

# ***TVP5150PBS Ultralow-Power NTSC/PAL Video Decoder***

## ***Data Manual***

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## 1 TVP5150 Features

- Accepts NTSC (N, 4.43), PAL (B, D, G, H, I, M, N) Video Data
- Supports ITU-R BT.601 Standard Sampling
- High-Speed 9-Bit A/D Converter
- Two Composite Inputs or One S-Video Input
- Fully Differential CMOS Analog Preprocessing Channels With Clamping and AGC For Best S/N Performance
- Ultralow Power Consumption: 113 mW Typical
- 32-Pin TQFP Package
- Power-Down Mode: <1 mW
- Brightness, Contrast, Saturation, Hue, and Sharpness Control Through I<sup>2</sup>C
- Complementary 4-Line (3-H Delay) Adaptive Comb Filters For Both Cross-Luminance And Cross-Chrominance Noise Reduction
- Patented Architecture For Locking To Weak, Noisy, Or Unstable Signals
- Single 14.318-MHz Crystal for All Standards
- Internal PLL For Line-Locked Clock and Sampling
- Subcarrier Genlock Output For Synchronizing Color Subcarrier Of External Encoder. Standard Programmable Video Output Format:
  - ITU-R BT.656, 8-Bit 4:2:2 With Embedded Syncs
- Macrovision™ Copy Protection Detection
- Advanced Programmable Video Output Formats:
  - 2x Oversampled Raw VBI Data During Active Video
  - Sliced VBI Data During Horizontal Blanking Or Active Video
- VBI Modes Supported
  - Teletext (NABTS, WST) Closed-Caption Decode With FIFO
  - Wide Screen Signaling, Video Program System, CGMS, Vertical Interval Time Code
  - Custom Configuration Mode That Allows The User To Program The Slice Engine For Unique VBI Data Signals
- Power-on Reset

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## 2 Introduction

### 2.1 Description

The TVP5150 device is an ultralow-power video decoder for NTSC and PAL video signals. Available in a space saving 32-pin TQFP package, the TVP5150 device converts NTSC and PAL video signals to 8-bit ITU-R BT.656 format. Discrete syncs are also available. The optimized architecture of the TVP5150 device allows for ultralow-power consumption. The device consumes 113 mW of power in typical operation and consumes less than 1 mW in power-down mode, considerably increasing battery life in portable applications. The device uses just one crystal for all supported standards. The TVP5150 device can be programmed using an I<sup>2</sup>C serial interface. The device uses a 1.8-V supply for its analog and digital supplies, and a 3.3-V supply for its I/O.

The TVP5150 device converts baseband analog NTSC and PAL video into digital YUV 4:2:2 component video. Luminance/chrominance (Y/C) composite and S-video inputs are also supported. The TVP5150 device includes one 9-bit A/D converter with 2x sampling. Sampling is ITU-R BT.601 (27.0 MHz, generated off the 14.318-MHz crystal or oscillator input) and is line-locked for correct pixel alignment. The output formats can be 8-bit 4:2:2 or 8-bit ITU-R BT.656 with embedded synchronization.

The TVP5150 device utilizes Texas Instruments patented technology for locking to weak, noisy, or unstable signals. A chroma frequency control output is generated for synchronizing downstream video encoders.

Complementary 3-line or 4-line adaptive comb filtering is available for both the luma and chroma data paths to reduce both cross-luma and cross-chroma artifacts; a chroma trap filter is also available.

Video characteristics including hue, contrast, brightness, saturation, and sharpness may be programmed using the I<sup>2</sup>C high speed serial interface. The TVP5150 device generates synchronization, blanking, field, lock, and clock signals in addition to digital video outputs. The TVP5150 device includes methods for advanced vertical blanking interval (VBI) data retrieval. The VBI data processor slices, parses, and performs error checking on Teletext, Closed Caption, and other data in several formats.

The TVP5150 device detects copy-protected input signals according to the Macrovision™ 7.1 standard.

The main blocks of the TVP5150 device include:

- A/D converter with analog processor
- Y/C separation
- Chrominance processor
- Luminance processor
- Video clock/timing processor and power-down control
- Output formatter
- I<sup>2</sup>C interface
- VBI data processor
- Macrovision™ detection for composite and S-video

### 2.2 Applications

- Digital television
- PDA
- Notebook PCs
- Cell phones
- Video recorder/players
- Internet appliances/web pads
- Handheld games

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## 2.3 Trademarks

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- Intel is a trademark of Intel Corporation.
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## 2.4 Document Conventions

Throughout this data manual, several conventions are used to convey information. These conventions are listed below:

1. To identify a binary number or field, a lower case b follows the numbers. For example: 000b is a 3-bit binary field.
2. To identify a hexadecimal number or field, a lower case h follows the numbers. For example: 8AFh is a 12-bit hexadecimal field.
3. All other numbers that appear in this document that do not have either a b or h following the number are assumed to be decimal format.
4. If the signal or terminal name has a bar above the name (for example,  $\overline{\text{RESETB}}$ ), then this indicates the logical NOT function. When asserted, this signal is a logic low, 0, or 0b.
5. RSVD indicates that the referenced item is reserved.

