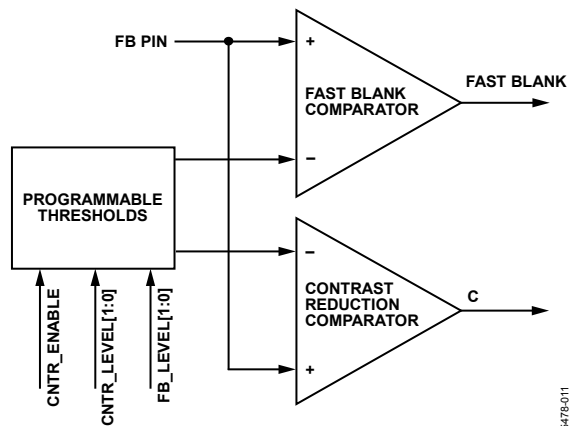


Figure 11. Fast Blank and Contrast Reduction Programmable Threshold

Table 15. Fast Blank and Contrast Reduction Programmable Threshold I<sup>2</sup>C Controls

CNTR_ENABLE	FB_LEVEL [1:0]	CNTR_LEVEL [1:0]	Fast Blanking Threshold (V)	Contrast Reduction Threshold (V)
0	00 (default)	XX	1.4	n/a
0	01	XX	1.6	n/a
0	10	XX	1.8	n/a
0	11	XX	2.0	n/a
1	00 (default)	00	1.6	0.4
1	01	01	1.8	0.6
1	10	10	2.0	0.8
1	11	11	2.2	2.0



# ADV7188

## **FB\_INV, Address 0xED [3], Write Only**

The interpretation of the polarity of the signal applied to the FB pin can be changed using FB\_INV.

0 (default)—The fast blank pin is active high.

1—The fast blank pin is active low.

## **Readback of FB Pin Status**

### **FB\_STATUS [3:0], Address 0xED [7:4]**

FB\_STATUS [3:0] is a readback value that provides the system information on the status of the FB pins, as shown in Table 16.

## **FB Timing**

### **FB\_SP\_ADJUST [3:0], Address 0xEF [7:4]**

The critical information extracted from the FB signal is the time at which it switches relative to the input video. Due to small timing inequalities either on the IC or on the PCB, it may be necessary to adjust the result by a fraction of one clock cycle. This is controlled by FB\_SP\_ADJUST [3:0].

Each LSB of FB\_SP\_ADJUST [3:0] corresponds to  $\frac{1}{8}$ <sup>th</sup> of an ADC clock cycle. Increasing the value is equivalent to adding delay to the FB signal. The reset value is chosen to produce equalized channels when the ADV7188 internal antialiasing filters are enabled and there are only intentional delays on the PCB.

The default value of FB\_SP\_ADJUST [3:0] is 0100.

## **Alignment of FB Signal**

### **FB\_DELAY [3:0], Address 0xF0 [3:0]**

In the event of misalignment between the FB input signal and the other input signals (CVBS and RGB) or unequalized delays in their processing, it is possible to alter the delay of the FB signal in 28.63636 MHz clock cycles. (For a finer granularity delay of the FB signal, refer to the FB\_SP\_ADJUST [3:0], Address 0xEF [7:4] section.)

The default value of FB\_DELAY [3:0] is 0100.

## **Color Space Converter Manual Adjust**

### **FB\_CSC\_MAN, Address 0xEE [7]**

As shown in Figure 9, the data from the CVBS and RGB sources are converted to YPbPr before being combined. For the RGB source, CSC must be used to perform this conversion. When SCART support is enabled, the parameters for CSC are automatically configured for this operation.

If the user wishes to use a different conversion matrix, this autoconfiguration can be disabled and the CSC can be manually programmed. For details on this manual configuration, contact an Analog Devices representative.

0 (default)—The CSC is configured automatically for the RGB-to-YPrPb conversion.

1—The CSC can be configured manually (not recommended).

**Table 16. FB\_STATUS Functions**

<b>FB_STATUS [3:0]</b>	<b>Bit Name</b>	<b>Description</b>
0	FB_STATUS.0	FB_RISE. A high value indicates that there has been a rising edge on FB since the last I <sup>2</sup> C read. The value is cleared by an I <sup>2</sup> C read (this is a self-clearing bit).
1	FB_STATUS.1	FB_FALL. A high value indicates that there has been a falling edge on FB since the last I <sup>2</sup> C read. The value is cleared by an I <sup>2</sup> C read (this is a self-clearing bit).
2	FB_STATUS.2	FB_STAT. The value of the FB input pin at the time of the read.
3	FB_STATUS.3	FB_HIGH. A high value indicates that there has been a rising edge on FB since the last I <sup>2</sup> C read. The value is cleared by an I <sup>2</sup> C read (this is a self-clearing bit).



## GLOBAL CONTROL REGISTERS

Register control bits listed in this section affect the whole chip.

### POWER-SAVING MODES

#### Power-Down

##### PDBP, Address 0x0F [2]

The digital core of the ADV7188 can be shut down by using the PWRDN pin or the PWRDN bit. The PDBP bit determines which of the two controls has the higher priority. The default is to give the pin ( $\overline{\text{PWRDN}}$ ) priority. This allows the user to have the ADV7188 powered down by default.

0 (default)—The digital core power is controlled by the PWRDN pin (the bit is disregarded).

1—The bit has priority (the pin is disregarded).

##### PWRDN, Address 0x0F [5]

Setting the PWRDN bit switches the ADV7188 into a chip-wide power-down mode. The power-down stops the clock from entering the digital section of the chip, thereby freezing its operation. No I<sup>2</sup>C bits are lost during power-down. The PWRDN bit also affects the analog blocks and switches them into low current modes. The I<sup>2</sup>C interface itself is unaffected and remains operational in power-down mode.

The ADV7188 leaves the power-down state if the PWRDN bit is set to 0 (via I<sup>2</sup>C) or if the overall part is reset using the RESET pin. Note that PDBP must be set to 1 for the PWRDN bit to power down the ADV7188.

0 (default)—The chip is operational.

1—The ADV7188 is in chip-wide power-down mode.

#### ADC Power-Down Control

The ADV7188 contains four 12-bit ADCs (ADC0, ADC1, ADC2, and ADC3). If required, it is possible to power down each ADC individually.

- In CVBS mode, ADC1 and ADC2 should be powered down to reduce power consumption.
- In S-video mode, ADC2 should be powered down to reduce power consumption.

##### PWRDN\_ADC\_0, Address 0x3A [3]

0 (default)—The ADC is in normal operation.

1—ADC0 is powered down.

##### PWRDN\_ADC\_1, Address 0x3A [2]

0 (default)—The ADC is in normal operation.

1—ADC1 is powered down.

##### PWRDN\_ADC\_2, Address 0x3A [1]

0 (default)—The ADC is in normal operation.

1—ADC2 is powered down.

##### PWRDN\_ADC\_3, Address 0x3A [0]

0 (default)—The ADC is in normal operation.

1—ADC3 is powered down.

##### FB\_PWRDN, Address 0x0F [1]

To achieve a very low power-down current, it is necessary to prevent activity on toggling input pins from reaching circuitry, where it could consume current. FB\_PWRDN gates signals from the FB input pin.

0 (default)—The FB input is in normal operation.

1—The FB input is in the power-saving mode.

### RESET CONTROL

#### RES, Chip Reset, Address 0x0F [7]

Setting this bit, which is equivalent to controlling the  $\overline{\text{RESET}}$  pin on the ADV7188, issues a chip reset. All I<sup>2</sup>C registers are reset to their default values, making these bits self-clearing. Some register bits do not have a reset value specified and instead keep the last value written to them. These bits are marked as having a reset value of x in the register tables. After the reset sequence, the part immediately starts to acquire the incoming video signal.

Executing a software reset takes approximately 2 ms. However, it is recommended to wait 5 ms before performing subsequent I<sup>2</sup>C writes.

The I<sup>2</sup>C master controller receives a no acknowledge condition on the ninth clock cycle when a chip reset is implemented. See the MPU Port Description section for a full description.

0 (default)—Operation is normal.

1—The reset sequence starts.

### GLOBAL PIN CONTROL

#### Three-State Output Drivers

##### TOD, Address 0x03 [6]

This bit allows the user to three-state the output drivers of the ADV7188. Upon setting the TOD bit, the P19 to P0, HS, VS, FIELD, and SFL pins are three-stated. The ADV7188 also supports three-stating via a dedicated pin,  $\overline{\text{OE}}$ . The output drivers are three-stated if the TOD bit or the  $\overline{\text{OE}}$  pin is set high.

The timing pins (HS, VS, and FIELD) can be forced active via the TIM\_OE bit of Register 0x04. For more information on three-state control, refer to the Three-State LLC Drivers and the Timing Signals Output Enable sections. Individual drive



# ADV7188

strength controls are provided by the DR\_STR\_S, DR\_STR\_C, and DR\_STR bits of Register 0xF4.

0 (default)—The output drivers are enabled.

1—The output drivers are three-stated.

## Three-State LLC Drivers

### TRI\_LLC, Address 0x1D [7]

This bit allows the output drivers for the LLC1 and LLC2 pins of the ADV7188 to be three-stated. For more information on three-state control, refer to the Three-State Output Drivers and the Timing Signals Output Enable sections. Individual drive strength controls are provided via the DR\_STR\_S, DR\_STR\_C, and DR\_STR bits.

0 (default)—The LLC pin drivers work according to the DR\_STR\_C [1:0] setting (pin enabled).

1—The LLC pin drivers are three-stated.

## Timing Signals Output Enable

### TIM\_OE, Address 0x04 [3]

The TIM\_OE bit should be regarded as an addition to the TOD bit. Setting it high forces the output drivers for HS, VS, and FIELD into the active (that is, driving) state even if the TOD bit is set. If the TIM\_OE bit is set to low, the HS, VS, and FIELD pins are three-stated depending on the TOD bit. This functionality is useful if the decoder is to be used only as a timing generator. This may be the case if only the timing signals are to be extracted from an incoming signal or if the part is in free-run mode, where, for example, a separate chip can output a company logo. For more information on three-state control, refer to the Three-State Output Drivers and the Three-State LLC Drivers sections. Individual drive strength controls are provided via the DR\_STR\_S, DR\_STR\_C, and DR\_STR bits.

0 (default)—HS, VS, and FIELD are three-stated according to the TOD bit.

1—HS, VS, and FIELD are forced active.

## Drive Strength Selection (Data)

### DR\_STR [1:0], Address 0xF4 [5:4]

Because of EMC and crosstalk factors, it may be desirable to strengthen or weaken the drive strength of the output drivers. The DR\_STR [1:0] bits affect the P [19:0] output drivers.

For more information on three-state control, refer to the Drive Strength Selection (Clock) and the Drive Strength Selection (Sync) sections.

Table 17. DR\_STR Function

DR_STR [1:0]	Description
01 (default)	Medium-low drive strength (2×)
10	Medium-high drive strength (3×)
11	High drive strength (4×)

## Drive Strength Selection (Clock)

### DR\_STR\_C [1:0], Address 0xF4 [3:2]

The DR\_STR\_C [1:0] bits can be used to select the strength of the clock signal output driver (LLC pin). For more information, refer to the Drive Strength Selection (Sync) and the Drive Strength Selection (Data) sections.

Table 18. DR\_STR\_C Function

DR_STR_C [1:0]	Description
01 (default)	Medium-low drive strength (2×)
10	Medium-high drive strength (3×)
11	High drive strength (4×)

## Drive Strength Selection (Sync)

### DR\_STR\_S [1:0], Address 0xF4 [1:0]

The DR\_STR\_S [1:0] bits allow the user to select the strength of the synchronization signals with which HS, VS, and FIELD are driven. For more information, refer to the Drive Strength Selection (Clock) and the Drive Strength Selection (Data) sections.

Table 19. DR\_STR\_S Function

DR_STR_S [1:0]	Description
01 (default)	Medium-low drive strength (2×)
10	Medium-high drive strength (3×)
11	High drive strength (4×)

## Enable Subcarrier Frequency Lock Pin

### EN\_SFL\_PIN, Address 0x04 [1]

The EN\_SFL\_PIN bit enables the output of subcarrier lock information (also known as genlock) from the ADV7188 core to an encoder in a decoder/encoder back-to-back arrangement.

0 (default)—The subcarrier frequency lock output is disabled.

1—The subcarrier frequency lock information is presented on the SFL pin.

## Polarity LLC Pin

### PCLK, Address 0x37 [0]

The polarity of the clock that leaves the ADV7188 via the LLC1 and LLC2 pins can be inverted using the PCLK bit. Changing the polarity of the LLC clock output may be necessary to meet the setup time and hold time expectations of follow-on chips. This bit also inverts the polarity of the LLC2 clock.

0—The LLC output polarity is inverted.

1 (default)—The LLC output polarity is normal, as per the timing diagrams (see Figure 2 to Figure 4).



## GLOBAL STATUS REGISTERS

Three registers provide summary information about the video decoder: Status Register 1, Status Register 2, and Status Register 3. These registers contain status bits that report operational information to the user.

### Status Register 1 [7:0], Address 0x10 [7:0]

This read-only register provides information about the internal status of the ADV7188. See the CIL [2:0], Count-Into-Lock, Address 0x51 [2:0] and the COL [2:0], Count-Out-of-Lock, Address 0x51 [5:3] sections for information on the timing.

Depending on the setting of the FSCLE bit, the IN\_LOCK [0] and LOST\_LOCK [1] bits of Status Register 1 are based solely on the horizontal timing information or on the horizontal timing and lock status of the color subcarrier. See the FSCLE, Fsc Lock Enable, Address 0x51 [7] section.

### AD\_RESULT [2:0], Autodetection Result, Address 0x10 [6:4]

These bits report the findings from the autodetection block. For more information on enabling the autodetection block, see the

**Table 21. Status Register 1 Function**

Status Register 1 [7:0]	Bit Name	Description
0	IN_LOCK	In lock (now)
1	LOST_LOCK	Lost lock (since last read of this register)
2	FSC_LOCK	Fsc locked (now)
3	FOLLOW_PW	AGC follows peak white algorithm.
4	AD_RESULT.0	Result of autodetection.
5	AD_RESULT.1	Result of autodetection.
6	AD_RESULT.2	Result of autodetection.
7	COL_KILL	Color kill is active

**Table 22. Status Register 2 Function**

Status Register 2 [7:0]	Bit Name	Description
0	MVCS_DET	Detected Macrovision color striping.
1	MVCS_T3	Macrovision color striping protection. Conforms to Type 3 if high, Type 2 if low.
2	MV_PS_DET	Detected Macrovision pseudosync pulses.
3	MV_AGC_DET	Detected Macrovision AGC pulses.
4	LL_NSTD	Line length is nonstandard.
5	FSC_NSTD	Fsc frequency is nonstandard
6	Reserved	
7	Reserved	

**Table 23. Status Register 3 Function**

Status Register 3 [7:0]	Bit Name	Description
0	INST_HLOCK	Horizontal lock indicator (instantaneous).
1	GEMD	Gemstar detect.
2	SD_OP_50HZ	Flags whether 50 Hz or 60 Hz is present at output.
3	CVBS	Indicates if a CVBS signal is detected in composite/S-video autodetection configuration
4	FREE_RUN_ACT	Indicates if the ADV7188 is in free-run mode. Outputs a blue screen by default. See the DEF_VAL_AUTO_EN, Default Value Automatic Enable, Address 0x0C [1] section for details about disabling this function.
5	STD_FLD_LEN	Field length is correct for currently selected video standard.
6	INTERLACED	Interlaced video detected (field sequence found).
7	PAL_SW_LOCK	Reliable sequence of swinging bursts detected.

General Setup section. For information on configuring this block, see the Autodetection of SD Modes section.

**Table 20. AD\_RESULT Function**

AD_RESULT [2:0]	Description
000	NTSC M/J
001	NTSC 443
010	PAL M
011	PAL 60
100	PAL B/G/H/I/D
101	SECAM
110	PAL Combination N
111	SECAM 525

### Status Register 2 [7:0], Address 0x12 [7:0]

See Table 22.

### Status Register 3 [7:0], Address 0x13 [7:0]

See Table 23.





## STANDARD DEFINITION PROCESSOR (SDP)

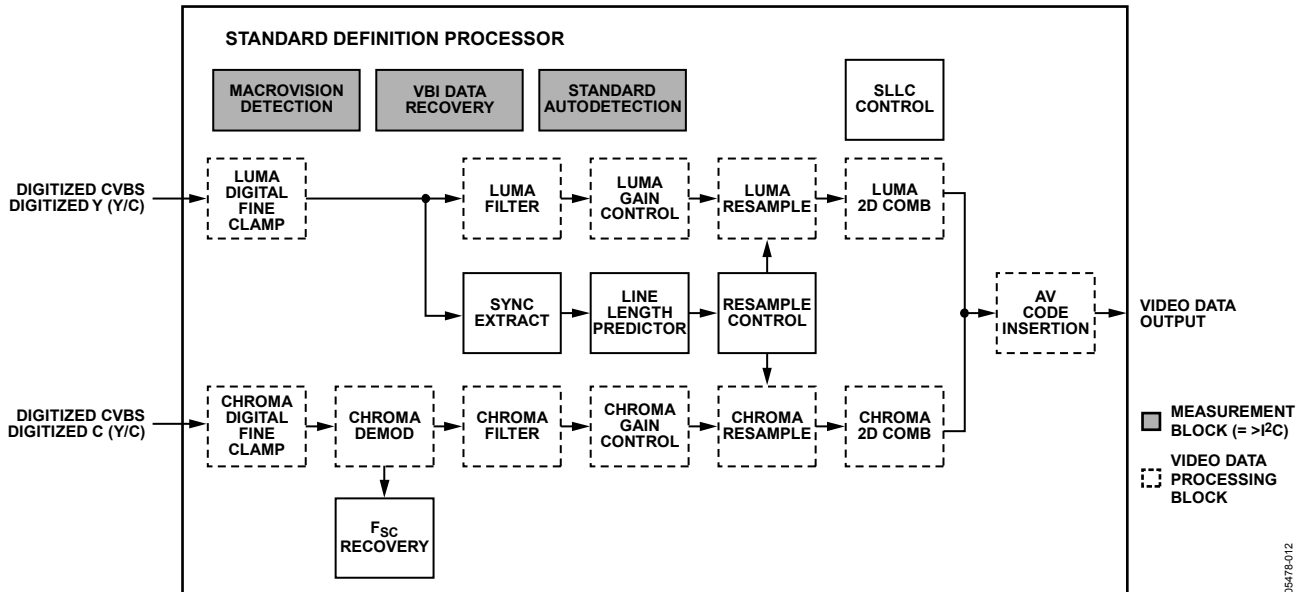


Figure 12. Block Diagram of the Standard Definition Processor

A block diagram of the ADV7188 standard definition processor (SDP) is shown in Figure 12.

The SDP can handle standard definition video in CVBS, Y/C, and YPrPb formats. It can be divided into a luminance path and a chrominance path. If the input video is of a composite type (CVBS), both processing paths are fed with the CVBS input.

### SD LUMA PATH

The input signal is processed by the following blocks:

- Luma Digital Fine Clamp. This block uses a high precision algorithm to clamp the video signal.
- Luma Filter. This block contains a luma decimation filter (YAA) with a fixed response and some luma-shaping filters (YSH) that have selectable responses.
- Luma Gain Control. The automatic gain control (AGC) can operate on a variety of modes, including a mode based on the depth of the horizontal sync pulse, a mode based on the peak white mode, and a mode that uses a fixed manual gain.
- Luma Resample. To correct for errors and dynamic changes in line lengths, the data is digitally resampled.
- Luma 2D Comb. The two-dimensional comb filter provides Y/C separation.
- AV Code Insertion. At this point, the decoded luma (Y) signal is merged with the retrieved chroma values. AV codes (as per ITU-R. BT-656) can be inserted.

### SD CHROMA PATH

The input signal is processed by the following blocks:

- Chroma Digital Fine Clamp. This block uses a high precision algorithm to clamp the video signal.
- Chroma Demodulation. This block uses a color subcarrier ( $F_{sc}$ ) recovery unit to regenerate the color subcarrier for any modulated chroma scheme and then performs an AM demodulation for PAL and NTSC and an FM demodulation for SECAM.
- Chroma Filter. This block contains a chroma decimation filter (CAA) with a fixed response and some chroma-shaping filters (CSH) that have selectable responses.
- Chroma Gain Control. Automatic gain control (AGC) can operate on several modes, including a mode based on the color subcarrier's amplitude, a mode based on the depth of the horizontal sync pulse on the luma channel, and a mode that uses a fixed manual gain.
- Chroma Resample. The chroma data is digitally resampled to keep it aligned with the luma data. The resampling is done to correct for static and dynamic errors in the line lengths of the incoming video signal.
- Chroma 2D Comb. The two-dimensional, 5-line, super-adaptive comb filter provides high quality Y/C separation in case the input signal is CVBS.
- AV Code Insertion. At this point, the demodulated chroma (Cr and Cb) signal is merged with the retrieved luma values. AV codes (as per ITU-R. BT-656) can be inserted.





## SYNC PROCESSING

The ADV7188 extracts syncs embedded in the video data stream. There is currently no support for external HS/VS inputs. The sync extraction is optimized to support imperfect video sources, such as videocassette recorders with head switches. The actual algorithm used employs a coarse detection based on a threshold crossing, followed by a more detailed detection using an adaptive interpolation algorithm. The raw sync information is sent to a line-length measurement and prediction block. The output of this block is then used to drive the digital resampling section to ensure that the ADV7188 outputs 720 active pixels per line.

The sync processing on the ADV7188 also includes the following specialized postprocessing blocks that filter and condition the raw sync information retrieved from the digitized analog video.

- Vsync Processor. This block provides extra filtering of the detected vsyncs to improve the vertical lock.
- Hsync Processor. The hsync processor is designed to filter incoming hsyncs that have been corrupted by noise, providing much improved performance for video signals with a stable time base but poor SNR.

## VBI DATA RECOVERY

The ADV7188 can retrieve the following information from the input video:

- Wide-screen signaling (WSS)
- Copy generation management system (CGMS)
- Closed captioning (CC)
- Macrovision protection presence
- Gemstar-compatible data slicing
- Teletext
- VITC/VPS

The ADV7188 is also capable of automatically detecting the incoming video standard with respect to

- Color subcarrier frequency
- Field rate
- Line rate

The ADV7188 can configure itself to support PAL (B/G/H/I/D/M/N), PAL Combination N, NTSC M, NTSC J, SECAM 50 Hz/60 Hz, NTSC 4.43, and PAL 60.

## GENERAL SETUP

### Video Standard Selection

The VID\_SEL [3:0] bits allow the user to force the digital core into a specific video standard. Under normal circumstances, this should not be necessary. The VID\_SEL [3:0] bits default to an autodetection mode that supports PAL, NTSC, SECAM, and variants thereof. The following section describes the autodetection system.

### Autodetection of SD Modes

To guide the autodetection system, individual enable bits are provided for each of the supported video standards. Setting the relevant bit to 0 inhibits the standard from being automatically detected. Instead, the system selects the closest of the remaining enabled standards. The results of the autodetection can be read back via the status registers. See the Global Status Registers section for more information.

### VID\_SEL [3:0], Address 0x00 [7:4]

Table 24. VID\_SEL Function

VID_SEL [3:0]	Description
0000 (default)	Autodetect PAL (B/G/H/I/D), NTSC (without pedestal), SECAM
0001	Autodetect PAL (B/G/H/I/D), NTSC M (with pedestal), SECAM
0010	Autodetect PAL N (without pedestal), NTSC M (without pedestal), SECAM
0011	Autodetect PAL N (with pedestal), NTSC M (with pedestal), SECAM
0100	NTSC J (1)
0101	NTSC M (1)
0110	PAL 60
0111	NTSC 4.43 (1)
1000	PAL B/G/H/I/D
1001	PAL N (PAL B/G/H/I/D without pedestal)
1010	PAL M (without pedestal)
1011	PAL M
1100	PAL Combination N
1101	PAL Combination N (with pedestal)
1110	SECAM
1111	SECAM (with pedestal)



# ADV7188

## **AD\_SEC525\_EN, SECAM 525 Autodetect Enable, Address 0x07 [7]**

0 (default)—Disables the autodetection of a 525-line system with a SECAM style, FM-modulated color component.

1—Enables autodetection.

## **AD\_SECAM\_EN, SECAM Autodetect Enable, Address 0x07 [6]**

0—Disables the autodetection of SECAM.

1 (default)—Enables autodetection.

## **AD\_N443\_EN, NTSC 443 Autodetect Enable, Address 0x07 [5]**

0—Disables the autodetection of NTSC style systems with a 4.43 MHz color subcarrier.

1 (default)—Enables autodetection.

## **AD\_P60\_EN, PAL 60 Autodetect Enable, Address 0x07 [4]**

0—Disables the autodetection of PAL systems with a 60 Hz field rate.

1 (default)—Enables autodetection.

## **AD\_PALN\_EN, PAL N Autodetect Enable, Address 0x07 [3]**

0—Disables the autodetection of the PAL N standard.

1 (default)—Enables autodetection.

## **AD\_PALM\_EN, PAL M Autodetect Enable, Address 0x07 [2]**

0—Disables the autodetection of PAL M.

1 (default)—Enables autodetection.

## **AD\_NTSC\_EN, NTSC Autodetect Enable, Address 0x07 [1]**

0—Disables the autodetection of standard NTSC.

1 (default)—Enables autodetection.

## **AD\_PAL\_EN, PAL (B/G/I/H) Autodetect Enable, Address 0x07 [0]**

0—Disables the autodetection of standard PAL.

1 (default)—Enables autodetection.

### **Subcarrier Frequency Lock Inversion**

The SFL\_INV bit of Register 0x41 controls the behavior of the PAL switch bit in the SFL (genlock telegram) data stream. It was implemented to solve some compatibility issues with video encoders. It solves two problems.

First, the PAL switch bit is only meaningful in PAL. Some encoders (including Analog Devices encoders) also look at the state of this bit in NTSC.

Second, there was a design change in Analog Devices encoders from ADV717x to ADV719x. The older versions used the SFL (genlock telegram) bit directly, whereas the more recent versions invert the bit prior to using it to compensate for the 1-line delay of an SFL (genlock telegram) transmission.

As a result, to be compatible with NTSC format, the PAL switch bit in the SFL (genlock telegram) must be 1 for ADV717x encoders and 0 for ADV7190/ADV7191/ADV7194 encoders. If the state of the PAL switch bit is set incorrectly, a 180° phase shift occurs.

In a decoder/encoder back-to-back system in which SFL is used, this bit must be set up properly for the specific encoder used.

### **SFL\_INV, Address 0x41 [6]**

0 (default)—Makes the part SFL compatible with ADV717x and ADV73xx encoders.

1—Makes the part SFL compatible with ADV7190/ADV7191/ADV7194 encoders.



**Lock-Related Controls**

Lock information is presented to the user through Bits [1:0] of Status Register 1. See the Status Register 1 [7:0], Address 0x10 [7:0] section. Figure 13 outlines the signal flow and the controls that are available to influence how the lock status information is generated.

**SRLS, Select Raw Lock Signal, Address 0x51 [6]**

Using the SRLS bit, the user can choose between two sources for determining the lock status, which is indicated via Status Register 1, Bits [1:0].

The TIME\_WIN signal is based on a line-to-line evaluation of the horizontal synchronization pulse of the incoming video. It reacts quickly.

The FREE\_RUN signal evaluates the properties of the incoming video over several fields, taking vertical synchronization information into account.

0 (default)—Selects the FREE\_RUN signal.

1—Selects the TIME\_WIN signal.

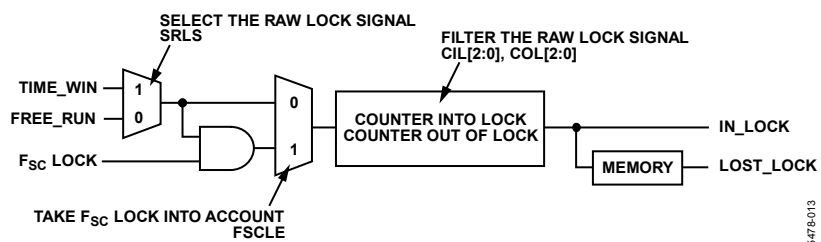


Figure 13. Lock-Related Signal Path

06478-013



# ADV7188

## FSCLE, F<sub>sc</sub> Lock Enable, Address 0x51 [7]

The FSCLE bit allows the user to choose if the status of the color subcarrier loop is taken into account when the overall lock status is determined and presented via Bits [1:0] in Status Register 1. The FSCLE bit must be set to 0 when operating in YPrPb (component) mode to generate a reliable horizontal lock status bit (INST\_HLOCK).

0 (default)—Makes the overall lock status dependent on the horizontal sync lock.

1—Makes the overall lock status dependent on the horizontal sync lock and the F<sub>sc</sub> lock.

## CIL [2:0], Count-Into-Lock, Address 0x51 [2:0]

CIL [2:0] determines the number of consecutive lines the system must remain in the into-lock condition before reporting a locked state in Status Register 1 [1:0]. It counts the value in lines of video.

**Table 25. CIL [2:0] Function**

CIL [2:0]	Description
000	1 line of video
001	2 lines of video
010	5 lines of video
011	10 lines of video
100 (default)	100 lines of video
101	500 lines of video
110	1000 lines of video
111	100,000 lines of video

## COL [2:0], Count-Out-of-Lock, Address 0x51 [5:3]

COL [2:0] determines the number of consecutive lines the system must be in the out-of-lock condition before reporting an unlocked state in Status Register 0 [1:0]. It counts the value in lines of video.

**Table 26. COL [2:0] Function**

COL [2:0]	Description
000	1 line of video
001	2 lines of video
010	5 lines of video
011	10 lines of video
100 (default)	100 lines of video
101	500 lines of video
110	1000 lines of video
111	100,000 lines of video

## VS\_COAST\_MODE [1:0], Address 0xF9 [3:2]

These bits are used to set the VS free-run (coast) frequency.

**Table 27. VS\_COAST\_MODE [1:0] Function**

VS_COAST_MODE [1:0]	Description
00 (default)	Autocoast mode—follows VS frequency from last video input
01	Forces 50 Hz coast mode
10	Forces 60 Hz coast mode
11	Reserved

## ST\_NOISE\_VLD, Sync Tip Noise Measurement Valid, Address 0xDE [3], Read Only

This read-only bit measures whether ST\_NOISE is valid or invalid.

0—The ST\_NOISE [10:0] measurement is invalid.

1 (default)—The ST\_NOISE [10:0] measurement is valid.

## ST\_NOISE [10:0], Sync Tip Noise Measurement, Addresses 0xDE [2:0], 0xDF [7:0]

The ST\_NOISE [10:0] measures the noise in the horizontal sync tip over four fields and shows a readback value of the average noise. ST\_NOISE\_VLD must be 1 for this measurement to be valid.

One bit of ST\_NOISE [10:0] = one ADC code.

One bit of ST\_NOISE [10:0] = 1.6 V/4096 = 390.625  $\mu$ V.

## COLOR CONTROLS

These registers allow the user to control the appearance of the picture, including control of the active data in the event of video being lost. These controls are independent of any other control. For instance, brightness control is independent of picture clamping, although both controls affect the dc level of the signal.

## CON [7:0], Contrast Adjust, Address 0x08 [7:0]

These bits allow the user to adjust the contrast of the picture.

**Table 28. CON [7:0] Function**

CON [7:0]	Description
0x80 (default)	Gain on luma channel = 1
0x00	Gain on luma channel = 0
0xFF	Gain on luma channel = 2

## SD\_SAT\_CB [7:0], SD Saturation Cb Channel, Address 0xE3 [7:0]

These bits allow the user to control only the gain of the Cb channel. The user can adjust the saturation of the picture.

**Table 29. SD\_SAT\_CB [7:0] Function**

SD_SAT_CB [7:0]	Description
0x80 (default)	Gain on Cb channel = 1
0x00	Gain on Cb channel = 0
0xFF	Gain on Cb channel = 2

## SD\_SAT\_CR [7:0], SD Saturation Cr Channel, Address 0xE4 [7:0]

These bits allow the user to control only the gain of the Cr channel. The user can adjust the saturation of the picture.

**Table 30. SD\_SAT\_CR [7:0] Function**

SD_SAT_CR [7:0]	Description
0x80 (default)	Gain on Cr channel = 1
0x00	Gain on Cr channel = 0
0xFF	Gain on Cr channel = 2



**SD\_OFF\_CB [7:0], SD Offset Cb Channel, Address 0xE1 [7:0]**

These bits allow the user to adjust the hue of the picture by selecting the offset for the Cb channel. There is a functional overlap with the HUE [7:0] bits.

**Table 31. SD\_OFF\_CB [7:0] Function**

SD_OFF_CB [7:0]	Description
0x80 (default)	0 mV offset applied to the Cb channel
0x00	-568 mV offset applied to the Cb channel
0xFF	+568 mV offset applied to the Cb channel

**SD\_OFF\_CR [7:0], SD Offset Cr Channel, Address 0xE2 [7:0]**

These bits allow the user to select an offset for data on only the Cr channel and to adjust the hue of the picture. There is a functional overlap with the HUE [7:0] bits.

**Table 32. SD\_OFF\_CR [7:0] Function**

SD_OFF_CR [7:0]	Description
0x80 (default)	0 mV offset applied to the Cr channel
0x00	-568 mV offset applied to the Cr channel
0xFF	+568 mV offset applied to the Cr channel

**BRI [7:0], Brightness Adjust, Address 0x0A [7:0]**

These bits control the brightness of the video signal and allow the user to adjust the brightness of the picture.

**Table 33. BRI [7:0] Function**

BRI [7:0]	Description
0x00 (default)	Offset of the luma channel = 0 mV
0x7F	Offset of the luma channel = +204 mV
0x80	Offset of the luma channel = -204 mV

**HUE [7:0], Hue Adjust, Address 0x0B [7:0]**

These bits contain the value for the color hue adjustment and allow the user to adjust the hue of the picture.

HUE [7:0] has a range of  $\pm 90^\circ$ , with a value of 0x00 equivalent to an adjustment of  $0^\circ$ . The resolution of HUE [7:0] for one bit is  $0.7^\circ$ .

The hue adjustment value is fed into the AM color demodulation block. Therefore, it only applies to video signals that contain chroma information in the form of an AM-modulated carrier (CVBS or Y/C in PAL or NTSC). It does not affect SECAM and does not work on component video inputs (YPrPb).

**Table 34. HUE [7:0] Function**

HUE [7:0]	Description
0x00 (default)	Phase of the chroma signal = $0^\circ$
0x7F	Phase of the chroma signal = $+90^\circ$
0x80	Phase of the chroma signal = $-90^\circ$

**DEF\_Y [5:0], Default Value Y, Address 0x0C [7:2]**

If the ADV7188 loses lock to the incoming video signal or if there is no input signal, the DEF\_Y [5:0] bits allow the user to specify a default luma value to be output. The register is used if

- The DEF\_VAL\_AUTO\_EN bit is set high and the ADV7188 loses lock to the input video signal. This is the intended mode of operation (automatic mode).
- The DEF\_VAL\_EN bit is set regardless of the lock status of the video decoder. This is a forced mode that may be useful during configuration.

The DEF\_Y [5:0] values define the six MSBs of the output video. The remaining LSBs are padded with 0s. For example, in 10-bit mode, the output is  $Y [9:0] = \{\text{DEF\_Y [5:0]}, 0, 0, 0, 0\}$ .

The value for Y is set by the DEF\_Y [5:0] bits. A value of 0x0D in conjunction with the DEF\_C [7:0] default setting produces a blue color.

Register 0x0C has a default value of 0x36.

**DEF\_C [7:0], Default Value C, Address 0x0D [7:0]**

The DEF\_C [7:0] bits complement the DEF\_Y [5:0] bits. These bits define the four MSBs of the Cr and Cb values to be output if

- The DEF\_VAL\_AUTO\_EN bit is set high and the ADV7188 cannot lock to the input video (automatic mode).
- The DEF\_VAL\_EN bit is set high (forced output).

The data that is finally output from the ADV7188 for the chroma side is the output pixel buses  $Cr [7:0] = \{\text{DEF\_C [7:4]}, 0, 0, 0, 0\}$  and  $Cb [7:0] = \{\text{DEF\_C [3:0]}, 0, 0, 0, 0\}$ .

In full 12-bit output mode, two extra LSBs of value 00 are appended.

The values for Cr and Cb are set by the DEF\_C [7:0] bits. A value of 0x7C in conjunction with the DEF\_Y [5:0] default setting produces a blue color.

**DEF\_VAL\_EN, Default Value Enable, Address 0x0C [0]**

This bit forces the use of the default values for Y, Cr, and Cb. Refer to the descriptions in the DEF\_Y [5:0], Default Value Y, Address 0x0C [7:2] and DEF\_C [7:0], Default Value C, Address 0x0D [7:0] sections for additional information. In this mode, the decoder also outputs a stable 27 MHz clock, HS, and VS.

0 (default)—Outputs a colored screen determined by user-programmable Y, Cr, and Cb values when the decoder free runs. Free-run mode is turned on and off via DEF\_VAL\_AUTO\_EN.

1—Forces a colored screen output determined by user-programmable Y, Cr, and Cb values. This overrides picture data even if the decoder is locked.



# ADV7188

## **DEF\_VAL\_AUTO\_EN, Default Value Automatic Enable, Address 0x0C [1]**

This bit enables the automatic use of the default values for Y, Cr, and Cb when the ADV7188 cannot lock to the video signal.

0—Disables free-run mode. If the decoder is unlocked, it outputs noise.

1 (default)—Enables free-run mode. A colored screen set by the user-programmable Y, Cr, and Cb values is displayed when the decoder loses lock.

## **CLAMP OPERATION**

The input video is ac-coupled into the ADV7188 through a 0.1  $\mu\text{F}$  capacitor. It is recommended that the range of the input video signal is 0.5 V to 1.6 V (typically 1 V p-p). If the signal exceeds this range, it cannot be processed correctly in the decoder. Because the input signal is ac-coupled into the decoder, its dc value needs to be restored. This process is referred to as clamping the video. This section explains the general process of clamping for the ADV7188 and shows the different ways that a user can configure the device's behavior.

The ADV7188 uses a combination of current sources and a digital processing block for clamping, as shown in Figure 14. There are three analog processing channels (like the one shown in Figure 14) inside the IC. Although only one channel (and only one ADC) is needed for a CVBS signal, two independent channels are needed for S-video (Y/C) type signals, and three independent channels are needed to allow component (YPrPb) signals to be processed.

The clamping can be divided into two sections:

- Clamping before the ADC (analog domain): current sources
- Clamping after the ADC (digital domain): digital processing block

The ADCs can digitize an input signal only if it is within the 1.6 V input voltage range. An input signal with a dc level that is too large or too small is clipped at the top or bottom of the ADC range.

The primary task of the analog clamping circuits is to ensure that the video signal stays within the valid ADC input window so that the analog-to-digital conversion can occur. Therefore, precise clamping of the input signal within the analog domain is unnecessary if the video signal fits within the ADC range.

After digitization, the digital fine-clamp block corrects for any remaining variations in dc level. Because the dc level of an input video signal refers directly to the brightness of the picture transmitted, it is important to perform a fine clamp with high accuracy; otherwise, brightness variations may occur. Furthermore, dynamic changes in the dc level usually lead to significant artifacts and must therefore be prohibited.

The clamping scheme must be able to acquire a newly connected video signal with a completely unknown dc level, and it must maintain the dc level during normal operation.

To quickly acquire an unknown video signal, activate the large-current clamps. It is assumed that the amplitude of the video signal at this point is of a nominal value. Control of the coarse- and fine-current clamp parameters is automatically performed by the decoder.

Standard definition video signals may contain excessive noise. In particular, CVBS signals transmitted by terrestrial broadcast and then demodulated using a tuner usually show very large levels of noise (>100 mV). A voltage clamp would be unsuitable for this type of video signal. Instead, the ADV7188 uses a set of four current sources that can cause coarse (>0.5 mA) and fine (<0.1 mA) currents to flow into and away from the high impedance node that carries the video signal (see Figure 14).

CCLEN, DCT [1:0], DCFE are the I<sup>2</sup>C signals that can be used to influence the behavior of the clamping block of the ADV7188.

## **CCLEN, Current Clamp Enable, Address 0x14 [4]**

The current clamp enable bit allows the user to switch off the current sources entirely in the analog front end. This may be useful if the incoming analog video signal is clamped externally.

0—The current sources are switched off.

1 (default)—The current sources are enabled.

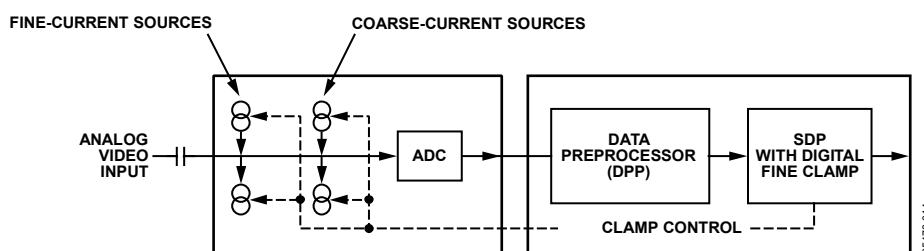


Figure 14. Clamping Overview





**DCT [1:0], Digital Clamp Timing, Address 0x15 [6:5]**

The clamp timing register determines the time constant of the digital fine-current clamp circuitry. It is important to realize that the digital fine-current clamp reacts quickly, correcting any residual dc level error for the active line immediately. Therefore, the time constant of the digital fine clamp must be much quicker than the one for the analog blocks.

By default, the time constant of the digital fine-current clamp is adjusted dynamically to suit the currently connected input signal.

**Table 35. DCT [1:0] Function**

DCT [1:0]	Description
00 (default)	Slow (TC = 1 sec)
01	Medium (TC = 0.5 sec)
10	Fast (TC = 0.1 sec)
11	TC determined by the input video parameters

**DCFE, Digital Clamp Freeze Enable, Address 0x15 [4]**

This register bit allows the user to freeze the digital clamp loop at any time. It is intended for users who do their own clamping. Users should disable the current sources for analog clamping via the appropriate register bits, wait until the digital clamp loop settles, and then freeze it via the DCFE bit.

0 (default)—The digital clamp is operational.

1—The digital clamp loop is frozen.

**LUMA FILTER**

Data from the digital fine-clamp block is processed by three sets of filters. The data format at this point is CVBS for CVBS input format or luma only for Y/C and YPrPb input formats.

- Luma Antialias (YAA) Filter. The ADV7188 receives video at a rate of 27 MHz. (For 4× oversampled video, the ADCs are sample at 54 MHz, and the first decimation is performed inside the DPP filters. Therefore, the data rate into the ADV7188 is always 27 MHz.) The ITU-R BT.601 standard recommends a sampling frequency of 13.5 MHz. The luma antialias filter decimates the oversampled video using a high quality linear phase, low-pass filter that preserves the luma signal and simultaneously attenuates out-of-band components. The luma antialias filter has a fixed response.
- Luma-Shaping (YSH) Filters. The shaping filter block is a programmable low-pass filter with a wide variety of responses. It can be used to selectively reduce the luma video signal bandwidth (needed prior to scaling, for example). For some video sources that contain high frequency noise, reducing the bandwidth of the luma signal improves visual picture quality. A follow-on video compression stage may work more efficiently if the video is low-pass filtered.

The ADV7188 has two responses for the shaping filter: one that is used for good quality composite, component, and

S-video type sources, and a second for nonstandard composite signals. The YSH filter responses also include a set of notches for PAL and NTSC. However, it is recommended to use the comb filters for Y/C separation.

- Digital Resampling Filter. This block allows dynamic resampling of the video signal to alter parameters such as the time base of a line of video. Fundamentally, the resampler is a set of low-pass filters. The actual response is chosen by the system without requiring user intervention.

Figure 16 through Figure 19 show the responses of all luma filters. Unless otherwise noted, the filters are set in a typical wideband mode.

**Y-Shaping Filter**

For input signals in CVBS format, the luma-shaping filters play an essential role in removing the chroma component from a composite signal. Y/C separation must aim for best possible crosstalk reduction while retaining as much bandwidth (especially on the luma component) as possible. High quality Y/C separation can be achieved by using the internal comb filters of the ADV7188. Comb filtering, however, relies on the frequency relationship of the luma component (multiples of the video line rate) and the color subcarrier ( $F_{sc}$ ). For good quality CVBS signals, this relationship is known and therefore the comb filter algorithms can be used to separate luma and chroma with high accuracy.

For nonstandard video signals, the frequency relationship may have an offset, and the comb filters may not be able to remove all crosstalk artifacts in an optimum fashion without the assistance of a shaping filter.

An automatic mode is provided. In this mode, the ADV7188 evaluates the quality of the incoming video signal and selects the filter responses in accordance with the signal quality and video standard. YFSM, WYSFMOVR, and WYSFM allow the user to override the automatic decisions manually in part or in full (see Figure 15).

The luma-shaping filter has three sets of control bits:

- YFSM [4:0] (Address 0x17) allow the user to manually select a shaping filter mode (applied to all video signals) or to enable an automatic selection (dependent on video quality and video standard).
- WYSFMOVR (Address 0x18) allows the user to override the automatic WYSFM filter selection and enable manual selection of the WYSFM filter via WYSFM [4:0].
- WYSFM [4:0] (Address 0x18) allow the user to select a different shaping filter mode for good quality composite (CVBS), component (YPrPb), and S-video (Y/C) input signals.