## 2.5 Ordering Information

| T <sub>A</sub> | PACKAGED DEVICES |
|----------------|------------------|
|                | 32TQFP-PBS       |
| 0°C to 70°C    | TVP5150PBS       |

## 2.6 Functional Block Diagram

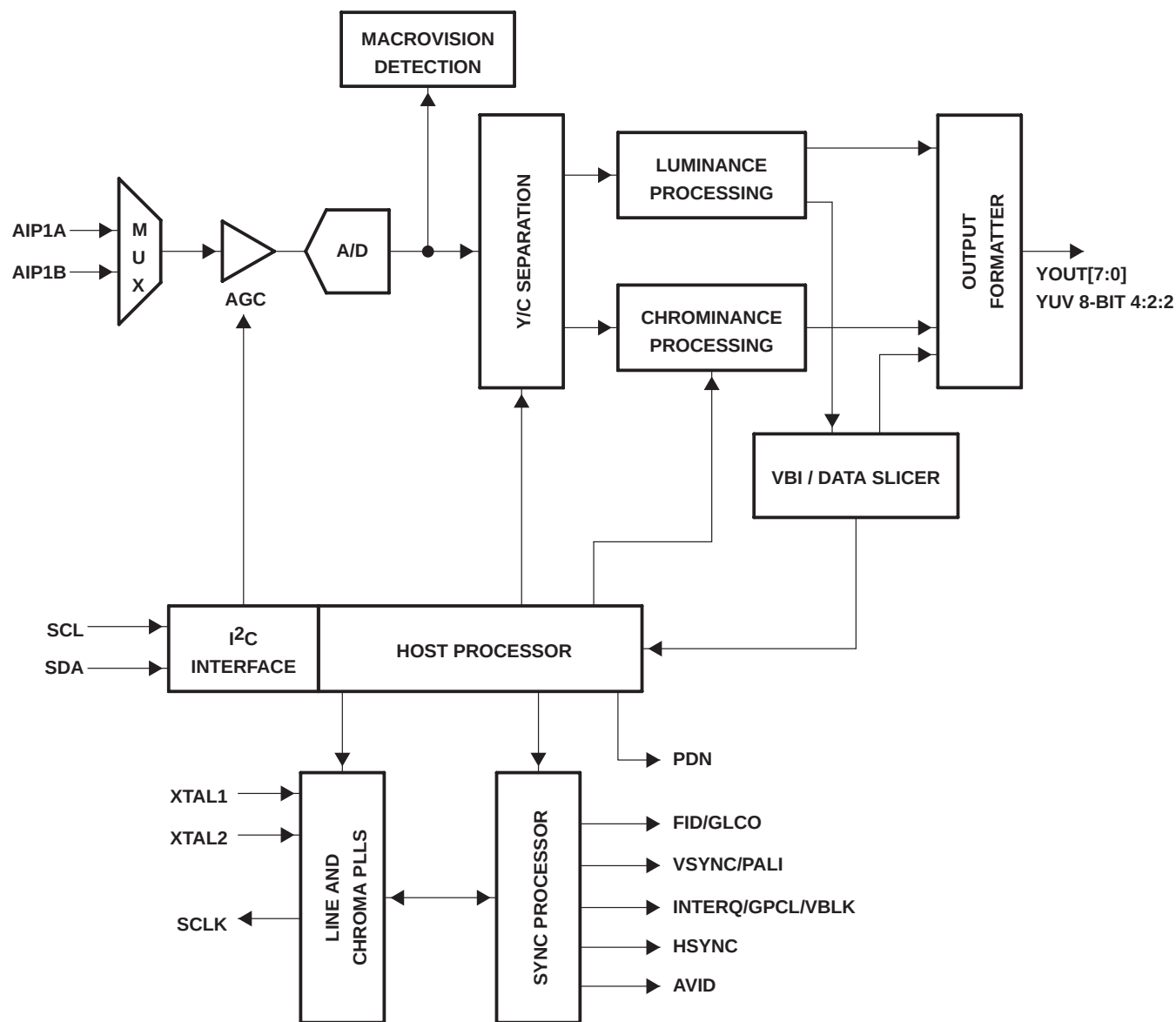


Figure 2–1. Functional Block Diagram

## 2.7 Terminal Assignments

The TVP5150 video decoder bridge is packaged in a 32-terminal PBS package. Figure 2–2 is the PBS-package terminal diagram. Table 2–1 gives a description of the terminals.