In automatic mode, the system preserves the maximum possible bandwidth for good CVBS sources (because they can successfully be combed) and for luma components of YPrPb and Y/C sources (because they need not be combed). For poor quality signals, the system selects from a set of proprietary shaping filter responses that complements comb filter operation to reduce visual artifacts. The control logic is shown in Figure 15.

### YSFM [4:0], Y-Shaping Filter Mode, Address 0x17 [4:0]

The Y-shaping filter mode bits allow the user to select from a wide range of low-pass and notch filters. When these bits are set to either of the automatic selection modes, the filter is selected based on other bit selections, such as detected video standard, and properties extracted from the incoming video itself, such as quality and time-base stability. The automatic selection always picks the widest possible bandwidth for the video input encountered.

If the YSFM settings specify a filter (that is, YSFM is set to values other than 00000 or 00001), the chosen filter is applied to all video, regardless of its quality.

In either of the automatic selection modes, the notch filters are only used for poor quality video signals. For all other video signals, wideband filters are used (see Table 36).

**Table 36. YSFM Function**

YSFM [4:0]	Description
00000	Automatic selection, including a wide-notch response (PAL/NTSC/SECAM)
00001 (default)	Automatic selection, including a narrow-notch response (PAL/NTSC/SECAM)
00010	SVHS 1
00011	SVHS 2
00100	SVHS 3
00101	SVHS 4
00110	SVHS 5
00111	SVHS 6
01000	SVHS 7
01001	SVHS 8
01010	SVHS 9
01011	SVHS 10
01100	SVHS 11
01101	SVHS 12
01110	SVHS 13
01111	SVHS 14
10000	SVHS 15
10001	SVHS 16
10010	SVHS 17
10011	SVHS 18 (CCIR 601)
10100	PAL NN 1
10101	PAL NN 2
10110	PAL NN 3
10111	PAL WN 1
11000	PAL WN 2
11001	NTSC NN 1
11010	NTSC NN 2
11011	NTSC NN 3
11100	NTSC WN 1
11101	NTSC WN 2
11110	NTSC WN 3
11111	Reserved

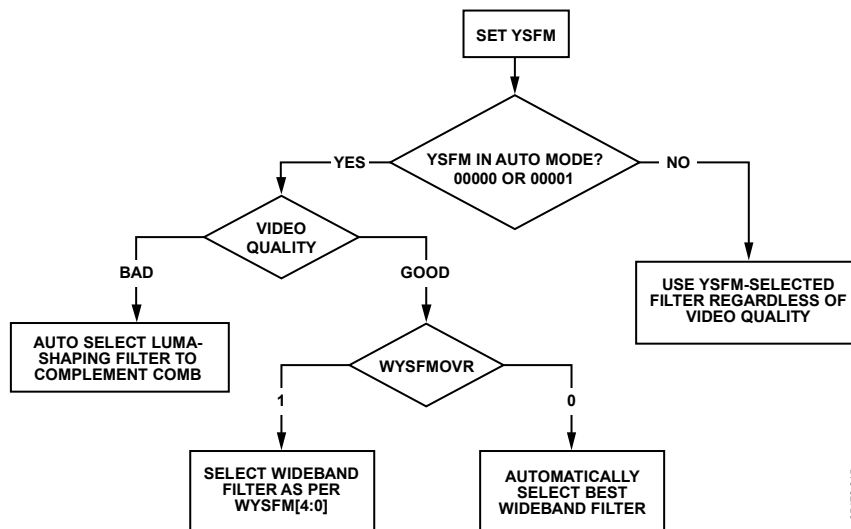


Figure 15. YSFM and WYSFM Control Flowchart



**WYSFMOVR, Wideband Y-Shaping Filter Override,  
Address 0x18 [7]**

Setting the WYSFMOVR bit enables the use of the WYSFM [4:0] settings for good quality video signals. For more information, refer to the general discussion of the luma-shaping filters in the Y-Shaping Filter section and the flowchart shown in Figure 15.

0—The best wideband Y-shaping filter for good quality video signals is selected automatically.

1 (default)—Enables manual selection of a wideband filter via WYSFM [4:0].

**WYSFM [4:0], Wideband Y-Shaping Filter Mode,  
Address 0x18 [4:0]**

The WYSFM [4:0] bits allow the user to select a wideband Y-shaping filter manually for good quality video signals, for example, CVBS with a stable time base, a luma component of YPrPb, or a luma component of Y/C. The WYSFM bits are active only if the WYSFMOVR bit is set to 1. See the general discussion of the shaping filter settings in the Y-Shaping Filter section.

**Table 37. WYSFM [4:0] Function**

WYSFM [4:0]	Description
00000	Reserved; do not use
00001	Reserved; do not use
00010	SVHS 1
00011	SVHS 2
00100	SVHS 3
00101	SVHS 4
00110	SVHS 5
00111	SVHS 6
01000	SVHS 7
01001	SVHS 8
01010	SVHS 9
01011	SVHS 10
01100	SVHS 11
01101	SVHS 12
01110	SVHS 13
01111	SVHS 14
10000	SVHS 15
10001	SVHS 16
10010	SVHS 17
10011 (default)	SVHS 18 (CCIR 601)
10100 to 11111	Reserved; do not use

Figure 16 shows the filter responses of the SVHS 1 (narrowest) to SVHS 18 (widest) shaping filter settings, Figure 18 shows the PAL notch filter responses, and Figure 19 shows the NTSC notch filter responses.

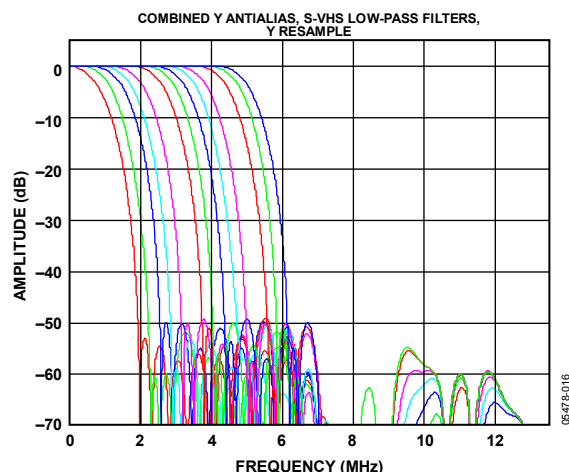


Figure 16. Y SVHS 1 to SVHS 18 Filter Responses

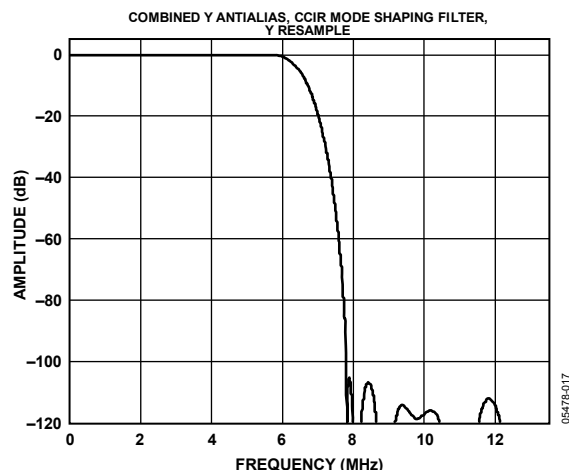


Figure 17. Y SVHS 18 Extra Wideband Filter (CCIR 601 Compliant)

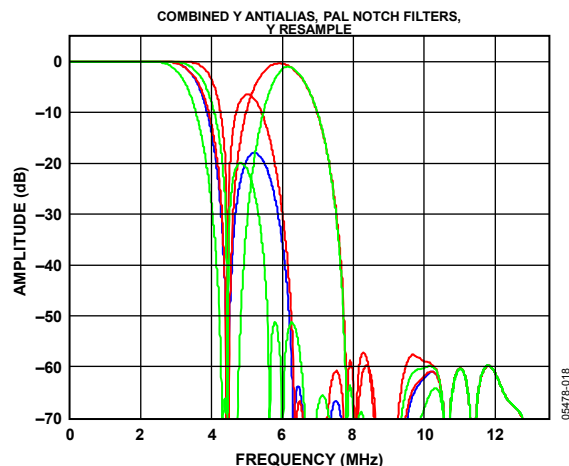


Figure 18. Y PAL Notch Filter Responses



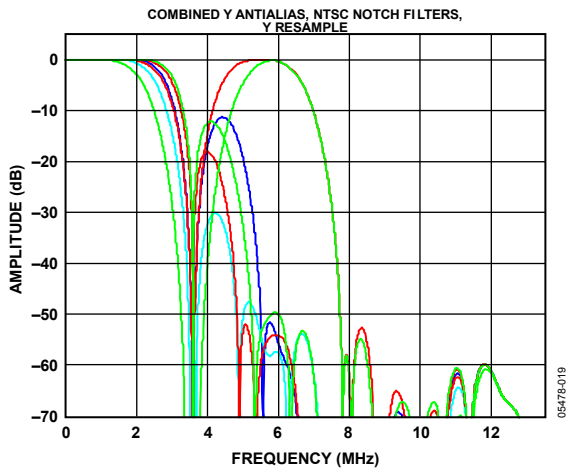


Figure 19. Y NTSC Notch Filter Responses

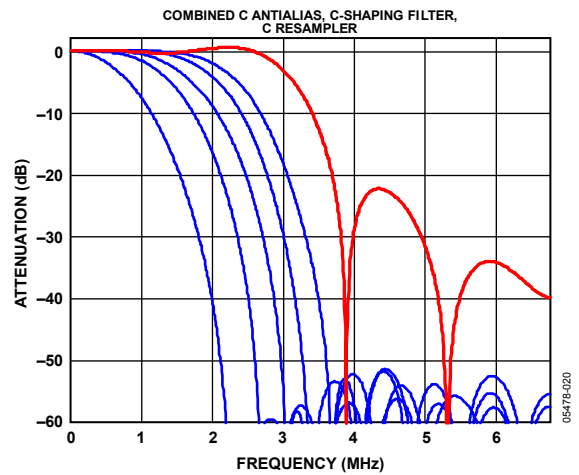


Figure 20. Chroma-Shaping Filter Responses

## CHROMA FILTER

Data from the digital fine-clamp block is processed by three sets of filters. The data format at this point is CVBS for CVBS inputs, chroma only for Y/C, or Cr/Cb interleaved for YPrPb input formats.

- Chroma Antialias (CAA) Filter. The ADV7188 oversamples the CVBS by a factor of 2 and the chroma or Cr/Cb by a factor of 4. CAA, a decimating filter, is used to preserve the active video band and to remove any out-of-band components. The CAA filter has a fixed response.
- Chroma-Shaping (CSH) Filters. These filters can be programmed to perform a variety of low-pass responses. They can be used to selectively reduce the bandwidth of the chroma signal for scaling or compression.
- Digital Resampling Filter. This filter is used to allow dynamic resampling of the video signal to alter parameters, such as the time base of a line of video. Fundamentally, the resampler is a set of low-pass filters. The actual response is chosen by the system without user intervention.

Figure 20 shows the overall response of all filters, from SH1 (narrowest) to SH5 (widest), in addition to the wideband mode (in red).

### CSFM [2:0], C-Shaping Filter Mode, Address 0x17 [7:5]

The C-shaping filter mode bits allow the user to select from a range of low-pass filters for the chrominance signal.

Table 38. CSFM [2:0] Function

CSFM [2:0]	Description
000 (default)	1.5 MHz bandwidth filter
001	2.17 MHz bandwidth filter
010	SH1
011	SH2
100	SH3
101	SH4
110	SH5
111	Wideband mode



## GAIN OPERATION

The gain control within the ADV7188 is done on a purely digital basis. The input ADCs support a 12-bit range, mapped into a 1.6 V analog voltage range. Gain correction takes place after the digitization in the form of a digital multiplier.

This architecture is advantageous because, unlike the commonly used programmable gain amplifier (PGA) placed in front of the ADCs, the gain is completely independent of supply, temperature, and process variations.

As shown in Figure 21, the ADV7188 can decode a video signal as long as it fits into the ADC window.

The two components of decoding a video signal are the amplitude of the input signal and the dc level on which it resides. The dc level is set by the clamping circuitry (see the Clamp Operation section).

If the amplitude of the analog video signal is too high, clipping can occur, resulting in visual artifacts. The analog input range of the ADC, together with the clamp level, determines the maximum supported amplitude of the video signal.

The minimum supported amplitude of the input video is determined by the ability of the ADV7188 to retrieve horizontal and vertical timing and to lock to the color burst, if present.

There are separate gain control units for luma and chroma data. Both can operate independently of each other. The chroma unit, however, can also take its gain value from the luma path.

The possible AGC modes are summarized in Table 39.

It is possible to freeze the automatic gain control loops. This causes the loops to stop updating and maintains the AGC-determined gain that is active at the time of the freeze until the loop is either unfrozen or the gain mode of operation is changed.

The currently active gain from any of the modes can be read back. Refer to the description of the dual-function manual gain bits, LMG [11:0] luma manual gain and CMG [11:0] chroma manual gain, in the Luma Gain and the Chroma Gain sections.

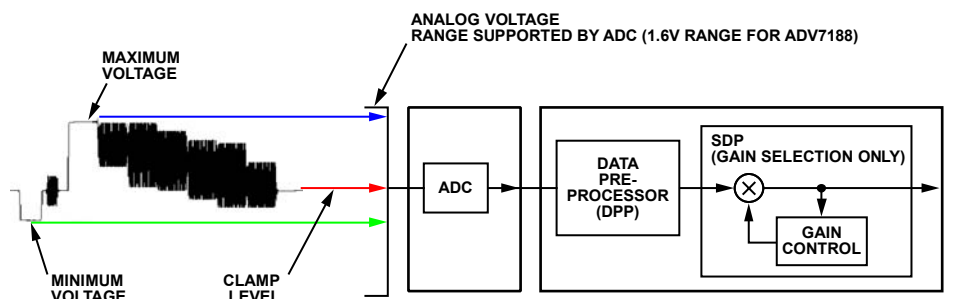


Figure 21. Gain Control Overview

Table 39. AGC Modes

Input Video Type	Luma Gain	Chroma Gain
Any	Manual luma gain	Manual chroma gain
CVBS	Dependent on horizontal sync depth	Dependent on color burst amplitude
	Peak white	Taken from luma path
	Dependent on color burst amplitude	Dependent on color burst amplitude
Y/C	Taken from luma path	Dependent on color burst amplitude
	Dependent on horizontal sync depth	Taken from luma path
	Peak white	Dependent on color burst amplitude
	Dependent on color burst amplitude	Taken from luma path
YPrPb	Dependent on horizontal sync depth	Taken from luma path



## Luma Gain

**LAGC [2:0], Luma Automatic Gain Control, Address 0x2C [6:4]**

The luma automatic gain control mode bits select the mode of operation for the gain control in the luma path.

Analog Devices internal parameters can be used to customize the peak white gain control. Contact an Analog Devices representative for more information.

**Table 40. LAGC [2:0] Function**

LAGC [2:0]	Description
000	Manual fixed gain (use LMG [11:0])
001	Reserved
010 (default)	AGC peak white algorithm enabled (blank level to sync tip)
011	Reserved
100	AGC peak white algorithm disabled (blank level to sync tip)
101	Reserved
110	Reserved
111	Freeze gain

**LAGT [1:0], Luma Automatic Gain Timing, Address 0x2F [7:6]**

The luma automatic gain timing bits allow the user to influence the tracking speed of the luminance automatic gain control.

Note that these bits only have an effect if the LAGC [2:0] bits are set to 010 or 100 (automatic gain control modes).

If peak white AGC is enabled and active (see the Status Register 1 [7:0], Address 0x10 [7:0] section), the actual gain update speed is dictated by the peak white AGC loop and, as a result, the LAGT settings have no effect. As soon as the part leaves peak white AGC, LAGT becomes relevant.

The update speed for the peak white algorithm can be customized by using internal parameters. Contact an Analog Devices representative for more information.

**Table 41. LAGT [1:0] Function**

LAGT [1:0]	Description
00	Slow (TC = 2 sec)
01	Medium (TC = 1 sec)
10	Fast (TC = 0.2 sec)
11 (default)	Adaptive

**LMG [11:0]/LG [11:0], Luma Manual Gain/Luma Gain, Address 0x2F [3:0], Address 0x30 [7:0]**

Luma manual gain [11:0] are dual-function bits. If these bits are written to, a desired manual luma gain can be programmed. This gain becomes active if the LAGC [2:0] mode is switched to manual fixed gain. Equation 2 and Equation 3 show how to calculate a desired gain for NTSC and PAL standards, respectively.

$$NTSC \text{ Luma\_Gain} = \frac{1024 < LMG [11:0] \leq 4095}{1128} = 0.9078 \dots 3.63 \quad (2)$$

$$PAL \text{ Luma\_Gain} = \frac{1024 < LMG [11:0] \leq 4095}{1222} = 0.838 \dots 3.351 \quad (3)$$

If read back, this register returns the current gain value. Depending on the settings of the LAGC [2:0] bits, this value is one of the following:

- Luma manual gain value (LAGC [2:0] set to luma manual gain mode)
- Luma automatic gain value (LAGC [2:0] set to any of the automatic modes)

**Table 42. LG [11:0]/LMG [11:0] Function**

LG [11:0]/LMG [11:0]	Read/Write	Description
LMG [11:0] = X	Write	Manual gain for luma path
LG [11:0]	Read	Actual gain used

For example, to program the ADV7188 into manual fixed gain mode with a desired gain of 0.89 for the NTSC standard:

1. Use Equation 2 to convert the gain:  
 $0.95 \times 1128 = 1071.6$
2. Truncate to integer value:  
 $1071.6 = 1071$
3. Convert to hexadecimal:  
 $1071d = 0x42F$
4. Split into two registers and program:  
Luma Gain Control 1 [3:0] = 0x4  
Luma Gain Control 2 [7:0] = 0x2F
5. Enable manual fixed gain mode:  
Set LAGC [2:0] to 000



## BETACAM, Enable BETACAM Levels, Address 0x01 [5]

If YPrPb data is routed through the ADV7188, the automatic gain control modes can target different video input levels, as outlined in Table 44. Note that the BETACAM bit is valid only if the input mode is YPrPb (component). The BETACAM bit sets the target value for AGC operation.

A review of the following sections is useful:

- The INSEL [3:0], Input Selection, Address 0x00 [3:0] section describes how component video (YPrPb) can be routed through the ADV7188.
- The Video Standard Selection section describes the various standards, for example, with and without pedestal.

The automatic gain control (AGC) algorithms adjust the levels based on the setting of the BETACAM bit.

**Table 43. BETACAM Function**

BETACAM	Description
0 (default)	Standard video input (assuming YPrPb is selected as input format) Selecting PAL with pedestal selects MII Selecting PAL without pedestal selects SMPTE Selecting NTSC with pedestal selects MII Selecting NTSC without pedestal selects SMPTE
1	BETACAM input enable (assuming YPrPb is selected as input format) Selecting PAL with pedestal selects BETACAM Selecting PAL without pedestal selects BETACAM variant Selecting NTSC with pedestal selects BETACAM Selecting NTSC without pedestal selects BETACAM variant

**Table 44. BETACAM Levels**

Name	BETACAM (mV)	BETACAM Variant (mV)	SMPTE (mV)	MIl (mV)
Y Range	0 to 714 (including 7.5% pedestal)	0 to 714	0 to 700	0 to 700 (including 7.5% pedestal)
Pr and Pb Ranges	−467 to +467	−505 to +505	−350 to +350	−324 to +324
Sync Depth	286	286	300	300

## PW\_UPD, Peak White Update, Address 0x2B [0]

The peak white and average video algorithms determine the gain based on measurements taken from the active video. The PW\_UPD bit determines the rate of gain change. LAGC [2:0] must be set to the appropriate mode to enable the peak white or average video mode.

For more information, refer to the LAGC [2:0], Luma Automatic Gain Control, Address 0x2C [6:4] section.

0—Updates the gain once per video line.

1 (default)—Updates the gain once per field.



# ADV7188

## Chroma Gain

### CAGC [1:0], Chroma Automatic Gain Control, Address 0x2C [1:0]

These two bits select the basic mode of operation for automatic gain control in the chroma path.

**Table 45. CAGC [1:0] Function**

CAGC [1:0]	Description
00	Manual fixed gain (use CMG [11:0])
01	Use luma gain for chroma
10 (default)	Automatic gain (based on color burst)
11	Freeze chroma gain

### CAGT [1:0], Chroma Automatic Gain Timing, Address 0x2D [7:6]

These bits allow the user to influence the tracking speed of the chroma automatic gain control, but have an effect only if the CAGC [1:0] bits are set to 10 (automatic gain).

**Table 46. CAGT [1:0] Function**

CAGT [1:0]	Description
00	Slow (TC = 2 sec)
01	Medium (TC = 1 sec)
10	Fast (TC = 0.2 sec)
11 (default)	Adaptive

### CMG [11:0]/CG [11:0], Chroma Manual Gain/Chroma Gain, Address 0x2D [3:0], Address 0x2E [7:0]

CMG [11:0] are dual-function bits. If these bits are written to, a desired manual chroma gain can be programmed. This gain becomes active if the CAGC [1:0] mode is switched to manual fixed gain. Refer to Equation 4 to calculate a desired gain. If read back, these bits return the current gain value. Depending on the setting in the CAGC [1:0] bits, this is either

- Chroma manual gain value (CAGC [1:0] set to chroma manual gain mode)
- Chroma automatic gain value (CAGC [1:0] set to any of the automatic modes)

**Table 47. CG [11:0]/CMG [11:0] Function**

CG [11:0]/CMG [11:0]	Read/Write	Description
CMG [11:0]	Write	Manual gain for chroma path
CG [11:0]	Read	Currently active gain

$$\text{Chroma\_Gain} = \frac{(0 < CG \leq 4095)}{1024} = 0 \dots 4 \quad (4)$$

For example, freezing the automatic gain loop results in a readback value of 0x47A for the CMG [11:0] bits.

1. Convert the readback value to decimal:  
0x47A = 1146d
2. Apply Equation 4 to convert the readback value:  
1146/1024 = 1.12

### CKE, Color-Kill Enable, Address 0x2B [6]

This bit allows the optional color-kill function to be switched on or off. For QAM-based video standards (PAL and NTSC) and FM-based systems (SECAM), the threshold for the color-kill decision is selectable via the CKILLTHR [2:0] bits (Address 0x3D).

If color kill is enabled and the color carrier of the incoming video signal is less than the threshold for 128 consecutive video lines, color processing is switched off (black and white output). To switch the color processing back on, another 128 consecutive lines with a color burst greater than the threshold are required.

The color-kill option only works for input signals with a modulated chroma part. For component (YPrPb) input, there is no color kill.

0—Disables color kill.

1 (default)—Enables color kill.

### CKILLTHR [2:0], Color-Kill Threshold, Address 0x3D [6:4]

The CKILLTHR [2:0] bits allow the user to select a threshold for the color-kill function. The threshold applies only to QAM-based (NTSC and PAL) or FM-modulated (SECAM) video standards.

To enable the color-kill function, the CKE bit must be set. For CKILLTHR settings 000, 001, 010, and 011, chroma demodulation inside the ADV7188 may not work satisfactorily for poor input video signals.

**Table 48. CKILLTHR [2:0] Function**

CKILLTHR [2:0]	Description	
	SECAM	NTSC, PAL
000	No color kill	Kill at <0.5%
001	Kill at <5%	Kill at <1.5%
010	Kill at <7%	Kill at <2.5%
011	Kill at <8%	Kill at <4.0%
100 (default)	Kill at <9.5%	Kill at <8.5%
101	Kill at <15%	Kill at <16.0%
110	Kill at <32%	Kill at <32.0%
111	Reserved for Analog Devices internal use only; do not select	



### CHROMA TRANSIENT IMPROVEMENT (CTI)

The signal bandwidth allocated for chroma is typically much smaller than that of luminance. With older devices, this was a valid way to fit a color video signal into a given overall bandwidth because the human eye is less sensitive to chrominance than to luminance.

The uneven bandwidth, however, may lead to visual artifacts during sharp color transitions. At the border of two bars of color, both components (luma and chroma) change at the same time (see Figure 22).

Due to the higher bandwidth, the signal transition of the luma component is usually much sharper than that of the chroma component. The color edge is not sharp and can be blurred, in the worst case, over several pixels.

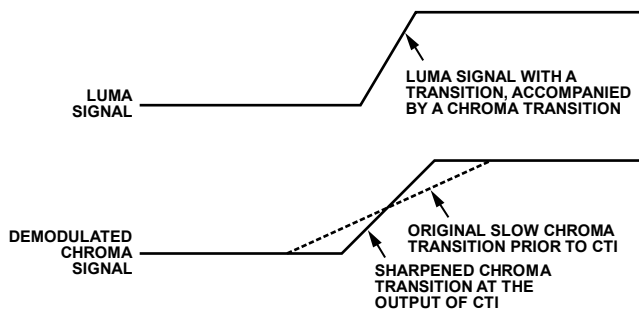


Figure 22. CTI Luma/Chroma Transition

To correct for such uneven bandwidths, the CTI block examines the input video data. It detects transitions of chroma and can be programmed to create steeper chroma edges in an attempt to artificially restore lost color bandwidth. By operating only on edges that are greater than a certain threshold, the CTI block ensures that noise is not emphasized. Care has also been taken to avoid edge ringing and undesirable saturation and hue distortion.

Chroma transient improvements are needed primarily for signals that have severe chroma bandwidth limitations. For these types of signals, it is strongly recommended to enable the CTI block via CTI\_EN.

#### CTI\_EN, Chroma Transient Improvement Enable, Address 0x4D [0]

0—Disables the CTI block.

1 (default)—Enables the CTI block.

#### CTI\_AB\_EN, Chroma Transient Improvement Alpha Blend Enable, Address 0x4D [1]

This bit enables an alpha-blend function, which mixes the transient improved chroma with the original signal. The sharpness of the alpha blending can be configured via the CTI\_AB [1:0] bits. For the alpha blender to be active, the CTI

block must be enabled via the CTI\_EN bit. The settings of the CTI\_AB\_EN bit are as follows:

0—Disables the CTI alpha blender.

1 (default)—Enables the CTI alpha blender.

#### CTI\_AB [1:0], Chroma Transient Improvement Alpha Blend, Address 0x4D [3:2]

The CTI\_AB [1:0] controls the behavior of alpha-blend circuitry, which mixes the sharpened chroma signal with the original one. It thereby controls the visual impact of CTI on the output data.

For CTI\_AB [1:0] to become active, the CTI block must be enabled via the CTI\_EN bit and the alpha blender must be switched on via CTI\_AB\_EN.

Sharp blending maximizes the effect of CTI on the picture, but may also increase the visual impact of small amplitude, high frequency chroma noise.

Table 49. CTI\_AB [1:0] Function

CTI_AB [1:0]	Description
00	Sharpest mixing
01	Sharp mixing
10	Smooth mixing
11 (default)	Smoothest mixing

#### CTI\_C\_TH [7:0], CTI Chroma Threshold, Address 0x4E [7:0]

The CTI\_C\_TH [7:0] value is an unsigned, 8-bit number specifying how big the amplitude step in a chroma transition must be to be steepened by the CTI block. Programming a small value into this register causes even, small edges to be steepened by the CTI block. Making CTI\_C\_TH [7:0] a large value causes the block to only improve large transitions.

The default value for CTI\_C\_TH [7:0] is 0x08, indicating the threshold for the chroma edges prior to CTI.

### DIGITAL NOISE REDUCTION (DNR) AND LUMA PEAKING FILTER

DNR is based on the assumption that high frequency signals with low amplitude are probably noise and that their removal therefore improves picture quality. There are two DNR blocks in the ADV7188: the DNR1 block before the luma peaking filter and the DNR2 block after the luma peaking filter, as shown in Figure 23.

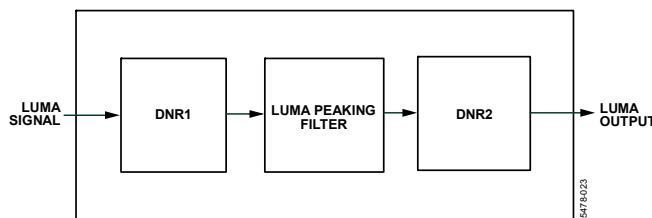


Figure 23. DNR and Peaking Block Diagram





# ADV7188

## **DNR\_EN, Digital Noise Reduction Enable, Address 0x4D [5]**

0—Bypasses DNR (disables it).

1 (default)—Enables DNR on the luma data.

## **DNR\_TH [7:0], DNR Noise Threshold, Address 0x50 [7:0]**

The DNR1 block is positioned before the luma peaking block. The DNR\_TH [7:0] value is an unsigned, 8-bit number that determines the maximum edge that is interpreted as noise and therefore blanked from the luma data. Programming a large value into DNR\_TH [7:0] causes the DNR block to interpret even, large transients as noise and remove them. As a result, the effect on the video data is more visible.

Programming a small value causes only small transients to be seen as noise and to be removed.

The recommended DNR\_TH [7:0] setting for A/V inputs is 0x04, and the recommended DNR\_TH [7:0] setting for tuner inputs is 0x0A.

The default value for DNR\_TH [7:0] is 0x08, indicating the threshold for maximum luma edges to be interpreted as noise.

## **PEAKING\_GAIN [7:0], Luma Peaking Gain, Address 0xFB [7:0]**

This filter can be manually enabled. The user can boost or attenuate the mid region of the Y spectrum around 3 MHz. The peaking filter can visually improve the picture by showing more definition on the picture details that contain frequency components around 3 MHz. The default value (0x40) in this register passes through the luma data unaltered (0 dB response). A lower value attenuates the signal, and a higher value amplifies it. A plot of the filter responses is shown in Figure 24.

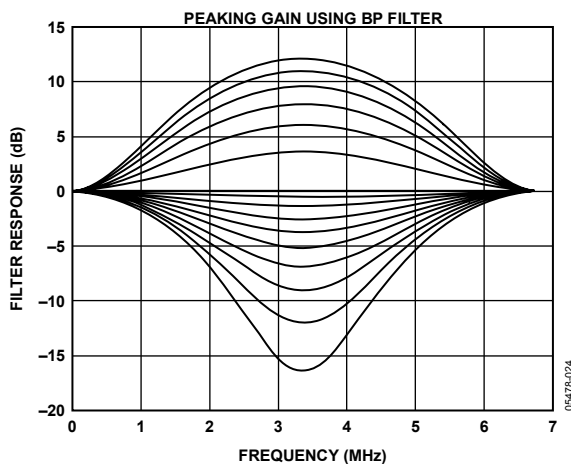


Figure 24. Peaking Filter Responses

## **DNR\_TH2 [7:0], DNR Noise Threshold 2, Address 0xFC [7:0]**

The DNR2 block is positioned after the luma peaking block and therefore affects the amplified luma signal. It operates in the same way as the DNR1 block, but has an independent threshold control, DNR\_TH2 [7:0]. This value is an unsigned, 8-bit number that determines the maximum edge that is interpreted as noise and therefore blanked from the luma data.

Programming a large value into DNR\_TH2 [7:0] causes the DNR block to interpret even, large transients as noise and remove them. As a result, the effect on the video data is more visible. Programming a small value causes only small transients to be seen as noise and to be removed.

## **COMB FILTERS**

The comb filters of the ADV7188 have been greatly improved to automatically handle video of all types, standards, and levels of quality. The NTSC and PAL configuration registers allow the user to customize comb filter operation, depending on which video standard is detected (by autodetection) or selected (by manual programming). In addition to the bits listed in this section, there are other Analog Devices internal controls. Contact an Analog Devices representative for more information.

### **NTSC Comb Filter Settings**

Used for NTSC M and NTSC J CVBS inputs.

### **NSFSEL [1:0], Split Filter Selection NTSC, Address 0x19 [3:2]**

NSFSEL [1:0] selects how much of the overall signal bandwidth is fed to the combs. A narrow bandwidth split filter results in better performance on diagonal lines, but more dot crawl in the final output image. The opposite is true for a wide bandwidth split filter.

Table 50. NSFSEL [1:0] Function

NSFSEL [1:0]	Description
00 (default)	Narrow
01	Medium
10	Medium
11	Wide

### **CTAPSN [1:0], Chroma Comb Taps NTSC, Address 0x38 [7:6]**

Table 51. CTAPSN [1:0] Function

CTAPSN [1:0]	Description
00	Do not use
01	NTSC chroma comb adapts three lines (three taps) to two lines (two taps)
10 (default)	NTSC chroma comb adapts five lines (five taps) to three lines (three taps)
11	NTSC chroma comb adapts five lines (five taps) to four lines (four taps)



## CCMN [2:0], Chroma Comb Mode NTSC, Address 0x38 [5:3]

Table 52. CCMN [1:0] Function

CCMN [2:0]	Description	Configuration
000 (default)	Adaptive comb mode	Adaptive 3-line chroma comb for CTAPSN = 01 Adaptive 4-line chroma comb for CTAPSN = 10 Adaptive 5-line chroma comb for CTAPSN = 11
100	Disable chroma comb	
101	Fixed chroma comb (top lines of line memory)	Fixed 2-line chroma comb for CTAPSN = 01 Fixed 3-line chroma comb for CTAPSN = 10 Fixed 4-line chroma comb for CTAPSN = 11
110	Fixed chroma comb (all lines of line memory)	Fixed 3-line chroma comb for CTAPSN = 01 Fixed 4-line chroma comb for CTAPSN = 10 Fixed 5-line chroma comb for CTAPSN = 11
111	Fixed chroma comb (bottom lines of line memory)	Fixed 2-line chroma comb for CTAPSN = 01 Fixed 3-line chroma comb for CTAPSN = 10 Fixed 4-line chroma comb for CTAPSN = 11

## YCMN [2:0], Luma Comb Mode NTSC, Address 0x38 [2:0]

Table 53. YCMN [2:0] Function

YCMN [2:0]	Description	Configuration
000 (default)	Adaptive comb mode	Adaptive 3-line (three taps) luma comb
100	Disable luma comb	Use low-pass/notch filter; see the Y-Shaping Filter section
101	Fixed luma comb (top lines of line memory)	Fixed 2-line (two taps) luma comb
110	Fixed luma comb (all lines of line memory)	Fixed 3-line (three taps) luma comb
111	Fixed luma comb (bottom lines of line memory)	Fixed 2-line (two taps) luma comb



# ADV7188

## PAL Comb Filter Settings

Used for PAL B/G/H/I/D, PAL M, PAL Combinational N, PAL 60, and NTSC 4.43 CVBS inputs.

### PSFSEL [1:0], Split Filter Selection PAL, Address 0x19 [1:0]

PSFSEL [1:0] selects how much of the overall signal bandwidth is fed to the combs. A wide bandwidth split filter eliminates dot crawl, but shows imperfections on diagonal lines. The opposite is true for a narrow bandwidth split filter.

**Table 54. PSFSEL [1:0] Function**

PSFSEL [1:0]	Description
00	Narrow
01 (default)	Medium
10	Wide
11	Widest

### CTAPSP [1:0], Chroma Comb Taps PAL, Address 0x39 [7:6]

**Table 55. CTAPSP [1:0] Function**

CTAPSP [1:0]	Description
00	Do not use.
01	PAL chroma comb adapts five lines (three taps) to three lines (two taps); cancels cross luma only.
10	PAL chroma comb adapts five lines (five taps) to three lines (three taps); cancels cross luma and hue error less well.
11 (default)	PAL chroma comb adapts five lines (five taps) to four lines (four taps); cancels cross luma and hue error well.

## CCMP [2:0], Chroma Comb Mode PAL, Address 0x39 [5:3]

**Table 56. CCMP [2:0] Function**

CCMP [2:0]	Description	Configuration
000 (default)	Adaptive comb mode	Adaptive 3-line chroma comb for CTAPSP = 01 Adaptive 4-line chroma comb for CTAPSP = 10 Adaptive 5-line chroma comb for CTAPSP = 11
100	Disable chroma comb	
101	Fixed chroma comb (top lines of line memory)	Fixed 2-line chroma comb for CTAPSP = 01 Fixed 3-line chroma comb for CTAPSP = 10 Fixed 4-line chroma comb for CTAPSP = 11
110	Fixed chroma comb (all lines of line memory)	Fixed 3-line chroma comb for CTAPSP = 01 Fixed 4-line chroma comb for CTAPSP = 10 Fixed 5-line chroma comb for CTAPSP = 11
111	Fixed chroma comb (bottom lines of line memory)	Fixed 2-line chroma comb for CTAPSP = 01 Fixed 3-line chroma comb for CTAPSP = 10 Fixed 4-line chroma comb for CTAPSP = 11

## YCMP [2:0], Luma Comb Mode PAL, Address 0x39 [2:0]

**Table 57. YCMP [2:0] Function**

YCMP [2:0]	Description	Configuration
0xx (default)	Adaptive comb mode	Adaptive 5-line, 3-tap luma comb
100	Disable luma comb	Use low-pass/notch filter (see the Y-Shaping Filter section)
101	Fixed luma comb (top lines of line memory)	Fixed 3-line, 2-tap luma comb
110	Fixed luma comb (all lines of line memory)	Fixed 5-line, 3-tap luma comb
111	Fixed luma comb (bottom lines of line memory)	Fixed 3-line, 2-tap luma comb



**Vertical Blank Control**

Each vertical blank control register (Addresses 0xEB and 0xEC) has the same meaning for the following bit settings:

- 00—Early by one line.
- 10—Delayed by one line.
- 11—Delayed by two lines.
- 01 (default)—Described in each register section.

**NVBIOLCM [1:0], NTSC VBI Odd Field Luma Comb Mode, Address 0xEB [7:6]**

These bits control the first combed line after VBI on NTSC odd field (luma comb).

- 01 (default)—SMPTE170-/ITU-R BT.470-compliant; blank Lines 1 to 20, 264 to 282; comb half lines.

**NVBIELCM [1:0], NTSC VBI Even Field Luma Comb Mode, Address 0xEB [5:4]**

These bits control the first combed line after VBI on NTSC even field (luma comb).

- 01 (default)—SMPTE170-/ITU-R BT.470-compliant; blank Lines 1 to 20, 264 to 282; comb half lines.

**PVBIOLCM [1:0], PAL VBI Odd Field Luma Comb Mode, Address 0xEB [3:2]**

These bits control the first combed line after VBI on PAL odd field (luma comb).

- 01 (default)—ITU-R BT.470-compliant; blank Lines 624 to 22, 311 to 335; comb half lines.

**PVBIELCM [1:0], PAL VBI Even Field Luma Comb Mode, Address 0xEB [1:0]**

These bits control the first combed line after VBI on PAL even field (luma comb).

- 01 (default)—ITU-R BT.470-compliant; blank Lines 624 to 22, 311 to 335; comb half lines.

**NVBIOCCM [1:0], NTSC VBI Odd Field Chroma Comb Mode, Address 0xEC [7:6]**

These bits control the first combed line after VBI on NTSC odd field (chroma comb).

- 01 (default)—SMPTE170-/ITU-R BT.470-compliant; no color on Lines 1 to 20, 264 to 282; chroma present on half lines.

**NVBI ECCM [1:0], NTSC VBI Even Field Chroma Comb Mode, Address 0xEC [5:4]**

These bits control the first combed line after VBI on NTSC even field (chroma comb).

- 01 (default)—SMPTE170-/ITU-R BT.470-compliant; no color on Lines 1 to 20, 264 to 282; chroma present on half lines.

**PVBI OCCM [1:0], PAL VBI Odd Field Chroma Comb Mode, Address 0xEC [3:2]**

These bits control the first combed line after VBI on PAL odd field (chroma comb).

- 01 (default)—ITU-R BT.470-compliant; no color on Lines 624 to 22, 311 to 335; chroma present on half lines.

**PVBI ECCM [1:0], PAL VBI Even Field Chroma Comb Mode, Address 0xEC [1:0]**

These bits control the position of the first combed line after VBI on PAL even field (chroma comb).

- 01 (default)—ITU-R BT.470-compliant; no color on Lines 624 to 22, 311 to 335; chroma present on half lines.

**AV CODE INSERTION AND CONTROLS**

This section describes the I<sup>2</sup>C-based controls that affect

- Insertion of AV codes into the data stream
- Data blanking during the vertical blanking interval (VBI)
- The range of data values permitted in the output data stream
- The relative delay of luma vs. chroma signals

Note that some of the decoded VBI data is inserted during the horizontal blanking interval. See the Gemstar Data Recovery section for more information.

**BT656-4, ITU-R BT.656-4 Enable, Address 0x04 [7]**

Revisions 3 and 4 of the ITU-R BT.656 standard have different positions for toggling the V bit within the SAV EAV codes for NTSC. The BT656-4 bit allows the user to select an output mode that is compliant with either the previous or new standard. For more information, visit the International Telecommunication Union's website.

Note that the standard change affects only NTSC and has no bearing on PAL.

0 (default)—The ITU-R BT.656-3 specification is used. The V bit goes low at EAV of Lines 10 and 273.

1—The ITU-R BT.656-4 specification is used. The V bit goes low at EAV of Lines 20 and 283.

**SD\_DUP\_AV, Duplicate AV Codes, Address 0x03 [0]**

Depending on the output interface width, it may be necessary to duplicate the AV codes from the luma path into the chroma path.

In an 8-/10-bit-wide output interface (Cb/Y/Cr/Y interleaved data), the AV codes are defined as FF/00/00/AV, with AV being the transmitted word that contains information about H/V/F.

In this output interface mode, the following assignment takes place: Cb = FF, Y = 00, Cr = 00, and Y = AV.



# ADV7188

In a 16-/20-bit output interface where Y and Cr/Cb are delivered via separate data buses, the AV code is over the whole 16/20 bits. The SD\_DUP\_AV bit allows the user to replicate the AV codes on both buses; therefore, the full AV sequence can be found on the Y data bus and on the Cr/Cb data bus (see Figure 25).

0 (default)—The AV codes are in single fashion (to suit 8-/10-bit interleaved data output).

1—The AV codes are duplicated (for 16-/20-bit interfaces).

## VBI\_EN, Vertical Blanking Interval Data Enable, Address 0x03 [7]

The VBI enable bit allows data such as intercast and closed caption data to be passed through the luma channel of the decoder with a minimal amount of filtering. All data for Line 1 to Line 21 is passed through and available at the output port.

The ADV7188 does not blank the luma data, but automatically switches all filters along the luma data path into their widest bandwidth. For active video, the filter settings for YSH and YPK are restored.

Refer to the BL\_C\_VBI, Blank Chroma During VBI, Address 0x04 [2] section for information on the chroma path.

0 (default)—All video lines are filtered and scaled.

1—Only the active video region is filtered and scaled.

## BL\_C\_VBI, Blank Chroma During VBI, Address 0x04 [2]

Setting BL\_C\_VBI high, blanks the Cr and Cb values of all VBI lines. This is done to prevent data that arrives during VBI from being decoded as color and output through Cr and Cb. As a result, it is possible to send VBI lines into the decoder, and then output them undistorted through an encoder. Without this blanking, any incorrectly decoded color would be encoded by the video encoder and therefore the VBI lines would be distorted.

0—Decodes and outputs color during VBI.

1 (default)—Blanks Cr and Cb values during VBI.

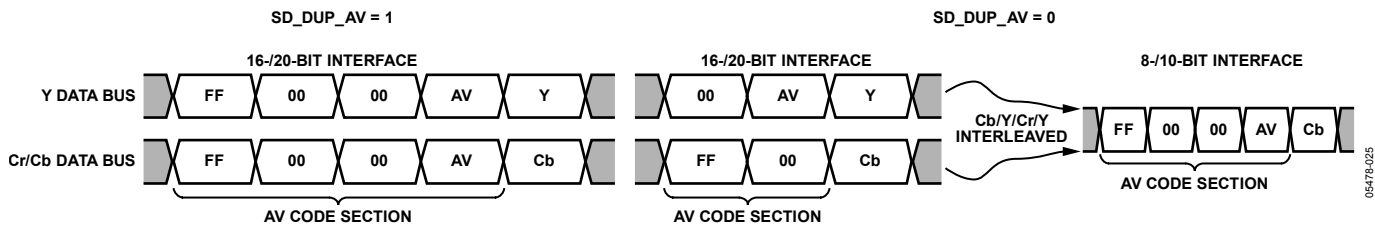


Figure 25. AV Code Duplication Control



**RANGE, Range Selection, Address 0x04 [0]**

AV codes (as per ITU-R BT.656, formerly known as CCIR 656) consist of a fixed header made up of 0xFF and 0x00 values. These two values are reserved and therefore are not to be used for active video. Additionally, the ITU specifies that the nominal range for video should be restricted to values between 16 and 235 for luma and between 16 and 240 for chroma.

The RANGE bit allows the user to limit the range of values output by the ADV7188 to the recommended value range. This ensures that the reserved values of 255d (0xFF) and 00d (0x00) are not presented on the output pins unless they are part of an AV code header.

**Table 58. RANGE Function**

RANGE	Description	
0	$16 \leq Y \leq 235$	$16 \leq C \leq 240$
1 (default)	$1 \leq Y \leq 254$	$1 \leq C \leq 254$

**AUTO\_PDC\_EN, Automatic Programmed Delay Control, Address 0x27 [6]**

Enabling AUTO\_PDC\_EN activates a function within the ADV7188 that automatically programs LTA [1:0] and CTA [2:0] to have the chroma and luma data match delays for all modes of operation.

0—The ADV7188 uses the LTA [1:0] and CTA [2:0] values for delaying luma and chroma samples. Refer to the LTA [1:0], Luma Timing Adjust, Address 0x27 [1:0] and the CTA [2:0], Chroma Timing Adjust, Address 0x27 [5:3] sections.

1 (default)—The ADV7188 automatically programs the LTA and CTA values to have luma and chroma aligned at the output. Manual registers LTA [1:0] and CTA [2:0] are not used.

**LTA [1:0], Luma Timing Adjust, Address 0x27 [1:0]**

These bits allow the user to specify a timing difference between chroma and luma samples.

Note that there is a certain functionality overlap with the CTA [2:0] bits. For manual programming, use the following defaults:

- CVBS input LTA [1:0] = 00
- Y/C input LTA [1:0] = 01
- YPrPb input LTA [1:0] = 01

**Table 59. LTA [1:0] Function**

LTA [1:0]	Description
00 (default)	No delay
01	Luma 1 clock (37 ns) delayed
10	Luma 2 clock (74 ns) early
11	Luma 1 clock (37 ns) early

**CTA [2:0], Chroma Timing Adjust, Address 0x27 [5:3]**

These bits allow the user to specify a timing difference between chroma and luma samples. This may be used to compensate for external filter group delay differences in the luma vs. chroma path and to allow a different number of pipeline delays while processing the video downstream. Review this functionality together with that of the LTA [1:0] bits.

The chroma can be delayed or advanced only in chroma pixel steps. One chroma pixel step is equal to two luma pixels. The programmable delay occurs after demodulation, when no delay by luma pixel steps are allowed.

For manual programming, use the following defaults:

- CVBS input CTA [2:0] = 011
- Y/C input CTA [2:0] = 101
- YPrPb input CTA [2:0] = 110

**Table 60. CTA Function**

CTA [2:0]	Description
000	Not used
001	Chroma plus two chroma pixels (early)
010	Chroma plus one chroma pixel (early)
011 (default)	No delay
100	Chroma minus one chroma pixel (delayed)
101	Chroma minus two chroma pixels (delayed)
110	Chroma minus three chroma pixels (delayed)
111	Not used

**SYNCHRONIZATION OUTPUT SIGNALS****HS Configuration**

The following controls allow the user to configure the behavior of the HS output pin only:

- HSB [10:0]: sets beginning of HS signal
- HSE [10:0]: sets end of HS signal
- PHS: sets polarity of HS

The HS begin (HSB) and HS end (HSE) bits allow the user to position the HS output pin anywhere within the video line. The values in HSB [10:0] and HSE [10:0] are measured in pixel units from the falling edge of HS. Using both values, the user can program both the position and length of the HS output signal.

**HSB [10:0], HS Begin, Address 0x34 [6:4], Address 0x35 [7:0]**

The position of this edge is controlled by placing a binary number into HSB [10:0]. The number applied offsets the edge with respect to an internal counter that is reset to 0 immediately after EAV Code FF, 00, 00, XY (see Figure 26). HSB [10:0] is set to 0000000010, which is two LLC1 clock cycles from Count [0].

The default value of HSB [10:0] is 0x002, indicating that the HS pulse starts two pixels after the falling edge of HS.



# ADV7188

**Table 61. HS Timing Parameters (see Figure 26)**

Standard	Characteristics				
	HS Begin Adjust (HSB [10:0]) (Default)	HS End Adjust (HSE [10:0]) (Default)	HS to Active Video (LLC1 Clock Cycles) (C in Figure 26) (Default)	Active Video Samples/Line (D in Figure 26)	Total LLC1 Clock Cycles (E in Figure 26)
NTSC	0000000010	0000000000	272	$720Y + 720C = 1440$	1716
NTSC Square Pixel	0000000010	0000000000	276	$640Y + 640C = 1280$	1560
PAL	0000000010	0000000000	284	$720Y + 720C = 1440$	1728

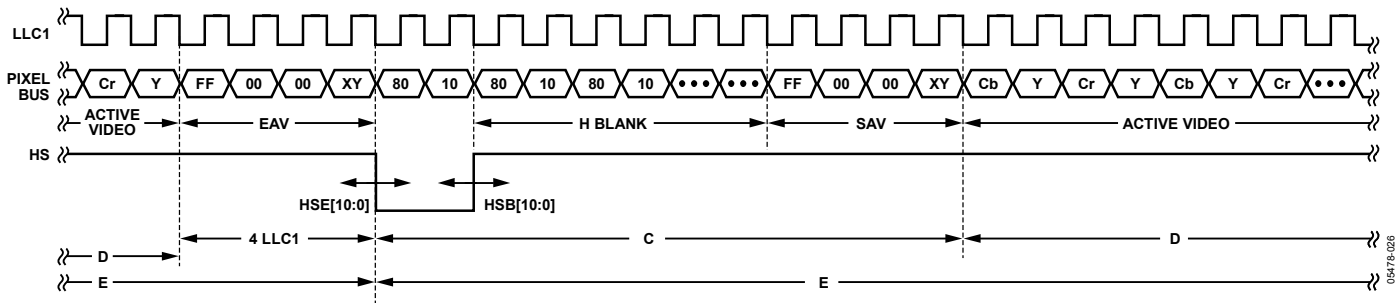


Figure 26. HS Timing

## HSE [10:0] HS End, Address 0x34 [2:0], Address 0x36 [7:0]

The position of this edge is controlled by placing a binary number into HSE [10:0]. The number applied offsets the edge with respect to an internal counter that is reset to 0 immediately after EAV Code FF, 00, 00, XY (see Figure 26). HSE is set to 0000000000, which is 0 LLC1 clock cycles from Count [0].

The default value of HSE [10:0] is 000, indicating that the HS pulse ends 0 pixels after the falling edge of HS.

For example,

- To shift the HS toward active video by 20 LLC1s, add 20 LLC1s to both HSB and HSE, that is, HSB [10:0] = [00000010110] and HSE [10:0] = [00000010100].
- To shift the HS away from active video by 20 LLC1s, add 1696 LLC1s to both HSB and HSE (for NTSC), that is, HSB [10:0] = [11010100010] and HSE [10:0] = [11010100000]. The number 1696 is derived from the NTSC total number of pixels = 1716.

To move 20 LLC1s away from active video is equal to subtracting 20 from 1716 and adding the result in binary to both HSB [10:0] and HSE [10:0].

## PHS Polarity HS, Address 0x37 [7]

The polarity of the HS pin can be inverted using the PHS bit.

0 (default)—HS is active high.

1—HS is active low.

## VS and FIELD Configuration

The following controls allow the user to configure the behavior of the VS and FIELD output pins and to generate the following embedded AV codes:

- ADV encoder-compatible signals via NEWAVMODE
- PVS, PF
- HVSTIM
- VSBHO, VSBHE
- VSEHO, VSEHE
- For NTSC control
  - NVBEGDELO, NVBEGDELE, NVBEGSIGN, NVBEG [4:0]
  - NVENDDELO, NVENDDELE, NVENDSIGN, NVEND [4:0]
  - NFTOGDELO, NFTOGDELE, NFTOGSIGN, NFTOG [4:0]
- For PAL control
  - PVBEGDELO, PVBEGDELE, PVBEGSIGN, PVBEG [4:0]
  - PVENDDELO, PVENDDELE, PVENDSIGN, PVEND [4:0]
  - PFTOGDELO, PFTOGDELE, PFTOGSIGN, PFTOG [4:0]





**NEWAVMODE, New AV Mode, Address 0x31 [4]**

0—EAV/SAV codes are generated to suit Analog Devices encoders. No adjustments are possible.

1 (default)—Enables the manual position of VS/FIELD and AV codes using Register 0x32, Register 0x33, and Register 0xE5 to Register 0xEA. Default register settings are CCIR 656 compliant; see Figure 27 for NTSC and Figure 32 for PAL. For recommended manual user settings, see Table 62 and Figure 28 for NTSC and Table 63 and Figure 33 for PAL.

**HVSTIM, Horizontal VS Timing, Address 0x31 [3]**

The HVSTIM bit allows the user to select where the VS signal is asserted within a line of video. Some interface circuitry may require VS to go low while HS is low.

0 (default)—The start of the line is relative to HSE.

1—The start of the line is relative to HSB.

**VSBO, VS Begin Horizontal Position Odd, Address 0x32 [7]**

This bit selects the position within a line at which the VS pin (not the bit in the AV code) becomes active. Some follow-on chips require the VS pin to change state only when HS is high or low.

0 (default)—The VS pin goes high at the middle of a line of video (odd field).

1—The VS pin changes state at the start of a line (odd field).

**VSBE, VS Begin Horizontal Position Even, Address 0x32 [6]**

This bit selects the position within a line at which the VS pin (not the bit in the AV code) becomes active. Some follow-on chips require the VS pin to change state only when HS is high or low.

0—The VS pin goes high at the middle of a line of video (even field).

1 (default)—The VS pin changes state at the start of a line (even field).

**VSEHO VS, End Horizontal Position Odd, Address 0x33 [7]**

This bit selects the position within a line at which the VS pin (not the bit in the AV code) becomes inactive. Some follow-on chips require the VS pin to change state only when HS is high or low.

0—The VS pin goes low (inactive) at the middle of a line of video (odd field).

1 (default)—The VS pin changes state at the start of a line (odd field).

**VSEHE, VS End Horizontal Position Even, Address 0x33 [6]**

This bit selects the position within a line at which the VS pin (not the bit in the AV code) becomes inactive. Some follow-on chips require the VS pin to change state only when HS is high or low.

0 (default)—The VS pin goes low (inactive) at the middle of a line of video (even field).

1—The VS pin changes state at the start of a line (even field).

**PVS, Polarity VS, Address 0x37 [5]**

The polarity of the VS pin can be inverted using the PVS bit.

0 (default)—VS is active high.

1—VS is active low.

**PF, Polarity FIELD, Address 0x37 [3]**

The polarity of the FIELD pin can be inverted using the PF bit.

0 (default)—FIELD is active high.

1—FIELD is active low.

**Table 62. Recommended User Settings for NTSC (See Figure 28)**

Register	Register Name	Write
0x31	Vsync Field Control 1	0x1A
0x32	Vsync Field Control 2	0x81
0x33	Vsync Field Control 3	0x84
0x34	Hsync Position 1	0x00
0x35	Hsync Position 2	0x00
0x36	Hsync Position 3	0x7D
0x37	Polarity	0xA1
0xE5	NTSV V bit begin	0x41
0xE6	NTSC V bit end	0x84
0xE7	NTSC F bit toggle	0x06



# ADV7188

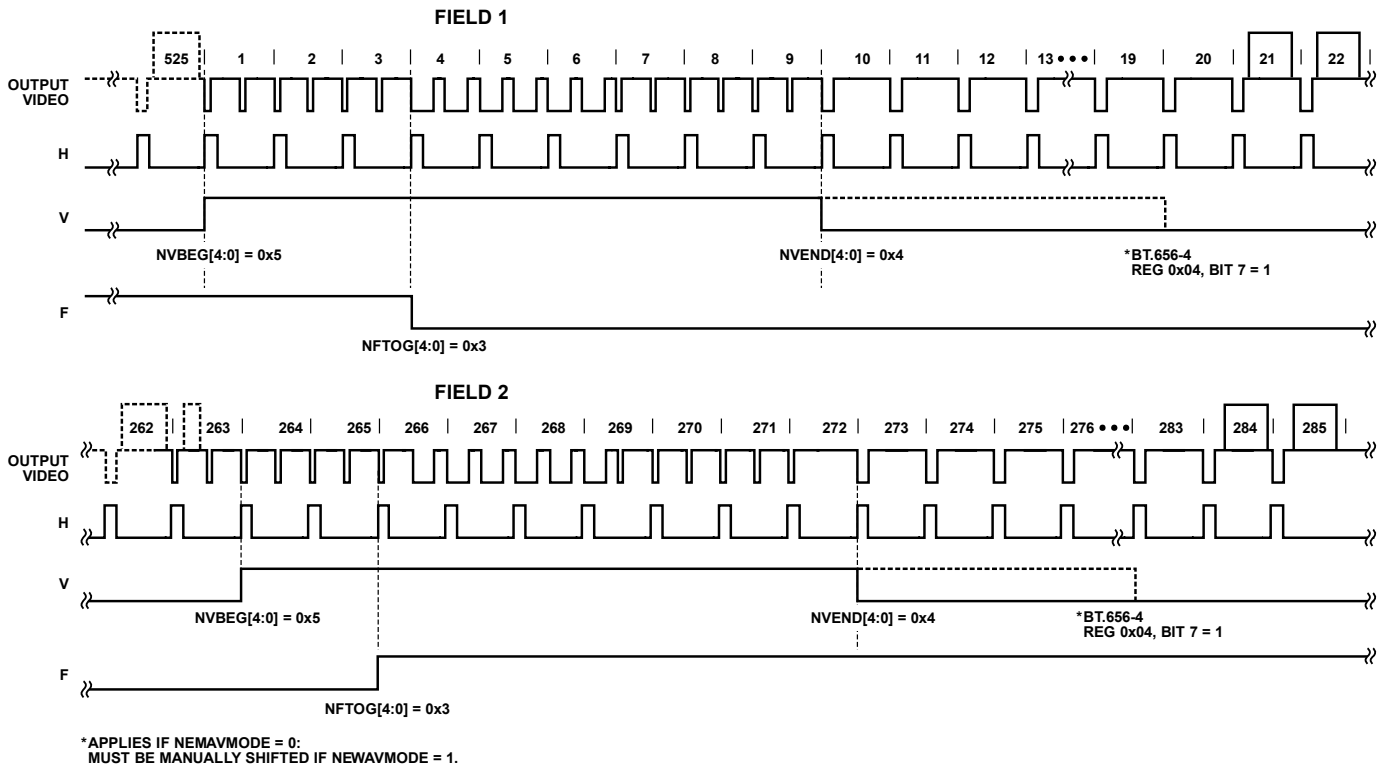


Figure 27. NTSC Default (ITU-R BT.656), the Polarities of HS, VS, and FIELD are Embedded in the Data

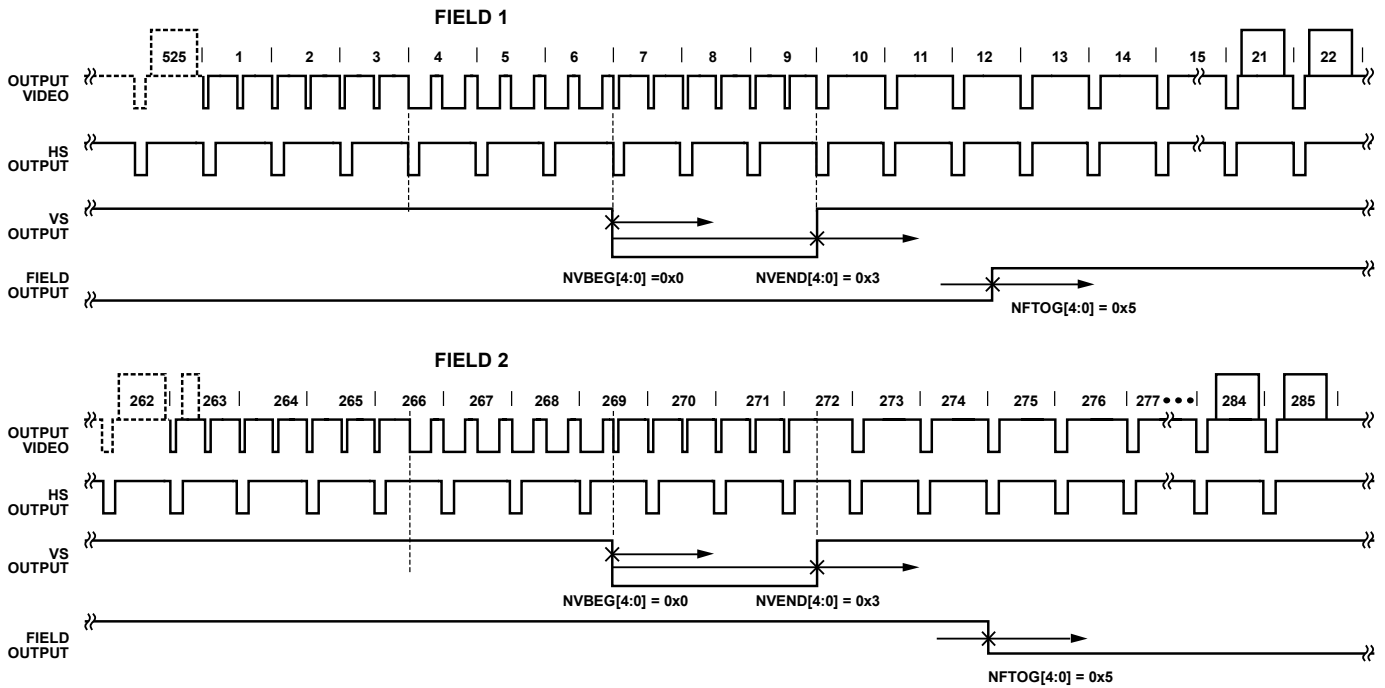


Figure 28. NTSC Typical VS/FIELD Positions Using Register Writes in Table 62



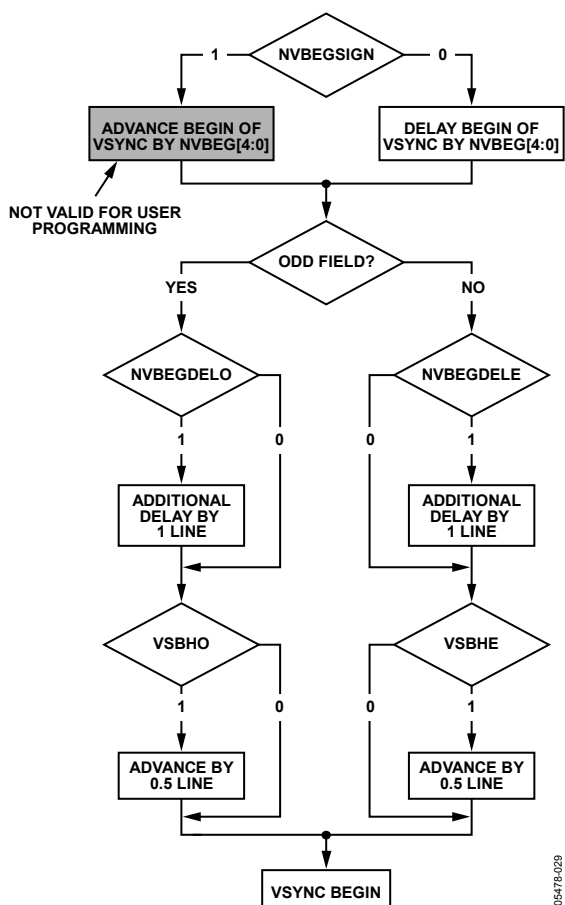


Figure 29. NTSC Vsync Begin

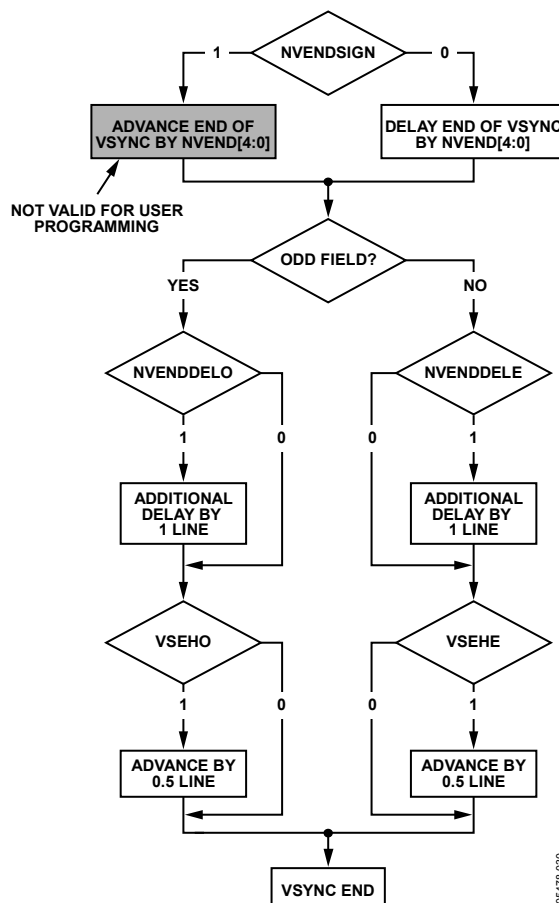


Figure 30. NTSC Vsync End

**NVBEGDELO, NTSC Vsync Begin Delay on Odd Field, Address 0xE5 [7]**

0 (default)—No delay.

1—Delays vsync going high on an odd field by a line relative to NVBEG.

**NVBEGDELE, NTSC Vsync Begin Delay on Even Field, Address 0xE5 [6]**

0 (default)—No delay.

1—Delays vsync going high on an even field by a line relative to NVBEG.

**NVBEGSIGN, NTSC Vsync Begin Sign, Address 0xE5 [5]**

0—Delays the start of vsync. Set for user manual programming.

1 (default)—Advances the start of vsync. Not recommended for user programming.

**NVBEG [4:0], NTSC Vsync Begin, Address 0xE5 [4:0]**

The default value of NVBEG is 00101, indicating the NTSC vsync begin position. For all NTSC/PAL vsync timing controls, both the V bit in the AV code and the vsync on the VS pin are modified.

**NVENDDELO, NTSC Vsync End Delay on Odd Field, Address 0xE6 [7]**

0 (default)—No delay.

1—Delays vsync from going low on an odd field by a line relative to NVEND.

**NVENDDELE, NTSC Vsync End Delay on Even Field, Address 0xE6 [6]**

0 (default)—No delay.

1—Delays vsync from going low on an even field by a line relative to NVEND.

**NVENDSIGN, NTSC Vsync End Sign, Address 0xE6 [5]**

0 (default)—Delays the end of vsync. Set for user manual programming.

1—Advances the end of vsync. Not recommended for user programming.

**NVEND [4:0], NTSC Vsync End, Address 0xE6 [4:0]**

The default value of NVEND is 00100, indicating the NTSC vsync end position.



# ADV7188

For all NTSC/PAL vsync timing controls, both the V bit in the AV code and the vsync on the VS pin are modified.

## NFTOGDELO, NTSC Field Toggle Delay on Odd Field, Address 0xE7 [7]

0 (default)—No delay.

1—Delays the field toggle/transition on an odd field by a line relative to NFTOG.

## NFTOGDELE, NTSC Field Toggle Delay on Even Field, Address 0xE7 [6]

0—No delay.

1 (default)—Delays the field toggle/transition on an even field by a line relative to NFTOG.

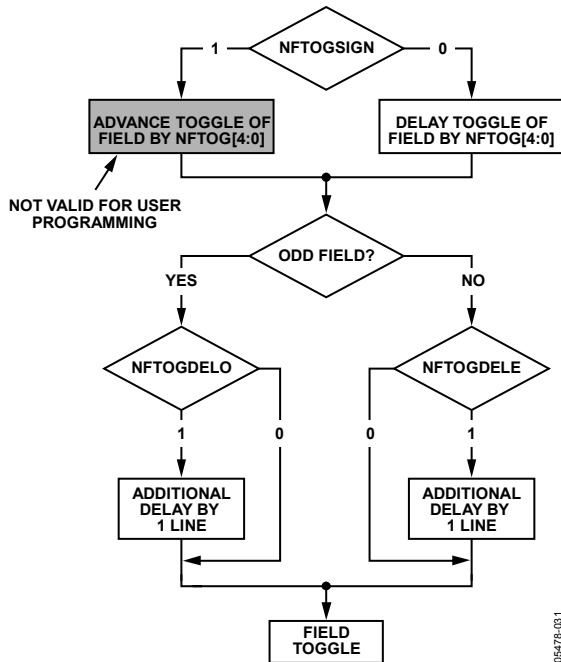


Figure 31. NTSC Field Toggle

## NFTOGSIGN, NTSC Field Toggle Sign, Address 0xE7 [5]

0—Delays the field transition. Set for manual programming.

1 (default)—Advances the field transition. Not recommended for user programming.

## NFTOG [4:0], NTSC Field Toggle, Address 0xE7 [4:0]

The default value of NFTOG is 00011, indicating the NTSC field toggle position.

For all NTSC/PAL field timing controls, both the F bit in the AV code and the field signal on the FIELD/DE pin are modified.

## PVBEGDELO, PAL Vsync Begin Delay on Odd Field, Address 0xE8 [7]

0 (default)—No delay.

1—Delays vsync going high on an odd field by a line relative to PVBEG.

## PVBEGDELE, PAL Vsync Begin Delay on Even Field, Address 0xE8 [6]

0 (default)—No delay.

1 (default)—Delays vsync going high on an even field by a line relative to PVBEG.

## PVBEGSIGN, PAL Vsync Begin Sign, Address 0xE8 [5]

0—Delays the beginning of vsync. Set for user manual programming.

1 (default)—Advances the beginning of vsync. Not recommended for user programming.

## PVBEG [4:0], PAL Vsync Begin, Address 0xE8 [4:0]

The default value of PVBEG is 00101, indicating the PAL vsync begin position.

For all NTSC/PAL vsync timing controls, both the V bit in the AV code and the vsync on the VS pin are modified.

Table 63. Recommended User Settings for PAL (see Figure 33)

Register	Register Name	Write
0x31	Vsync Field Control 1	0x1A
0x32	Vsync Field Control 2	0x81
0x33	Vsync Field Control 3	0x84
0x34	Hsync Position 1	0x00
0x35	Hsync Position 2	0x00
0x36	Hsync Position 3	0x7D
0x37	Polarity	0xA1
0xE8	PAL V bit begin	0x41
0xE9	PAL V bit end	0x84
0xEA	PAL F bit toggle	0x06



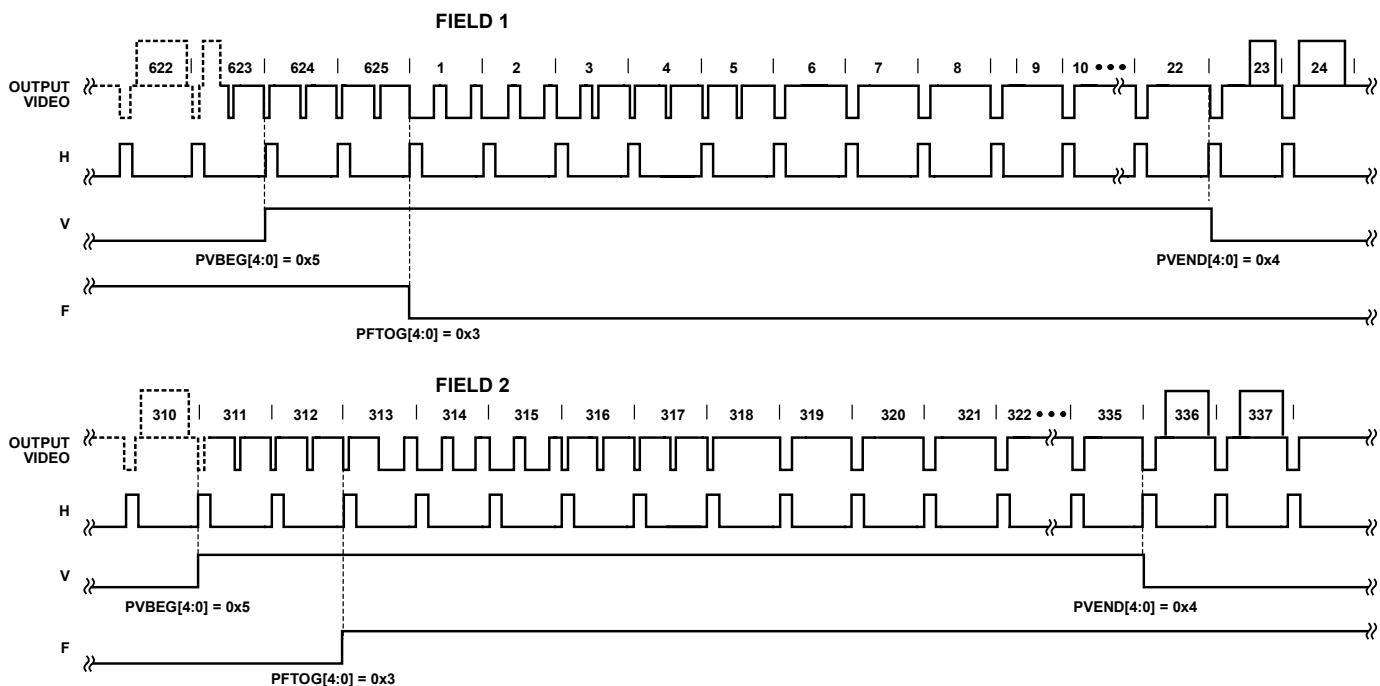


Figure 32. PAL Default (ITU-R BT.656), the Polarities of HS, VS, and FIELD are Embedded in the Data

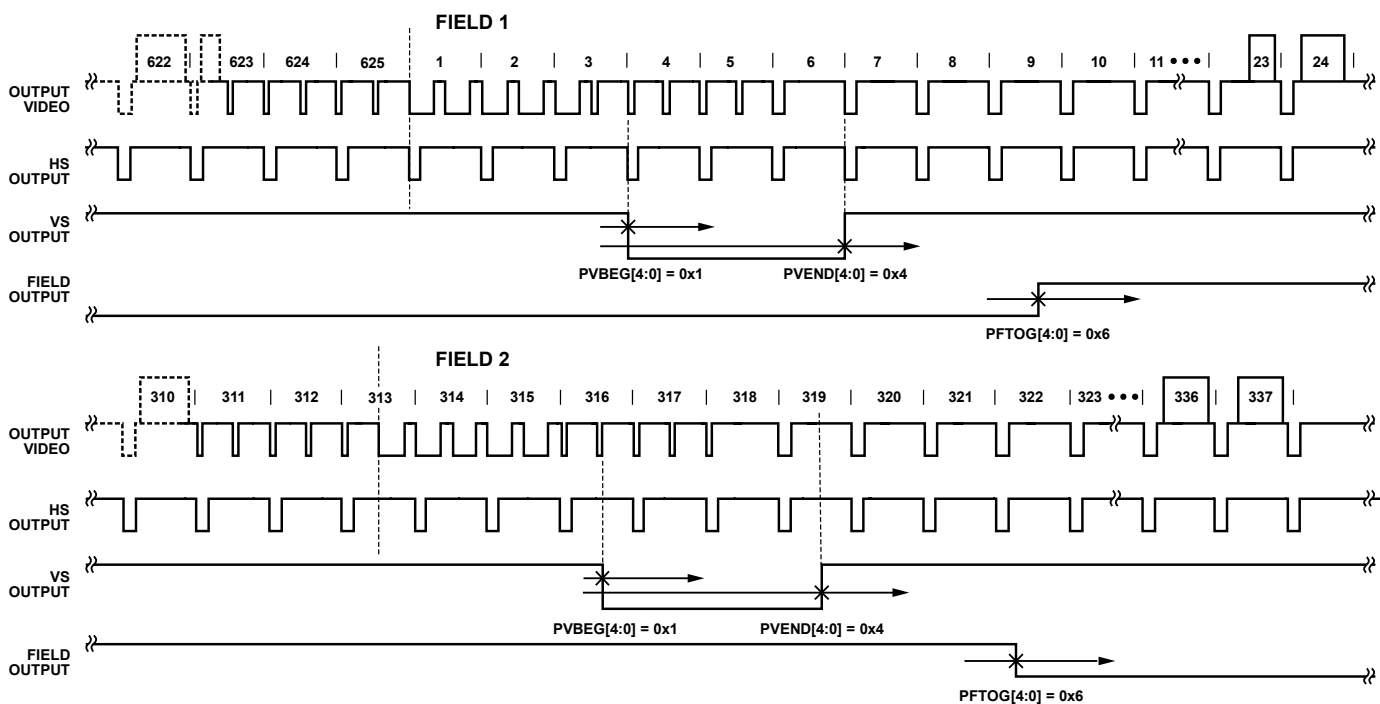


Figure 33. PAL Typical VS/FIELD Positions Using Register Writes in Table 63



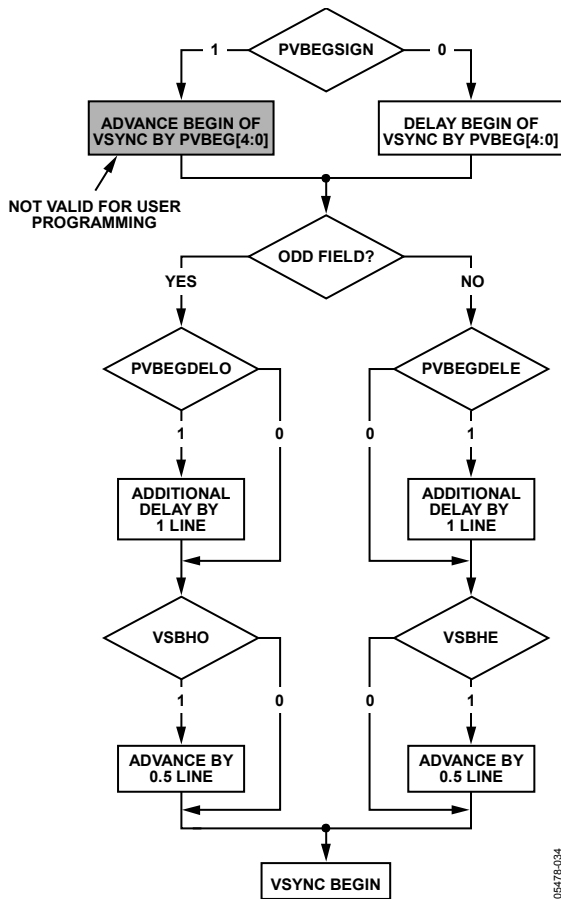


Figure 34. PAL Vsync Begin

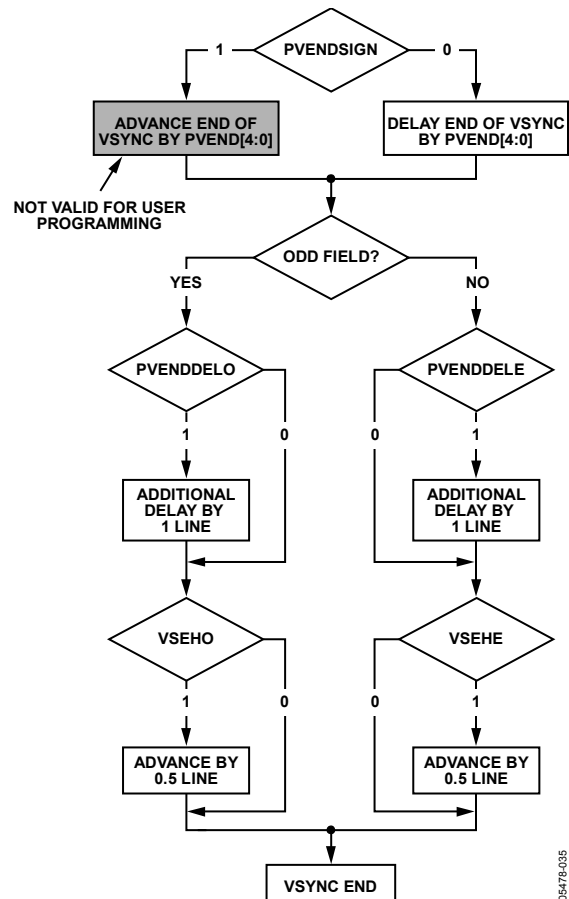


Figure 35. PAL Vsync End

### PVENDELO, PAL Vsync End Delay on Odd Field, Address 0xE9 [7]

0 (default)—No delay.

1—Delays vsync going low on an odd field by a line relative to PVEND.

### PVENDELE, PAL Vsync End Delay on Even Field, Address 0xE9 [6]

0 (default)—No delay.

1—Delays vsync going low on an even field by a line relative to PVEND.

### PVENDSIGN, PAL Vsync End Sign, Address 0xE9 [5]

0 (default)—Delays the end of vsync. Set for user manual programming.

1—Advances the end of vsync. Not recommended for user programming.

### PVEND [4:0], PAL Vsync End, Address 0xE9 [4:0]

The default value of PVEND is 10100, indicating the PAL vsync end position.

For all NTSC/PAL vsync timing controls, both the V bit in the AV code and the vsync on the VS pin are modified.

### PFTOGDELO, PAL Field Toggle Delay on Odd Field, Address 0xEA [7]

0 (default)—No delay.

1—Delays the F toggle/transition on an odd field by a line relative to PFTOG.

### PFTOGDELE, PAL Field Toggle Delay on Even Field, Address 0xEA [6]

0 (default)—No delay.

1 (default)—Delays the F toggle/transition on an even field by a line relative to PFTOG.



## PFTOFSIGN, PAL Field Toggle Sign, Address 0xEA [5]

0—Delays the field transition. Set for manual programming.

1 (default)—Advances the field transition. Not recommended for user programming.

## PFTOG, PAL Field Toggle, Address 0xEA [4:0]

The default value of PFTOG is 00011, indicating the PAL field toggle position.

For all NTSC/PAL field timing controls, the F bit in the AV code and the field signal on the FIELD/DE pin are modified.

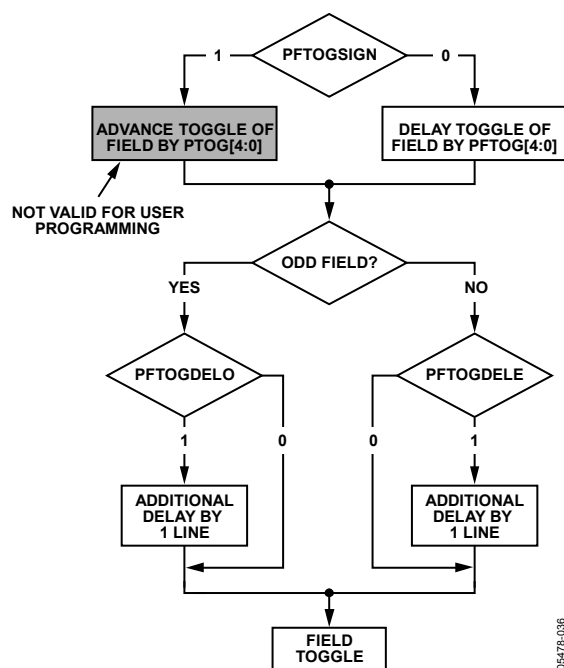


Figure 36. PAL F Toggle

## SYNC PROCESSING

The ADV7188 has two additional sync processing blocks that postprocess the raw synchronization information extracted from the digitized input video. If desired, the blocks can be disabled via the following two I<sup>2</sup>C bits.

### ENHSPLL, Enable Hsync Processor, Address 0x01 [6]

The hsync processor is designed to filter incoming hsyncs that have been corrupted by noise; therefore, it improves the performance of the ADV7188 for video signals with stable time bases but poor SNR.

0—Disables the hsync processor.

1 (default)—Enables the hsync processor.

### ENVSPROC, Enable Vsync Processor, Address 0x01 [3]

This block provides extra filtering of the detected vsyncs to improve vertical lock.

0—Disables the vsync processor.

1 (default)—Enables the vsync processor.

## VBI DATA DECODE

There are two VBI data slicers on the ADV7188. The first is called the VBI data processor (VDP), and the second is called the VBI System 2.

The VDP can slice both low bandwidth standards and high bandwidth standards, such as teletext. VBI System 2 can slice low data rate VBI standards only.

The VDP is capable of slicing multiple VBI data standards on SD video. It decodes the VBI data on the incoming CVBS and Y/C or YUV data. The decoded results are available as ancillary data in the output 656 data stream. For low data rate VBI standards such as CC/WSS/CGMS, the user can read the decoded data bytes from I<sup>2</sup>C registers. The VBI data standards that can be decoded by the VDP are shown in Table 64 and Table 65.

Table 64. PAL

Feature	Standard
Teletext System A or C or D	ITU-R BT.653
Teletext System B/WST	ITU-R BT.653
VPS (Video Programming System)	ETSI EN 300 231 V1.3.1
VITC (Vertical Interval Time Codes)	–
WSS (Wide-Screen Signaling)	BT.1119-1/ETSI EN 300 294
CC (Closed Captioning)	–

Table 65. NTSC

Feature	Standard
Teletext System B and D	ITU-R BT.653
Teletext System C/NABTS	ITU-R BT.653/EIA-516
VITC (Vertical Interval Time Codes)	–
CGMS (Copy Generation Management System)	EIA-J CPR-1204/IEC 61880
Gemstar	–
CC (Closed Captioning)	EIA-608

The VBI data standard that the VDP decodes on a particular line of incoming video has been set by default, as described in Table 66. This can be overridden manually, and any VBI data can be decoded on any line. The details of manual programming are described in Table 67 and Table 68.

### VDP Default Configuration

The VDP can decode different VBI data standards on a line-to-line basis. The various standards supported by default on different lines of VBI are explained in Table 66.





# ADV7188

## VDP Manual Configuration

### MAN\_LINE\_PGM, Enable Manual Line Programming of VBI Standards, Address 0x64 [7], User Sub Map

The user can configure the VDP to decode different standards on a line-to-line basis through manual line programming. For this, the user must set the MAN\_LINE\_PGM bit and write to the VBI\_DATA\_Px\_Ny line programming bits (see Register 0x64 to Register 0x77 of the user sub map).

0 (default)—The VDP decodes default standards on lines as shown in Table 66.

1—The VBI standards to be decoded are manually programmed.

### VBI\_DATA\_Px\_Ny [3:0], VBI Standard to be Decoded on Line x for PAL, Line y for NTSC, Addresses 0x64 to 0x77, User Sub Map

These bits are related 4-bit clusters in Register 0x64 to Register 0x77 of the user sub map. The 4-bit line-programming registers, named VBI\_DATA\_Px\_Ny, identify the VBI data standard that would be decoded on Line x in PAL mode or on Line y in NTSC mode. The

different types of VBI standards decoded by VBI\_DATA\_Px\_Ny are shown in Table 67. Note that the interpretation of its value depends on whether the ADV7188 is in PAL or NTSC mode.

## Notes

- Full field detection (lines other than VBI lines) of any standard can also be enabled by writing into the VBI\_DATA\_P24\_N22 [3:0] and VBI\_DATA\_P337\_N285 [3:0] bits. Therefore, if VBI\_DATA\_P24\_N22 [3:0] is programmed with any teletext standard, then teletext is decoded from the entire odd field. The corresponding bits for the even field are VBI\_DATA\_P337\_N285 [3:0].
- In teletext system identification, VDP assumes that if teletext is present in a video channel, all the teletext lines comply with a single standard system. Therefore, the line programming using VBI\_DATA\_Px\_Ny registers identifies whether the data in line is teletext; the actual standard is identified by the VDP\_TTXT\_TYPE\_MAN bit. To program the VDP\_TTXT\_TYPE\_MAN bit, the VDP\_TTXT\_TYPE\_MAN\_ENABLE bit must be set to 1.

Table 66. Default Line Standards for PAL and NTSC

PAL—625/50				NTSC—525/60			
Line No.	Default VBI Data Decoded	Line No.	Default VBI Data Decoded	Line No.	Default VBI Data Decoded	Line No.	Default VBI Data Decoded
6	WST	318	VPS	23	Gemstar 1x	—	—
7	WST	319	WST	24	Gemstar 1x	286	Gemstar 1x
8	WST	320	WST	25	Gemstar 1x	287	Gemstar 1x
9	WST	321	WST	—	—	288	Gemstar 1x
10	WST	322	WST	—	—	—	—
11	WST	323	WST	—	—	—	—
12	WST	324	WST	10	NABTS	272	NABTS
13	WST	325	WST	11	NABTS	273	NABTS
14	WST	326	WST	12	NABTS	274	NABTS
15	WST	327	WST	13	NABTS	275	NABTS
16	VPS	328	WST	14	VITC	276	NABTS
17	—	329	VPS	15	NABTS	277	VITC
18	—	330	—	16	VITC	278	NABTS
19	VITC	331	—	17	NABTS	279	VITC
20	WST	332	VITC	18	NABTS	280	NABTS
21	WST	333	WST	19	NABTS	281	NABTS
22	CC	334	WST	20	CGMS	282	NABTS
23	WSS	335	CC	21	CC	283	CGMS
24 + full odd field	WST	336	WST	22 + full odd field	NABTS	284	CC
		337 + full even field	WST			285 + full even field	NABTS



**Table 67. VBI Data Standards for Manual Configuration**

VBI_DATA_Px_Ny	PAL—625/50	NTSC—525/60
0000	Disable VDP	Disable VDP
0001	Teletext system identified by VDP_TTXT_TYPE	Teletext system identified by VDP_TTXT_TYPE
0010	VPS—ETSI EN 300 231 V 1.3.1	Reserved
0011	VITC	VITC
0100	WSS ITU-R BT.1119-1/ETSI.EN.300294	CGMS EIA-J CPR-1204/IEC 61880
0101	Reserved	Gemstar 1x
0110	Reserved	Gemstar 2x
0111	CC	CC EIA-608
1000 to 1111	Reserved	Reserved

**Table 68. VBI Data Standards to be Decoded on Line Px (PAL) or Line Ny (NTSC)**

Signal Name	Register Location	Address	
		Dec	Hex
VBI_DATA_P6_N23	VDP_LINE_00F [7:4]	101	0x65
VBI_DATA_P7_N24	VDP_LINE_010 [7:4]	102	0x66
VBI_DATA_P8_N25	VDP_LINE_011 [7:4]	103	0x67
VBI_DATA_P9	VDP_LINE_012 [7:4]	104	0x68
VBI_DATA_P10	VDP_LINE_013 [7:4]	105	0x69
VBI_DATA_P11	VDP_LINE_014 [7:4]	106	0x6A
VBI_DATA_P12_N10	VDP_LINE_015 [7:4]	107	0x6B
VBI_DATA_P13_N11	VDP_LINE_016 [7:4]	108	0x6C
VBI_DATA_P14_N12	VDP_LINE_017 [7:4]	109	0x6D
VBI_DATA_P15_N13	VDP_LINE_018 [7:4]	110	0x6E
VBI_DATA_P16_N14	VDP_LINE_019 [7:4]	111	0x6F
VBI_DATA_P17_N15	VDP_LINE_01A [7:4]	112	0x70
VBI_DATA_P18_N16	VDP_LINE_01B [7:4]	113	0x71
VBI_DATA_P19_N17	VDP_LINE_01C [7:4]	114	0x72
VBI_DATA_P20_N18	VDP_LINE_01D [7:4]	115	0x73
VBI_DATA_P21_N19	VDP_LINE_01E [7:4]	116	0x74
VBI_DATA_P22_N20	VDP_LINE_01F [7:4]	117	0x75
VBI_DATA_P23_N21	VDP_LINE_020 [7:4]	118	0x76
VBI_DATA_P24_N22	VDP_LINE_021 [7:4]	119	0x77
VBI_DATA_P318	VDP_LINE_00E [3:0]	100	0x64
VBI_DATA_P319_N286	VDP_LINE_00F [3:0]	101	0x65
VBI_DATA_P320_N287	VDP_LINE_010 [3:0]	102	0x66
VBI_DATA_P321_N288	VDP_LINE_011 [3:0]	103	0x67
VBI_DATA_P322	VDP_LINE_012 [3:0]	104	0x68
VBI_DATA_P323	VDP_LINE_013 [3:0]	105	0x69
VBI_DATA_P324_N272	VDP_LINE_014 [3:0]	106	0x6A
VBI_DATA_P325_N273	VDP_LINE_015 [3:0]	107	0x6B
VBI_DATA_P326_N274	VDP_LINE_016 [3:0]	108	0x6C
VBI_DATA_P327_N275	VDP_LINE_017 [3:0]	109	0x6D
VBI_DATA_P328_N276	VDP_LINE_018 [3:0]	110	0x6E
VBI_DATA_P329_N277	VDP_LINE_019 [3:0]	111	0x6F
VBI_DATA_P330_N278	VDP_LINE_01A [3:0]	112	0x70
VBI_DATA_P331_N279	VDP_LINE_01B [3:0]	113	0x71
VBI_DATA_P332_N280	VDP_LINE_01C [3:0]	114	0x72
VBI_DATA_P333_N281	VDP_LINE_01D [3:0]	115	0x73
VBI_DATA_P334_N282	VDP_LINE_01E [3:0]	116	0x74
VBI_DATA_P335_N283	VDP_LINE_01F [3:0]	117	0x75
VBI_DATA_P336_N284	VDP_LINE_020 [3:0]	118	0x76
VBI_DATA_P337_N285	VDP_LINE_021 [3:0]	119	0x77



# ADV7188

## VDP\_TTXT\_TYPE\_MAN\_ENABLE, Enable Manual Selection of Teletext Type, Address 0x60 [2], User Sub Map

0 (default)—Manual programming of the teletext type is disabled.