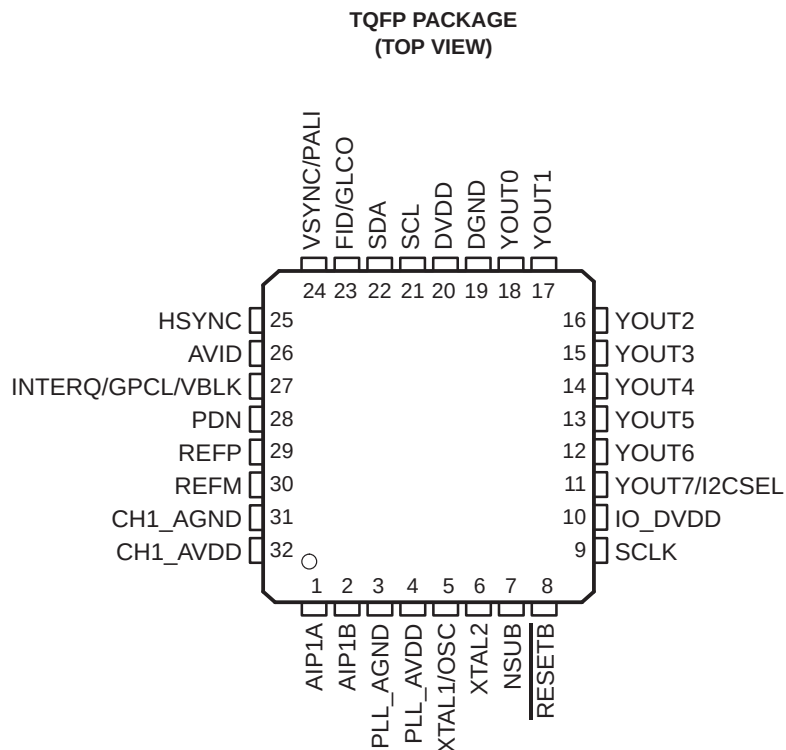


Figure 2–2. TVP5150 PBS-Package Terminal Diagram

Table 2–1. Terminal Functions

| TERMINAL<br>NAME      | NUMBER | I/O | DESCRIPTION                                                                                                                                                                                                                                                                              |
|-----------------------|--------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Analog Section</b> |        |     |                                                                                                                                                                                                                                                                                          |
| AIP1A                 | 1      | I   | Analog input. Connect to the video analog input via 0.1- $\mu$ F to 1- $\mu$ F capacitor. The maximum input range is 0–0.75 V <sub>PP</sub> , and may require an attenuator to reduce the input amplitude to the desired level. If not used, connect to AGND via 0.1- $\mu$ F capacitor. |
| AIP1B                 | 2      | I   | Analog input. Connect to the video analog input via 0.1- $\mu$ F to 1- $\mu$ F capacitor. The maximum input range is 0–0.75 V <sub>PP</sub> , and may require an attenuator to reduce the input amplitude to the desired level. If not used, connect to AGND via 0.1- $\mu$ F capacitor. |
| CH1_AGND              | 31     | I   | Analog ground                                                                                                                                                                                                                                                                            |
| CH1_AVDD              | 32     | I   | Analog supply. Connect to 1.8-V analog supply.                                                                                                                                                                                                                                           |
| NSUB                  | 7      | I   | Substrate. Connect to analog ground.                                                                                                                                                                                                                                                     |
| PLL_AGND              | 3      | I   | PLL ground. Connect to analog ground.                                                                                                                                                                                                                                                    |
| PLL_AVDD              | 4      | I   | PLL supply. Connect to 1.8-V analog supply.                                                                                                                                                                                                                                              |
| REFM                  | 30     | I   | A/D reference ground. Connect to analog ground through 1- $\mu$ F capacitor. Also recommended to connect directly to REFP through 1- $\mu$ F capacitor.                                                                                                                                  |
| REFP                  | 29     | I   | A/D reference supply. Connect to analog ground through 1- $\mu$ F capacitor.                                                                                                                                                                                                             |