1—Manual programming of the teletext type is enabled.

## VDP\_TTXT\_TYPE\_MAN [1:0], Specify the Teletext Type, Address 0x60 [1:0], User Sub Map

These bits specify the teletext type to be decoded. These bits are functional only if VDP\_TTXT\_TYPE\_MAN\_ENABLE is set to 1.

**Table 69. VDP\_TTXT\_TYPE\_MAN Function**

VDP_TTXT_TYPE_MAN [1:0]	Description	
	625/50 (PAL)	525/60 (NTSC)
00 (default)	Teletext-ITU-R BT.653-625/50-A	Reserved
01	Teletext-ITU-R BT.653-625/50-B (WST)	Teletext-ITU-R BT.653-525/60-B
10	Teletext-ITU-R BT.653-625/50-C	Teletext-ITU-R BT.653-525/60-C or EIA516 (NABTS)
11	Teletext-ITU-R BT.653-625/50-D	Teletext-ITU-R BT.653-525/60-D

## VDP Ancillary Data Output

Reading the data back via I<sup>2</sup>C may not be feasible for VBI data standards with high data rates (for example, teletext). An alternative is to place the sliced data in a packet within the line blanking of the digital output CCIR 656 stream. This is available for all standards sliced by the VDP module.

When data is sliced on a given line, the corresponding ancillary data packet is placed immediately after the next EAV code that occurs at the output (that is, data sliced from multiple lines is not buffered up and then emitted in a burst). Note that the line on which the packet is placed differs from the line on which the data was sliced due to the vertical delay through the comb filters.

The user can enable or disable the insertion of VDP-decoded results into the 656 ancillary streams by using the ADF\_ENABLE bit.

## ADF\_ENABLE, Enable Ancillary Data Output Through 656 Stream, Address 0x62 [7], User Sub Map

0 (default)—Disables insertion of VBI decoded data into an ancillary 656 stream.

1—Enables insertion of VBI decoded data into an ancillary 656 stream.

The user can select the data identification word (DID) and the secondary data identification word (SDID) by programming the ADF\_DID [4:0] and ADF\_SDID [5:0] bits, respectively, as explained in the following sections.

## ADF\_DID [4:0], User-Specified Data ID Word in Ancillary Data, Address 0x62 [4:0], User Sub Map

These bits select the DID to be inserted into the ancillary data stream with the data decoded by the VDP.

The default value of ADF\_DID [4:0] is 10101.

## ADF\_SDID [5:0], User-Specified Secondary Data ID Word in Ancillary Data, Address 0x63 [5:0], User Sub Map

These bits select the SDID to be inserted in the ancillary data stream with the data decoded by the VDP.

The default value of ADF\_SDID [5:0] is 101010.

## DUPLICATE\_ADF, Enable Duplication/Spreading of Ancillary Data over Y and C Buses, Address 0x63 [7], User Sub Map

This bit determines whether the ancillary data is duplicated over both the Y and C buses or if the data packets are spread between the two channels.

0 (default)—The ancillary data packet is spread across the Y and C data streams.

1—The ancillary data packet is duplicated on the Y and C data streams.

## ADF\_MODE [1:0], Determine the Ancillary Data Output Mode, Address 0x62 [6:5], User Sub Map

These bits determine if the ancillary data output mode is in byte mode or nibble mode.

**Table 70. ADF\_MODE [1:0]**

ADF_MODE [1:0]	Description
00 (default)	Nibble mode
01	Byte mode, no code restrictions
10	Byte mode, but 0x00 and 0xFF are prevented (0x00 replaced by 0x01, 0xFF replaced by 0xFE)
11	Reserved

The ancillary data packet sequence is explained in Table 71 and Table 72. The nibble output mode is the default mode of output from the ancillary stream when ancillary stream output is enabled. This format complies with ITU-R BT.1364.

Some definitions of the abbreviations used in Table 71 and Table 72 are as follows:

- EP. Even parity for Bits B8 to B2. This means that Parity Bit EP is set so that an even number of 1s are in Bits B8 to B2, including the D8 parity bit.
- CS. Checksum word. The CS word is used to increase the integrity of the ancillary data packet from the DID, SDID, and dc through user data-words (UDWs). It consists of 10 bits: a 9-bit calculated value and B9 as the inverse of B8.



The checksum value of B8 to B0 is equal to the nine LSBs of the sum of the nine LSBs of the DID, SDID, and dc, as well as all UDWs in the packet. Prior to the start of the checksum count cycle, all checksum and carry bits are preset to 0. Any carry resulting from the checksum count cycle is ignored.

- $\overline{EP}$ . The MSB, B9, is the inverse of EP. This ensures that restricted Codes 0x00 and 0xFF do not occur.
- Line\_number [9:0]. The number of the line that immediately precedes the ancillary data packet. This number is as per the

numbering system of ITU-R BT.470, ranging from 1 to 625 in a 625-line system and from 1 to 263 in a 525-line system. Note that the line on which the packet is output differs from the line on which the VBI data was sliced due to the vertical delay through the comb filters.

- Data Count. The data count specifies the number of UDWs in the ancillary stream for the standard. The total number of user data-words is four times the data count. Padding words can be introduced so that the total number of UDWs is divisible by 4.

**Table 71. Ancillary Data in Nibble Output Format**

Byte	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	Description	
0	0	0	0	0	0	0	0	0	0	0	Ancillary data preamble.	
1	1	1	1	1	1	1	1	1	1	1		
2	1	1	1	1	1	1	1	1	1	1		
3	$\overline{EP}$	EP	0	I2C_DID6_2 [4:0]				0	0		DID (data identification word).	
4	$\overline{EP}$	EP	I2C_SDID7_2 [5:0]				0	0			SDID (secondary data identification word).	
5	$\overline{EP}$	EP	0	DC [4:0]				0	0		Data count.	
6	$\overline{EP}$	EP	padding [1:0]		VBI_DATA_STD [3:0]			0	0		ID0 (User Data-Word 1).	
7	EP	EP	0	Line_number [9:5]				0	0		ID1 (User Data-Word 2).	
8	$\overline{EP}$	EP	Even_Field	Line_number [4:0]				0	0		ID2 (User Data-Word 3).	
9	$\overline{EP}$	EP	0	0	0	0	VDP_TTX_TTYPE [1:0]	0	0		ID3 (User Data-Word 4).	
10	$\overline{EP}$	EP	0	0	VBI_WORD_1 [7:4]			0	0		User Data-Word 5.	
11	$\overline{EP}$	EP	0	0	VBI_WORD_1 [3:0]			0	0		User Data-Word 6.	
12	EP	EP	0	0	VBI_WORD_2 [7:4]			0	0		User Data-Word 7.	
13	$\overline{EP}$	EP	0	0	VBI_WORD_2 [3:0]			0	0		User Data-Word 8.	
14	$\overline{EP}$	EP	0	0	VBI_WORD_3 [7:4]			0	0		User Data-Word 9.	
.	.	.	.	.	.	.	.	.	.	.	Pad 0x200. These padding words may not be present depending on ancillary data type. User Data-Word XX.	
.	.	.	.	.	.	.	.	.	.	.		
.	.	.	.	.	.	.	.	.	.	.		
n - 3	1	0	0	0	0	0	0	0	0	0		
n - 2	1	0	0	0	0	0	0	0	0	0		
n - 1	$\overline{B8}$	Checksum								0	0	CS (checksum word).



# ADV7188

**Table 72. Ancillary Data in Byte Output Format<sup>1</sup>**

Byte	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	Description	
0	0	0	0	0	0	0	0	0	0	0	Ancillary data preamble.	
1	1	1	1	1	1	1	1	1	1	1		
2	1	1	1	1	1	1	1	1	1	1		
3	EP	EP	0	I2C_DID6_2 [4:0]					0	0	DID.	
4	EP	EP	I2C_SDID7_2 [5:0]					0	0	SDID.		
5	EP	EP	0	DC [4:0]					0	0	Data count.	
6	EP	EP	padding [1:0]		VBI_DATA_STD [3:0]			0	0	ID0 (User Data-Word 1).		
7	EP	EP	0	Line_number [9:5]					0	0	ID1 (User Data-Word 2).	
8	EP	EP	Even_Field	Line_number [4:0]					0	0	ID2 (User Data-Word 3).	
9	EP	EP	0	0	0	0	VDP_TTXT_TYPE [1:0]		0	0	ID3 (User Data-Word 4).	
10	VBI_WORD_1 [7:0]								0	0	User Data-Word 5.	
11	VBI_WORD_2 [7:0]								0	0	User Data-Word 6.	
12	VBI_WORD_3 [7:0]								0	0	User Data-Word 7.	
13	VBI_WORD_4 [7:0]								0	0	User Data-Word 8.	
14	VBI_WORD_5 [7:0]								0	0	User Data-Word 9.	
.	.	.	.	.	.	.	.	.	.	.	Pad 0x200. These padding words may not be present depending on ancillary data type. User Data-Word XX.	
.	.	.	.	.	.	.	.	.	.	.		
.	.	.	.	.	.	.	.	.	.	.		
n-3	1	0	0	0	0	0	0	0	0	0		
n-2	1	0	0	0	0	0	0	0	0	0		
n-1	B8	Checksum								0	0	CS (checksum word).

<sup>1</sup> This mode does not fully comply with ITU-R BT.1364.

## Structure of VBI Words in Ancillary Data Stream

Each VBI data standard has been split into a clock run-in (CRI), a framing code (FC), and a number of data bytes (n). The data packet in the ancillary stream includes only the FC and data bytes. The VBI\_WORD\_X in the ancillary data stream has the format described in Table 73.

**Table 73. Structure of VBI Data-Words in Ancillary Stream**

Ancillary Data Byte Number	Byte Type	Byte Description
VBI_WORD_1	FC0	Framing Code [23:16]
VBI_WORD_2	FC1	Framing Code [15:8]
VBI_WORD_3	FC2	Framing Code [7:0]
VBI_WORD_4	DB1	First data byte
...	...	...
VBI_WORD_N+3	DBn	Last (n <sup>th</sup> ) data byte

## VDP Framing Code

The length of the actual framing code depends on the VBI data standard. For uniformity, the length of the framing code reported in the ancillary data stream is always 24 bits. For standards with a shorter framing code length, the extra LSB bits are set to 0. The valid length of the framing code can be decoded from the VBI\_DATA\_STD bit available in ID0 (UDW1).

The framing code is always reported in the reverse order of transmission. Table 74 shows the framing code and its valid length for VBI data standards supported by VDP.

## Example

For teletext (B-WST), the framing code byte is 11100100 (0xE4), with bits shown in the order of transmission. Thus, VBI\_WORD\_1 = 0x27, VBI\_WORD\_2 = 0x00, and VBI\_WORD\_3 = 0x00. Translating these into UDWs in the ancillary data stream, for the nibble mode,

UDW5 [5:2] = 0010

UDW6 [5:2] = 0111

UDW7 [5:2] = 0000 (undefined bits, automatically set to 0)

UDW8 [5:2] = 0000 (undefined bits, automatically set to 0)

UDW9 [5:2] = 0000 (undefined bits, automatically set to 0)

UDW10 [5:2] = 0000 (undefined bits, automatically set to 0)

and for the byte mode,

UDW5 [9:2] = 0010\_0111

UDW6 [9:2] = 0000\_0000 (undefined bits, automatically set to 0)

UDW7 [9:2] = 0000\_0000 (undefined bits, automatically set to 0)

## Data Bytes

VBI\_WORD\_4 to VBI\_WORD\_N+3 contain the data-words that were decoded by the VDP in the order of transmission. The position of bits in bytes is in the reverse order of transmission. For example, closed captioning has two user data bytes, as shown in Table 80. The data bytes in the ancillary data stream in this case are as follows:

VBI\_WORD\_4 = BYTE1 [7:0]

VBI\_WORD\_5 = BYTE2 [7:0]

The number of VBI\_WORDS for each VBI data standard and the total number of UDWs in the ancillary data stream are shown in Table 75.



Table 74. Framing Code Sequence for Different VBI Standards

VBI Standard	Length in Bits	Error-Free Framing Code Bits (In Order of Transmission )	Error-Free Framing Code Reported by VDP (In Reverse Order of Transmission )
TTXT_SYSTEM_A (PAL)	8	11100111	11100111
TTXT_SYSTEM_B (PAL)	8	11100100	00100111
TTXT_SYSTEM_B (NTSC)	8	11100100	00100111
TTXT_SYSTEM_C (PAL and NTSC)	8	11100111	11100111
TTXT_SYSTEM_D (PAL and NTSC)	8	11100101	10100111
VPS (PAL)	16	10001010100011001	1001100101010001
VITC (NTSC and PAL)	1	0	0
WSS (PAL)	24	000111100011110000011111	111110000011110001111000
Gemstar 1× (NTSC)	3	001	100
Gemstar 2× (NTSC)	11	1001 1011 101	101 1101 1001
CC (NTSC and PAL)	3	001	100
CGMS (NTSC)	1	0	0

Table 75. Total User Data-Words for Different VBI Standards<sup>1</sup>

VBI Standard	ADF Mode	Framing Code UDWs	VBI Data- Words	Number of Padding Words	Total UDWs
TTXT_SYSTEM_A (PAL)	00 (nibble mode)	6	74	0	84
	01, 10 (byte mode)	3	37	0	44
TTXT_SYSTEM_B (PAL)	00 (nibble mode)	6	84	2	96
	01, 10 (byte mode)	3	42	3	52
TTXT_SYSTEM_B (NTSC)	00 (nibble mode)	6	68	2	80
	01, 10 (byte mode)	3	34	3	44
TTXT_SYSTEM_C (PAL and NTSC)	00 (nibble mode)	6	66	0	76
	01, 10 (byte mode)	3	33	2	42
TTXT_SYSTEM_D (PAL and NTSC)	00 (nibble mode)	6	68	2	80
	01, 10 (byte mode)	3	34	3	44
VPS (PAL)	00 (nibble mode)	6	26	0	36
	01, 10 (byte mode)	3	13	0	20
VITC (NTSC and PAL)	00 (nibble mode)	6	18	0	28
	01, 10 (byte mode)	3	9	0	16
WSS (PAL)	00 (nibble mode)	6	4	2	16
	01, 10 (byte mode)	3	2	3	12
Gemstar 1× (NTSC)	00 (nibble mode)	6	4	2	16
	01, 10 (byte mode)	3	2	3	12
Gemstar 2× (NTSC)	00 (nibble mode)	6	8	2	20
	01, 10 (byte mode)	3	4	1	12
CC (NTSC and PAL)	00 (nibble mode)	6	4	2	16
	01, 10 (byte mode)	3	2	3	12
CGMS (NTSC)	00 (nibble mode)	6	6	0	16
	01, 10 (byte mode)	3	3 + 3	2	12

<sup>1</sup> The first four UDWs are always the identification word.

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

Dedicated I<sup>2</sup>C readback registers are available for CC, CGMS, WSS, Gemstar, VPS, PDC/UTC, and VITC. Because teletext is a high data rate standard, data extraction is supported only through the ancillary data packet. The details of these registers and their access procedures are described in this section.

**User Interface for I<sup>2</sup>C Readback Registers**

The VDP decodes all enabled VBI data standards in real time. Because the I<sup>2</sup>C access speed is much slower than the decoded rate, the registers may be updated with data from the next line when they are being accessed. To avoid this, VDP has a self-clearing CLEAR bit and an AVAILABLE status bit accompanying all the I<sup>2</sup>C readback registers.

The user has to clear the I<sup>2</sup>C readback register by writing a high to the CLEAR bit. This resets the state of the AVAILABLE bit to low and indicates that the data in the associated readback registers is not valid. After the VDP decodes the next line of the corresponding VBI data, the decoded data is placed in the I<sup>2</sup>C readback register and the AVAILABLE bit is set high to indicate that valid data is now available.

Although the VDP, if present, decodes this VBI data in subsequent lines, the decoded data is not updated to the readback registers until the CLEAR bit is set high again. However, this data is available through the 656 ancillary data packets.

The CLEAR and AVAILABLE bits are in the VDP\_STATUS\_CLEAR (Address 0x78, user sub map, write only) and VDP\_STATUS (0x78, User Sub Map, read only) registers.

**Example I<sup>2</sup>C Readback Procedure**

To read one packet (line) of PDC data from the decoder

1. Write 10 to I2C\_GS\_VPS\_PDC\_UTC [1:0] (Address 0x9C, user sub map) to specify that PDC data has to be updated to I<sup>2</sup>C registers.
2. Write high to the GS\_PDC\_VPS\_UTC\_CLEAR bit (Address 0x78, user sub map) to enable I<sup>2</sup>C register updating.
3. Poll the GS\_PDC\_VPS\_UTC\_AVL bit (Address 0x78, user sub map) going high to check the availability of the PDC packets.
4. Read the data bytes from the PDC I<sup>2</sup>C registers. To read another line or packet of data, repeat the previous steps.

To read a packet of CC, CGMS, or WSS data, only Steps 1 through 3 are required because these types of data have dedicated registers.

**VDP—Content-Based Data Update**

For certain standards, such as WSS, CGMS, Gemstar, PDC, UTC, and VPS, the information content in the signal transmitted remains the same over numerous lines, and the user may want to be notified only when there is a change in the information content or loss of the information content. The user needs to enable content-based updating for the required standard through the GS\_VPS\_PDC\_UTC\_CB\_CHANGE and WSS\_CGMS\_CB\_CHANGE bits. Therefore, the AVAILABLE bit shows the availability of that standard only when its content has changed.

Content-based updating also applies to loss of data at the lines where some data was previously present. Thus, for standards like VPS, Gemstar, CGMS, and WSS, if no data arrives in the next four lines programmed, the corresponding AVAILABLE bit in the VDP\_STATUS register is set high and the content in the I<sup>2</sup>C registers for that standard is set to 0. The user must write high to the corresponding CLEAR bit so that when a subsequent valid line is decoded, the decoded results are available in the I<sup>2</sup>C registers, with the AVAILABLE status bit set high.

If content-based updating is enabled, the AVAILABLE bit is set high (assuming the CLEAR bit was written to) in the following cases:

- The data contents changed.
- Data was being decoded and four lines with no data have been detected.
- No data was being decoded and new data is now being decoded.

**GS\_VPS\_PDC\_UTC\_CB\_CHANGE, Enable Content-Based Updating for Gemstar/VPS/PDC/UTC, Address 0x9C [5], User Sub Map**

0—Disables content-based updating.

1 (default)—Enables content-based updating.

**WSS\_CGMS\_CB\_CHANGE, Enable Content-Based Updating for WSS/CGMS, Address 0x9C [4], User Sub Map**

0—Disables content-based updating.

1 (default)—Enables content-based updating.





**VDP—Interrupt-Based Reading of VDP I<sup>2</sup>C Registers**

Some VDP status bits are also linked to the interrupt request controller so that the user does not have to poll the AVAILABLE status bit. The user can configure the video decoder to trigger an interrupt request on the INTRQ pin in response to the valid data available in I<sup>2</sup>C registers. This function is available for the following data types:

- CGMS or WSS. The user can select triggering an interrupt request each time sliced data is available or triggering an interrupt request only when the sliced data has changed. Selection is made via the WSS\_CGMS\_CB\_CHANGE bit.
- Gemstar, PDC, VPS, or UTC. The user can select triggering an interrupt request each time sliced data is available or triggering an interrupt request only when the sliced data has changed. Selection is made via the GS\_VPS\_PDC\_UTC\_CB\_CHANGE bit.

The sequence for the interrupt-based reading of the VDP I<sup>2</sup>C data registers is as follows for the CC standard:

1. The user unmask the CC interrupt mask bit (Bit 0 of Address 0x50, user sub map, set to 1). CC data occurs upon the incoming video. VDP slices CC data and places it in the VDP readback registers.
2. The VDP CC available bit goes high, and the VDP module signals to the interrupt controller to stimulate an interrupt request (for CC in this case).
3. The user reads the interrupt status bits (user sub map) and sees that new CC data is available (Bit 0 of Address 0x4E, user sub map, set to 1).
4. The user writes 1 to the CC interrupt clear bit (Bit 0 of Address 0x4F, user sub map, set to 1) in the interrupt I<sup>2</sup>C space (this is a self-clearing bit). This clears the interrupt on the INTRQ pin but does not have an effect in the VDP I<sup>2</sup>C area.
5. The user reads the CC data from the VDP I<sup>2</sup>C area.
6. The user writes to a bit, CC\_CLEAR (Bit 0 of Address 0x78, user sub map, set to 1) in the VDP\_STATUS [0] register, to signify that the CC data has been read and the VDP CC can be updated at the next occurrence of CC).
7. Back to Step 2.

**Interrupt Mask Register Details**

The following bits set the interrupt mask on the signal from the VDP VBI data slicer.

**VDP\_CCAPD\_MSKB, Address 0x50 [0], User Sub Map**

0 (default)—Disables interrupt on VDP\_CCAPD\_Q signal.

1—Enables interrupt on VDP\_CCAPD\_Q signal.

**VDP\_CGMS\_WSS\_CHNGD\_MSKB, Address 0x50 [2], User Sub Map**

0 (default)—Disables interrupt on VDP\_CGMS\_WSS\_CHNGD\_Q signal.

1—Enables interrupt on VDP\_CGMS\_WSS\_CHNGD\_Q signal.

**VDP\_GS\_VPS\_PDC\_UTC\_CHNG\_MSKB, Address 0x50 [4], User Sub Map**

0 (default)—Disables interrupt on VDP\_GS\_VPS\_PDC\_UTC\_CHNG\_Q signal.

1—Enables interrupt on VDP\_GS\_VPS\_PDC\_UTC\_CHNG\_Q signal.

**VDP\_VITC\_MSKB, Address 0x50 [6], User Sub Map**

0 (default)—Disables interrupt on VDP\_VITC\_Q signal.

1—Enables interrupt on VDP\_VITC\_Q signal.

**Interrupt Status Register Details**

The following read-only bits contain data detection information from the VDP module since the status bit was last cleared or unmasked.

**VDP\_CCAPD\_Q, Address 0x4E [0], User Sub Map**

0 (default)—Closed caption data was not detected.

1—Closed caption data was detected.

**VDP\_CGMS\_WSS\_CHNGD\_Q, Address 0x4E [2], User Sub Map**

0 (default)—CGMS or WSS data was not detected.

1—CGM or WSS data was detected.

**VDP\_GS\_VPS\_PDC\_UTC\_CHNG\_Q, Address 0x4E [4], User Sub Map**

0 (default)—Gemstar, PDC, UTC, or VPS data was not detected.

1—Gemstar, PDC, UTC, or VPS data was detected.

**VDP\_VITC\_Q, Address 0x4E [6], User Sub Map, Read Only**

0 (default)—VITC data was not detected.

1—VITC data was detected.

**Interrupt Status Clear Register Details**

It is not necessary to write 0 to these write-only bits because they automatically reset when they are set (self-clearing).

**VDP\_CCAPD\_CLR, Address 0x4F [0], User Sub Map**

1—Clears the VDP\_CCAPD\_Q bit.



# ADV7188

**VDP\_CGMS\_WSS\_CHNGD\_CLR, Address 0x4F [2], User Sub Map**

1—Clears the VDP\_CGMS\_WSS\_CHNGD\_Q bit.

**VDP\_GS\_VPS\_PDC\_UTC\_CHNG\_CLR, Address 0x4F [4], User Sub Map**

1—Clears the VDP\_GS\_VPS\_PDC\_UTC\_CHNG\_Q bit.

**VDP\_VITC\_CLR, Address 0x4F [6], User Sub Map**

1—Clears the VDP\_VITC\_Q bit.

## STANDARD DETECTION AND IDENTIFICATION

The standard detection and identification (STDI) block of the ADV7188 monitors the synchronization signals received on the SOY pin. STDI\_LINE\_COUNT\_MODE must be set to 1 to enable the STDI block and achieve valid synchronization signal analysis. Four key measurements are performed:

- **Block Length BL [13:0].** This is the number of clock cycles in a block of eight lines. From this, the time duration of one line can be concluded. Please note that the crystal frequency determines the clock cycle and that a crystal frequency of 28.63636 MHz should be used for the ADV7188.
- **Line Count in Field LCF [10:0].** The LCF [10:0] readback value is the number of lines between two vsyncs, that is, over one field.
- **Line Count in Vsync LCVS [4:0].** The LCVS [4:0] readback value is the number of lines within one vsync period.
- **Field Length FCL [12:0].** This is the number of clock cycles in 1/256<sup>th</sup> of a field. Multiplying this value by 256 calculates the field length in clock cycles.

By interpreting these four parameters, it is possible to distinguish among the types of input signals.

A data valid flag, STDI\_VALID, is provided that is held low during the measurements. The four parameters should only be read after the STDI\_VALID flag has gone high. Refer to Table 76 for information on the readback values.

### Notes

- Types of synchronization pulses include horizontal synchronization pulses, equalization and serration pulses, and Macrovision pulses.
- Macrovision pseudosynchronization and AGC pulses are counted by the STDI block in normal readback mode. This does not prohibit the identification of the video signal.
- The ADV7188 only measures the parameters; it does not take any action based on these measurements. Therefore, the part helps to identify the input to avoid problems in the scheduling of a system controller, but it does not reconfigure itself.

**STDI\_DVALID, Standard Identification Data Valid Read Back, Address 0xB1 [7]**

X—This bit is set by the ADV7188 as soon as the measurements of the STDI block are finished. A high level signals the validity of the BL, LCVS, LCF, and STDI\_INTLCD parameters. To prevent false readouts, especially during the signal acquisition, the DVALID bit only goes high after recording four fields with the same length. As a result, the measurements can require up to five fields to finish.

**STDI\_LINE\_COUNT\_MODE, Address 0x86 [3]**

0 (default)—Disables the STDI functionality.

1—Enables STDI functionality. This enables valid readback of the STDI block registers.

**BL [13:0], Block Length Readback, Address 0xB1 [5:0], Address 0xB2 [7:0]**

XX XXXX XXXX XXXX—Number of clock cycles in a block of eight lines of incoming video. Data is only valid if STDI\_DVALID is high.

**LCVS [4:0], Line Count in Vsync Readback, Address 0xB3 [7:3]**

X XXXX—Number of lines within a vertical synchronization period. Data is only valid if STDI\_DVALID is high.

**LCF [10:0], Line Count in Field Readback, Address 0xB3 [2:0], Address 0xB4 [7:0]**

XX XXXX XXXX—Number of lines between two vsyncs per one field/frame. Data is only valid if STDI\_DVALID is high.

**FCL [12:0], 1/256<sup>th</sup> of Field Length in Number of Crystal Clocks Read back, Address 0xCA [4:0], Address 0xCB [7:0]**

XXX—Number of crystal clocks (with the recommended 28.63636 MHz frequency) in 1/256<sup>th</sup> of a field. Data is only valid if STDI\_DVALID is high.



**STDI Readback Values for SD, PR, and HD**

The readback values provided are only valid when using a crystal with the recommended 28.63636 MHz frequency.

**Table 76. STDI Results for Video Standards (SD, PR, and HD)**

Video Standard	BL [13:0]	LCF [10:0]	LCVS [4:0]
525i 60	14552 ± 80	261 ± 50	3 ± 3
240p 60	14552 ± 80	261 ± 50	2 ± 2
625i 50	14653 ± 80	311 ± 50	2 ± 2
288p 50	14654 ± 80	313 ± 50	2 ± 2
480p 60	7271 ± 40	524 ± 50	5 ± 2
720p 50	6101 ± 40	749 ± 50	4 ± 2
720p 60	5083 ± 40	749 ± 50	4 ± 2
1035i 30	6780 ± 40	562 ± 50	5 ± 2
1080i 25	7322 ± 40	1249 ± 50	0 ± 2
1080i 30	6780 ± 40	561 ± 50	4 ± 2
1080p 25	8137 ± 40	1124 ± 50	4 ± 2
1080p 50	4064 ± 40	1124 ± 50	4 ± 2
1080p 60	3385 ± 40	1124 ± 50	4 ± 2
1152i 50 Wide	7321 ± 40	623 ± 50	0 ± 2
1152i 50 Full	7321 ± 40	623 ± 50	4 ± 2

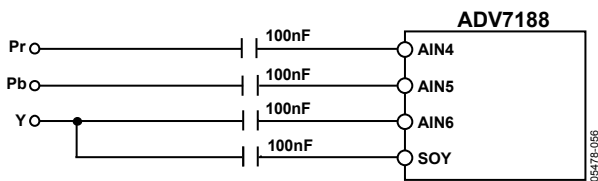


Figure 37. Example Connection of SOY pin

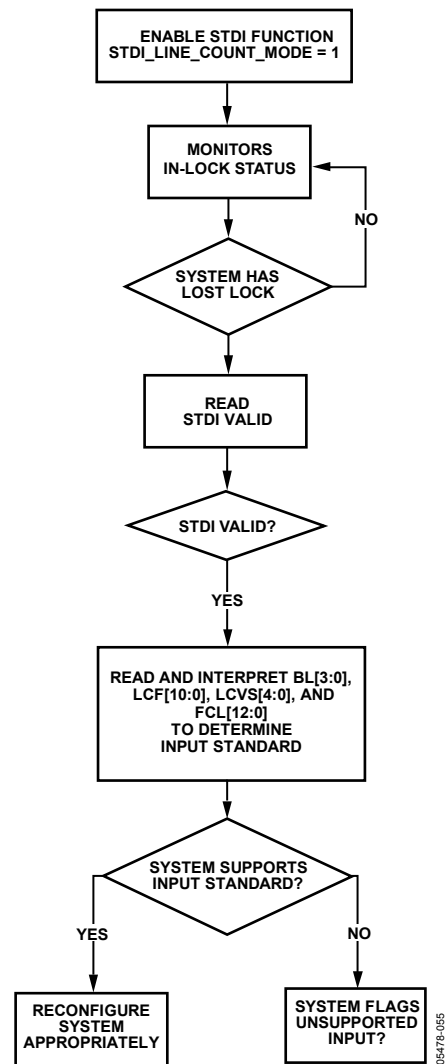


Figure 38. Example Use of STDI Block



# ADV7188

## I<sup>2</sup>C READBACK REGISTERS

### Teletext

Because teletext is a high data rate standard, the decoded bytes are available only as ancillary data. However, a TTX\_AVL bit is provided in I<sup>2</sup>C so that the user can check whether the VDP has detected teletext. Note that the TTXT\_AVL bit is a plain status bit and does not use the protocol identified in the I<sup>2</sup>C Interface section.

### TTXT\_AVL, Teletext Detected Status Bit, Address 0x78 [7], User Sub Map, Read Only

0—Teletext was not detected.

1—Teletext was detected.

### WST Packet Decoding

For WST only, the VDP decodes the magazine and row address of WST teletext packets and further decodes the packet's 8 × 4 hamming coded words. This feature can be disabled by using the WST\_PKT\_DECOD\_DISABLE bit (Bit 3, Register 0x60, user sub map). This feature is only valid for WST.

**Table 78. WST Packet Description**

Packet	Byte	Description
Header Packet (X/00)	1 <sup>st</sup> byte	Magazine number—dehammed Byte 4
	2 <sup>nd</sup> byte	Row number—dehammed Byte 5
	3 <sup>rd</sup> byte	Page number—dehammed Byte 6
	4 <sup>th</sup> byte	Page number—dehammed Byte 7
	5 <sup>th</sup> to 10 <sup>th</sup> byte	Control Bytes—dehammed Byte 8 to Byte 13
	11 <sup>th</sup> to 42 <sup>nd</sup> byte	Raw data bytes
Text Packets (X/01 to X/25)	1 <sup>st</sup> byte	Magazine number—dehammed Byte 4
	2 <sup>nd</sup> byte	Row number—dehammed Byte 5
	3 <sup>rd</sup> to 42 <sup>nd</sup> byte	Raw data bytes
8/30 (Format 1) packet Design Code = 0000 or 0001 UTC	1 <sup>st</sup> byte	Magazine number—dehammed Byte 4
	2 <sup>nd</sup> byte	Row number—dehammed Byte 5
	3 <sup>rd</sup> byte	Design code—dehammed Byte 6
	4 <sup>th</sup> to 10 <sup>th</sup> byte	Dehammed Initial teletext page, Byte 7 to Byte 12
	11 <sup>th</sup> to 23 <sup>rd</sup> byte	UTC bytes—dehammed Byte 13 to Byte 25
	24 <sup>th</sup> to 42 <sup>nd</sup> byte	Raw status bytes
8/30 (Format 2) packet Design Code = 0010 or 0011 PDC	1 <sup>st</sup> byte	Magazine number—dehammed Byte 4
	2 <sup>nd</sup> byte	Row number—dehammed Byte 5
	3 <sup>rd</sup> byte	Design code—dehammed Byte 6
	4 <sup>th</sup> to 10 <sup>th</sup> byte	Dehammed Initial teletext page, Byte 7 to Byte 12
	11 <sup>th</sup> to 23 <sup>rd</sup> byte	PDC bytes—dehammed Byte 13 to Byte 25
	24 <sup>th</sup> to 42 <sup>nd</sup> byte	Raw status bytes
X/26, X/27, X/28, X/29, X/30, X/31 <sup>1</sup>	1 <sup>st</sup> byte	Magazine number—dehammed Byte 4
	2 <sup>nd</sup> byte	Row number—dehammed Byte 5
	3 <sup>rd</sup> byte	Design code—dehammed Byte 6
	4 <sup>th</sup> to 42 <sup>nd</sup> byte	Raw data bytes

<sup>1</sup> For X/26, X/28, and X/29, further decoding needs 24 × 18 hamming decoding. Not supported at present.

### WST\_PKT\_DECOD\_DISABLE, Disable Hamming Decoding of Bytes in WST, Address 0x60 [3], User Sub Map

0—Enables hamming decoding of WST packets.

1 (default)—Disables hamming decoding of WST packets.

For hamming coded bytes, the dehammed nibbles, along with error information from the hamming decoder, are output as follows:

- Input hamming coded byte: {D3, P3, D2, P2, D1, P1, D0, P0} (bits in decoded order)
- Output dehammed byte: {E1, E0, 0, 0, D3', D2', D1', D0'} (where Di' is the corrected bit, and Ei represents the error information).

**Table 77. Explanation of Error Bits in the Dehammed Output Byte**

E [1:0]	Error Information	Output Data Bits in Nibble
00	No errors detected	Okay
01	Error in P4	Okay
10	Double error	Not okay
11	Single error found and corrected	Okay

The types of WST packets that are decoded are described in Table 78.



**CGMS and WSS**

The CGMS and WSS data packets convey the same type of information for different video standards. WSS is for PAL and CGMS is for NTSC; therefore, the CGMS and WSS readback registers are shared. WSS is biphas coded, and the VDP performs a biphas decoding to produce the 14 raw WSS bits in the CGMS/WSS readback I<sup>2</sup>C registers and to set the CGMS\_WSS\_AVL bit.

**CGMS\_WSS\_CLEAR, CGMS/WSS Clear, Address 0x78 [2], User Sub Map, Write Only, Self-Clearing**

1—Reinitializes the CGMS/WSS readback registers.

**CGMS\_WSS\_AVL CGMS/WSS, Available Bit, Address 0x78 [2], User Sub Map, Read Only**

0—CGMS/WSS was not detected.

1—CGMS/WSS was detected.

**CGMS\_WSS\_DATA\_0 [3:0], Address 0x7D [3:0]****CGMS\_WSS\_DATA\_1 [7:0], Address 0x7E [7:0]****CGMS\_WSS\_DATA\_2 [7:0], Address 0x7F [7:0]**

These read-only bits, located in the user sub map, hold the decoded CGMS or WSS data.

Refer to Figure 39 and Figure 40 for the I<sup>2</sup>C to WSS and CGMS bit mapping.

**CC**

Two bytes of decoded closed caption data are available in the I<sup>2</sup>C registers. The field information of the decoded CC data can be obtained from the CC\_EVEN\_FIELD bit (Register 0x78).

**CC\_CLEAR, Closed Captioning Clear, Address 0x78 [0], User Sub Map, Write Only, Self-Clearing**

1—Reinitializes the CC readback registers.

**CC\_AVL, Closed Captioning Available, Address 0x78 [0], User Sub Map, Read Only**

0—Closed captioning was not detected.

1—Closed captioning was detected.

**CC\_EVEN\_FIELD, Address 0x78 [1], User Sub Map, Read Only**

Identifies the field from which the CC data was decoded.

0—Closed captioning was detected on an odd field.

1—Closed captioning was detected on an even field.

**VDP\_CCAP\_DATA\_0, Address 0x79 [7:0], User Sub Map, Read Only**

Decoded Byte 1 of CC data.

**VDP\_CCAP\_DATA\_1, Address 0x7A [7:0], User Sub Map, Read Only**

Decoded Byte 2 of CC data.



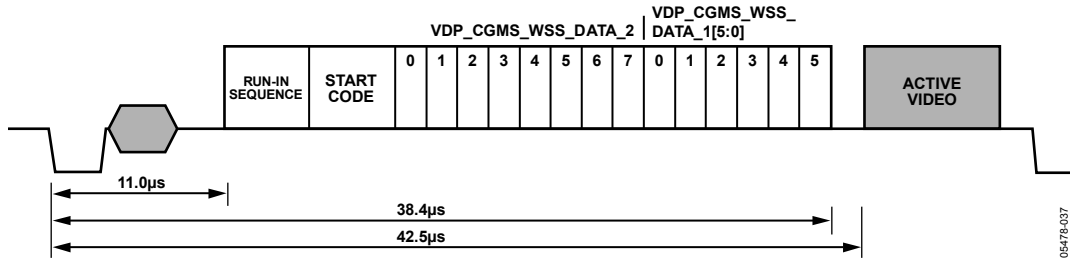


Figure 39. WSS Waveform

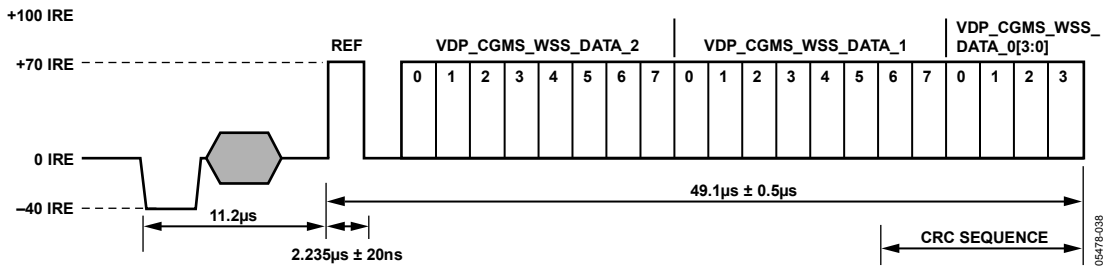


Figure 40. CGMS Waveform

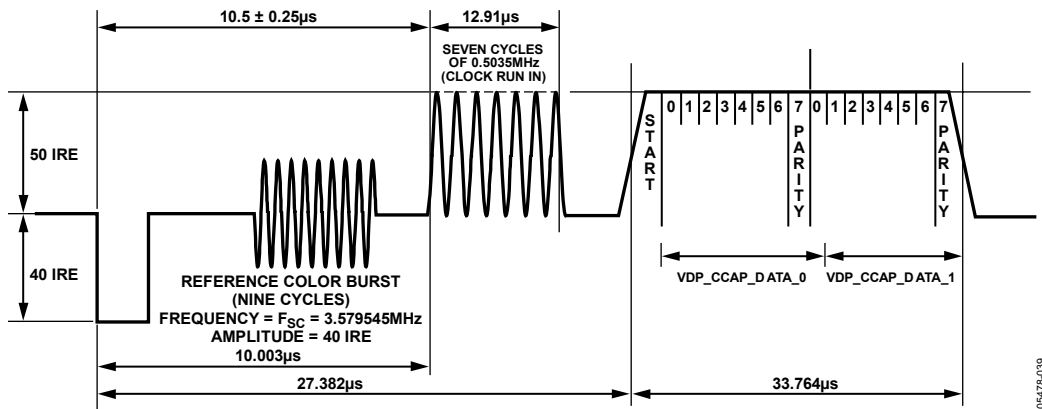


Figure 41. CC Waveform and Decoded Data Correlation

Table 79. CGMS Readback Registers<sup>1</sup>

Signal Name	Register Location	Address (User Sub Map)	
		Dec	Hex
CGMS_WSS_DATA_0 [3:0]	VDP_CGMS_WSS_DATA_0 [3:0]	125d	0x7D
CGMS_WSS_DATA_1 [7:0]	VDP_CGMS_WSS_DATA_1 [7:0]	126d	0x7E
CGMS_WSS_DATA_2 [7:0]	VDP_CGMS_WSS_DATA_2 [7:0]	127d	0x7F

<sup>1</sup> The register is a readback register; the default value does not apply.

Table 80. Closed Captioning Readback Registers<sup>1</sup>

Signal Name	Register Location	Address (User Sub Map)	
		Dec	Hex
CCAP_BYTE_1 [7:0]	VDP_CCAP_DATA_0 [7:0]	121d	0x79
CCAP_BYTE_2 [7:0]	VDP_CCAP_DATA_1 [7:0]	122d	0x7A

<sup>1</sup> The register is a readback register; the default value does not apply.



**VITC**

VITC has a sequence of 10 syncs in between each data byte. The VDP strips these syncs from the data stream to output only the data bytes. The VITC results are available in the VDP\_VITC\_DATA\_0 to VDP\_VITC\_DATA\_8 registers (Register 0x92 to Register 0x9A, user sub map).

The VITC has a CRC byte at the end; the syncs in between each data byte are also used in this CRC calculation. Because these syncs are not output, the CRC is calculated internally. The calculated CRC is also available for the user in the VDP\_VITC\_CALC\_CRC register (Register 0x9B, User Sub Map). After the VDP completes decoding the VITC line, the VDP\_VITC\_DATA\_x and VDP\_VITC\_CALC\_CRC registers are updated and the VITC\_AVL bit is set.

**VITC\_CLEAR, VITC Clear, Address 0x78 [6], User Sub Map, Write Only, Self-Clearing**

1—Reinitializes the VITC readback registers.

**VITC\_AVL, VITC Available, Address 0x78 [6], User Sub Map**

0—VITC data was not detected.

1—VITC data was detected.

**VITC Readback Registers**

See Figure 42 for the I<sup>2</sup>C to VITC bit mapping.

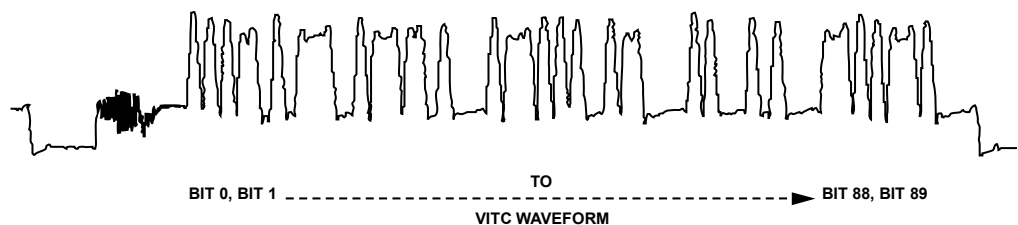


Figure 42. VITC Waveform and Decoded Data Correlation

Table 81. VITC Readback Registers<sup>1</sup>

Signal Name	Register Location	Address (User Sub Map)	
		Dec	Hex
VITC_DATA_0 [7:0]	VDP_VITC_DATA_0 [7:0] (VITC Bits [9:2])	146d	0x92
VITC_DATA_1 [7:0]	VDP_VITC_DATA_1 [7:0] (VITC Bits [19:12])	147d	0x93
VITC_DATA_2 [7:0]	VDP_VITC_DATA_2 [7:0] (VITC Bits [29:22])	148d	0x94
VITC_DATA_3 [7:0]	VDP_VITC_DATA_3 [7:0] (VITC Bits [39:32])	149d	0x95
VITC_DATA_4 [7:0]	VDP_VITC_DATA_4 [7:0] (VITC Bits [49:42])	150d	0x96
VITC_DATA_5 [7:0]	VDP_VITC_DATA_5 [7:0] (VITC Bits [59:52])	151d	0x97
VITC_DATA_6 [7:0]	VDP_VITC_DATA_6 [7:0] (VITC Bits [69:62])	152d	0x98
VITC_DATA_7 [7:0]	VDP_VITC_DATA_7 [7:0] (VITC Bits [79:72])	153d	0x99
VITC_DATA_8 [7:0]	VDP_VITC_DATA_8 [7:0] (VITC Bits [89:82])	154d	0x9A
VITC_CALC_CRC [7:0]	VDP_VITC_CALC_CRC [7:0]	155d	0x9B

<sup>1</sup> The register is a readback register; the default value does not apply.





## VPS/PDC/UTC/Gemstar

The readback registers for VPS, PDC, and UTC are shared. Gemstar is a high data rate standard and therefore is available only through the ancillary stream. For evaluation purposes, any one line of Gemstar is available through the I<sup>2</sup>C registers sharing the same register space as PDC, UTC, and VPS. Therefore, only one of the following standards can be read through the I<sup>2</sup>C at a time: VPS, PDC, UTC, or Gemstar.

To identify the data that should be made available in the I<sup>2</sup>C registers, the user must program I2C\_GS\_VPS\_PDC\_UTC [1:0] (Address 0x9C, user sub map).

### I2C\_GS\_VPS\_PDC\_UTC (VDP) [1:0], Address 0x9C [6:5], User Sub Map

These bits specify which standard result is available for I<sup>2</sup>C readback.

**Table 82. I2C\_GS\_VPS\_PDC\_UTC [1:0] Function**

I2C_GS_VPS_PDC_UTC [1:0]	Description
00 (default)	Gemstar 1×/2×
01	VPS
10	PDC
11	UTC

### GS\_PDC\_VPS\_UTC\_CLEAR, GS/PDC/VPS/UTC Clear, Address 0x78 [4], User Sub Map, Write Only, Self-Clearing

1—Reinitializes the GS/PDC/VPS/UTC data readback registers.

### GS\_PDC\_VPS\_UTC\_AVL, GS/PDC/VPS/UTC Available, Address 0x78 [4], User Sub Map, Read Only

0—GS, PDC, VPS, or UTC data was not detected.

1—GS, PDC, VPS, or UTC data was detected.

### VDP\_GS\_VPS\_PDC\_UTC Readback Registers, Addresses 0x84 to 0x90, User Sub Map

See Table 83.

## VPS

The VPS data bits are biphasic decoded by the VDP. The decoded data is available in both the ancillary stream and in the I<sup>2</sup>C readback registers. VPS decoded data is available in the VDP\_GS\_VPS\_PDC\_UTC\_0 to VDP\_VPS\_PDC\_UTC\_12 registers (Addresses 0x84 to 0x90, user sub map). The GS\_VPS\_PDC\_UTC\_AVL bit is set if the user had programmed I2C\_GS\_VPS\_PDC\_UTC to 01, as explained in Table 82.

## Gemstar

The Gemstar decoded data is available in the ancillary stream, and any one line of Gemstar is available in I<sup>2</sup>C registers for evaluation purposes. To obtain the Gemstar results in the I<sup>2</sup>C registers, the user must program I2C\_GS\_VPS\_PDC\_UTC to 00, as explained in Table 82.

VDP supports autodetection of Gemstar, distinguishing between Gemstar 1× and Gemstar 2×, and decodes data accordingly. For this autodetection mode to operate correctly, the user must set the AUTO\_DETECT\_GS\_TYPE I<sup>2</sup>C bit (Register 0x61, user sub map) and program the decoder to decode Gemstar 2× on the required lines through line programming. The type of Gemstar decoding can be determined by observing the GS\_DATA\_TYPE bit (Register 0x78, user sub map).

### AUTO\_DETECT\_GS\_TYPE, Address 0x61 [4], User Sub Map

0 (default)—Disables autodetection of Gemstar type.

1—Enables autodetection of Gemstar type.

### GS\_DATA\_TYPE, Address 0x78 [5], User Sub Map, Read Only

This bit identifies the decoded Gemstar data type.

0—Gemstar 1× mode is detected. Read two data bytes from 0x84.

1—Gemstar 2× mode is detected. Read four data bytes from 0x84.

The Gemstar data that is available in the I<sup>2</sup>C register may be from any line of the input video on which Gemstar was decoded. To read the Gemstar data on a particular video line, the user should use the manual configuration as described in Table 67 and Table 68 and enable Gemstar decoding only on the required line.



Table 83. GS/VPS/PDC/UTC Readback Registers<sup>1</sup>

Signal Name	Register Location	Address (User Sub Map)	
		Dec	Hex
GS_VPS_PDC_UTC_BYTE_0 [7:0]	VDP_GS_VPS_PDC_UTC_0 [7:0]	132d	0x84
GS_VPS_PDC_UTC_BYTE_1 [7:0]	VDP_GS_VPS_PDC_UTC_1 [7:0]	133d	0x85
GS_VPS_PDC_UTC_BYTE_2 [7:0]	VDP_GS_VPS_PDC_UTC_2 [7:0]	134d	0x86
GS_VPS_PDC_UTC_BYTE_3 [7:0]	VDP_GS_VPS_PDC_UTC_3 [7:0]	135d	0x87
VPS_PDC_UTC_BYTE_4 [7:0]	VDP_VPS_PDC_UTC_4 [7:0]	136d	0x88
VPS_PDC_UTC_BYTE_5 [7:0]	VDP_VPS_PDC_UTC_5 [7:0]	137d	0x89
VPS_PDC_UTC_BYTE_6 [7:0]	VDP_VPS_PDC_UTC_6 [7:0]	138d	0x8A
VPS_PDC_UTC_BYTE_7 [7:0]	VDP_VPS_PDC_UTC_7 [7:0]	139d	0x8B
VPS_PDC_UTC_BYTE_8 [7:0]	VDP_VPS_PDC_UTC_8 [7:0]	140d	0x8C
VPS_PDC_UTC_BYTE_9 [7:0]	VDP_VPS_PDC_UTC_9 [7:0]	141d	0x8D
VPS_PDC_UTC_BYTE_10 [7:0]	VDP_VPS_PDC_UTC_10 [7:0]	142d	0x8E
VPS_PDC_UTC_BYTE_11 [7:0]	VDP_VPS_PDC_UTC_11 [7:0]	143d	0x8F
VPS_PDC_UTC_BYTE_12 [7:0]	VDP_VPS_PDC_UTC_12 [7:0]	144d	0x90

<sup>1</sup> The register is a readback register; the default value does not apply.

## PDC/UTC

PDC and UTC are data transmitted through Teletext Packet 8/30 Format 2 (Magazine 8, Row 30, Design Code 2 or 3), and Packet 8/30 Format 1 (Magazine 8, Row 30, Design Code 0 or 1). Therefore, if PDC or UTC data is to be read through I<sup>2</sup>C, the corresponding teletext standard (WST or PAL System B) should be decoded by VDP. The whole teletext decoded packet is output on the ancillary data stream. The user can look for the magazine number, row number, and design code and qualify the data as PDC, UTC, or neither of these.

If PDC/UTC packets are identified, Byte 0 to Byte 12 are updated to the GS\_VPS\_PDC\_UTC\_0 to VPS\_PDC\_UTC\_12 registers and the GS\_VPS\_PDC\_UTC\_AVL bit is set. The full packet data is also available in the ancillary data format.

Note that the data available in the I<sup>2</sup>C register depends on the status of the WST\_PKT\_DECODE\_DISABLE bit (Bit 3, Subaddress 0x60, user sub map).

## VBI System 2

The user can choose to use an alternative VBI data slicer, called VBI System 2. This data slicer is used to decode Gemstar and closed caption VBI signals only.

Using this system, the Gemstar data is only available in the ancillary data stream. A special mode enables one line of data to be read back via I<sup>2</sup>C. For more information, contact an Analog Devices representative for an engineering note on ADV7188 VBI processing.

## Gemstar Data Recovery

The Gemstar-compatible data recovery block (GSCD) supports Gemstar 1× and Gemstar 2× data transmissions. In addition, it can serve as a decoder for closed captioning. Gemstar-compatible

data transmissions can occur only in NTSC mode. Closed caption data can be decoded in both PAL and NTSC modes.

The block is configured via the I<sup>2</sup>C in the following ways:

- GDECEL [15:0] allows data recovery for selected video lines on even fields to be enabled and disabled.
- GDECOL [15:0] enables the data recovery for selected lines for odd fields.
- GDECAD configures the way in which data is embedded in the video data stream.

The recovered data is not available through I<sup>2</sup>C, but is inserted into the horizontal blanking period of an ITU-R BT.656-compatible data stream. The data format is intended to comply with the ITU-R BT.1364 recommendation by the International Telecommunications Union. For more information, visit the International Telecommunications Union's website. See Figure 43.

## GDE\_SEL\_OLD\_ADF, Address 0x4C [3], User Map

The ADV7188 has an ancillary data output block that can be used by the VDP data slicer and the VBI System 2 data slicer. The new ancillary data formatter is used by setting GDE\_SEL\_OLD\_ADF to 0 (this is the default setting). If this bit is set low, refer to Table 71 and Table 72 for information about how the data is packaged in the ancillary data stream.

To use the old ancillary data formatter (to be backward compatible with the ADV7189B), set GDE\_SEL\_OLD\_ADF to 1. The ancillary data format in this section refers to the ADV7189B-compatible ancillary data formatter.

0 (default)—Enables the new ancillary data system (for use with VDP and VBI System 2)

1—Enables the old ancillary data system (for use with VBI System 2 only; ADV7189B compatible).



# ADV7188

The format of the data packet depends on the following criteria:

- Transmission is Gemstar 1× or Gemstar 2×.
- Data is output in 8-bit or 4-bit format (see the GDECAD, Gemstar Decode Ancillary Data Format, Address 0x4C [0] section).
- Data is closed captioning (CC) or Gemstar compatible.

Data packets are output if the corresponding enable bit is set (see the GDECEL [15:0], Gemstar Decoding Even Lines, Address 0x48 [7:0], Address 0x49 [7:0] and the GDECOL [15:0], Gemstar Decoding Odd Lines, Address 0x4A [7:0], Address 0x4B [7:0] sections) and the decoder detects the presence of data. This means that for video lines where no data has been decoded, no data packet is output, even if the corresponding line enable bit is set.

Each data packet starts immediately after the EAV code of the preceding line. Figure 43 and Table 84 show the overall structure of the data packet.

Entries within the packet are as follows:

- A fixed preamble sequence of 0x00, 0xFF, and 0xFF.
- The data identification word (DID) (10-bit value), the value of which is 0x140 for a Gemstar or CC data packet.
- The secondary data identification word (SDID), which contains information about the video line from which data was retrieved, whether the Gemstar transmission was of 1× or 2× format, and whether it was retrieved from an even or odd field.
- The data count byte, which provides the number of user data-words that follow.
- User data section. This contains the user data, which can be four or eight words of data.
- Optional padding to ensure that the length of the user data-word section of a packet is a multiple of four bytes (requirement, as set in ITU-R BT.1364).
- Checksum byte. This contains the checksum of the packet.

Table 84 lists the values within a generic data packet that are output by the ADV7188 in 10-bit format.

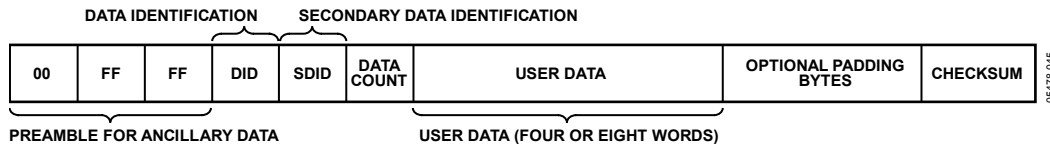


Figure 43. Gemstar and CC Embedded Data Packet (Generic)

Table 84. Generic Data Output Packet

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	EP	EP	EF	2X	line [3:0]				0	0	SDID
5	EP	EP	0	0	0	0	DC [1]	DC [0]	0	0	Data count (DC)
6	EP	EP	0	0	word1 [7:4]				0	0	User data-words
7	EP	EP	0	0	word1 [3:0]				0	0	User data-words
8	EP	EP	0	0	word2 [7:4]				0	0	User data-words
9	EP	EP	0	0	word2 [3:0]				0	0	User data-words
10	EP	EP	0	0	word3 [7:4]				0	0	User data-words
11	EP	EP	0	0	word3 [3:0]				0	0	User data-words
12	EP	EP	0	0	word4 [7:4]				0	0	User data-words
13	EP	EP	0	0	word4 [3:0]				0	0	User data-words
14	CS[8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	0	0	Checksum



Table 85. Data Byte Allocation

Gemstar 2×	Raw Information Bytes Retrieved from the Video Line	GDECAD	User Data-Words (Including Padding)	Padding Bytes	DC [1:0]
1	4	0	8	0	10
1	4	1	4	0	01
0	2	0	4	0	01
0	2	1	4	2	01

### Gemstar Bit Names

- DID. The data identification value is 0x140 (10-bit value). Care has been taken that in 8-bit systems, the two LSBs do not carry vital information.
- EP and  $\overline{EP}$ . The EP bit is set to ensure even parity on the data-word D [8:0]. Even parity means there is always an even number of 1s within the D [8:0] bit arrangement. This includes the EP bit.  $\overline{EP}$  describes the logic inverse of EP and is output on D [9]. The  $\overline{EP}$  is output to ensure that the reserved codes of 00 and FF cannot occur.
- EF. Even field identifier. EF = 1 indicates that the data was recovered from a video line on an even field.
- 2×. This bit indicates whether the data sliced was in Gemstar 1× or 2× format. A high indicates Gemstar 2× format. The 2× bit determines whether the raw information retrieved from the video line was two or four bytes. The state of the GDECAD bit affects whether the bytes are transmitted straight (that is, two bytes transmitted as two bytes) or whether they are split into nibbles (that is, two bytes transmitted as four half bytes). Padding bytes are then added where necessary.
- line [3:0]. This entry provides a code that is unique for each of the 16 possible source lines of video from which Gemstar data may have been retrieved. Refer to Table 94 and Table 95.
- DC [1:0]. Data count value. The number of UDWs in the packet divided by 4. The number of UDWs in any packet must be an integral number of 4. Padding is required at the end, if necessary, as set in ITU-R BT.1364. See Table 85.
- CS [8:2]. The checksum is provided to determine the integrity of the ancillary data packet. It is calculated by summing up D [8:2] of DID, SDID, data count byte, and all UDWs, and ignoring any overflow during the summation. Because all data bytes that are used to calculate the checksum have their two LSBs set to 0, the CS [1:0] bits are also always 0.

$\overline{CS[8]}$  describes the logic inversion of CS [8]. The value  $\overline{CS[8]}$  is included in the checksum entry of the data packet to ensure that the reserved values of 0x00 and 0xFF do not occur. Table 86 to Table 91 outline the possible data packages.

### Gemstar 2× Format, Half-Byte Output Mode

Half-byte output mode is selected by setting GDECAD to 0; full-byte output mode is selected by setting GDECAD to 1. See the GDECAD, Gemstar Decode Ancillary Data Format, Address 0x4C [0] section.

### Gemstar 1× Format, Half-Byte Output Mode

Half-byte output mode is selected by setting GDECAD to 0; full-byte output mode is selected by setting GDECAD to 1. See the GDECAD, Gemstar Decode Ancillary Data Format, Address 0x4C [0] section.



# ADV7188

**Table 86. Gemstar 2× Data, Half-Byte Mode<sup>1</sup>**

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	$\overline{EP}$	EP	EF	<b>1</b>	line [3:0]				0	0	SDID
5	$\overline{EP}$	EP	0	0	0	0	<b>1</b>	<b>0</b>	0	0	Data count
6	$\overline{EP}$	EP	0	0	Gemstar Word1 [7:4]				0	0	User data-words
7	$\overline{EP}$	EP	0	0	Gemstar Word1 [3:0]				0	0	User data-words
8	$\overline{EP}$	EP	0	0	Gemstar Word2 [7:4]				0	0	User data-words
9	$\overline{EP}$	EP	0	0	Gemstar Word2 [3:0]				0	0	User data-words
10	$\overline{EP}$	EP	0	0	Gemstar Word3 [7:4]				0	0	User data-words
11	$\overline{EP}$	EP	0	0	Gemstar Word3 [3:0]				0	0	User data-words
12	$\overline{EP}$	EP	0	0	Gemstar Word4 [7:4]				0	0	User data-words
13	$\overline{EP}$	EP	0	0	Gemstar Word4 [3:0]				0	0	User data-words
14	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.

**Table 87. Gemstar 2× Data, Full-Byte Mode<sup>1</sup>**

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	$\overline{EP}$	EP	EF	<b>1</b>	line [3:0]				0	0	SDID
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count
6	Gemstar Word1 [7:0]								0	0	User data-words
7	Gemstar Word2 [7:0]								0	0	User data-words
8	Gemstar Word3 [7:0]								0	0	User data-words
9	Gemstar Word4 [7:0]								0	0	User data-words
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.

**Table 88. Gemstar 1× Data, Half-Byte Mode<sup>1</sup>**

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	$\overline{EP}$	EP	EF	<b>0</b>	line [3:0]				0	0	SDID
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count
6	$\overline{EP}$	EP	0	0	Gemstar Word1 [7:4]				0	0	User data-words
7	$\overline{EP}$	EP	0	0	Gemstar Word1 [3:0]				0	0	User data-words
8	$\overline{EP}$	EP	0	0	Gemstar Word2 [7:4]				0	0	User data-words
9	$\overline{EP}$	EP	0	0	Gemstar Word2 [3:0]				0	0	User data-words
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.



Table 89. Gemstar 1× Data, Full-Byte Mode<sup>1</sup>

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description	
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble	
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble	
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble	
3	0	1	0	1	0	0	0	0	0	0	DID	
4	$\overline{EP}$	EP	EF	<b>0</b>	line [3:0]				0	0	SDID	
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count	
6	Gemstar Word1 [7:0]									0	0	User data-words
7	Gemstar Word2 [7:0]									0	0	User data-words
8	1	0	0	0	0	0	0	0	0	0	UDW padding 0x200	
9	1	0	0	0	0	0	0	0	0	0	UDW padding 0x200	
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum	

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.

Table 90. NTSC CC Data, Half-Byte Mode<sup>1</sup>

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	$\overline{EP}$	EP	EF	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	0	0	SDID
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count
6	$\overline{EP}$	EP	0	0	CCAP Word1 [7:4]				0	0	User data-words
7	$\overline{EP}$	EP	0	0	CCAP Word1 [3:0]				0	0	User data-words
8	$\overline{EP}$	EP	0	0	CCAP Word2 [7:4]				0	0	User data-words
9	$\overline{EP}$	EP	0	0	CCAP Word2 [3:0]				0	0	User data-words
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.

Table 91. NTSC CC Data, Full-Byte Mode<sup>1</sup>

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description	
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble	
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble	
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble	
3	0	1	0	1	0	0	0	0	0	0	DID	
4	$\overline{EP}$	EP	EF	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>	0	0	SDID	
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count	
6	CCAP Word1 [7:0]									0	0	User data-words
7	CCAP Word2 [7:0]									0	0	User data-words
8	1	0	0	0	0	0	0	0	0	0	UDW padding 0x200	
9	1	0	0	0	0	0	0	0	0	0	UDW padding 0x200	
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum	

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.



# ADV7188

**Table 92. PAL CC Data, Half-Byte Mode<sup>1</sup>**

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	$\overline{EP}$	EP	EF	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	0	0	SDID
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count
6	$\overline{EP}$	EP	0	0	CCAP Word1 [7:4]				0	0	User data-words
7	$\overline{EP}$	EP	0	0	CCAP Word1 [3:0]				0	0	User data-words
8	$\overline{EP}$	EP	0	0	CCAP Word2 [7:4]				0	0	User data-words
9	$\overline{EP}$	EP	0	0	CCAP Word2 [3:0]				0	0	User data-words
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.

**Table 93. PAL CC Data, Full-Byte Mode<sup>1</sup>**

Byte	D [9]	D [8]	D [7]	D [6]	D [5]	D [4]	D [3]	D [2]	D [1]	D [0]	Description
0	0	0	0	0	0	0	0	0	0	0	Fixed preamble
1	1	1	1	1	1	1	1	1	1	1	Fixed preamble
2	1	1	1	1	1	1	1	1	1	1	Fixed preamble
3	0	1	0	1	0	0	0	0	0	0	DID
4	$\overline{EP}$	EP	EF	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	0	0	SDID
5	$\overline{EP}$	EP	0	0	0	0	<b>0</b>	<b>1</b>	0	0	Data count
6	CCAP Word1 [7:0]								0	0	User data-words
7	CCAP Word2 [7:0]								0	0	User data-words
8	1	0	0	0	0	0	0	0	0	0	UDW padding 0x200
9	1	0	0	0	0	0	0	0	0	0	UDW padding 0x200
10	$\overline{CS}$ [8]	CS [8]	CS [7]	CS [6]	CS [5]	CS [4]	CS [3]	CS [2]	CS [1]	CS [0]	Checksum

<sup>1</sup> The bold values represent Gemstar- or CC-specific values.

## NTSC CC Data

Half-byte output mode is selected by setting GDECAD to 0; full-byte mode is enabled by setting GDECAD to 1. See the GDECAD, Gemstar Decode Ancillary Data Format, Address 0x4C [0] section. The data packet formats are shown in Table 90 and Table 91. Only closed caption data can be embedded in the output data stream.

NTSC closed caption data is sliced on Line 21 on even and odd fields. The corresponding enable bit must be set high. See the GDECEL [15:0], Gemstar Decoding Even Lines, Address 0x48 [7:0], Address 0x49 [7:0] and the GDECOL [15:0], Gemstar Decoding Odd Lines, Address 0x4A [7:0], Address 0x4B [7:0] sections.

## PAL CC Data

Half-byte output mode is selected by setting GDECAD to 0; full-byte output mode is selected by setting GDECAD to 1. See the GDECAD, Gemstar Decode Ancillary Data Format, Address 0x4C [0] section. Table 92 and Table 93 list the bytes of the data packet.

PAL closed caption data is sliced from Line 22 and Line 335. The corresponding enable bits must be set.

Only closed caption data can be embedded in the output data stream. See the GDECEL [15:0], Gemstar Decoding Even Lines, Address 0x48 [7:0], Address 0x49 [7:0] and the GDECOL [15:0], Gemstar Decoding Odd Lines, Address 0x4A [7:0], Address 0x4B [7:0] sections.

## GDECEL [15:0], Gemstar Decoding Even Lines, Address 0x48 [7:0], Address 0x49 [7:0]

The 16 bits of GDECEL [15:0] are interpreted as a collection of 16 individual lines of decode-enable signals. Each bit refers to a line of video in an even field. Setting the bit enables the decoder block trying to find Gemstar or closed caption-compatible data on that particular line. Setting the bit to 0 prevents the decoder from trying to retrieve data. See Table 94 and Table 95.

To retrieve closed caption data services on NTSC (Line 284), GDECEL [11] must be set.





To retrieve closed caption data services on PAL (Line 335), GDECEL [14] must be set.

The default value of GDECEL [15:0] is 0x0000. This setting instructs the decoder not to attempt to decode Gemstar or CC data from any line in the even field. The user should only enable Gemstar slicing on lines where VBI data is expected.

**Table 94. NTSC Line Enable Bits and Corresponding Line Numbering**

line [3:0]	Line Number (ITU-R BT.470)	Enable Bit	Comment
0	10	GDECOL [0]	Gemstar
1	11	GDECOL [1]	Gemstar
2	12	GDECOL [2]	Gemstar
3	13	GDECOL [3]	Gemstar
4	14	GDECOL [4]	Gemstar
5	15	GDECOL [5]	Gemstar
6	16	GDECOL [6]	Gemstar
7	17	GDECOL [7]	Gemstar
8	18	GDECOL [8]	Gemstar
9	19	GDECOL [9]	Gemstar
10	20	GDECOL [10]	Gemstar
11	21	GDECOL [11]	Gemstar or CC
12	22	GDECOL [12]	Gemstar
13	23	GDECOL [13]	Gemstar
14	24	GDECOL [14]	Gemstar
15	25	GDECOL [15]	Gemstar
0	273 (10)	GDECEL [0]	Gemstar
1	274 (11)	GDECEL [1]	Gemstar
2	275 (12)	GDECEL [2]	Gemstar
3	276 (13)	GDECEL [3]	Gemstar
4	277 (14)	GDECEL [4]	Gemstar
5	278 (15)	GDECEL [5]	Gemstar
6	279 (16)	GDECEL [6]	Gemstar
7	280 (17)	GDECEL [7]	Gemstar
8	281 (18)	GDECEL [8]	Gemstar
9	282 (19)	GDECEL [9]	Gemstar
10	283 (20)	GDECEL [10]	Gemstar
11	284 (21)	GDECEL [11]	Gemstar or CC
12	285 (22)	GDECEL [12]	Gemstar
13	286 (23)	GDECEL [13]	Gemstar
14	287 (24)	GDECEL [14]	Gemstar
15	288 (25)	GDECEL [15]	Gemstar

**Table 95. PAL Line Enable Bits and Corresponding Line Numbering<sup>1</sup>**

Line [3:0]	Line Number (ITU-R BT.470)	Enable Bit	Comment
12	8	GDECOL [0]	Not valid
13	9	GDECOL [1]	Not valid
14	10	GDECOL [2]	Not valid
15	11	GDECOL [3]	Not valid
0	12	GDECOL [4]	Not valid
1	13	GDECOL [5]	Not valid
2	14	GDECOL [6]	Not valid
3	15	GDECOL [7]	Not valid
4	16	GDECOL [8]	Not valid
5	17	GDECOL [9]	Not valid
6	18	GDECOL [10]	Not valid
7	19	GDECOL [11]	Not valid
8	20	GDECOL [12]	Not valid
9	21	GDECOL [13]	Not valid
<b>10</b>	<b>22</b>	<b>GDECOL [14]</b>	<b>CC</b>
11	23	GDECOL [15]	Not valid
12	321 (8)	GDECEL [0]	Not valid
13	322 (9)	GDECEL [1]	Not valid
14	323 (10)	GDECEL [2]	Not valid
15	324 (11)	GDECEL [3]	Not valid
0	325 (12)	GDECEL [4]	Not valid
1	326 (13)	GDECEL [5]	Not valid
2	327 (14)	GDECEL [6]	Not valid
3	328 (15)	GDECEL [7]	Not valid
4	329 (16)	GDECEL [8]	Not valid
5	330 (17)	GDECEL [9]	Not valid
6	331 (18)	GDECEL [10]	Not valid
7	332 (19)	GDECEL [11]	Not valid
8	333 (20)	GDECEL [12]	Not valid
9	334 (21)	GDECEL [13]	Not valid
<b>10</b>	<b>335 (22)</b>	<b>GDECEL [14]</b>	<b>CC</b>
11	336 (23)	GDECEL [15]	Not valid

<sup>1</sup> As indicated by the bold rows, two standards can use the same line for VBI data.



# ADV7188

## **GDECOL [15:0], Gemstar Decoding Odd Lines, Address 0x4A [7:0], Address 0x4B [7:0]**

The 16 bits of the GDECOL [15:0] form a collection of 16 individual line decode enable signals. See Table 94 and Table 95.

To retrieve closed caption data services on NTSC (Line 21), GDECOL [11] must be set.

To retrieve closed caption data services on PAL (Line 22), GDECOL [14] must be set.

The default value of GDECOL [15:0] is 0x0000. This setting instructs the decoder not to attempt to decode Gemstar or CC data from any line in the odd field. The user should only enable Gemstar slicing on lines where VBI data is expected.

## **GDECAD, Gemstar Decode Ancillary Data Format, Address 0x4C [0]**

The decoded data from Gemstar-compatible transmissions or closed caption transmission is inserted into the horizontal blanking period of the respective line of video. A potential problem can arise if the retrieved data bytes have the value 0x00 or 0xFF. In an ITU-R BT.656-compatible data stream, these values are reserved and used only to form a fixed preamble.

The GDECAD bit allows the data to be inserted into the horizontal blanking period in two ways:

- Insert all data straight into the data stream, even the reserved values of 0x00 and 0xFF, if they occur. This may violate the output data format specification ITU-R BT.1364.
- Split all data into nibbles and insert the half-bytes over twice the number of cycles in a 4-bit format.

0 (default)—The data is split into half-bytes and inserted.

1—The data is output straight in 8-bit format.

### **Letterbox Detection**

Incoming video signals may conform to different aspect ratios (16:9 wide-screen or 4:3 standard). For certain transmissions in the wide-screen format, a digital sequence (WSS) is transmitted with the video signal. If a WSS sequence is provided, the aspect ratio of the video can be derived from the digitally decoded bits that WSS contains.

In the absence of a WSS sequence, letterbox detection can be used to find wide-screen signals. The detection algorithm examines the active video content of lines at the start and end of a field. If black lines are detected, this may indicate that the currently shown picture is in wide-screen format.

The active video content (luminance magnitude) over a line of video is summed together. At the end of a line, this accumulated value is compared with a threshold and a decision is made as to whether a particular line is black. The threshold value needed may depend on the type of input signal; some control is provided via LB\_TH [4:0].

### **Detection at the Start of a Field**

The ADV7188 expects a section of at least six consecutive black lines of video at the top of a field. Once those lines are detected, Register LB\_LCT [7:0] is updated. Register LB\_LCT [7:0] reports the number of black lines that were actually found. By default, the ADV7188 starts looking for those black lines in sync with the beginning of active video, for example, immediately after the last VBI video line. LB\_SL [3:0] allows the user to set the start of letterbox detection from the beginning of a frame on a line-by-line basis. The letterbox detection ends in the middle of the field.

### **Detection at the End of a Field**

The ADV7188 expects at least six continuous lines of black video at the bottom of a field before reporting the number of lines actually found via the LB\_LCB [7:0] value. The activity window for letterbox detection (end of field) starts in the middle of an active field. Its end is programmable via LB\_EL [3:0].

### **Detection at the Midrange**

Some transmissions of wide-screen video include subtitles within the lower black box. If the ADV7188 finds at least two black lines followed by more nonblack video, for example, the subtitle followed by the remainder of the bottom black block, it reports a midcount via LB\_LCM [7:0]. If no subtitles are found, LB\_LCM [7:0] reports the same number as LB\_LCB [7:0].

There is a two-field delay in the reporting of line count parameters.

There is no letterbox detected bit. Read the LB\_LCT [7:0] and LB\_LCB [7:0] bit values to conclude whether or not the letterbox type of video is present in the software.

**LB\_LCT [7:0], Letterbox Line Count Top, Address 0x9B [7:0];  
LB\_LCM [7:0], Letterbox Line Count Mid, Address 0x9C [7:0];  
LB\_LCB [7:0], Letterbox Line Count Bottom,  
Address 0x9D [7:0]**

**Table 96. LB\_LCx [7:0] Access Information<sup>1</sup>**

Signal Name	Address
LB_LCT [7:0]	0x9B
LB_LCM [7:0]	0x9C
LB_LCB [7:0]	0x9D

<sup>1</sup> This register is a readback register; the default value does not apply.



**LB\_TH [4:0], Letterbox Threshold Control, Address 0xDC [4:0]**

**Table 97. LB\_TH [4:0] Function**

LB_TH [4:0]	Description
01100 (default)	Default threshold for detection of black lines.
01101 to 10000	Increase threshold (need larger active video content before identifying nonblack lines).
00000 to 01011	Decrease threshold (even small noise levels can cause the detection of nonblack lines).

**LB\_SL [3:0], Letterbox Start Line, Address 0xDD [7:4]**

The LB\_SL [3:0] bits are set at 0100 by default. For an NTSC signal, the letterbox detection is from Line 23 to Line 286.

By changing the bits to 0101, the detection starts on Line 24 and ends on Line 287.

**LB\_EL [3:0], Letterbox End Line, Address 0xDD [3:0]**

The LB\_EL [3:0] bits are set at 1101 by default. This means that letterbox detection ends with the last active video line. For an NTSC signal, the detection is from Line 262 to Line 525.

By changing the settings of the bits to 1100, the detection starts on Line 261 and ends on Line 254.

**IF Compensation Filter**

**IFFILTSEL [2:0], IF Filter Select, Address 0xF8 [2:0]**

The IFFILTSEL [2:0] register allows the user to compensate for SAW filter characteristics on a composite input, such as those associated with tuner outputs. Figure 44 and Figure 45 show IF filter compensation for NTSC and PAL.

The options for this feature are as follows:

- Bypass mode (default)
- NTSC—consists of three filter characteristics
- PAL—consists of three filter characteristics

See Table 105 for programming details.

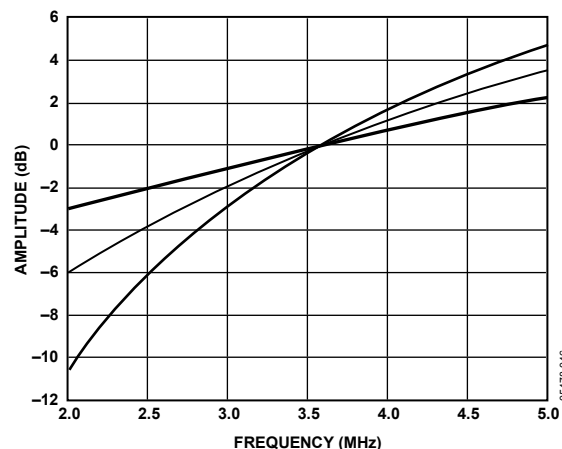


Figure 44. NTSC IF Compensation Filter Responses

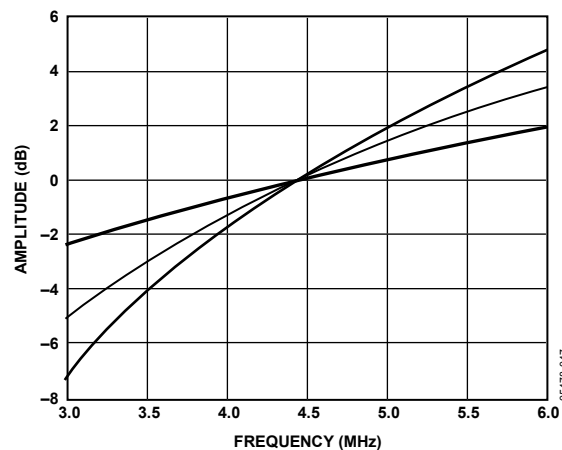


Figure 45. PAL IF Compensation Filter Responses

**PC Interrupt System**

The ADV7188 has a comprehensive interrupt register set. This map is located in the user sub map. See Table 107 for details of the interrupt register map. Figure 48 describes how to access this map.



# ADV7188

## Interrupt Request Output Operation

When an interrupt event occurs, the interrupt pin  $\overline{\text{INTRQ}}$  goes low, with a programmable duration given by  $\text{INTRQ\_DUR\_SEL}$  [1:0]

### $\text{INTRQ\_DUR\_SEL}$ [1:0], Interrupt Duration Select, Address 0x40 [7:6], User Sub Map

Table 98.  $\text{INTRQ\_DUR\_SEL}$  [1:0] Function

$\text{INTRQ\_DUR\_SEL}$ [1:0]	Description
00 (default)	3 XTAL periods
01	15 XTAL periods
10	63 XTAL periods
11	Active until cleared

When the active-until-cleared interrupt duration is selected and the event that caused the interrupt is no longer in force, the interrupt persists until it is masked or cleared.

For example, if the ADV7188 loses lock, an interrupt is generated and the  $\overline{\text{INTRQ}}$  pin goes low. If the ADV7188 returns to the locked state,  $\overline{\text{INTRQ}}$  continues to be driven low until the  $\text{SD\_LOCK}$  bit is either masked or cleared.

## Interrupt Drive Level

The ADV7188 resets with open drain enabled and interrupt masking disabled. Therefore,  $\overline{\text{INTRQ}}$  is in a high impedance state after a reset. Either 01 or 10 must be written to  $\text{INTRQ\_OP\_SEL}$  [1:0] for a logic level to be driven out from the  $\overline{\text{INTRQ}}$  pin.

It is also possible to write to a bit in the ADV7188 that manually asserts the  $\overline{\text{INTRQ}}$  pin. This bit is  $\text{MPU\_STIM\_INTRQ}$ .

### $\text{INTRQ\_OP\_SEL}$ [1:0], Interrupt Duration Select, Address 0x40 [1:0], User Sub Map

Table 99.  $\text{INTRQ\_OP\_SEL}$  [1:0] Function

$\text{INTRQ\_OP\_SEL}$ [1:0]	Description
00 (default)	Open drain
01	Driven low when active
10	Driven high when active
11	Reserved

## Multiple Interrupt Events

If an interrupt event occurs and then another interrupt event occurs before the system controller has cleared or masked the first interrupt event, the ADV7188 does not generate a second interrupt signal. Therefore, the system controller should check all unmasked interrupt status bits because more than one may be active.

## Macrovision Interrupt Selection Bits

The user can select between pseudosync pulse and color stripe detection as outlined in Table 100.

### $\text{MV\_INTRQ\_SEL}$ [1:0], Macrovision Interrupt Selection Bits, Address 0x40 [5:4], User Sub Map

Table 100.  $\text{MV\_INTRQ\_SEL}$  [1:0] Function

$\text{MV\_INTRQ\_SEL}$ [1:0]	Description
00	Reserved
01 (default)	Pseudosync only
10	Color stripe only
11	Either pseudosync or color stripe

Additional information about the interrupt system is detailed in Table 107.



## PIXEL PORT CONFIGURATION

The ADV7188 has a very flexible pixel port that can be configured in a variety of formats to accommodate downstream ICs. Table 101 and Table 102 summarize the various functions that the ADV7188 pins can have in different modes of operation.

The order of components, for example, the order of Cr and Cb, on the output pixel bus can be changed. Refer to the SWPC, Swap Pixel Cr/Cb, Address 0x27 [7] section. Table 101 indicates the default positions for the Cr/Cb components.

### PIXEL PORT-RELATED CONTROLS

#### OF\_SEL [3:0], Output Format Selection, Address 0x03 [5:2]

The modes in which the ADV7188 pixel port can be configured are controlled by OF\_SEL [3:0]. See Table 102 for details.

The default LLC frequency output on the LLC1 pin is approximately 27 MHz. For modes that operate with a nominal data rate of 13.5 MHz (0001, 0010), the clock frequency on the LLC1 pin stays at the higher rate of 27 MHz. For information on outputting the nominal 13.5 MHz clock on the LLC1 pin, see the LLC\_PAD\_SEL [2:0], LLC1 Output Selection, Address 0x8F [6:4] section.

#### SWPC, Swap Pixel Cr/Cb, Address 0x27 [7]

0 (default)—No swapping is allowed.

1—The Cr and Cb values can be swapped.

#### LLC\_PAD\_SEL [2:0], LLC1 Output Selection, Address 0x8F [6:4]

The following I<sup>2</sup>C write allows the user to select between LLC1 (nominally at 27 MHz) and LLC2 (nominally at 13.5 MHz).

The LLC2 signal is useful for LLC2-compatible wide bus (16-/20-bit) output modes. See the OF\_SEL [3:0], Output Format Selection, Address 0x03 [5:2] section for additional information. The LLC2 signal and data on the data bus are synchronized. By default, the rising edge of LLC1/LLC2 is aligned with the Y data; the falling edge occurs when the data bus holds C data. The polarity of the clock, and therefore the Y/C assignments for the clock edges, can be altered by using the polarity LLC pin.

000 (default)—The output is nominally 27 MHz LLC on the LLC1 pin.

101—The output is nominally 13.5 MHz LLC on the LLC1 pin.

Table 101. P19 to P0 Output/Input Pin Mapping

Processor, Format, and Mode	Output of Data Port Pins P [19:0]																			
	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Video Output, 8-Bit, 4:2:2	YCrCb [7:0]																			
Video Output, 10-Bit, 4:2:2	YCrCb [9:0]																			
Video Output, 16-Bit, 4:2:2	Y [7:0]									CrCb [7:0]										
Video Output, 20-Bit, 4:2:2	Y [9:0]									CrCb [9:0]										

Table 102. Standard Definition Pixel Port Modes

OF_SEL [3:0]	Format	Pixel Port Pins P [19:0]			
		P [19:10]		P9 [9:0]	
		P [19:12]	P [11:10]	P [9:2]	P [1:0]
0000	10-Bit at LLC1 4:2:2	YCrCb [9:2]	YCrCb [1:0]	Three-state	Three-state
0001	20-Bit at LLC2 4:2:2	Y [9:2]	Y [1:0]	CrCb [9:2]	CrCb [1:0]
0010	16-Bit at LLC2 4:2:2	Y [7:0]	Three-state	CrCb [7:0]	Three-state
0011 (default)	8-Bit at LLC1 4:2:2	YCrCb [7:0]	Three-state	Three-state	Three-state
0110 to 1111	Reserved	Reserved—do not use			



# ADV7188

## MPU PORT DESCRIPTION

The ADV7188 supports a 2-wire (I<sup>2</sup>C-compatible) serial interface. Two inputs, serial data (SDA) and serial clock (SCLK), carry information between the ADV7188 and the system I<sup>2</sup>C master controller. Each slave device is recognized by a unique address. The ADV7188's I<sup>2</sup>C port allows the user to set up and configure the decoder and then to read back captured VBI data. The ADV7188 has four possible slave addresses for both read and write operations, depending on the logic level on the ALSB pin. These four unique addresses are shown in Table 103. The ADV7188's ALSB pin controls Bit 1 of the slave address. By altering the ALSB, it is possible to control two ADV7188s in an application without having a conflict with the same slave address. The LSB (Bit 0) sets either a read or write operation. Logic 1 corresponds to a read operation; Logic 0 corresponds to a write operation.

**Table 103. I<sup>2</sup>C Address**

ALSB	R/W	Slave Address
0	0	0x40
0	1	0x41
1	0	0x42
1	1	0x43

To control the device on the bus, a specific protocol must be followed. First, the master initiates a data transfer by establishing a start condition, which is defined by a high-to-low transition on SDA while SCLK remains high. This indicates that an address/data stream follows. All peripherals respond to the start condition and shift the next eight bits (7-bit address + R/W bit). The bits are transferred from MSB down to LSB. The peripheral that recognizes the transmitted address responds by pulling the data line low during the ninth clock pulse; this is known as an acknowledge bit. All other devices withdraw from the bus at this point and maintain an idle condition. The idle condition is where the device monitors the SDA and SCLK lines, waiting for the start condition and the correct transmitted address.

The R/W bit determines the direction of the data. If the first byte of the LSB is Logic 0, the master writes information to the peripheral. If the first byte of the LSB is Logic 1, the master reads information from the peripheral.

The ADV7188 acts as a standard slave device on the bus. The data on the SDA pin is eight bits long, supporting the 7-bit addresses plus the R/W bit. The ADV7188 has 249 subaddresses to enable access to the internal registers. It therefore interprets the first byte as the device address and the second byte as the starting subaddress. The subaddresses autoincrement, allowing data to be written to or read from the starting subaddress. A data transfer is always terminated by a stop condition. The user can also access any subaddress register on a one-by-one basis without updating all the registers.

Stop and start conditions can be detected at any stage during the data transfer. If these conditions are asserted out of sequence with normal read and write operations, they cause an immediate jump to the idle condition. During a given SCLK high period, the user should issue only one start condition, one stop condition, or a single stop condition followed by a single start condition. If an invalid subaddress is issued by the user, the ADV7188 does not issue an acknowledge and returns to the idle condition.

If the highest subaddress is exceeded in autoincrement mode, the following action is taken:

1. During a read, the highest subaddress register contents continue to be output until the master device issues a no acknowledge. This indicates the end of a read. In a no acknowledge condition, the SDA line is not pulled low on the ninth pulse.
2. During a write, the data for the invalid byte is not loaded into a subaddress register. Instead, a no acknowledge is issued by the ADV7188, and the part returns to the idle condition.

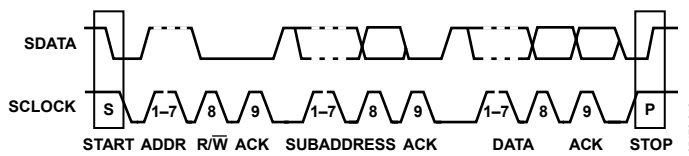


Figure 46. Bus Data Transfer

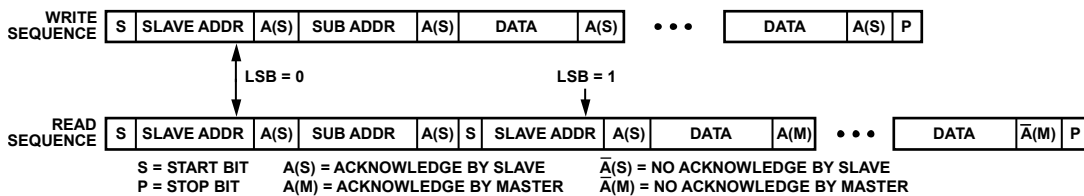


Figure 47. Read and Write Sequence



## REGISTER ACCESSES

The MPU can write to and read from all of the ADV7188's registers except those that are read only or write only. The subaddress register determines which register the next read or write operation accesses. All communications with the part through the bus start with an access to the subaddress register. A read/write operation is then performed from/to the target address, which then increments to the next address until a stop command on the bus is performed.

## REGISTER PROGRAMMING

The I<sup>2</sup>C Register Maps section describes each register in terms of its configuration. After the part has been accessed via the bus and a read/write operation is selected, the subaddress is set up. The subaddress register determines to/from which register the operation takes place. Table 106 and Table 107 list the various operations controlled by the subaddress register.

As can be seen in Figure 48, the registers in the ADV7188 are arranged into two maps: the user map (enabled by default) and the user sub map. The user sub map has controls for the interrupt and VDP functionality of the ADV7188, and the user map controls everything else.

The user map and the user sub map consist of a common space from Address 0x00 to Address 0x3F. Depending on how Bit 5 in Register 0x0E (SUB\_USR\_EN) is set, the register map is then split into two sections.

### SUB\_USR\_EN, Address 0x0E[5]

This bit splits the register map at Register 0x40.

0 (default)—The register map does not split and the user map is enabled.

1—The register map splits and the user sub map is enabled.

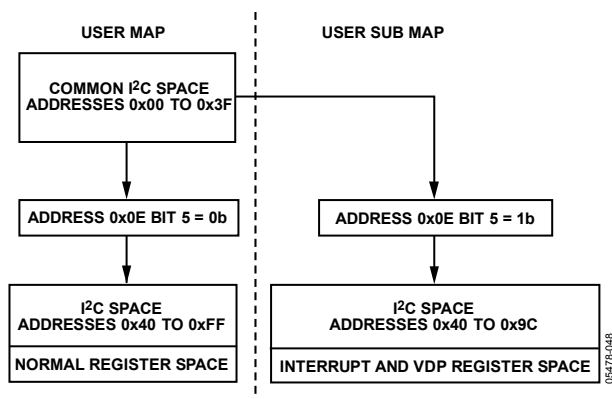


Figure 48. Register Access —User Map and User Sub Map

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

An I<sup>2</sup>C sequencer is used when a parameter exceeds eight bits and is therefore distributed over two or more I<sup>2</sup>C registers, for example, HSB [11:0].

When such a parameter is changed using two or more I<sup>2</sup>C write operations, the parameter may hold an invalid value for the time between the first and last I<sup>2</sup>Cs. In other words, the top bits of the parameter may hold the new value while the remaining bits of the parameter still hold the previous value.

To avoid this problem, the I<sup>2</sup>C sequencer holds the already updated bits of the parameter in local memory. All bits of the parameter are updated together after the last register write operation has completed.

The correct operation of the I<sup>2</sup>C sequencer relies on the following:

- All I<sup>2</sup>C registers for the parameter in question must be written to in order of ascending addresses. For example, for HSB [10:0], write to Address 0x34 first, followed by Address 0x35.
- No other I<sup>2</sup>C can take place between the two (or more) I<sup>2</sup>C writes for the sequence. For example, for HSB [10:0], write to Address 0x34 first immediately followed by Address 0x35.

## I<sup>2</sup>C PROGRAMMING EXAMPLES

A register programming script consisting of I<sup>2</sup>C programming examples for all standard modes supported by the ADV7188 is available from the ADV7188 product page on the Analog Devices website. The examples provided are applicable to a system with the analog inputs arranged as shown in Figure 52. The input selection registers change in accordance with the layout of the PCB.





# ADV7188

## I<sup>2</sup>C REGISTER MAPS

### USER MAP

The collective name for the registers in Table 104 is the user map.

**Table 104. User Map Register Details**

Address	Dec	Hex	Register Name	RW	7	6	5	4	3	2	1	0	Reset Value	(Hex)
0	00		Input Control	RW	VID_SEL.3	VID_SEL.2	VID_SEL.1	VID_SEL.0	INSEL.3	INSEL.2	INSEL.1	INSEL.0	00000000	00
1	01		Video Selection	RW		ENHSPLL	BETACAM		ENVSPROC				11001000	C8
3	03		Output Control	RW	VBI_EN	TOD	OF_SEL.3	OF_SEL.2	OF_SEL.1	OF_SEL.0		SD_DUP_AV	00001100	0C
4	04		Extended Output Control	RW	BT656-4				TIM_OE	BL_C_VBI	EN_SFL_PIN	RANGE	01xx0101	45
7	07		Autodetect Enable	RW	AD_SEC525_EN	AD_SECAM_EN	AD_N443_EN	AD_P60_EN	AD_PALN_EN	AD_PALM_EN	AD_NTSC_EN	AD_PAL_EN	01111111	7F
8	08		Contrast	RW	CON.7	CON.6	CON.5	CON.4	CON.3	CON.2	CON.1	CON.0	10000000	80
10	0A		Brightness	RW	BRI.7	BRI.6	BRI.5	BRI.4	BRI.3	BRI.2	BRI.1	BRI.0	00000000	00
11	0B		Hue	RW	HUE.7	HUE.6	HUE.5	HUE.4	HUE.3	HUE.2	HUE.1	HUE.0	00000000	00
12	0C		Default Value Y	RW	DEF_Y.5	DEF_Y.4	DEF_Y.3	DEF_Y.2	DEF_Y.1	DEF_Y.0	DEF_VAL_AUTO_EN	DEF_VAL_EN	00110110	36
13	0D		Default Value C	RW	DEF_C.7	DEF_C.6	DEF_C.5	DEF_C.4	DEF_C.3	DEF_C.2	DEF_C.1	DEF_C.0	01111100	7C
14	0E		Analog Devices Control				SUB_USR_EN						00000000	00
15	0F		Power Management	RW	RES		PWRDN			PDBP	FB_PWRDN		00000000	00
16	10		Status 1	R	COL_KILL	AD_RESULT.2	AD_RESULT.1	AD_RESULT.0	FOLLOW_PW	FSC_LOCK	LOST_LOCK	IN_LOCK	-	-
18	12		Status 2	R		FSC_NSTD	LL_NSTD	MV_AGC_DET	MV_PS_DET	MVCS_T3	MVCS_DET		-	-
19	13		Status 3	R	PAL_SW_LOCK	INTERLACE	STD_FLD_LEN	FREE_RUN_ACT	CVB5	SD_OP_50Hz	GEMD	INST_HLOCK	-	-
19	13		Analog Control Internal	W						XTAL_TTL_SEL			00000000	00
20	14		Analog Clamp Control	RW				CLEN					00010010	12
21	15		Digital Clamp Control 1	RW		DCT.1	DCT.0						0000xxxx	00
23	17		Shaping Filter Control	RW	CSFM.2	CSFM.1	CSFM.0	YSFM.4	YSFM.3	YSFM.2	YSFM.1	YSFM.0	00000001	01
24	18		Shaping Filter Control 2	RW	WYSFMOVR			WYSFM.4	WYSFM.3	WYSFM.2	WYSFM.1	WYSFM.0	10010011	93
25	19		Comb Filter Control	RW					NSFSEL.1	NSFSEL.0	PSFSEL.1	PSFSEL.0	11110001	F1
29	1D		Analog Devices Control 2	RW	TRI_LLC	EN28XTAL							00000xxx	00
39	27		Pixel Delay Control	RW	SWPC	AUTO_PDC_EN	CTA.2	CTA.1	CTA.0		LTA.1	LTA.0	01011000	58
43	2B		Misc Gain Control	RW		CKE						PW_UPD	11100001	E1
44	2C		AGC Mode Control	RW		LAGC.2	LAGC.1	LAGC.0			CAGC.1	CAGC.0	10101110	AE
45	2D		Chroma Gain Control 1	W	CAGT.1	CAGT.0			CMG.11	CMG.10	CMG.9	CMG.8	11110100	F4
46	2E		Chroma Gain Control 2	W	CMG.7	CMG.6	CMG.5	CMG.4	CMG.3	CMG.2	CMG.1	CMG.0	00000000	00
47	2F		Luma Gain Control 1	W	LAGT.1	LAGT.0			LMG.11	LMG.10	LMG.9	LMG.8	1111xxxx	F0
48	30		Luma Gain Control 2	W	LMG.7	LMG.6	LMG.5	LMG.4	LMG.3	LMG.2	LMG.1	LMG.0	xxxxxxxx	00
49	31		Vsync Field Control 1	RW				NEWAVMODE	HVSTIM				00010010	12
50	32		Vsync Field Control 2	RW	VSBHO	VSBHE							01000001	41
51	33		Vsync Field Control 3	RW	VSEHO	VSEHE							10000100	84
52	34		Hsync Position Control 1	RW		HSB.10	HSB.9	HSB.8		HSE.10	HSE.9	HSE.8	00000000	00
53	35		Hsync Position Control 2	RW	HSB.7	HSB.6	HSB.5	HSB.4	HSB.3	HSB.2	HSB.1	HSB.0	00000010	02
54	36		Hsync Position Control 3	RW	HSE.7	HSE.6	HSE.5	HSE.4	HSE.3	HSE.2	HSE.1	HSE.0	00000000	00
55	37		Polarity	RW	PHS		PVS		PF			PCLK	00000001	01
56	38		NTSC Comb Control	RW	CTAPSN.1	CTAPSN.0	CCMN.2	CCMN.1	CCMN.0	YCMN.2	YCMN.1	YCMN.0	10000000	80
57	39		PAL Comb Control	RW	CTAPSP.1	CTAPSP.0	CCMP.2	CCMP.1	CCMP.0	YCMP.2	YCMP.1	YCMP.0	11000000	C0
58	3A		ADC Control	RW					PDN_ADC0	PDN_ADC1	PDN_ADC2	PDN_ADC3	00010001	11
61	3D		Manual Window Control	RW		CKILLTHR.2	CKILLTHR.1	CKILLTHR.0					01000011	43
65	41		Resample Control	RW		SFL_INV							00000001	01
72	48		Gemstar Control 1	RW	GDECEL.15	GDECEL.14	GDECEL.13	GDECEL.12	GDECEL.11	GDECEL.10	GDECEL.9	GDECEL.8	00000000	00



Address		Register Name	RW	7	6	5	4	3	2	1	0	Reset Value	(Hex)
Dec	Hex												
73	49	Gemstar Control 2	RW	GDECEL.7	GDECEL.6	GDECEL.5	GDECEL.4	GDECEL.3	GDECEL.2	GDECEL.1	GDECEL.0	00000000	00
74	4A	Gemstar Control 3	RW	GDECOL.15	GDECOL.14	GDECOL.13	GDECOL.12	GDECOL.11	GDECOL.10	GDECOL.9	GDECOL.8	00000000	00
75	4B	Gemstar Control 4	RW	GDECOL.7	GDECOL.6	GDECOL.5	GDECOL.4	GDECOL.3	GDECOL.2	GDECOL.1	GDECOL.0	00000000	00
76	4C	Gemstar Control 5	RW								GDECAD	xxxx0000	00
77	4D	CTI DNR Control 1	RW			DNR_EN		CTI_AB.1	CTI_AB.0	CTI_AB_EN	CTI_EN	11101111	EF
78	4E	CTI DNR Control 2	RW	CTI_C_TH.7	CTI_C_TH.6	CTI_C_TH.5	CTI_C_TH.4	CTI_C_TH.3	CTI_C_TH.2	CTI_C_TH.1	CTI_C_TH.0	00001000	08
80	50	CTI DNR Control 4	RW	DNR_TH.7	DNR_TH.6	DNR_TH.5	DNR_TH.4	DNR_TH.3	DNR_TH.2	DNR_TH.1	DNR_TH.0	00001000	08
81	51	Lock Count	RW	FSCLE	SRLS	COL.2	COL.1	COL.0	CIL.2	CIL.1	CIL.0	00100100	24
105	69	Config 1	RW	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	SDM_SEL.1	SDM_SEL.0	0000x00	00
143	8F	Free-Run Line Length 1	W		LLC_PAD_SEL_MAN	LLC_PAD_SEL.1	LLC_PAD_SEL.0					00000000	00
153	99	CCAP 1	R	CCAP1.7	CCAP1.6	CCAP1.5	CCAP1.4	CCAP1.3	CCAP1.2	CCAP1.1	CCAP1.0	-	-
154	9A	CCAP 2	R	CCAP2.7	CCAP2.6	CCAP2.5	CCAP2.4	CCAP2.3	CCAP2.2	CCAP2.1	CCAP2.0	-	-
155	9B	Letterbox 1	R	LB_LCT.7	LB_LCT.6	LB_LCT.5	LB_LCT.4	LB_LCT.3	LB_LCT.2	LB_LCT.1	LB_LCT.0	-	-
156	9C	Letterbox 2	R	LB_LCM.7	LB_LCM.6	LB_LCM.5	LB_LCM.4	LB_LCM.3	LB_LCM.2	LB_LCM.1	LB_LCM.0	-	-
157	9D	Letterbox 3	R	LB_LCB.7	LB_LCB.6	LB_LCB.5	LB_LCB.4	LB_LCB.3	LB_LCB.2	LB_LCB.1	LB_LCB.0	-	-
195	C3	ADC Switch 1	RW	ADC1_SW.3	ADC1_SW.2	ADC1_SW.1	ADC1_SW.0	ADC0_SW.3	ADC0_SW.2	ADC0_SW.1	ADC0_SW.0	xxxxxxxx	00
196	C4	ADC Switch 2	RW	ADC_SW_MAN				ADC2_SW.3	ADC2_SW.2	ADC2_SW.1	ADC2_SW.0	0xxxxxxx	00
220	DC	Letterbox Control 1	RW				LB_TH.4	LB_TH.3	LB_TH.2	LB_TH.1	LB_TH.0	10101100	AC
221	DD	Letterbox Control 2	RW	LB_SL.3	LB_SL.2	LB_SL.1	LB_SL.0	LB_EL.3	LB_EL.2	LB_EL.1	LB_EL.0	01001100	4C
222	DE	ST Noise Readback 1	R					ST_NOISE_VLD	ST_NOISE.10	ST_NOISE.9	ST_NOISE.8	---	---
223	DF	ST Noise Readback 2	R	ST_NOISE.7	ST_NOISE.6	ST_NOISE.5	ST_NOISE.4	ST_NOISE.3	ST_NOISE.2	ST_NOISE.1	ST_NOISE.0	---	---
225	E1	SD Offset Cb	RW	SD_OFF_CB.7	SD_OFF_CB.6	SD_OFF_CB.5	SD_OFF_CB.4	SD_OFF_CB.3	SD_OFF_CB.2	SD_OFF_CB.1	SD_OFF_CB.0	10000000	80
226	E2	SD Offset Cr	RW	SD_OFF_CR.7	SD_OFF_CR.6	SD_OFF_CR.5	SD_OFF_CR.4	SD_OFF_CR.3	SD_OFF_CR.2	SD_OFF_CR.1	SD_OFF_CR.0	10000000	80
227	E3	SD Saturation CB	RW	SD_SAT_CB.7	SD_SAT_CB.6	SD_SAT_CB.5	SD_SAT_CB.4	SD_SAT_CB.3	SD_SAT_CB.2	SD_SAT_CB.1	SD_SAT_CB.0	10000000	80
228	E4	SD Saturation Cr	RW	SD_SAT_CR.7	SD_SAT_CR.6	SD_SAT_CR.5	SD_SAT_CR.4	SD_SAT_CR.3	SD_SAT_CR.2	SD_SAT_CR.1	SD_SAT_CR.0	10000000	80
229	E5	NTSC V bit begin	RW	NVBEGDELO	NVBEGDELE	NVBEGSIGN	NVBEG.4	NVBEG.3	NVBEG.2	NVBEG.1	NVBEG.0	00100101	25
230	E6	NTSC V bit end	RW	NVENDDELO	NVENDDELE	NVENDSIGN	NVEND.4	NVEND.3	NVEND.2	NVEND.1	NVEND.0	00000100	04
231	E7	NTSC F bit toggle	RW	NFTOGDELO	NFTOGDELE	NFTOGSIGN	NFTOG.4	NFTOG.3	NFTOG.2	NFTOG.1	NFTOG.0	01100011	63
232	E8	PAL V bit begin	RW	PVBEGDELO	PVBEGDELE	PVBEGSIGN	PVBEG.4	PVBEG.3	PVBEG.2	PVBEG.1	PVBEG.0	01100101	65
233	E9	PAL V bit end	RW	PVENDDELO	PVENDDELE	PVENDSIGN	PVEND.4	PVEND.3	PVEND.2	PVEND.1	PVEND.0	00010100	14
234	EA	PAL F bit toggle	RW	PFTOGDELO	PFTOGDELE	PFTOGSIGN	PFTOG.4	PFTOG.3	PFTOG.2	PFTOG.1	PFTOG.0	01100011	63
235	EB	Vblank Control 1	RW	NVBIOLCM.1	NVBIOLCM.0	NVBIELCM.1	NVBIELCM.0	PVBIOLCM.1	PVBIOLCM.0	PVBIELCM.1	PVBIELCM.0	01010101	55
236	EC	Vblank Control 2	RW	NVBIOCCM.1	NVBIOCCM.0	NVBIIECCM.1	NVBIIECCM.0	PVBIIOCCM.1	PVBIIOCCM.0	PVBIIECCM.1	PVBIIECCM.0	01010101	55
237	ED	FB_STATUS	R	FB_STATUS.3	FB_STATUS.2	FB_STATUS.1	FB_STATUS.0					-	-
237	ED	FB_CONTROL1	W					FB_INV	CVBS_RGB_SEL	FB_MODE.1	FB_MODE.0	00010000	10
238	EE	FB_CONTROL 2	RW	FB_CSC_MAN	MAN_ALPHA_VAL.6	MAN_ALPHA_VAL.5	MAN_ALPHA_VAL.4	MAN_ALPHA_VAL.3	MAN_ALPHA_VAL.2	MAN_ALPHA_VAL.1	MAN_ALPHA_VAL.0	00000000	00
239	EF	FB_CONTROL 3	RW	FB_SP_ADJUST.3	FB_SP_ADJUST.2	FB_SP_ADJUST.1	FB_SP_ADJUST.0	CNTR_ENABLE	FB_EDGE_SHAPE.2	FB_EDGE_SHAPE.1	FB_EDGE_SHAPE.0	01001010	4A
240	F0	FB_CONTROL 4	RW					FB_DELAY.3	FB_DELAY.2	FB_DELAY.1	FB_DELAY.0	01000100	44
241	F1	FB_CONTROL 5	RW	CNTR_LEVEL.1	CNTR_LEVEL.0	FB_LEVEL.1	FB_LEVEL.0	CNTR_MODE.1	CNTR_MODE.0		RGB_IP_SEL	00001100	0C
243	F3	AFE_CONTROL 1	RW	ADC3_SW.3	ADC3_SW.2	ADC3_SW.1	ADC3_SW.0	AA_FILT_EN.3	AA_FILT_EN.2	AA_FILT_EN.1	AA_FILT_EN.0	00000000	00
244	F4	Drive Strength	RW			DR_STR	DR_STR.0	DR_STR_C	DR_STR_C.0	DR_STR_S	DR_STR_S.0	xx010101	15
248	F8	IF Comp Control	RW						IFFILTSEL.2	IFFILTSEL.1	IFFILTSEL.0	00000000	00
249	F9	VS Mode Control	RW					VS_COAST_MODE.1	VS_COAST_MODE.0	EXTEND_VS_MAX_FREQ	EXTEND_VS_MIN_FREQ	00000000	00
251	FB	Peaking Control	RW	PEAKING_GAIN.7	PEAKING_GAIN.6	PEAKING_GAIN.5	PEAKING_GAIN.4	PEAKING_GAIN.3	PEAKING_GAIN.2	PEAKING_GAIN.1	PEAKING_GAIN.0	01000000	40
252	FC	Coring Threshold 2	RW	DNR_TH_2.7	DNR_TH_2.6	DNR_TH_2.5	DNR_TH_2.4	DNR_TH_2.3	DNR_TH_2.2	DNR_TH_2.1	DNR_TH_2.0	00000100	04



# ADV7188

Table 105 provides a detailed description of the registers located in the user map.

**Table 105. User Map Detailed Description**

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
0x00	Input Control	INSEL [3:0]. These bits allow the user to select an input channel and format.					0	0	0	0	CVBS in on AIN1; SCART: G on AIN6/AIN9, B on AIN4/AIN7, R on AIN5/AIN8	Composite and SCART RGB (RGB analog input options selectable via RGB_IP_SEL)	
							0	0	0	1	CVBS in on AIN2; SCART: G on AIN6/AIN9, B on AIN4/AIN7, R on AIN5/AIN8		
							0	0	1	0	CVBS in on AIN3; SCART: G on AIN6/AIN9, B on AIN4/AIN7, R on AIN5/AIN8		
							0	0	1	1	CVBS in on AIN4; SCART: G on AIN9, B on AIN7, R on AIN8		
							0	1	0	0	CVBS in on AIN5; SCART: G on AIN9, B on AIN7, R on AIN8		
							0	1	0	1	CVBS in on AIN6; SCART: G on AIN9, B on AIN7, R on AIN8		
							0	1	1	0	Y on AIN1, C on AIN4		S-video
							0	1	1	1	Y on AIN2, C on AIN5		
							1	0	0	0	Y on AIN3, C on AIN6		
							1	0	0	1	Y on AIN1, Pb on AIN4, Pr on AIN5		YPbPr
							1	0	1	0	Y on AIN2, Pb on AIN3, Pr on AIN6		
							1	0	1	1	CVBS in on AIN7; SCART: G on AIN6, B on AIN4, R on AIN5		Composite and SCART RGB (RGB analog input options selectable via RGB_IP_SEL)
							1	1	0	0	CVBS in on AIN8; SCART: G on AIN6, B on AIN4, R on AIN5		
							1	1	0	1	CVBS in on AIN9; SCART: G on AIN6, B on AIN4, R on AIN5		
							1	1	1	0	CVBS in on AIN10; SCART: G on AIN6/AIN9, B on AIN4/AIN7, R on AIN5/AIN8		
							1	1	1	1	CVBS in on AIN11; SCART: G on AIN6/AIN9, B on AIN4/AIN7, R on AIN5/AIN8		
							0	0	0	0	Autodetect PAL (B/G/H/I/D), NTSC (without pedestal), SECAM		
					VID_SEL [3:0]. These bits allow the user to select the input video standard.	0	0	0	1				
					0	0	1	0				Autodetect PAL N, NTSC M (without pedestal), SECAM	
					0	0	1	1				Autodetect PAL N, NTSC M (with pedestal), SECAM	
			0	1	0	0				NTSC J			
			0	1	0	1				NTSC M			
			0	1	1	0				PAL 60			
			0	1	1	1				NTSC 4.43			
			1	0	0	0				PAL B/G/H/I/D			
			1	0	0	1				PAL N (B/G/H/I/D without pedestal)			
			1	0	1	0				PAL M (without pedestal)			
			1	0	1	1				PAL M			
			1	1	0	0				PAL Combination N			
			1	1	0	1				PAL Combination N			
			1	1	1	0				SECAM (with pedestal)			
			1	1	1	1				SECAM (with pedestal)			
0x01	Video Selection	Reserved.						0	0	0	Set to default		
		ENVSPROC.					0				Disable vsync processor		
							1				Enable vsync processor		
		Reserved.				0					Set to default		
		BETACAM. Enable BETACAM levels. This bit sets the target value for AGC operation.			0						Standard video input		
		ENHSPLL.			0						Disable hsync processor		
					1						Enable hsync processor		
	Reserved.		1						Set to default				



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes		
			7	6	5	4	3	2	1	0				
0x03	Output Control	SD_DUP_AV. This bit duplicates the AV codes from the luma into the chroma path.									0	AV codes to suit 8-/10-bit interleaved data output		
												1		AV codes duplicated for 16-/20-bit interfaces
		Reserved.									0	Set as default		
		OF_SEL [3:0]. These bits allow the user to choose from a set of output formats.	0 0 0 0	10-bit format at LLC1 4:2:2										
			0 0 0 1	20-bit format at LLC2 4:2:2										
			0 0 1 0	16-bit format at LLC2 4:2:2										
			0 0 1 1	8-bit format at LLC1 4:2:2 ITU-R BT.656										
			0 1 0 0	Not used										
			0 1 0 1	Not used										
			0 1 1 0	Not used										
			0 1 1 1	Not used										
			1 0 0 0	Not used										
			1 0 0 1	Not used										
			1 0 1 0	Not used										
			1 0 1 1	Not used										
		TOD. Three-state output drivers. This bit allows the user to three-state the output drivers: P [19:0], HS, VS, FIELD, and SFL.	0	Output pins enabled										
			1	Drivers three-stated										
VBI_EN. This bit allows VBI data (Lines 1 to 21) to be passed through with minimum filtering.	0	All lines filtered and scaled												
	1	Only active video region filtered												
0x04	Extended Output Control	RANGE. This bit allows the user to select the range of output values. It can be ITU-R BT.656 compliant or fill the whole accessible number range.									0	16 < Y < 235, 16 < C < 240	ITU-R BT.656	
												1	1 < Y < 254, 1 < C < 254	Extended range
		EN_SFL_PIN.										0	SFL output is disabled	SFL output enables connecting encoder and decoder directly
												1	SFL information output on the SFL pin	
		BL_C_VBI. Blank chroma during VBI. When set, this bit enables data in the VBI region to be passed through the decoder undistorted.										0	Decode and output color	During VBI
												1	Blank Cr and Cb	
		TIM_OE. Timing signals output enable.										0	HS, VS, FIELD three-stated	Controlled by TOD bit
												1	HS, VS, FIELD forced active	
		Reserved.		x	x									
		Reserved.		1										
		BT.656. ITU-R BT.656-4 enable. This bit allows the user to select an output mode compatible with ITU-R BT.656-3 or ITU-R BT.656-4.	0	ITU-R BT.656-3 compatible										
1	ITU-R BT.656-4 compatible													
0x07	Autodetect Enable	AD_PAL_EN. PAL B/G/I/H autodetect enable.									0	Disable		
												1	Enable	
		AD_NTSC_EN. NTSC autodetect enable.										0	Disable	
												1	Enable	
		AD_PALM_EN. PAL M autodetect enable.										0	Disable	
												1	Enable	
		AD_PALN_EN. PAL N autodetect enable.										0	Disable	
												1	Enable	
		AD_P60_EN. PAL 60 autodetect enable.										0	Disable	
												1	Enable	
		AD_N443_EN. NTSC 443 autodetect enable.										0	Disable	
												1	Enable	
		AD_SECAM_EN. SECAM autodetect enable.										0	Disable	
										1	Enable			
AD_SEC525_EN. SECAM 525 autodetect enable.										0	Disable			
										1	Enable			
0x08	Contrast Register	CON [7:0]. Contrast adjust. This is the user control for contrast adjustment.	1	0	0	0	0	0	0	0	0	Luma gain = 1	0x00 gain = 0 0x80 gain = 1 0xFF gain = 2	
0x09	Reserved	Reserved.	1	0	0	0	0	0	0	0	0			



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>							Comments	Notes		
			7	6	5	4	3	2	1			0	
0x0A	Brightness Register	BRI [7:0]. These bits control the brightness of the video signal.	0	0	0	0	0	0	0	0		0x00 = 0 mV 0x7F = +204 mV 0x80 = -204 mV	
0x0B	Hue Register	HUE [7:0]. These bits contain the value for the color hue adjustment.	0	0	0	0	0	0	0	0		Hue range = -90° to +90°	
0x0C	Default Value Y	DEF_VAL_EN. Default value enable.								0	Free-run mode dependent on DEF_VAL_AUTO_EN		
										1	Force free-run mode on and output blue screen		
		DEF_VAL_AUTO_EN. Default value.									0	Disable free-run mode	When lock is lost, free-run mode can be enabled to output stable timing, clock, and a set color.
											1	Enable automatic free-run mode (blue screen)	
		DEF_Y [5:0]. Default value Y. These bits hold the Y default value.	0	0	1	1	0	1			Y [7:0] = {DEF_Y [5:0], 0, 0}	Default Y value output in free-run mode.	
0x0D	Default Value C	DEF_C [7:0]. Default value C. The Cr and Cb default values are defined in these bits.	0	1	1	1	1	1	0	0	Cr [7:0] = {DEF_C [7:4], 0, 0, 0, 0} Cb [7:0] = {DEF_C [3:0], 0, 0, 0, 0}	Default Cb/Cr value output in free-run mode. Default values give blue screen output.	
0x0E	Analog Devices Control	Reserved.				0	0	0	0	0	Set as default		
		SUB_USR_EN. This bit enables the user to access the user sub map.			0						Access user map	See Figure 48.	
					1						Access user sub map		
		Reserved.	0	0							Set as default		
0x0F	Power Management	Reserved.								0	Set to default		
		FB_PWRDN.								0	FB input operational		
											1	FB input in power-saving mode	
		PDBP. Power-down bit priority. This bit selects between the PWRDN bit and the PWRDN pin.							0			Chip power-down controlled by pin	This bit must be set to 1 for the PWRDN bit to power down the part.
										1	Bit has priority (pin disregarded)		
		Reserved.				0	0					Set to default	
		PWRDN. Power-down. This bit places the decoder in full power-down mode.			0							System functional	The PDBP bit must be set to 1 for the PWRDN bit to power down the part (see PDBP, 0x0F Bit 2).
					1							Powered down	
		Reserved.		0							Set to default		
		RES. Chip Reset. This bit loads all I <sup>2</sup> C bits with default values.	0								Normal operation	Executing reset takes approximately 2 ms. This bit is self-clearing.	
			1							Start reset sequence			
0x10	Status Register 1 (Read Only)	IN_LOCK.								x	1 = in lock (now)	Provides information about the internal status of the decoder.	
		LOST_LOCK.								x	1 = lost lock (since last read)		
		FSC_LOCK.								x	1 = F <sub>sc</sub> lock (now)		
		FOLLOW_PW.						x			1 = peak white AGC mode active		
		AD_RESULT [2:0]. Autodetection result. These bits report the standard of the input video.	0	0	0							NTSM M/J	Detected standard.
			0	0	1							NTSC 443	
			0	1	0							PAL M	
			0	1	1							PAL 60	
			1	0	0							PAL B/G/H/I/D	
			1	0	1							SECAM	
	1	1	0							PAL Combination N			
	1	1	1							SECAM 525			
		COL_KILL.	x								1 = color kill is active	Color kill.	
0x11	IDENT (Read Only)	IDENT [7:0]. These bits provide identification on the revision of the part.	x	x	x	x	x	x	x	x			
0x12	Status Register 2 (Read Only)	MVCS DET.								x	MV color striping detected	1 = detected.	
		MVCS T3.								x	MV color striping type	0 = Type 2; 1 = Type 3.	
		MV_PS DET.								x	MV pseudosync detected	1 = detected.	
		MV_AGC DET.							x		MV AGC pulses detected	1 = detected.	
		LL_NSTD.					x				Nonstandard line length	1 = detected.	
		FSC_NSTD.				x					F <sub>sc</sub> frequency nonstandard	1 = detected.	
		Reserved.	x	x									
0x13	Status Register 3 (Read only)	INST_HLOCK.								x	1 = horizontal lock achieved	Unfiltered.	
		GEMD.								x	1 = Gemstar data detected	When the GEMD bit goes high, it remains high until the end of the active video lines in that field.	
		SD_OP_50Hz.								x	SD field rate detect	0 = SD 60 Hz detected; 1 = SD 50 Hz detected.	
		CVBS.							x		Result of composite/S-video autodetection	0 = Y/C; 1 = CVBS.	



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
		FREE_RUN_ACT.				x						1 = free-run mode active	Blue screen output
		STD_FLD_LEN.			x							1 = field length standard	Correct field length found
		INTERLACED.		x								1 = interlaced video detected	Field sequence found
		PAL_SW_LOCK.	x									1 = swinging burst detected	Reliable swinging burst sequence
	Analog Control Internal (Write Only)	Reserved.								0	0		
		XTAL_TTL_SEL.								0		Crystal used to derive 28.63636 MHz clock	
		Reserved.								1		External TTL level clock supplied	
0x14	Analog Clamp Control	Reserved.						0	0	1	0	Set to default	
		CCLEN. Current clamp enable. This bit allows the user to switch off the current sources in the analog front end.				0						Current sources switched off	
						1						Current sources enabled	
		Reserved.	0	0	0							Set to default	
0x15	Digital Clamp Control 1	Reserved.					x	x	x	x	Set to default		
		DCFE. Digital clamp freeze enable.				0						Disable digital clamp freeze	
						1						Enable digital clamp freeze	
		DCT [1:0]. Digital clamp timing. These bits determine the time constant of the digital fine-clamp circuitry.	0	0								Slow (TC = 1 sec)	
			0	1								Medium (TC = 0.5 sec)	
			1	0								Fast (TC = 0.1 sec)	
			1	1								TC dependent on video	
Reserved.	0									Set to default			
0x17	Shaping Filter Control	YSFM [4:0]. Selects Y-shaping filter mode when in CVBS only mode. These bits allow the user to select a wide range of low-pass and notch filters.				0	0	0	0	0	0	Automatically uses wide notch filter for poor quality sources and wideband filter with comb for good quality input	Decoder selects optimum Y-shaping filter depending on CVBS quality.  If one of these modes is selected, the decoder does not change filter modes. A fixed filter response (the one selected) is used regardless of video quality.
						0	0	0	0	0	1	Automatically uses narrow notch filter for poor quality sources and wideband filter with comb for good quality input	
						0	0	0	1	0		SVHS 1	
						0	0	0	1	1		SVHS 2	
						0	0	1	0	0		SVHS 3	
						0	0	1	0	1		SVHS 4	
						0	0	1	1	0		SVHS 5	
						0	0	1	1	1		SVHS 6	
						0	1	0	0	0		SVHS 7	
						0	1	0	0	1		SVHS 8	
						0	1	0	1	0		SVHS 9	
						0	1	0	1	1		SVHS 10	
						0	1	1	0	0		SVHS 11	
						0	1	1	0	1		SVHS 12	
						0	1	1	1	0		SVHS 13	
						0	1	1	1	1		SVHS 14	
						1	0	0	0	0		SVHS 15	
						1	0	0	0	1		SVHS 16	
						1	0	0	1	0		SVHS 17	
						1	0	0	1	1		SVHS 18 (CCIR 601)	
						1	0	1	0	0		PAL NN 1	
						1	0	1	0	1		PAL NN 2	
						1	0	1	1	0		PAL NN 3	
						1	0	1	1	1		PAL WN 1	
						1	1	0	0	0		PAL WN 2	
						1	1	0	0	1		NTSC NN1	
						1	1	0	1	0		NTSC NN2	
						1	1	0	1	1		NTSC NN3	
						1	1	1	0	0		NTSC WN 1	
						1	1	1	0	1		NTSC WN 2	
			1	1	1	1	0		NTSC WN 3				
			1	1	1	1	1		Reserved				



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>							Comments	Notes		
			7	6	5	4	3	2	1			0	
		CSFM [2:0]. C-shaping filter mode. These bits allow selection from a range of low-pass chrominance filters, SH1 to SH5, and wideband mode.	0	0	0						Automatic selection of 15 MHz	Automatically selects optimum C-shaping filter for the specified bandwidth, based on video quality.	
			0	0	1						Automatic selection of 2.17 MHz		
			0	1	0						SH1		
			0	1	1						SH2		
			1	0	0						SH3		
			1	0	1						SH4		
			1	1	0						SH5		
			1	1	1						Wideband mode		
0x18	Shaping Filter Control 2	WYSFM [4:0]. Wideband Y-shaping filter mode. These bits allow the user to select which Y-shaping filter is used for the Y component of Y/C, YPbPr, B/W input signals; it is also used when a good quality input CVBS signal is detected. For all other inputs, the Y-shaping filter chosen is controlled by YSFM [4:0].				0	0	0	0	0	Reserved; do not use		
						0	0	0	0	0	1		Reserved; do not use
						0	0	0	1	0			SVHS 1
						0	0	0	1	1			SVHS 2
						0	0	1	0	0			SVHS 3
						0	0	1	0	1			SVHS 4
						0	0	1	1	0			SVHS 5
						0	0	1	1	1			SVHS 6
						0	1	0	0	0			SVHS 7
						0	1	0	0	1			SVHS 8
						0	1	0	1	0			SVHS 9
						0	1	0	1	1			SVHS 10
						0	1	1	0	0			SVHS 11
						0	1	1	0	1			SVHS 12
						0	1	1	1	0			SVHS 13
						0	1	1	1	1			SVHS 14
						1	0	0	0	0			SVHS 15
						1	0	0	0	1			SVHS 16
						1	0	0	1	0			SVHS 17
						1	0	0	1	1			SVHS 18 (CCIR 601)
			1	0	1	0	0		Reserved; do not use				
			~	~	~	~	~		Reserved; do not use				
			1	1	1	1	1		Reserved; do not use				
		Reserved.	0	0						Set to default			
		WYSFMOVR. Enables the use of the manual WYSFM filter selection.	0							Automatic selection of best wideband Y-shaping filter			
			1							Manual selection of filter using WYSFM [4:0]			
0x19	Comb Filter Control	PSFSEL [1:0]. These bits control the signal bandwidth that is fed to the comb filters (PAL).						0	0	Narrow			
								0	1	Medium			
								1	0	Wide			
								1	1	Widest			
		NSFSEL [1:0]. These bits control the signal bandwidth that is fed to the comb filters (NTSC).				0	0			Narrow			
							0	1		Medium			
							1	0		Medium			
							1	1		Wide			
		Reserved.	1	1	1	1			Set as default				
0x1D	ADI Control 2	Reserved.			0	0	0	x	x	x	Set to default		
		EN28XTAL.		0							Use 27 MHz crystal		
				1							Use 28.63636 MHz crystal		
		TRI_LLC.		0							LLC pin active		
			1							LLC pin three-stated			
0x27	Pixel Delay Control	LTA [1:0]. Luma timing adjust. These bits allow the user to specify a timing difference between chroma and luma samples.						0	0	No delay	CVBS mode LTA [1:0] = 00b S-video mode LTA [1:0] = 01b YPrPb mode LTA [1:0] = 01b		
									0	1		Luma one clock (37 ns) delayed	
									1	0		Luma two clock (74 ns) early	
									1	1		Luma one clock (37 ns) early	
				Reserved.					0			Set to 0	





Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes			
			7	6	5	4	3	2	1	0					
		CTA [2:0]. Chroma timing adjust. These bits allow a specified timing difference between the luma and chroma samples.			0	0	0					Not a valid setting	CVBS mode CTA [2:0] = 011b S-video mode CTA [2:0] = 101b YPrPb mode CTA [2:0] = 110b		
					0	0	1					Chroma + two pixels (early)			
					0	1	0					Chroma + one pixel (early)			
					0	1	1					No delay			
					1	0	0					Chroma – one pixel (delayed)			
					1	0	1					Chroma – two pixels (delayed)			
					1	1	0					Chroma – three pixels (delayed)			
					1	1	1					Not a valid setting			
				AUTO_PDC_EN. This bit automatically programs the LTA/CTA values to align luma and chroma at the output for all modes of operation.	0								Use values in LTA [1:0] and CTA [2:0] for delaying luma and chroma		
				SWPC. This bit allows the Cr and Cb samples to be swapped.	0								No swapping		
			1								Swap the Cr and Cb output samples				
0x2B	Miscellaneous Gain Control	PW_UPD. Peak white update. This bit determines the rate of gain change.								0	Update once per video line	Peak white must be enabled (see LAGC [2:0])			
											1		Update once per field		
		Reserved.			1	0	0	0	0	0	Set to default				
		CKE. Color-kill enable. This bit allows the color-kill function to be switched on and off.	0									Color kill disabled	For SECAM color kill, threshold is set at 8% (see CKILLTHR [2:0])		
			1									Color kill enabled			
Reserved.	1									Set to default					
0x2C	AGC Mode Control	CAGC [1:0]. Chroma automatic gain control. These bits select the basic mode of operation for the AGC in the chroma path.								0	0	Manual fixed gain	Use CMG [11:0]		
											0	1		Use luma gain for chroma	
											1	0		Automatic gain	Based on color burst
											1	1		Freeze chroma gain	
		Reserved.					1	1				Set to 1			
		LAGC [2:0]. Luma automatic gain control. These bits select the mode of operation for the gain control in the luma path.	0	0	0								Manual fixed gain	Use LMG [11:0]	
			0	0	1								Reserved	Blank level to sync tip	
			0	1	0								AGC peak white algorithm enabled	Blank level to sync tip	
			0	1	1								Reserved		
			1	0	0								AGC peak white algorithm disabled	Blank level to sync tip	
			1	0	1								Reserved		
			1	1	0								Reserved		
		Reserved.	1	1	1								Freeze gain		
Reserved.	1										Set to 1				
0x2D	Chroma Gain Control 1	CG [11:8]/CMG [11:8]. Chroma manual gain. These bits can be used to program a desired manual chroma gain. Reading back from these bits in AGC mode gives the current gain.						0	1	0	0		CAGC [1:0] must be set to 00 (manual fixed gain) to use CMG [11:0].		
			Reserved.			1	1							Set to 1	
		CAGT [1:0]. Chroma automatic gain timing. These bits allow adjustment of the chroma AGC tracking speed.	0	0									Slow (TC = 2 sec)	Has an effect only if CAGC [1:0] is set to 10 (automatic gain).	
			0	1									Medium (TC = 1 sec)		
			1	0									Fast (TC = 0.2 sec)		
Reserved.	1	1									Adaptive				
0x2E	Chroma Gain Control 2	CG [7:0]/CMG [7:0]. Lower eight bits of chroma manual gain. See CG [11:8]/CMG [11:8] for description.	0	0	0	0	0	0	0	0	0	CMG [11:0] = 750d, gain is 1 in NTSC; CMG [11:0] = 741d, gain is 1 in PAL	Minimum value is 0d (G = -60 dB); maximum value is 3750d (G = +5 dB).		
0x2F	Luma Gain Control 1	LG [11:8]/LMG [11:8]. Luma manual gain. These bits can be used to program a desired manual chroma gain or to read back the actual gain value used.						x	x	x	x	LAGC [2:0] settings decide in which mode LMG [11:0] operates			
			Reserved.			1	1						Set to 1		
		LAGT [1:0]. Luma automatic gain timing. These bits allow adjustment of the luma AGC tracking speed.	0	0									Slow (TC = 2 sec)	Only has an effect if LAGC [2:0] is set to 010 or 100 (autogain).	
			0	1									Medium (TC = 1 sec)		
			1	0									Fast (TC = 0.2 sec)		
Reserved.	1	1									Adaptive				
0x30	Luma Gain Control 2	LG [7:0]/LMG [7:0]. Luma manual gain. These bits can be used to program a desired manual chroma gain or to read back the actual gain value used.	x	x	x	x	x	x	x	x	x	LMG [11:0] = 1128d, gain is 1 in NTSC; LMG [11:0] = 1222d, gain is 1 in PAL	Minimum value of NTSC is 1024 (G = 0.90) and of PAL is 1024 (G = 0.84); Maximum value of NTSC is 4095 (G = 3.63) and of PAL is 4095 (G = 3.35).		



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
0x31	Vsync Field Control 1	Reserved.							0	1	0	Set to default	
		HVSTIM. This bit selects where within a line of video the VS signal is asserted.							0			Start of line relative to HSE	HSE = hsync end.
									1			Start of line relative to HSB	HSB = hsync begin.
		NEWAVMODE. Sets the EAV/SAV mode.				0						EAV/SAV codes generated to suit ADI encoders	
						1						Manual VS/FIELD position controlled by Registers 0x32, 0x33, and 0xE5 to 0xEA	
	Reserved.		0	0	0						Set to default		
0x32	Vsync Field Control 2	Reserved.				0	0	0	0	0	1	Set to default	NEWAVMODE bit must be set high.
		VSBE.		0								VS goes high in the middle of the line (even field)	
				1								VS changes state at the start of the line (even field)	
		VSBEHO.		0								VS goes high in the middle of the line (odd field)	
				1								VS changes state at the start of the line (odd field)	
0x33	Vsync Field Control 3	Reserved.				0	0	0	1	0	0	Set to default	
		VSEHE.		0								VS goes low in the middle of the line (even field)	NEWAVMODE bit must be set high.
				1								VS changes state at the start of the line (even field)	
		VSEHO.		0								VS goes low in the middle of the line (odd field)	
				1								VS changes state at the start of the line (odd field)	
0x34	Hsync Position Control 1	HSE [10:8]. HS end. These bits allow the positioning of the HS output within the video line.							0	0	0	HS output ends HSE [10:0] pixels after the falling edge of hsync	Using HSB and HSE, the user can program the position and length of the output hsync.
		Reserved.							0			Set to 0	
		HSB [10:8]. HS begin. These bits allow the positioning of the HS output within the video line.		0	0	0						HS output starts HSB [10:0] pixels after the falling edge of hsync	
		Reserved.		0								Set to 0	
0x35	Hsync Position Control 2	HSB [7:0]. Using HSB [10:0] and HSE [10:0] (see Register 0x34), the user can program the position and length of the HS output signal.	0	0	0	0	0	0	0	1	0		
0x36	Hsync Position Control 3	HSE [7:0]. See Registers 0x34 and 0x35.	0	0	0	0	0	0	0	0	0		
0x37	Polarity	PCLK. Sets the polarity of LLC.									0	Invert polarity	Sets the polarity of LLC on both LLC1 and LLC2.
											1	Normal polarity, as per the timing diagrams (Figure 2 to Figure 4)	
		Reserved.								0	0	Set to 0	
		PF. Sets the FIELD polarity.							0			Active high	
									1			Active low	
		Reserved.				0						Set to 0	
		PVS. Sets the VS polarity.				0						Active high	
						1						Active low	
		Reserved.				0						Set to 0	
		PHS. Sets the HS polarity.				0						Active high	
				1						Active low			
0x38	NTSC Comb Control	YCMN [2:0]. Luma comb mode NTSC.						0	0	0	Adaptive 3-line, 3-tap luma		
								1	0	0	Use low-pass notch		
								1	0	1	Fixed luma comb (two lines)	Top lines of memory.	
								1	1	0	Fixed luma comb (three lines)	All lines of memory.	
								1	1	1	Fixed luma comb (two lines)	Bottom lines of memory.	



Address	Register	Bit Description	Bit <sup>1</sup>							Comments	Notes		
			7	6	5	4	3	2	1			0	
		CCMN [2:0]. Chroma comb mode NTSC.			0	0	0				Adaptive 3-line for CTAPSN = 01 Adaptive 4-line for CTAPSN = 10 Adaptive 5-line for CTAPSN = 11		
					1	0	0				Disable chroma comb		
					1	0	1				Fixed 2-line for CTAPSN = 01 Fixed 3-line for CTAPSN = 10 Fixed 4-line for CTAPSN = 11		Top lines of memory.
					1	1	0				Fixed 3-line for CTAPSN = 01 Fixed 4-line for CTAPSN = 10 Fixed 5-line for CTAPSN = 11		All lines of memory.
					1	1	1				Fixed 2-line for CTAPSN = 01 Fixed 3-line for CTAPSN = 10 Fixed 4-line for CTAPSN = 11		Bottom lines of memory.
		CTAPSN [1:0]. Chroma comb taps NTSC.	0	0							Not used		
			0	1							Adapts three lines to two lines		
			1	0							Adapts five lines to three lines		
			1	1							Adapts five lines to four lines		
		0x39	PAL Comb Control	YCMP [2:0]. Luma comb mode PAL.						0	0	0	Adaptive 5-line, 3-tap luma comb
								1	0	0	Use low-pass notch		
							1	0	1		Fixed luma comb (three lines)	Top lines of memory.	
							1	1	0		Fixed luma comb (five lines)	All lines of memory.	
							1	1	1		Fixed luma comb (three lines)	Bottom lines of memory.	
CCMP [2:0]. Chroma comb mode PAL.					0	0	0				Adaptive 3-line for CTAPSP = 01 Adaptive 4-line for CTAPSP = 10 Adaptive 5-line for CTAPSP = 11		
					1	0	0				Disable chroma comb		
					1	0	1				Fixed 2-line for CTAPSP = 01 Fixed 3-line for CTAPSP = 10 Fixed 4-line for CTAPSP = 11		Top lines of memory
					1	1	0				Fixed 3-line for CTAPSP = 01 Fixed 4-line for CTAPSP = 10 Fixed 5-line for CTAPSP = 11		All lines of memory
					1	1	1				Fixed 2-line for CTAPSP = 01 Fixed 3-line for CTAPSP = 10 Fixed 4-line for CTAPSP = 11		Bottom lines of memory
CTAPSP [1:0]. Chroma comb taps PAL.	0	0							Not used				
	0	1							Adapts five lines to two lines (two taps)				
	1	0							Adapts five lines to three lines (three taps)				
	1	1							Adapts five lines to four lines (four taps)				
0x3A	ADC Control	PWRDN_ADC_3. This bit enables power-down of ADC3.							0	ADC3 normal operation			
									1	Power down ADC3			
		PWRDN_ADC_2. This bit enables power-down of ADC2.							0	ADC2 normal operation			
									1	Power down ADC2			
		PWRDN_ADC_1. This bit enables power-down of ADC1.							0	ADC1 normal operation			
									1	Power down ADC1			
PWRDN_ADC_0. This bit enables power-down of ADC0.							0	ADC0 normal operation					
							1	Power down ADC0					
Reserved.	0	0	0	1					Set as default				
0x3D	Manual Window Control	Reserved.				0	0	1	1	Set to default	CKE = 1 enables the color-kill function and must be enabled for CKILLTHR [2:0] to take effect. (See Table 48 for kill thresholds for SECAM.)		
		CKILLTHR [2:0]. Color-kill threshold.	0	0	0							Kill at 0.5%	
			0	0	1							Kill at 1.5%	
			0	1	0							Kill at 2.5%	
			0	1	1							Kill at 4.0%	
			1	0	0							Kill at 8.5%	
			1	0	1							Kill at 16.0%	
			1	1	0							Kill at 32.0%	
		Reserved.	1	1	1							Reserved	
		Reserved.	0									Set to default	



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
0x41	Resample Control	Reserved.			0	0	0	0	0	0	1	Set to default	
		SFL_INV. This bit controls the behavior of the PAL switch bit.	0									SFL compatible with ADV717x and ADV73xx encoders	
			1									SFL compatible with ADV7190/ADV7191/ADV7194 encoders	
		Reserved.	0									Set to default	
0x48	Gemstar Control 1	GDECEL [15:8]. See the Comments column.	0	0	0	0	0	0	0	0	0	GDECEL [15:0]. The 16 individual enable bits that select the lines of video (even field Lines 10 to 25) that the decoder checks for Gemstar-compatible data.	LSB = Line 10; MSB = Line 25. Default = do not check for Gemstar-compatible data on any lines (Lines 10 to 25) in even fields
0x49	Gemstar Control 2	GDECEL [7:0]. See the Comments column.	0	0	0	0	0	0	0	0	0		
0x4A	Gemstar Control 3	GDECOL [15:8]. See the Comments column.	0	0	0	0	0	0	0	0	0	GDECOL [15:0]. The 16 individual enable bits that select the lines of video (odd field Lines 10 to 25) that the decoder checks for Gemstar-compatible data.	LSB = Line 10; MSB = Line 25. Default = do not check for Gemstar-compatible data on any lines (Lines 10 to 25) in odd fields.
0x4B	Gemstar Control 4	GDECOL [7:0]. See the Comments column.	0	0	0	0	0	0	0	0	0		
0x4C	Gemstar Control 5	GDECAD. This bit controls the manner in which decoded Gemstar data is inserted into the horizontal blanking period.									0	Split data into half byte	To avoid 0x00 and 0xFF codes.
											1	Output in straight 8-bit format	
		Reserved.	x	x	x	x	0	0	0	0		Undefined	
0x4D	CTI DNR Control 1	CTI_EN. CTI enable.									0	Disable CTI	
											1	Enable CTI	
		CTI_AB_EN. CTI alpha blend enable. This bit enables the mixing of the transient improved chroma with the original signal.									0	Disable CTI alpha blender	
											1	Enable CTI alpha blender	
		CTI_AB [1:0]. CTI alpha blend control. These bits control the behavior of the alpha-blend circuitry.					0	0				Sharpest mixing	
							0	1				Sharp mixing	
							1	0				Smooth mixing	
							1	1				Smoothest mixing	
		Reserved.				0						Set to default	
		DNR_EN. This bit enables or bypasses the DNR block.				0						Bypass the DNR block	
				1						Enable the DNR block			
Reserved.	1	1								Set to default			
0x4E	CTI DNR Control 2	CTI_C_TH [7:0]. CTI chroma threshold. These bits specify how big the amplitude step must be to be steepened by the CTI block.	0	0	0	0	0	1	0	0	0		
0x50	CTI DNR Control 4	DNR_TH [7:0]. DNR threshold. These bits specify the maximum edge that is interpreted as noise and is therefore blanked.	0	0	0	0	0	1	0	0	0	Set to 0x04 for A/V input; set to 0x0A for tuner input	
0x51	Lock Count	CIL [2:0]. Count-into-lock. These bits determine the number of lines the system must remain in lock before reporting a locked status.						0	0	0	1 line of video		
								0	0	1	2 lines of video		
								0	1	0	5 lines of video		
								0	1	1	10 lines of video		
								1	0	0	100 lines of video		
								1	0	1	500 lines of video		
								1	1	0	1000 lines of video		
								1	1	1	100,000 lines of video		
						0	0	0					1 line of video
					0	0	1				2 lines of video		
					0	1	0				5 lines of video		
					0	1	1				10 lines of video		
					1	0	0				100 lines of video		
					1	0	1				500 lines of video		
					1	1	0				1000 lines of video		
					1	1	1				100,000 lines of video		
				SRLS. Select raw lock signal. Selects the source for determining the lock status.	0								Over field with vertical information
					1								Line-to-line evaluation
		FSCLE. F <sub>sc</sub> lock enable.	0							Lock status set only by horizontal lock			
			1							Lock status set by horizontal lock and subcarrier lock.			



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes			
			7	6	5	4	3	2	1	0					
0x69	Configuration 1	SDM_SEL [1:0]. Y/C and CVBS autodetect mode select.							0	0	INSEL selects analog input muxing				
										0	1		Composite—AIN11		
									1	0	S-video—Y on AIN10 and C on AIN12				
								1	1	Composite/S-video autodetect Composite on AIN11 Y on AIN11 C on AIN12					
		Reserved.	0	0	0	0	0	x							
0x86	STDI Control	Reserved.							0	1	1	Reserved			
		STDI_LINE_COUNT_MODE.							0			Disables STDI functionality			
								1				Enables STDI functionality			
		Reserved.	0	0	x	0									
0x8F	Free-Run Line Length 1	Reserved.							0	0	0	0	Set to default	For 16-bit 4:2:2 out, OF_SEL [3:0] = 0010.	
		LLC_PAD_SEL [2:0]. These bits enable manual selection of a clock for the LLC1 pin.	0	0	0								LLC1 (nominally 27 MHz) selected output on LLC1 pin		
			1	0	1								LLC2 (nominally 13.5 MHz) selected output on LLC1 pin		
		Reserved.	0										Set to default		
0x99	CCAP1 (Read Only)	CCAP1 [7:0]. Closed caption data bits.	x	x	x	x	x	x	x	x	x	CCAP1 [7] contains parity bit for Byte 0	Only for use with VBI System 2		
0x9A	CCAP2 (Read Only)	CCAP2 [7:0]. Closed caption data bits.	x	x	x	x	x	x	x	x	x	CCAP2 [7] contains parity bit for Byte 0	Only for use with VBI System 2		
0x9B	Letterbox 1 (Read Only)	LB_LCT [7:0]. Letterbox data register.	x	x	x	x	x	x	x	x	x	Reports the number of black lines detected at the top of active video	This feature examines the active video at the start and end of each field, enabling format detection even if the video is not accompanied by a CGMS or WSS sequence.		
0x9C	Letterbox 2 (Read Only)	LB_LCM [7:0]. Letterbox data register.	x	x	x	x	x	x	x	x	x	Reports the number of black lines detected in the bottom half of active video if subtitles are detected			
0x9D	Letterbox 3 (Read Only)	LB_LCB [7:0]. Letterbox data register.	x	x	x	x	x	x	x	x	x	Reports the number of black lines detected at the bottom of active video			
0xB1	Standard Ident 1 (Read Only)	BL [13:8]. Block length data register.			x	x	x	x	x	x	x	BL [13:0] reports the number of clock cycles in a block of eight lines of incoming video		Data is valid only if STDI_DVALID is 1 and STDI_LINE_COUNT_MODE is set to 1.	
		Reserved		x								Reserved			
		STDI_DVALID. Standard identification data valid readback.	0										Indicates that BL [13:0], LCF [10:0], and LCVS [4:0] are not valid parameters		
			1										Indicates that BL [13:0], LCF [10:0], and LCVS [4:0] are valid parameters		
0xB2	Standard Ident 2 (Read Only)	BL [7:0]. Block length data register.	x	x	x	x	x	x	x	x	x	BL [13:0] reports the number of clock cycles in a block of eight lines of incoming video			
0xB3	Standard Ident 3 (Read Only)	LCF [10:8]. Line count in field.							x	x	x	Reports the number of lines between two vsyncs or one field	Data is valid only if STDI_DVALID is 1 and STDI_LINE_COUNT_MODE is set to 1.		
		LCVS [4:0].	x	x	x	x	x					Reports the number of lines within a vertical synchronization period	Data is valid only if STDI_DVALID is 1 and STDI_LINE_COUNT_MODE is set to 1.		
0xB4	Standard Ident 4 (Read Only)	LCF [7:0].	x	x	x	x	x	x	x	x	x		Data is valid only if STDI_DVALID is 1 and STDI_LINE_COUNT_MODE is set to 1.		
0xC3	ADC Switch 1	ADC0_SW [3:0]. Manual muxing control for ADC0.						0	0	0	0	No connection	Set ADC_SW_MAN_EN to 1		
									0	0	0	1		AIN1	
										0	0	1		0	AIN2
										0	0	1		1	AIN3
										0	1	0		0	AIN4
										0	1	0		1	AIN5
										0	1	1		0	AIN6
										0	1	1		1	No connection
										1	0	0		0	No connection
										1	0	0		1	AIN7
										1	0	1		0	AIN8
										1	0	1		1	AIN9
										1	1	0		0	AIN10
										1	1	0		1	AIN11
							1	1	1	0	AIN12				
							1	1	1	1	No connection				



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
		ADC1_SW [3:0]. Manual muxing control for ADC1.	0	0	0	0						No connection	Set ADC_SW_MAN_EN to 1
			0	0	0	1						No connection	
			0	0	1	0						No connection	
			0	0	1	1						AIN3	
			0	1	0	0						AIN4	
			0	1	0	1						AIN5	
			0	1	1	0						AIN6	
			0	1	1	1						No connection	
			1	0	0	0						No connection	
			1	0	0	1						No connection	
			1	0	1	0						No connection	
			1	0	1	1						AIN9	
			1	1	0	0						AIN10	
			1	1	0	1						AIN11	
1	1	1	0						AIN12				
1	1	1	1						No connection				
0xC4	ADC Switch 2	ADC2_SW [3:0]. Manual muxing control for ADC2.					0	0	0	0	No connection	Set ADC_SW_MAN_EN to 1	
							0	0	0	1	No connection		
							0	0	1	0	AIN2		
							0	0	1	1	No connection		
							0	1	0	0	No connection		
							0	1	0	1	AIN5		
							0	1	1	0	AIN6		
							0	1	1	1	No connection		
							1	0	0	0	No connection		
							1	0	0	1	No connection		
							1	0	1	0	AIN8		
							1	0	1	1	No connection		
							1	1	0	0	No connection		
							1	1	0	1	AIN11		
				1	1	1	0	AIN12					
				1	1	1	1	No connection					
		Reserved.	x	x	x								
		ADC_SW_MAN_EN. This bit enables manual setting of the input signal muxing.	0							Disable			
			1							Enable			
0xDC	Letterbox Control 1	LB_TH [4:0]. These bits set the threshold value that determines if a line is black.				0	1	1	0	0	Default threshold for the detection of black lines.		
		Reserved.	1	0	1						Set as default		
0xDD	Letterbox Control 2	LB_EL [3:0]. These bits program the end line of letterbox detection (end of field).					1	1	0	0	Letterbox detection ends with the last line of active video on a field, 1100b: 262/525		
		LB_SL [3:0]. These bits program the start line of letterbox detection (start of field).	0	1	0	0					Letterbox detection aligned with the start of active video, 0100b: 23/286 NTSC		
0xDE	ST Noise Readback 1 (Read Only)	ST_NOISE [10:8]. Sync tip noise measurement.						x	x	x			
		ST_NOISE_VLD.					x				1 = ST_NOISE [10:0] measurement is valid; 0 = ST_NOISE [10:0] measurement is invalid		
		Reserved.	x	x	x	x							
0xDF	ST Noise Readback 2 (Read Only)	ST_NOISE [7:0]. See ST_NOISE [10:0].	x	x	x	x	x	x	x	x			
0xE1	SD Offset Cb	SD_OFF_CB [7:0]. These bits adjust the hue by selecting the offset for the Cb channel.	1	0	0	0	0	0	0	0			
0xE2	SD Offset Cr	SD_OFF_CR [7:0]. These bits adjust the hue by selecting the offset for the Cr channel.	1	0	0	0	0	0	0	0			
0xE3	SD Saturation Cb	SD_SAT_CB [7:0]. These bits adjust the saturation of the picture by affecting gain on the Cb channel.	1	0	0	0	0	0	0	0	Chroma gain = 0 dB		
0xE4	SD Saturation Cr	SD_SAT_CR [7:0]. These bits adjust the saturation of the picture by affecting gain on the Cr channel.	1	0	0	0	0	0	0	0	Chroma gain = 0 dB		



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
0xE5	NTSC V Bit Begin	NVBEG [4:0]. Number of lines after I <sub>COUNT</sub> rollover to set V high.				0	0	1	0	1	NTSC default (ITU-R BT.656)		
		NVBEGSIGN.			0						Set to low when manual programming		
					1							Not suitable for user programming	
		NVBEGDELE. This bit delays the V bit going high by one line relative to NVBEG (even field).		0								No delay	
				1								Additional delay by one line	
NVBEGDELO. This bit delays the V bit going high by one line relative to NVBEG (odd field).		0								No delay			
		1								Additional delay by one line			
0xE6	NTSC V Bit End	NVEND [4:0]. These bits control the number of lines after I <sub>COUNT</sub> rollover to set V low.				0	0	1	0	0	NTSC default (ITU-R BT.656)		
		NVENDSIGN.			0						Set to low when manual programming		
					1							Not suitable for user programming	
		NVENDDELE. This bit delays the V bit going low by one line relative to NVEND (even field).		0								No delay	
				1								Additional delay by one line	
NVENDDELO. This bit delays the V bit going low by one line relative to NVEND (odd field).		0								No delay			
		1								Additional delay by one line			
0xE7	NTSC F Bit Toggle	NFTOG [4:0]. These bits control the number of lines after I <sub>COUNT</sub> rollover to toggle F signal.				0	0	0	1	1	NTSC default		
		NFTOGSIGN.			0						Set to low when manual programming		
					1							Not suitable for user programming	
		NFTOGDELE. This bit delays the F transition by one line relative to NFTOG (even field).		0								No delay	
				1								Additional delay by one line	
NFTOGDELO. This bit delays the F transition by one line relative to NFTOG (odd field).		0								No delay			
		1								Additional delay by one line			
0xE8	PAL V Bit Begin	PVBEG [4:0]. These bits control the number of lines after I <sub>COUNT</sub> rollover to set V high.				0	0	1	0	1	PAL default (ITU-R BT.656)		
		PVBEGSIGN.			0						Set to low when manual programming		
					1							Not suitable for user programming	
		PVBEGDELE. This bit delays the V bit going high by one line relative to PVBEG (even field).		0								No delay	
				1								Additional delay by one line	
PVBEGDELO. This bit delays the V bit going high by one line relative to PVBEG (odd field).		0								No delay			
		1								Additional delay by one line			
0xE9	PAL V Bit End	PVEND [4:0]. These bits control the number of lines after I <sub>COUNT</sub> rollover to set the V bit low.				1	0	1	0	0	PAL default (ITU-R BT.656)		
		PVENDSIGN.			0						Set to low when manual programming		
					1							Not suitable for user programming	
		PVENDDELE. This bit delays the V bit going low by one line relative to PVEND (even field).		0								No delay	
				1								Additional delay by one line	
PVENDDELO. This bit delays the V bit going low by one line relative to PVEND (odd field).		0								No delay			
		1								Additional delay by one line			
0xEA	PAL F Bit Toggle	PFTOG [4:0]. These bits control the number of lines after I <sub>COUNT</sub> rollover to toggle the F signal.				0	0	0	1	1	PAL default (ITU-R BT.656)		
		PFTOGSIGN.			0						Set to low when manual programming		
					1							Not suitable for user programming	
		PFTOGDELE. This bit delays the F transition by one line relative to PFTOG (even field).		0								No delay	
				1								Additional delay by one line	
PFTOGDELO. This bit delays the F transition by one line relative to PFTOG (odd field).		0								No delay			
		1								Additional delay by one line			





# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes
			7	6	5	4	3	2	1	0		
0xEB	V Blank Control 1	PVBIELCM [1:0]. PAL VBI even field luma comb mode.							0	0	VBI ends one line earlier (Line 335)	Controls position of first active (comb filtered) line after VBI on even field in PAL
									0	1	ITU-R BT.470 compliant (Line 336)	
									1	0	VBI ends one line later (Line 337)	
									1	1	VBI ends two lines later (Line 338)	
		PVBIOLCM [1:0]. PAL VBI odd field luma comb mode.					0	0			VBI ends one line earlier (Line 22)	Controls position of first active (comb filtered) line after VBI on odd field in PAL
							0	1			ITU-R BT.470 compliant (Line 23)	
							1	0			VBI ends one line later (Line 24)	
							1	1			VBI ends two lines later (Line 25)	
		NVBIELCM [1:0]. NTSC VBI even field luma comb mode.			0	0					VBI ends one line earlier (Line 282)	Controls position of first active (comb filtered) line after VBI on even field in NTSC
					0	1					ITU-R BT.470 compliant (Line 283)	
					1	0					VBI ends one line later (Line 284)	
					1	1					VBI ends two lines later (Line 285)	
		NVBIOLCM [1:0]. NTSC VBI odd field luma comb mode.		0	0						VBI ends one line earlier (Line 20)	Controls position of first active (comb filtered) line after VBI on odd field in NTSC
				0	1						ITU-R BT.470 compliant (Line 21)	
				1	0						VBI ends one line later (Line 22)	
				1	1						VBI ends two lines later (Line 23)	
0xEC	V Blank Control 2	PVBIECM [1:0]. PAL VBI even field chroma comb mode.							0	0	Color output beginning Line 335	Controls the position of first line that outputs color after VBI on even field in PAL
									0	1	ITU-R BT.470 compliant color output beginning Line 336	
									1	0	Color output beginning Line 337	
									1	1	Color output beginning Line 338	
		PVBIOLCM [1:0]. PAL VBI odd field chroma comb mode.					0	0			Color output beginning Line 22	Controls the position of first line that outputs color after VBI on odd field in PAL
							0	1			ITU-R BT.470-compliant color output beginning Line 23	
							1	0			Color output beginning Line 24	
							1	1			Color output beginning Line 25	
		NVBIECM [1:0]. NTSC VBI even field chroma comb mode.			0	0					Color output beginning Line 282	Controls the position of first line that outputs color after VBI on even field in NTSC
					0	1					ITU-R BT.470-compliant color output beginning Line 283	
					1	0					VBI ends one line later (Line 284)	
					1	1					Color output beginning Line 285	
		NVBIOLCM [1:0]. NTSC VBI odd field chroma comb mode.		0	0						Color output beginning Line 20	Controls the position of first line that outputs color after VBI on odd field in NTSC
				0	1						ITU-R BT.470-compliant color output beginning Line 21	
				1	0						Color output beginning Line 22	
				1	1						Color output beginning Line 23	
0xED	FB_STATUS (Read Only)	Reserved.					x	x	x	x		
		FB_STATUS [3:0]. These bits provide information about the status of the FB pin (see individual entries for each bit).										
		FB_STATUS [0].				x					FB_RISE, 1 = rising edge on the FB pin since the last I <sup>2</sup> C read	Self-clearing bit
		FB_STATUS [1].			x					FB_FALL, 1 = falling edge on the FB pin since the last I <sup>2</sup> C read	Self-clearing bit	
		FB_STATUS [2].			x					FB_STAT provides instantaneous value of FB signal at time of the I <sup>2</sup> C read		
		FB_STATUS [3].	x							FB_HIGH indicates that the FB signal has gone high since the last I <sup>2</sup> C read	Self-clearing bit	
	FB_CONTROL 1 (Write Only)	FB_MODE [1:0]. These bits select the FB mode.							0	0	Static switch mode—full RGB or full CVBS data	
									0	1	Fixed alpha blending (see MAN_ALPHA_VAL [6:0])	
									1	0	Dynamic switching (fast mux)	
									1	1	Dynamic switching with edge enhancement	
CVBS_RGB_SEL. This bit selects either CVBS or RGB to be output.							0		CVBS source			
							1		RGB source			
FB_INV.						0			FB pin active high			
						1			FB pin active low			
Reserved.	0	0	0	1								



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes		
			7	6	5	4	3	2	1	0				
0xEE	FB_CONTROL 2	MAN_ALPHA_VAL [6:0]. These bits determine in what proportion the video from the CVBS and RGB sources are blended.	0	0	0	0	0	0	0	0				
		FB_CSC_MAN.	0									Automatic configuration of the CSC for SCART support	CSC is used to convert RGB portion of SCART signal to YCrCb	
			1									Enable manual programming of CSC		
0xEF	FB_CONTROL 3	FB_EDGE_SHAPE [2:0].					0	0	0		No edge shaping	Improves picture transition for high speed fast blank switching. All other settings are invalid.		
							0	0	1		Level 1 edge shaping			
							0	1	0		Level 2 edge shaping			
							0	1	1		Level 3 edge shaping			
							1	0	0		Level 4 edge shaping			
		CNTR_ENABLE.				0						Contrast reduction mode disabled and FB signal interpreted as bilevel signal		
						1						Contrast reduction mode enabled and FB signal interpreted as trilevel signal		
		FB_SP_ADJUST.	0	1	0	0					Adjusts FB timing in reference to the sampling clock	Each LSB corresponds to 1/8 <sup>th</sup> of a clock cycle		
0xF0	FB_CONTROL 4	FB_DELAY [3:0].					0	1	0	0	Delay on FB signal in 28.63636 MHz clock cycles			
		Reserved.	0	1	0	0								
0xF1	FB_CONTROL 5	RGB_IP_SEL.									0	SD RGB input for FB on AIN7, AIN8, and AIN9		
												1		SD RGB input for FB on AIN4, AIN5, and AIN6
		Reserved.									0	Set to 0		
		CNTR_MODE [1:0]. These bits allow adjustment of contrast level in the contrast reduction box.						0	0				25%	
								0	1				50%	
								1	0				75%	
								1	1				100%	
		FB_LEVEL [1:0]. These bits control reference level for fast blank comparator.			0	0							CNTR_ENABLE = 0, FB threshold = 1.4 V	
					0	1							CNTR_ENABLE = 0, FB threshold = 1.6 V	
					1	0							CNTR_ENABLE = 0, FB threshold = 1.8 V	
					1	1							CNTR_ENABLE = 0, FB threshold = 2 V	
		CNTR_LEVEL [1:0]. These bits control reference level for contrast reduction comparator.			0	0							0.4 V contrast reduction threshold	CNTR_ENABLE = 1
					0	1							0.6 V contrast reduction threshold	
			1	0							0.8 V contrast reduction threshold			
			1	1							Not used			
0xF3	AFE_CONTROL 1	AA_FILT_EN [0].									0	Disables the internal antialiasing filter on Channel 0		
												1		Enables the internal antialiasing filter on Channel 0
		AA_FILT_EN [1].										0	Disables the internal antialiasing filter on Channel 1	
												1	Enables the internal antialiasing filter on Channel 1	
		AA_FILT_EN [2].										0	Disables the internal antialiasing filter on Channel 2	
												1	Enables the internal antialiasing filter on Channel 2	
		AA_FILT_EN [3].										0	Disables the internal antialiasing filter on Channel 3	
												1	Enables the internal antialiasing filter on Channel 3	



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes		
			7	6	5	4	3	2	1	0				
		ADC3_SW [3:0].	0	0	0	0							No connection	
			0	0	0	1							No connection	
			0	0	1	0							No connection	
			0	0	1	1							No connection	
			0	1	0	0							AIN4	
			0	1	0	1							No connection	
			0	1	1	0							No connection	
			0	1	1	1							No connection	
			1	0	0	0							No connection	
			1	0	0	1							AIN7	
			1	0	1	0							No connection	
			1	0	1	1							No connection	
			1	1	0	0							No connection	
			1	1	0	1							No connection	
			1	1	1	0							No connection	
			1	1	1	1							No connection	
0xF4	Drive Strength	DR_STR_S [1:0]. These bits select the drive strength for the sync output signals.									0	0	Reserved	
											0	1	Medium-low drive strength (2x)	
										1	0	Medium-high drive strength (3x)		
										1	1	High drive strength (4x)		
		DR_STR_C [1:0]. These bits select the drive strength for the clock output signal.					0	0					Reserved	
							0	1					Medium-low drive strength (2x)	
							1	0					Medium-high drive strength (3x)	
							1	1					High drive strength (4x)	
		DR_STR [1:0]. These bits select the drive strength for the data output signals. Can be increased or decreased for EMC or crosstalk reasons.		0	0								Reserved	
				0	1								Medium-low drive strength (2x)	
				1	0								Medium-high drive strength (3x)	
				1	1								High drive strength (4x)	
		Reserved.	x	x									No delay	
0xF8	IF Comp Control	IFFILTSEL [2:0]. IF filter selection for PAL and NTSC.						0	0	0			Bypass mode	0 dB
											<b>2 MHz</b>	<b>5 MHz</b>		NTSC filters
								0	0	1	-3 dB	+2 dB		
								0	1	0	-6 dB	+3.5 dB		
								0	1	1	-10 dB	+5 dB		
								1	0	0	Reserved			
											<b>3 MHz</b>	<b>6 MHz</b>		PAL filters
								1	0	1	-2 dB	+2 dB		
								1	1	0	-5 dB	+3 dB		
								1	1	1	-7 dB	+5 dB		
		Reserved.	0	0	0	0	0							
0xF9	VS Mode Control	EXTEND_VS_MAX_FREQ.									0			
											1			
		EXTEND_VS_MIN_FREQ.									0			
											1			
		VS_COAST_MODE [1:0].					0	0					Autocoast mode	This value sets up the output coast frequency.
							0	1					50 Hz coast mode	
							1	0					60 Hz coast mode	
							1	1					Reserved	
		Reserved.	0	0	0	0								
0xFB	Peaking Control	PEAKING_GAIN [7:0]. These bits increase/decrease the gain for high frequency portions of the video signal.	0	1	0	0	0	0	0	0	0	0		
0xFC	Coring Threshold 2	DNR_TH2 [7:0]. DNR Threshold 2. These bits specify the maximum edge that is interpreted as noise and is therefore blanked.	0	0	0	0	0	0	1	0	0	0		

<sup>1</sup> Shading indicates default settings.



**USER SUB MAP**

The collective name for the subaddress registers in Table 106 is user sub map. To access the user sub map, SUB\_USR\_EN in Register Address 0x0E (user map) must be programmed to 1.

**Table 106. User Sub Map Register Details**

Address		Register Name	RW	7		6		5		4		3		2		1		0		Reset Value	(Hex)		
Dec	Hex			6	5	4	3	2	1	0	6	5	4	3	2	1	0	6	5			4	3
64	40	Interrupt Configuration 0	RW	INTRQ_DUR_SEL.1	INTRQ_DUR_SEL.0	MV_INTRQ_SEL.1	MV_INTRQ_SEL.0	MPU_STIM_I	NTRQ	INTRQ_OP_SEL.1	INTRQ_OP_SEL.0	0001x000	10										
66	42	Interrupt Status 1	R		MV_PS_CS_Q	SD_FR_HNG_Q										SD_UNLOCK_Q	SD_LOCK_Q			-	-		
67	43	Interrupt Clear 1	W		MV_PS_CS_CLR	SD_FR_CHNG_CLR										SD_UNLOCK_CLR	SD_LOCK_CLR			x0000000	00		
68	44	Interrupt Mask 1	RW		MV_PS_CS_MSKB	SD_FR_CHNG_MSKB										SD_UNLOCK_MSKB	SD_LOCK_MSKB			x0000000	00		
69	45	Raw Status 2	R	MPU_STIM_INTRQ				EVEN_FIELD									CCAPD			-	-		
70	46	Interrupt Status 2	R	MPU_STIM_INTRQ_Q				SD_FIELD_CHNGD_Q								GEMD_Q	CCAPD_Q			-	-		
71	47	Interrupt Clear 2	W	MPU_STIM_INTRQ_CLR				SD_FIELD_CHNGD_CLR								GEMD_CLR	CCAPD_CLR			0xx00000	00		
72	48	Interrupt Mask 2	RW	MPU_STIM_INTRQ_MSKB				SD_FIELD_CHNGD_MSKB								GEMD_MSKB	CCAPD_MSKB			0xx00000	00		
73	49	Raw Status 3	R					SCM_LOCK						SD_H_LOCK	SD_V_LOCK	SD_OP_50Hz				-	-		
74	4A	Interrupt Status 3	R			PAL_SW_LK_CHNG_Q	SCM_LOCK_CHNG_Q	SD_AD_CHNG_Q	SD_H_LOCK_CHNG_Q	SD_V_LOCK_CHNG_Q	SD_OP_CHNG_Q									-	-		
75	4B	Interrupt Clear 3	W			PAL_SW_LK_CHNG_CLR	SCM_LOCK_CHNG_CLR	SD_AD_CHNG_CLR	SD_H_LOCK_CHNG_CLR	SD_V_LOCK_CHNG_CLR	SD_OP_CHNG_CLR									xx000000	00		
76	4C	Interrupt Mask 3	RW			PAL_SW_LK_CHNG_MSKB	SCM_LOCK_CHNG_MSKB	SD_AD_CHNG_MSKB	SD_H_LOCK_CHNG_MSKB	SD_V_LOCK_CHNG_MSKB	SD_OP_CHNG_MSKB									xx000000	00		
78	4E	Interrupt Status 4	R		VDP_VITC_Q			VDP_GS_VPS_PDC_UTC_CHNG_Q								VDP_CGMS_WSS_CHNGD_Q				-	-		
79	4F	Interrupt Clear 4	W		VDP_VITC_CLR			VDP_GS_VPS_PDC_UTC_CHNG_CLR								VDP_CGMS_WSS_CHNGD_CLR				00x0x0x0	00		
80	50	Interrupt Mask 4	RW		VDP_VITC_MSKB			VDP_GS_VPS_PDC_UTC_CHNG_MSKB								VDP_CGMS_WSS_CHNGD_MSKB				00x0x0x0	00		
96	60	VDP_Config_1	RW							WST_PKT_DECOD_DISABLE	VDP_TTXT_TYPE_MAN_ENABLE	VDP_TTXT_TYPE_MAN.1	VDP_TTXT_TYPE_MAN.0	10001000	88								
97	61	VDP_Config_2	RW					AUTO_DETECT_GS_TYPE												0001xx00	10		
98	62	VDP_ADF_Config_1	RW	ADF_ENABLE	ADF_MODE.1	ADF_MODE.0	ADF_DID.4	ADF_DID.3	ADF_DID.2	ADF_DID.1	ADF_DID.0	00010101	15										
99	63	VDP_ADF_Config_2	RW	DUPLICATE ADF		ADF_SDID.5	ADF_SDID.4	ADF_SDID.3	ADF_SDID.2	ADF_SDID.1	ADF_SDID.0	0x101010	2A										
100	64	VDP_LINE_00E	RW	MAN_LINE_PGM						VBI_DATA_P318.3	VBI_DATA_P318.2	VBI_DATA_P318.1	VBI_DATA_P318.0	0xxx0000	00								
101	65	VDP_LINE_00F	RW	VBI_DATA_P6_N23.3	VBI_DATA_P6_N23.2	VBI_DATA_P6_N23.1	VBI_DATA_P6_N23.0	VBI_DATA_P319_N286.3	VBI_DATA_P319_N286.2	VBI_DATA_P319_N286.1	VBI_DATA_P319_N286.0	00000000	00										
102	66	VDP_LINE_010	RW	VBI_DATA_P7_N24.3	VBI_DATA_P7_N24.2	VBI_DATA_P7_N24.1	VBI_DATA_P7_N24.0	VBI_DATA_P320_N287.3	VBI_DATA_P320_N287.2	VBI_DATA_P320_N287.1	VBI_DATA_P320_N287.0	00000000	00										
103	67	VDP_LINE_011	RW	VBI_DATA_P8_N25.3	VBI_DATA_P8_N25.2	VBI_DATA_P8_N25.1	VBI_DATA_P8_N25.0	VBI_DATA_P321_N288.3	VBI_DATA_P321_N288.2	VBI_DATA_P321_N288.1	VBI_DATA_P321_N288.0	00000000	00										
104	68	VDP_LINE_012	RW	VBI_DATA_P9.3	VBI_DATA_P9.2	VBI_DATA_P9.1	VBI_DATA_P9.0	VBI_DATA_P322.3	VBI_DATA_P322.2	VBI_DATA_P322.1	VBI_DATA_P322.0	00000000	00										
105	69	VDP_LINE_013	RW	VBI_DATA_P10.3	VBI_DATA_P10.2	VBI_DATA_P10.1	VBI_DATA_P10.0	VBI_DATA_P323.3	VBI_DATA_P323.2	VBI_DATA_P323.1	VBI_DATA_P323.0	00000000	00										
106	6A	VDP_LINE_014	RW	VBI_DATA_P11.3	VBI_DATA_P11.2	VBI_DATA_P11.1	VBI_DATA_P11.0	VBI_DATA_P324_N272.3	VBI_DATA_P324_N272.2	VBI_DATA_P324_N272.1	VBI_DATA_P324_N272.0	00000000	00										
107	6B	VDP_LINE_015	RW	VBI_DATA_P12_N10.3	VBI_DATA_P12_N10.2	VBI_DATA_P12_N10.1	VBI_DATA_P12_N10.0	VBI_DATA_P325_N273.3	VBI_DATA_P325_N273.2	VBI_DATA_P325_N273.1	VBI_DATA_P325_N273.0	00000000	00										
108	6C	VDP_LINE_016	RW	VBI_DATA_P13_N11.3	VBI_DATA_P13_N11.2	VBI_DATA_P13_N11.1	VBI_DATA_P13_N11.0	VBI_DATA_P326_N274.3	VBI_DATA_P326_N274.2	VBI_DATA_P326_N274.1	VBI_DATA_P326_N274.0	00000000	00										
109	6D	VDP_LINE_017	RW	VBI_DATA_P14_N12.3	VBI_DATA_P14_N12.2	VBI_DATA_P14_N12.1	VBI_DATA_P14_N12.0	VBI_DATA_P327_N275.3	VBI_DATA_P327_N275.2	VBI_DATA_P327_N275.1	VBI_DATA_P327_N275.0	00000000	00										
110	6E	VDP_LINE_018	RW	VBI_DATA_P15_N13.3	VBI_DATA_P15_N13.2	VBI_DATA_P15_N13.1	VBI_DATA_P15_N13.0	VBI_DATA_P328_N276.3	VBI_DATA_P328_N276.2	VBI_DATA_P328_N276.1	VBI_DATA_P328_N276.0	00000000	00										
111	6F	VDP_LINE_019	RW	VBI_DATA_P16_N14.3	VBI_DATA_P16_N14.2	VBI_DATA_P16_N14.1	VBI_DATA_P16_N14.0	VBI_DATA_P329_N277.3	VBI_DATA_P329_N277.2	VBI_DATA_P329_N277.1	VBI_DATA_P329_N277.0	00000000	00										
112	70	VDP_LINE_01A	RW	VBI_DATA_P17_N15.3	VBI_DATA_P17_N15.2	VBI_DATA_P17_N15.1	VBI_DATA_P17_N15.0	VBI_DATA_P330_N278.3	VBI_DATA_P330_N278.2	VBI_DATA_P330_N278.1	VBI_DATA_P330_N278.0	00000000	00										
113	71	VDP_LINE_01B	RW	VBI_DATA_P18_N16.3	VBI_DATA_P18_N16.2	VBI_DATA_P18_N16.1	VBI_DATA_P18_N16.0	VBI_DATA_P331_N279.3	VBI_DATA_P331_N279.2	VBI_DATA_P331_N279.1	VBI_DATA_P331_N279.0	00000000	00										
114	72	VDP_LINE_01C	RW	VBI_DATA_P19_N17.3	VBI_DATA_P19_N17.2	VBI_DATA_P19_N17.1	VBI_DATA_P19_N17.0	VBI_DATA_P332_N280.3	VBI_DATA_P332_N280.2	VBI_DATA_P332_N280.1	VBI_DATA_P332_N280.0	00000000	00										
115	73	VDP_LINE_01D	RW	VBI_DATA_P20_N18.3	VBI_DATA_P20_N18.2	VBI_DATA_P20_N18.1	VBI_DATA_P20_N18.0	VBI_DATA_P333_N281.3	VBI_DATA_P333_N281.2	VBI_DATA_P333_N281.1	VBI_DATA_P333_N281.0	00000000	00										



# ADV7188

Address		Register Name	RW	7	6	5	4	3	2	1	0	Reset Value	(Hex)
Dec	Hex												
116	74	VDP_LINE_01E	RW	VBL_DATA_P21_N19.3	VBL_DATA_P21_N19.2	VBL_DATA_P21_N19.1	VBL_DATA_P21_N19.0	VBL_DATA_P334_N282.3	VBL_DATA_P334_N282.2	VBL_DATA_P334_N282.1	VBL_DATA_P334_N282.0	00000000	00
117	75	VDP_LINE_01F	RW	VBL_DATA_P22_N20.3	VBL_DATA_P22_N20.2	VBL_DATA_P22_N20.1	VBL_DATA_P22_N20.0	VBL_DATA_P335_N283.3	VBL_DATA_P335_N283.2	VBL_DATA_P335_N283.1	VBL_DATA_P335_N283.0	00000000	00
118	76	VDP_LINE_020	RW	VBL_DATA_P23_N21.3	VBL_DATA_P23_N21.2	VBL_DATA_P23_N21.1	VBL_DATA_P23_N21.0	VBL_DATA_P336_N284.3	VBL_DATA_P336_N284.2	VBL_DATA_P336_N284.1	VBL_DATA_P336_N284.0	00000000	00
119	77	VDP_LINE_021	RW	VBL_DATA_P24_N22.3	VBL_DATA_P24_N22.2	VBL_DATA_P24_N22.1	VBL_DATA_P24_N22.0	VBL_DATA_P337_N285.3	VBL_DATA_P337_N285.2	VBL_DATA_P337_N285.1	VBL_DATA_P337_N285.0	00000000	00
120	78	VDP_STATUS_CLEAR	W		VITC_CLEAR		GS_PDC_VPS_UTC_CLEAR		CGMS_WSS_CLEAR		CC_CLEAR	00000000	00
120	78	VDP_STATUS	R	TTXT_AVL	VITC_AVL	GS_DATA_TYPE	GS_PDC_VPS_UTC_AVL		CGMS_WSS_AVL	CC_EVEN_FIELD	CC_AVL	-	-
121	79	VDP_CCAP_DATA_0	R	CCAP_BYTE_1.7	CCAP_BYTE_1.6	CCAP_BYTE_1.5	CCAP_BYTE_1.4	CCAP_BYTE_1.3	CCAP_BYTE_1.2	CCAP_BYTE_1.1	CCAP_BYTE_1.0	-	-
122	7A	VDP_CCAP_DATA_1	R	CCAP_BYTE_2.7	CCAP_BYTE_2.6	CCAP_BYTE_2.5	CCAP_BYTE_2.4	CCAP_BYTE_2.3	CCAP_BYTE_2.2	CCAP_BYTE_2.1	CCAP_BYTE_2.0	-	-
125	7D	CGMS_WSS_DATA_0	R	zero	zero	zero	zero	CGMS_CRC.5	CGMS_CRC.4	CGMS_CRC.3	CGMS_CRC.2	-	-
126	7E	CGMS_WSS_DATA_1	R	CGMS_CRC.1	CGMS_CRC.0	CGMS_WSS.13	CGMS_WSS.12	CGMS_WSS.11	CGMS_WSS.10	CGMS_WSS.9	CGMS_WSS.8	-	-
127	7F	CGMS_WSS_DATA_2	R	CGMS_WSS.7	CGMS_WSS.6	CGMS_WSS.5	CGMS_WSS.4	CGMS_WSS.3	CGMS_WSS.2	CGMS_WSS.1	CGMS_WSS.0	-	-
132	84	VDP_GS_VPS_PDC_UTC_0	R	GS_VPS_PDC_UTC_BYTE_0.7	GS_VPS_PDC_UTC_BYTE_0.6	GS_VPS_PDC_UTC_BYTE_0.5	GS_VPS_PDC_UTC_BYTE_0.4	GS_VPS_PDC_UTC_BYTE_0.3	GS_VPS_PDC_UTC_BYTE_0.2	GS_VPS_PDC_UTC_BYTE_0.1	GS_VPS_PDC_UTC_BYTE_0.0	-	-
133	85	VDP_GS_VPS_PDC_UTC_1	R	GS_VPS_PDC_UTC_BYTE_1.7	GS_VPS_PDC_UTC_BYTE_1.6	GS_VPS_PDC_UTC_BYTE_1.5	GS_VPS_PDC_UTC_BYTE_1.4	GS_VPS_PDC_UTC_BYTE_1.3	GS_VPS_PDC_UTC_BYTE_1.2	GS_VPS_PDC_UTC_BYTE_1.1	GS_VPS_PDC_UTC_BYTE_1.0	-	-
134	86	VDP_GS_VPS_PDC_UTC_2	R	GS_VPS_PDC_UTC_BYTE_2.7	GS_VPS_PDC_UTC_BYTE_2.6	GS_VPS_PDC_UTC_BYTE_2.5	GS_VPS_PDC_UTC_BYTE_2.4	GS_VPS_PDC_UTC_BYTE_2.3	GS_VPS_PDC_UTC_BYTE_2.2	GS_VPS_PDC_UTC_BYTE_2.1	GS_VPS_PDC_UTC_BYTE_2.0	-	-
135	87	VDP_GS_VPS_PDC_UTC_3	R	GS_VPS_PDC_UTC_BYTE_3.7	GS_VPS_PDC_UTC_BYTE_3.6	GS_VPS_PDC_UTC_BYTE_3.5	GS_VPS_PDC_UTC_BYTE_3.4	GS_VPS_PDC_UTC_BYTE_3.3	GS_VPS_PDC_UTC_BYTE_3.2	GS_VPS_PDC_UTC_BYTE_3.1	GS_VPS_PDC_UTC_BYTE_3.0	-	-
136	88	VDP_VPS_PDC_UTC_4	R	VPS_PDC_UTC_BYTE_4.7	VPS_PDC_UTC_BYTE_4.6	VPS_PDC_UTC_BYTE_4.5	VPS_PDC_UTC_BYTE_4.4	VPS_PDC_UTC_BYTE_4.3	VPS_PDC_UTC_BYTE_4.2	VPS_PDC_UTC_BYTE_4.1	VPS_PDC_UTC_BYTE_4.0	-	-
137	89	VDP_VPS_PDC_UTC_5	R	VPS_PDC_UTC_BYTE_5.7	VPS_PDC_UTC_BYTE_5.6	VPS_PDC_UTC_BYTE_5.5	VPS_PDC_UTC_BYTE_5.4	VPS_PDC_UTC_BYTE_5.3	VPS_PDC_UTC_BYTE_5.2	VPS_PDC_UTC_BYTE_5.1	VPS_PDC_UTC_BYTE_5.0	-	-
138	8A	VDP_VPS_PDC_UTC_6	R	VPS_PDC_UTC_BYTE_6.7	VPS_PDC_UTC_BYTE_6.6	VPS_PDC_UTC_BYTE_6.5	VPS_PDC_UTC_BYTE_6.4	VPS_PDC_UTC_BYTE_6.3	VPS_PDC_UTC_BYTE_6.2	VPS_PDC_UTC_BYTE_6.1	VPS_PDC_UTC_BYTE_6.0	-	-
139	8B	VDP_VPS_PDC_UTC_7	R	VPS_PDC_UTC_BYTE_7.7	VPS_PDC_UTC_BYTE_7.6	VPS_PDC_UTC_BYTE_7.5	VPS_PDC_UTC_BYTE_7.4	VPS_PDC_UTC_BYTE_7.3	VPS_PDC_UTC_BYTE_7.2	VPS_PDC_UTC_BYTE_7.1	VPS_PDC_UTC_BYTE_7.0	-	-
140	8C	VDP_VPS_PDC_UTC_8	R	VPS_PDC_UTC_BYTE_8.7	VPS_PDC_UTC_BYTE_8.6	VPS_PDC_UTC_BYTE_8.5	VPS_PDC_UTC_BYTE_8.4	VPS_PDC_UTC_BYTE_8.3	VPS_PDC_UTC_BYTE_8.2	VPS_PDC_UTC_BYTE_8.1	VPS_PDC_UTC_BYTE_8.0	-	-
141	8D	VDP_VPS_PDC_UTC_9	R	VPS_PDC_UTC_BYTE_9.7	VPS_PDC_UTC_BYTE_9.6	VPS_PDC_UTC_BYTE_9.5	VPS_PDC_UTC_BYTE_9.4	VPS_PDC_UTC_BYTE_9.3	VPS_PDC_UTC_BYTE_9.2	VPS_PDC_UTC_BYTE_9.1	VPS_PDC_UTC_BYTE_9.0	-	-
142	8E	VDP_VPS_PDC_UTC_10	R	VPS_PDC_UTC_BYTE_10.7	VPS_PDC_UTC_BYTE_10.6	VPS_PDC_UTC_BYTE_10.5	VPS_PDC_UTC_BYTE_10.4	VPS_PDC_UTC_BYTE_10.3	VPS_PDC_UTC_BYTE_10.2	VPS_PDC_UTC_BYTE_10.1	VPS_PDC_UTC_BYTE_10.0	-	-
143	8F	VDP_VPS_PDC_UTC_11	R	VPS_PDC_UTC_BYTE_11.7	VPS_PDC_UTC_BYTE_11.6	VPS_PDC_UTC_BYTE_11.5	VPS_PDC_UTC_BYTE_11.4	VPS_PDC_UTC_BYTE_11.3	VPS_PDC_UTC_BYTE_11.2	VPS_PDC_UTC_BYTE_11.1	VPS_PDC_UTC_BYTE_11.0	-	-
144	90	VDP_VPS_PDC_UTC_12	R	VPS_PDC_UTC_BYTE_12.7	VPS_PDC_UTC_BYTE_12.6	VPS_PDC_UTC_BYTE_12.5	VPS_PDC_UTC_BYTE_12.4	VPS_PDC_UTC_BYTE_12.3	VPS_PDC_UTC_BYTE_12.2	VPS_PDC_UTC_BYTE_12.1	VPS_PDC_UTC_BYTE_12.0	-	-
146	92	VDP_VITC_DATA_0	R	VITC_DATA_1.7	VITC_DATA_1.6	VITC_DATA_1.5	VITC_DATA_1.4	VITC_DATA_1.3	VITC_DATA_1.2	VITC_DATA_1.1	VITC_DATA_1.0	-	-
147	93	VDP_VITC_DATA_1	R	VITC_DATA_2.7	VITC_DATA_2.6	VITC_DATA_2.5	VITC_DATA_2.4	VITC_DATA_2.3	VITC_DATA_2.2	VITC_DATA_2.1	VITC_DATA_2.0	-	-
148	94	VDP_VITC_DATA_2	R	VITC_DATA_3.7	VITC_DATA_3.6	VITC_DATA_3.5	VITC_DATA_3.4	VITC_DATA_3.3	VITC_DATA_3.2	VITC_DATA_3.1	VITC_DATA_3.0	-	-
149	95	VDP_VITC_DATA_3	R	VITC_DATA_4.7	VITC_DATA_4.6	VITC_DATA_4.5	VITC_DATA_4.4	VITC_DATA_4.3	VITC_DATA_4.2	VITC_DATA_4.1	VITC_DATA_4.0	-	-
150	96	VDP_VITC_DATA_4	R	VITC_DATA_5.7	VITC_DATA_5.6	VITC_DATA_5.5	VITC_DATA_5.4	VITC_DATA_5.3	VITC_DATA_5.2	VITC_DATA_5.1	VITC_DATA_5.0	-	-
151	97	VDP_VITC_DATA_5	R	VITC_DATA_6.7	VITC_DATA_6.6	VITC_DATA_6.5	VITC_DATA_6.4	VITC_DATA_6.3	VITC_DATA_6.2	VITC_DATA_6.1	VITC_DATA_6.0	-	-
152	98	VDP_VITC_DATA_6	R	VITC_DATA_7.7	VITC_DATA_7.6	VITC_DATA_7.5	VITC_DATA_7.4	VITC_DATA_7.3	VITC_DATA_7.2	VITC_DATA_7.1	VITC_DATA_7.0	-	-
153	99	VDP_VITC_DATA_7	R	VITC_DATA_8.7	VITC_DATA_8.6	VITC_DATA_8.5	VITC_DATA_8.4	VITC_DATA_8.3	VITC_DATA_8.2	VITC_DATA_8.1	VITC_DATA_8.0	-	-
154	9A	VDP_VITC_DATA_8	R	VITC_DATA_9.7	VITC_DATA_9.6	VITC_DATA_9.5	VITC_DATA_9.4	VITC_DATA_9.3	VITC_DATA_9.2	VITC_DATA_9.1	VITC_DATA_9.0	-	-
155	9B	VDP_VITC_CALC_CRC	R	VITC_CRC.7	VITC_CRC.6	VITC_CRC.5	VITC_CRC.4	VITC_CRC.3	VITC_CRC.2	VITC_CRC.1	VITC_CRC.0	-	-
156	9C	VDP_OUTPUT_SEL	RW	I2C_GS_VPS_PDC_UTC.1	I2C_GS_VPS_PDC_UTC.0	GS_VPS_PDC_UTC_CB_CHANGE	WSS_CGMS_CB_CHANGE					00110000	30



Table 107 provides a detailed description of the registers located in the user sub map.

**Table 107. User Sub Map Detailed Description**

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes				
			7	6	5	4	3	2	1	0						
0x40	Interrupt Configuration 1	INTRQ_OP_SEL [1:0]. Interrupt drive level select.								0	0	Open drain.				
											0	1		Drive low when active.		
											1	0		Drive high when active.		
											1	1		Reserved.		
		MPU_STIM_INTRQ [1:0]. Manual interrupt set mode.									0			Manual interrupt mode disabled.		
											1			Manual interrupt mode enabled.		
		Reserved.								x					Not used.	
							0	0							Reserved.	
							0	1								Pseudosync only.
							1	0								Color stripe only.
		INTRQ_DUR_SEL [1:0]. Interrupt duration select.					1	1							Pseudosync or color stripe.	
					0	0									3 XTAL periods.	
0	1												15 XTAL periods.			
1	0												63 XTAL periods.			
									1	1	Active until cleared.					
0x42	Interrupt Status 1 (Read Only)	SD_LOCK_Q.									0	No change.	These bits can be cleared or masked in Registers 0x43 and 0x44, respectively.			
											1	SD input has caused the decoder to go from an unlocked state to a locked state.				
		SD_UNLOCK_Q.									0	No change				
											1	SD input has caused the decoder to go from a locked state to an unlocked state.				
		Reserved.									x					
												x				
		Reserved.						x								
							0								No change.	
		SD_FR_CHNG_Q.					1								Denotes a change in the free-run status.	
						0									No change.	
		MV_PS_CS_Q.				1									Pseudosync/color striping detected. See Register 0x40 MV_INTRQ_SEL [1:0] for selection.	
					x											
0x43	Interrupt Clear 1 (Write Only)	SD_LOCK_CLR.									0	Does not clear.				
											1	Clears SD_LOCK_Q bit.				
		SD_UNLOCK_CLR.									0	Does not clear.				
											1	Clears SD_UNLOCK_Q bit.				
		Reserved.									0	Not used.				
									0					Not used.		
		Reserved.					0							Not used.		
							0								Do not clear.	
		SD_FR_CHNG_CLR.					1							Clears SD_FR_CHNG_Q bit.		
						0									Does not clear.	
MV_PS_CS_CLR.				1								Clears MV_PS_CS_Q bit.				
			x									Not used.				
0x44	Interrupt Mask 1 (Read/Write)	SD_LOCK_MSKB.									0	Masks SD_LOCK_Q bit.				
											1	Unmasks SD_LOCK_Q bit.				
		SD_UNLOCK_MSKB.									0	Masks SD_UNLOCK_Q bit.				
											1	Unmasks SD_UNLOCK_Q bit.				
		Reserved.									0	Not used.				
									0					Not used.		
		Reserved.					0							Not used.		
							0								Masks SD_FR_CHNG_Q bit.	
		SD_FR_CHNG_MSKB.					1							Unmasks SD_FR_CHNG_Q bit.		
						0									Masks MV_PS_CS_Q bit.	
		MV_PS_CS_MSKB.				1									Unmasks MV_PS_CS_Q bit.	
					x										Not used.	



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes			
			7	6	5	4	3	2	1	0					
0x45	Raw Status 2 (Read Only)	CCAPD.									0	No CCAPD data detected.	These bits are status bits only. They cannot be cleared or masked. Register 0x46 is used for this purpose.		
		Reserved.					x	x	x		1	CCAPD data detected.			
		EVEN_FIELD.				0								Current SD field is odd numbered.	
		Reserved.				1								Current SD field is even numbered.	
		Reserved.		x	x										
		MPU_STIM_INTRQ.	0												MPU_STIM_INT = 0.
			1									MPU_STIM_INT = 1.			
0x46	Interrupt Status 2 (Read Only)	CCAPD_Q.										0	Closed captioning not detected in the input video signal.	These bits can be cleared or masked by Registers 0x47 and 0x48, respectively.  Note that interrupt in Register 0x46 for the CC, Gemstar, CGMS, and WSS data is using the Mode 1 data slicer.	
		Reserved.										1	Closed caption data detected in the video input signal.		
		GEMD_Q.											0		Gemstar data not detected in the input video signal.
		Reserved.											1		Gemstar data detected in the input video signal.
		Reserved.					x	x							
		SD_FIELD_CHNGD_Q.				0									SD signal has not changed the field from odd to even or vice versa.
		Reserved.				1									SD signal has changed the field from odd to even or vice versa.
		Reserved.			x										Not used.
		Reserved.		x											Not used.
		MPU_STIM_INTRQ_Q.	0												Manual interrupt not set.
			1									Manual interrupt set.			
0x47	Interrupt Clear 2 (Write Only)	CCAPD_CLR.										0	Does not clear.	Note that interrupt in Register 0x46 for the CC, Gemstar, CGMS, and WSS data is using the Mode 1 data slicer.	
		Reserved.										1	Clears CCAPD_Q bit.		
		GEMD_CLR.											0		Does not clear.
		Reserved.							0	0					
		SD_FIELD_CHNGD_CLR.				0									Does not Clear.
		Reserved.				1									Clears SD_FIELD_CHNGD_Q bit.
		Reserved.		x											Not used.
		Reserved.		x											Not used.
MPU_STIM_INTRQ_CLR.	0											Does not clear.			
			1									Clears MPU_STIM_INTRQ_Q bit.			
0x48	Interrupt Mask 2 (Read/Write)	CCAPD_MSKB.										0	Masks CCAPD_Q bit.	Note that interrupt in Register 0x46 for the CC, Gemstar, CGMS, and WSS data is using the Mode 1 data slicer.	
		Reserved.										1	Unmasks CCAPD_Q bit.		
		GEMD_MSKB.											0		Masks GEMD_Q bit.
		Reserved.											1		Unmasks GEMD_Q bit.
		CGMS_MSKB.					0	0							Masks CGMS_CHNGD_Q bit.
		SD_FIELD_CHNGD_MSKB.				0									Masks SD_FIELD_CHNGD_Q bit.
		Reserved.				1									Unmasks SD_FIELD_CHNGD_Q bit.
Reserved.		0	0									Not used.			
MPU_STIM_INTRQ_MSKB.	0											Masks MPU_STIM_INTRQ_Q bit.			
			1									Unmasks MPU_STIM_INTRQ_Q bit.			
0x49	Raw Status 3 (Read Only)	SD_OP_50Hz. This bit indicates if the SD 60 Hz or SD 50 Hz frame rate is at output.										0	SD 60 Hz signal output.	These bits are status bits only. They cannot be cleared or masked. Register 0x4A is used for this purpose.	
		Reserved.										1	SD 50 Hz signal output.		
		SD_V_LOCK.											0		SD vertical sync lock not established.
		Reserved.											1		SD vertical sync lock established.
		SD_H_LOCK.											0		SD horizontal sync lock not established.
		Reserved.											1		SD horizontal sync lock established.
		Reserved.					x								Not used.
		SCM_LOCK.				0									SECAM lock not established.
		Reserved.				1									SECAM lock established.
		Reserved.		x											Not used.
Reserved.		x										Not used.			
Reserved.		x										Not used.			





Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes				
			7	6	5	4	3	2	1	0						
0x4A	Interrupt Status 3 (Read Only)	SD_OP_CHNG_Q. This bit indicates if the SD 60 Hz or SD 50 Hz frame rate is at output.									0	No change in SD signal standard detected at the output.	These bits can be cleared and masked by Register 0x4B if no change is detected and by Register 0x4C if a change is detected.			
											1	A change in SD signal standard is detected at the output.				
		SD_V_LOCK_CHNG_Q.										0		No change in SD vertical sync lock status.		
												1		SD vertical sync lock status has changed.		
		SD_H_LOCK_CHNG_Q.										0		No change in SD horizontal sync lock status.		
												1		SD horizontal sync lock status has changed.		
		SD_AD_CHNG_Q. SD autodetect changed.										0		No change in AD_RESULT [2:0] bits in Status Register 1.		
												1		AD_RESULT [2:0] bits in Status Register 1 have changed.		
		SCM_LOCK_CHNG_Q. SECAM lock.										0		No change in SECAM lock status.		
												1		SECAM lock status has changed.		
PAL_SW_LK_CHNG_Q.										0	No change in PAL swinging burst lock status.					
										1	PAL swinging burst lock status has changed.					
Reserved.										x	Not used.					
Reserved.										x	Not used.					
0x4B	Interrupt Clear 3 (Write Only)	SD_OP_CHNG_CLR.										0	Do not clear.			
												1	Clears SD_OP_CHNG_Q bit.			
		SD_V_LOCK_CHNG_CLR.											0		Do not clear.	
													1		Clears SD_V_LOCK_CHNG_Q bit.	
		SD_H_LOCK_CHNG_CLR.											0		Do not clear.	
													1		Clears SD_H_LOCK_CHNG_Q bit.	
		SD_AD_CHNG_CLR.											0		Do not clear.	
													1		Clears SD_AD_CHNG_Q bit.	
		SCM_LOCK_CHNG_CLR.											0		Do not clear.	
													1		Clears SCM_LOCK_CHNG_Q bit.	
PAL_SW_LK_CHNG_CLR.											0	Do not clear.				
											1	Clears PAL_SW_LK_CHNG_Q bit.				
Reserved.											x	Not used.				
Reserved.											x	Not used.				
0x4C	Interrupt Mask 2 (Read/Write)	SD_OP_CHNG_MSKB.											0	Masks SD_OP_CHNG_Q bit.		
													1	Unmasks SD_OP_CHNG_Q bit.		
		SD_V_LOCK_CHNG_MSKB.												0		Masks SD_V_LOCK_CHNG_Q bit.
														1		Unmasks SD_V_LOCK_CHNG_Q bit.
		SD_H_LOCK_CHNG_MSKB.												0		Masks SD_H_LOCK_CHNG_Q bit.
														1		Unmasks SD_H_LOCK_CHNG_Q bit.
		SD_AD_CHNG_MSKB.												0		Masks SD_AD_CHNG_Q bit.
														1		Unmasks SD_AD_CHNG_Q bit.
		SCM_LOCK_CHNG_MSKB.												0		Masks SCM_LOCK_CHNG_Q bit.
														1		Unmasks SCM_LOCK_CHNG_Q bit.
PAL_SW_LK_CHNG_MSKB.												0	Masks PAL_SW_LK_CHNG_Q bit.			
												1	Unmasks PAL_SW_LK_CHNG_Q bit.			
Reserved.												x	Not used.			
Reserved.												x	Not used.			
0x4E	Interrupt Status 4 (Read Only)	VDP_CCAPD_Q.											0	Closed captioning not detected.	These bits can be cleared by Register 0x4F and masked by Register 0x50.  Note that an interrupt in Register 0x4E for the CC, Gemstar, CGMS, WSS, VPS, PDC, UTC, and VITC data can be initiated by using the VDP data slicer.	
													1	Closed captioning detected.		
		Reserved.												x		
		VDP_CGMS_WSS_CHNGD_Q. See Register 0x9C, Bit 4, of the user sub map to determine whether an interrupt is issued for a change in detected data or when data is detected regardless of content.												0		CGMS/WSS data is not changed/not available.
														1		CGMS/WSS data is changed/available.
Reserved												x				



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes		
			7	6	5	4	3	2	1	0				
		VDP_GS_VPS_PDC_UTC_CHNG_Q. See Register 0x9C, Bit 5, of the user sub map to determine whether an interrupt is issued for a change in detected data or when data is detected regardless of content.				0						Gemstar/PDC/VPS/UTC data is not changed/available.		
						1						Gemstar/PDC/VPS/UTC data is changed/available.		
		Reserved.		x										
		VDP_VITC_Q.		0								VITC data is not available in the VDP.		
				1								VITC data is available in the VDP.		
		Reserved.	x											
0x4F	Interrupt Clear 4 (Write Only)	VDP_CCAPD_CLR.								0		Does not clear.	Note that an interrupt in Register 0x4E for the CC, Gemstar, CGMS, WSS, VPS, PDC, UTC, and VITC data can be initiated by using the VDP data slicer.	
										1		Clears VDP_CCAPD_Q.		
			Reserved.								x			
			VDP_CGMS_WSS_CHNGD_CLR.							0				Does not clear.
										1				Clears VDP_CGMS_WSS_CHNGD_Q.
			Reserved.					x						
			VDP_GS_VPS_PDC_UTC_CHNG_CLR.				0							Does not clear.
							1							Clears VDP_GS_VPS_PDC_UTC_CHNG_Q.
		Reserved.		x										
		VDP_VITC_CLR.		0								Does not clear.		
				1								Clears VDP_VITC_Q.		
		Reserved.	x											
0x50	Interrupt Mask 4	VDP_CCAPD_MSKB.								0		Masks VDP_CCAPD_Q.	Note that an interrupt in Register 0x4E for the CC, Gemstar, CGMS, WSS, VPS, PDC, UTC, and VITC data can be initiated by using the VDP data slicer.	
										1		Unmasks VDP_CCAP_D_Q.		
			Reserved.								x			
			VDP_CGMS_WSS_CHNGD_MSKB.							0				Masks VDP_CGMS_WSS_CHNGD_Q.
										1				Unmasks VDP_CGMS_WSS_CHNGD_Q.
			Reserved.					x						
			VDP_GS_VPS_PDC_UTC_CHNG_MSKB.				0							Masks VDP_GS_VPS_PDC_UTC_CHNG_Q.
							1							Unmasks VDP_GS_VPS_PDC_UTC_CHNG_Q.
		Reserved.		x										
		VDP_VITC_MSKB.		0								Masks VDP_VITC_Q.		
				1								Unmasks VDP_VITC_Q.		
		Reserved.	x											
0x60	VDP_Config_1	VDP_TTXT_TYPE_MAN [1:0].								0	0	PAL: teletext-ITU-R BT.653-625/50-A. NTSC: reserved.		
											0	1		PAL: teletext-ITU-R BT.653-625/50-B (WST). NTSC: teletext-ITU-R BT.653-525/60-B.
											1	0		PAL: teletext-ITU-R BT.653-625/50-C. NTSC: teletext-ITU-R BT.653-525/60-C or EIAS16 (NABTS).
											1	1		PAL: teletext-ITU-R BT.653-625/50-D. NTSC: teletext-ITU-R BT.653-525/60-D.
			VDP_TTXT_TYPE_MAN_ENABLE.							0				User programming of teletext type disabled.
										1				User programming of teletext type enabled.
			WST_PKT_DECOD_DISABLE.							0				Enables hamming decoding of WST packets.
										1				Disables hamming decoding of WST packets.
			Reserved.	1	0	0	0							
0x61		VDP_Config_2	Reserved.					x	x	0	0			
			AUTO_DETECT_GS_TYPE.				0						Disables autodetection of Gemstar type.	
							1						Enables autodetection of Gemstar type.	
		Reserved.	0	0	0									



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes
			7	6	5	4	3	2	1	0		
0x62	VDP_ADF_Config_1	ADF_DID [4:0].				1	0	1	0	1	User-specified DID sent in the ancillary data stream with VDP decoded data.	
		ADF_MODE [1:0].	0 0								Nibble mode.	
			0 1								Byte mode, no code restrictions.	
			1 0								Byte mode with values 0x00 and 0xFF prevented.	
			1 1								Reserved.	
ADF_ENABLE.	0								Disable insertion of VBI decoded data into ancillary 656 stream.			
1									Enable insertion of VBI decoded data into ancillary 656 stream.			
0x63	VDP_ADF_Config_2	ADF_SDID [5:0].			1	0	1	0	1	0	User-specified SDID sent in the ancillary data stream with VDP decoded data.	
		Reserved.	x									
		DUPLICATE_ADF.	0								Ancillary data packet is spread across the Y and C data streams.	
1									Ancillary data packet is duplicated on the Y and C data streams.			
0x64	VDP_LINE_00E	VBI_DATA_P318 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 318 (PAL). NTSC—N/A.	
		Reserved.	0	0	0							
		MAN_LINE_PGM.	0								Decode default standards on the lines indicated in Table 66.	
1									Manually program the VBI standard to be decoded on each line. See Table 67.			
0x65	VDP_LINE_00F	VBI_DATA_P319_N286 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 319 (PAL), 286 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P6_N23 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 6 (PAL), 23 (NTSC).	
0x66	VDP_LINE_010	VBI_DATA_P320_N287 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 320 (PAL), 287 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P7_N24 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 7 (PAL), 24 (NTSC).	
0x67	VDP_LINE_011	VBI_DATA_P321_N288 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 321 (PAL), 288 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P8_N25 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 8 (PAL), 25 (NTSC).	
0x68	VDP_LINE_012	VBI_DATA_P322 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 322 (PAL), NTSC—N/A.	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P9 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 9 (PAL), NTSC—N/A.	
0x69	VDP_LINE_013	VBI_DATA_P323 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 323 (PAL), NTSC—N/A.	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P10 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 10 (PAL), NTSC—N/A.	
0x6A	VDP_LINE_014	VBI_DATA_P324_N272 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 324 (PAL), 272 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P11 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 11 (PAL), NTSC—N/A.	
0x6B	VDP_LINE_015	VBI_DATA_P325_N273 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 325 (PAL), 273 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P12_N10 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 12 (PAL), 10 (NTSC).	
0x6C	VDP_LINE_016	VBI_DATA_P326_N274 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 326 (PAL), 274 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P13_N11 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 13 (PAL), 11 (NTSC).	
0x6D	VDP_LINE_017	VBI_DATA_P327_N275 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 327 (PAL), 275 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P14_N12 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 14 (PAL), 12 (NTSC).	
0x6E	VDP_LINE_018	VBI_DATA_P328_N276 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 328 (PAL), 276 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.
		VBI_DATA_P15_N13 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 15 (PAL), 13 (NTSC).	



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
0x6F	VDP_LINE_019	VBI_DATA_P329_N277 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 329 (PAL), 277 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P16_N14 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 16 (PAL), 14 (NTSC).		
0x70	VDP_LINE_01A	VBI_DATA_P330_N278 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 330 (PAL), 278 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P17_N15 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 17 (PAL), 15 (NTSC).		
0x71	VDP_LINE_01B	VBI_DATA_P331_N279 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 331 (PAL), 279 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P18_N16 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 18 (PAL), 16 (NTSC).		
0x72	VDP_LINE_01C	VBI_DATA_P332_N280 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 332 (PAL), 280 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P19_N17 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 19 (PAL), 17 (NTSC).		
0x73	VDP_LINE_01D	VBI_DATA_P333_N281 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 333 (PAL), 281 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P20_N18 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 20 (PAL), 18 (NTSC).		
0x74	VDP_LINE_01E	VBI_DATA_P334_N282 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 334 (PAL), 282 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P21_N19 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 21 (PAL), 19 (NTSC).		
0x75	VDP_LINE_01F	VBI_DATA_P335_N283 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 335 (PAL), 283 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P22_N20 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 22 (PAL), 20 (NTSC).		
0x76	VDP_LINE_020	VBI_DATA_P336_N284 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 336 (PAL), 284 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P23_N21 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 23 (PAL), 21 (NTSC).		
0x77	VDP_LINE_021	VBI_DATA_P337_N285 [3:0].					0	0	0	0	Sets VBI standard to be decoded from Line 337 (PAL), 285 (NTSC).	MAN_LINE_PGM must be set to 1 for these bits to be effective.	
		VBI_DATA_P24_N22 [3:0].	0	0	0	0					Sets VBI standard to be decoded from Line 24 (PAL), 22 (NTSC).		
0x78	VDP_STATUS (Read Only)	CC_AVL.								0	Closed captioning not detected.	CC_CLEAR resets the CC_AVL bit.	
										1	Closed captioning detected.		
		CC_EVEN_FIELD.									0	Closed captioning decoded from odd field.	
											1	Closed captioning decoded from even field.	
		CGMS_WSS_AVL.									0	CGMS/WSS not detected.	CGMS_WSS_CLEAR resets the CGMS_WSS_AVL bit.
											1	CGMS/WSS detected.	
		Reserved.									0		
		GS_PDC_VPS_UTC_AVL.					0					VPS not detected.	GS_PDC_VPS_UTC_CLEAR resets the GS_PDC_VPS_UTC_AVL bit.
							1					VPS detected.	
		GS_DATA_TYPE.					0					Gemstar 1x detected.	
							1					Gemstar 2x detected.	
		VITC_AVL.					0					VITC not detected.	VITC_CLEAR resets the VITC_AVL bit.
							1					VITC detected.	
		TTXT_AVL.					0					Teletext not detected.	
					1					Teletext detected.			
VDP_STATUS_CLEAR (Write Only)	CC_CLEAR.									0	Does not reinitialize the CC registers.	This is a self-clearing bit.	
										1	Reinitializes the CC readback registers.		
		Reserved.									0		
		CGMS_WSS_CLEAR.									0	Does not reinitialize the CGMS/WSS registers.	This is a self-clearing bit.
											1	Reinitializes the CGMS/WSS readback registers.	
	Reserved.									0			



Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
		GS_PDC_VPS_UTC_CLEAR.				0						Does not reinitialize the GS/PDC/VPS/UTC registers.	This is a self-clearing bit.
					1							Refreshes the GS/PDC/VPS/UTC readback registers.	
		Reserved.			0								
		VITC_CLEAR.		0								Does not reinitialize the VITC registers.	This is a self-clearing bit.
				1								Reinitializes the VITC readback registers.	
		Reserved.	0										
0x79	VDP_CCAP_DATA_0 (Read Only)	CCAP_BYTE_1 [7:0].	x	x	x	x	x	x	x	x	x	Decoded Byte 1 of CC.	
0x7A	VDP_CCAP_DATA_1 (Read Only)	CCAP_BYTE_2 [7:0].	x	x	x	x	x	x	x	x	x	Decoded Byte 2 of CC.	
0x7D	VDP_CGMS_WSS_DATA_0 (Read Only)	CGMS_CRC [5:2].					x	x	x	x		Decoded CRC sequence for CGMS.	
		Reserved.	0	0	0	0							
0x7E	VDP_CGMS_WSS_DATA_1 (Read Only)	CGMS_WSS [13:8].			x	x	x	x	x	x		Decoded CGMS/WSS data.	
		CGMS_CRC [1:0].	x	x								Decoded CRC sequence for CGMS.	
0x7F	VDP_CGMS_WSS_DATA_2 (Read Only)	CGMS_WSS [7:0].	x	x	x	x	x	x	x	x		Decoded CGMS/WSS data.	
0x84	VDP_GS_VPS_PDC_UTC_0 (Read Only)	GS_VPS_PDC_UTC_BYTE_0 [7:0].	x	x	x	x	x	x	x	x		Decoded Gemstar/VPS/PDC/UTC data.	
0x85	VDP_GS_VPS_PDC_UTC_1 (Read Only)	GS_VPS_PDC_UTC_BYTE_1 [7:0].	x	x	x	x	x	x	x	x		Decoded Gemstar/VPS/PDC/UTC data.	
0x86	VDP_GS_VPS_PDC_UTC_2 (Read Only)	GS_VPS_PDC_UTC_BYTE_2 [7:0].	x	x	x	x	x	x	x	x		Decoded Gemstar/VPS/PDC/UTC data.	
0x87	VDP_GS_VPS_PDC_UTC_3 (Read Only)	GS_VPS_PDC_UTC_BYTE_3 [7:0].	x	x	x	x	x	x	x	x		Decoded Gemstar/VPS/PDC/UTC data.	
0x88	VDP_VPS_PDC_UTC_4 (Read Only)	VPS_PDC_UTC_BYTE_4 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x89	VDP_VPS_PDC_UTC_5 (Read Only)	VPS_PDC_UTC_BYTE_5 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x8A	VDP_VPS_PDC_UTC_6 (Read Only)	VPS_PDC_UTC_BYTE_6 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x8B	VDP_VPS_PDC_UTC_7 (Read Only)	VPS_PDC_UTC_BYTE_7 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x8C	VDP_VPS_PDC_UTC_8 (Read Only)	VPS_PDC_UTC_BYTE_8 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x8D	VDP_VPS_PDC_UTC_9 (Read Only)	VPS_PDC_UTC_BYTE_9 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x8E	VDP_VPS_PDC_UTC_10 (Read Only)	VPS_PDC_UTC_BYTE_10 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x8F	VDP_VPS_PDC_UTC_11 (Read Only)	VPS_PDC_UTC_BYTE_11 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x90	VDP_VPS_PDC_UTC_12 (Read Only)	VPS_PDC_UTC_BYTE_12 [7:0].	x	x	x	x	x	x	x	x		Decoded VPS/PDC/UTC data.	
0x92	VDP_VITC_DATA_0 (Read Only)	VITC_DATA_0 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x93	VDP_VITC_DATA_1 (Read Only)	VITC_DATA_1 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x94	VDP_VITC_DATA_2 (Read Only)	VITC_DATA_2 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x95	VDP_VITC_DATA_3 (Read Only)	VITC_DATA_3 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x96	VDP_VITC_DATA_4 (Read Only)	VITC_DATA_4 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x97	VDP_VITC_DATA_5 (Read Only)	VITC_DATA_5 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x98	VDP_VITC_DATA_6 (Read Only)	VITC_DATA_6 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x99	VDP_VITC_DATA_7 (Read Only)	VITC_DATA_7 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x9A	VDP_VITC_DATA_8 (Read Only)	VITC_DATA_8 [7:0].	x	x	x	x	x	x	x	x		Decoded VITC data.	
0x9B	VDP_VITC_CALC_CRC (Read Only)	VITC_CRC [7:0].	x	x	x	x	x	x	x	x		Decoded VITC CRC data.	



# ADV7188

Address	Register	Bit Description	Bit <sup>1</sup>								Comments	Notes	
			7	6	5	4	3	2	1	0			
0x9C	VDP_OUTPUT_SEL	Reserved.					0	0	0	0			
		WSS_CGMS_CB_CHANGE.				0						Disable content-based updating of CGMS and WSS data.	The AVAILABLE bit shows the availability of data only when its content changes.
					1							Enable content-based updating of CGMS and WSS data.	
		GS_VPS_PDC_UTC_CB_CHANGE.			0							Disable content-based updating of Gemstar, VPS, PDC, and UTC data.	
					1							Enable content-based updating of Gemstar, VPS, PDC, and UTC data.	
		I2C_GS_VPS_PDC_UTC [1:0].	0 0									Gemstar 1x/2x.	Standard expected to be decoded.
			0 1									VPS.	
			1 0									PDC.	
		1 1									UTC.		

<sup>1</sup> Shading indicates default settings.



## PCB LAYOUT RECOMMENDATIONS

The ADV7188 is a high precision, high speed mixed-signal device. To achieve the maximum performance from the part, it is important to have a well laid out PCB board. The following is a guide for designing a board using the ADV7188.

### ANALOG INTERFACE INPUTS

Care should be taken when routing the inputs on the PCB. Track lengths should be kept to a minimum, and 75  $\Omega$  trace impedances should be used when possible. Trace impedances other than 75  $\Omega$  increase the chance of reflections.

### POWER SUPPLY DECOUPLING

It is recommended to decouple each power supply pin with 0.1  $\mu\text{F}$  and 10 nF capacitors. The fundamental idea is to have a decoupling capacitor within about 0.5 cm of each power pin. Also, avoid placing the capacitor on the side of the PC board opposite from the ADV7188, because doing so interposes resistive vias in the path. The decoupling capacitors should be 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 100 nF capacitor pads, down to the power plane, is generally the best approach (see Figure 49).

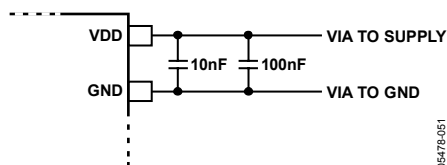


Figure 49. Recommended Power Supply Decoupling

It is particularly important to maintain low noise and good stability of PVDD. Careful attention must be paid to regulation, filtering, and decoupling. It is highly desirable to provide separate regulated supplies for each of the analog circuitry groups (AVDD, DVDD, DVDDIO, and PVDD).

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 PVDD, 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. This ground plane should have a space between the analog and digital sections of the PCB (see Figure 50).

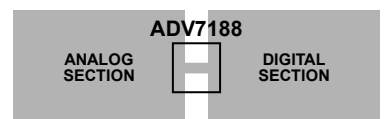


Figure 50. PCB Ground Layout

Experience has repeatedly shown that the 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. For those cases, it is recommended to place a single ground plane under the ADV7188. The location of the split should be under the ADV7188. 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). An example of a current loop is from the power plane to ADV7188 to digital output trace to digital data receiver to digital ground plane to analog ground plane.

### PLL

Place the PLL loop filter components as close as possible to the ELPF pin. Do not place any digital or other high frequency traces near these components. Use the values suggested in Figure 52 with tolerances of 10% or less.

### DIGITAL OUTPUTS (BOTH DATA AND CLOCKS)

Try to minimize the trace length that the digital outputs drive. Longer traces have higher capacitance, which requires more current, causing more internal digital noise. Shorter traces reduce the possibility of reflections.

Adding a 30  $\Omega$  to 50  $\Omega$  series resistor can suppress reflections, reduce EMI, and reduce the current spikes inside the ADV7188. If series resistors are used, place them as close as possible to the ADV7188 pins. However, try not to add vias or extra length to the output trace to make the resistors closer.

If possible, limit the capacitance that each digital output drives to less than 15 pF. This can easily be accomplished by keeping traces short and by connecting the outputs to only one device. Loading the outputs with excessive capacitance increases the current transients inside the ADV7188, creating more digital noise on its power supplies.





# ADV7188

## DIGITAL INPUTS

The digital inputs on the ADV7188 are designed to work with 3.3 V signals and are not tolerant of 5 V signals. Extra components are needed if 5 V logic signals are required to be applied to the decoder.

## XTAL AND LOAD CAPACITOR VALUES SELECTION

Figure 51 shows an example reference clock circuit for the ADV7188. Special care must be taken when using a crystal circuit to generate the reference clock for the ADV7188. Small variations in reference clock frequency may cause autodetection issues and impair the ADV7188 performance.

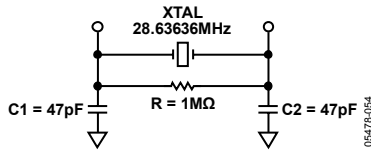


Figure 51. Crystal Circuit

Use the following guidelines to ensure correct operation:

- Use a crystal of the correct frequency, 28.63636 MHz. Tolerance should be 50 ppm or better.
- User a parallel-resonant crystal.
- Know the  $C_{load}$  for the crystal part selected. The values of the C1 and C2 capacitors must be calculated using this  $C_{load}$  value.

To find C1 and C2, use the following formula:

$$C = 2(C_{load} - C_{stray}) - C_{pg}$$

where  $C_{stray}$  is usually 2 pF to 3 pF, depending on board traces, and  $C_{pg}$  (pin-to-ground capacitance) is 4 pF for the ADV7188.

For example, if  $C_{load}$  is 30 pF, the values of C1 and C2 are calculated to be 50 pF each, and the nearest standard capacitor value is 47 pF.



## TYPICAL CIRCUIT CONNECTION

An example of how to connect the ADV7188 video decoder is shown in Figure 52. For a detailed schematic diagram for the ADV7188, refer to the ADV7188 evaluation note, which can be obtained from an Analog Devices representative.

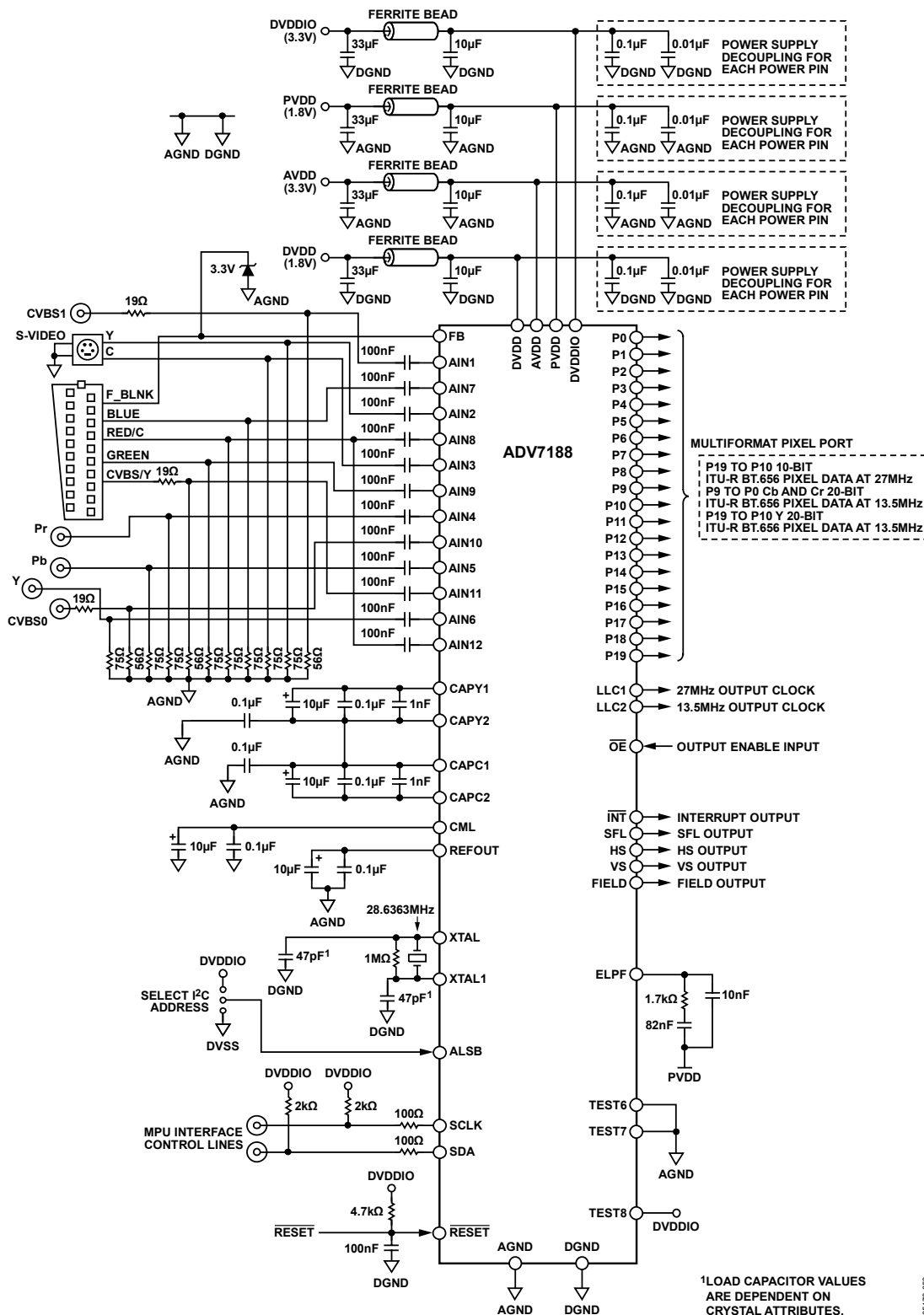
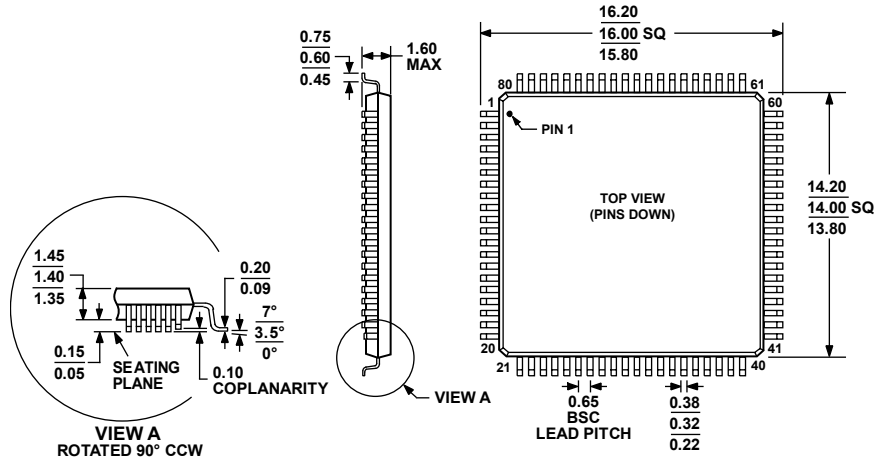


Figure 52. Typical Connection Diagram

05178-003

# ADV7188

## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-026-BEC

Figure 53. 80-Lead Low Profile Quad Flat Package [LQFP] (ST-80-2)

Dimensions shown in millimeters

051706-A

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
ADV7188BSTZ <sup>2</sup>	-40°C to +85°C	80-Lead Low Profile Quad Flat Package [LQFP]	ST-80-2
EVAL-ADV7188EB		Evaluation Board	

<sup>1</sup> The ADV7188 is a Pb-free, environmentally friendly product. It is manufactured using the most up-to-date materials and processes. The coating on the leads of each device is 100% pure Sn electroplate. The device is suitable for Pb-free applications and is able to withstand surface-mount soldering of up to 255°C (±5°C). In addition, it is backward compatible with conventional SnPb soldering processes. This means that the electroplated Sn coating can be soldered with SnPb solder pastes at conventional reflow temperatures of 220°C to 235°C.

<sup>2</sup> Z = Pb-free part.

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