Table 2–1. Terminal Functions (Continued)

| TERMINAL<br>NAME       | NUMBER                           | I/O    | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|----------------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Digital Section</b> |                                  |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| AVID                   | 26                               | O      | Active video indicator. This signal is high during the horizontal active time of the video output on the Y and UV terminals. AVID continues to toggle during vertical blanking intervals. This terminal can be placed in a high-impedance state.                                                                                                                                                                                                                                                                                                                                           |
| DGND                   | 19                               | I      | Digital ground                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DVDD                   | 20                               | I      | Digital supply. Connect to 1.8-V digital supply                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| FID/GLCO               | 23                               | O      | FID: Odd/even field indicator or vertical lock indicator. For the odd/even indicator, a 1 indicates the odd field.<br>GLCO: This serial output carries color PLL information. A slave device can decode the information to allow chroma frequency control from the TVP5150 device. Data is transmitted at the SCLK rate in Genlock mode. In RTC mode, SCLK/4 is used.                                                                                                                                                                                                                      |
| HSYNC                  | 25                               | O      | Horizontal synchronization signal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| INTREQ/GPCL/<br>VBLK   | 27                               | I/O    | INTREQ: Interrupt request output.<br>GPCL: General-purpose control logic. This terminal has three functions:<br>1. General-purpose output. In this mode the state of GPCL is directly programmed via I <sup>2</sup> C.<br>2. Vertical blank output. In this mode the GPCL terminal is used to indicate the vertical blanking interval of the output video. The beginning and end times of this signal are programmable via I <sup>2</sup> C.<br>3. Sync lock control input. In this mode when GPCL is high, the output clock frequencies and the sync timing are forced to nominal values. |
| IO_DVDD                | 10                               | I      | Digital supply. Connect to 3.3 V.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| PDN                    | 28                               | I      | Power-down terminal (active low). Puts the device in standby mode. Preserves the value of the registers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| RESETB                 | 8                                | I      | Active-low reset. RESETB can be used only when PDN = 1.<br>When RESETB is pulled low, it resets all the registers, restarts the internal microprocessor.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| SCL                    | 21                               | I/O    | I <sup>2</sup> C serial clock (pullup to IO_DVDD with 1.2-k $\Omega$ resistor)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| SCLK                   | 9                                | O      | System clock at either 1x or 2x the frequency of the pixel clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| SDA                    | 22                               | I/O    | I <sup>2</sup> C serial data (pullup to IO_DVDD with 1.2-k $\Omega$ resistor)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| VSYNC/PALI             | 24                               | O      | VSYNC: Vertical synchronization signal<br>PALI: PAL line indicator or horizontal lock indicator<br>For the PAL line indicator, a 1 indicates a noninverted line, and a 0 indicates an inverted line.                                                                                                                                                                                                                                                                                                                                                                                       |
| XTAL1<br>XTAL2         | 5<br>6                           | I<br>O | External clock reference. The user may connect XTAL1 to an oscillator or to one terminal of a crystal oscillator. The user may connect XTAL2 to the other terminal of the crystal oscillator or not connect XTAL2 at all. One single 14.318-MHz crystal or oscillator is needed for ITU–R BT.601 sampling, for all supported standards.                                                                                                                                                                                                                                                    |
| YOUT[6:0]              | 12, 13,<br>14, 15,<br>16, 17, 18 | I/O    | Output decoded ITU–R BT.656 output/YUV 422 output with discrete sync.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| YOUT(7)/I2CSEL         | 11                               | I/O    | I2CSEL: Determines address for I <sup>2</sup> C (sampled at startup). A pullup or pulldown register is needed (>1 k $\Omega$ ) to program the terminal to the desired address.<br>Logic 1: Address = 0xBA, Logic 0: Address = 0xB8<br>YOUT7: MSB of output decoded ITU–R BT.656 output/YUV 422 output.                                                                                                                                                                                                                                                                                     |

## 3 Functional Description

### 3.1 Input Multiplexers and Buffers

The TVP5150 device has an analog input channel that accepts two video inputs, ac-coupled through 0.1- $\mu$ F to 1- $\mu$ F capacitors. The two analog input ports can be connected as follows:

- Two selectable composite video inputs or
- One S-video input

The internal video multiplexers can be configured via I<sup>2</sup>C. The internal nodes are grounded for zero channel crosstalk. The input buffers are continuous time amplifiers that allow an input range of up to 0.75 V<sub>PP</sub>. This allows the decoder to support input ranges of 0 to 1.5 V with an external attenuation of one-half.

### 3.2 Clamp

An internal clamping circuit restores the ac-coupled video signal to a fixed dc level. The clamping circuit provides line-by-line restoration of the video sync level to a fixed dc reference voltage. Two modes of clamping are provided, coarse and fine.

- In coarse mode, the most negative portion of the input signal (typically the sync tip) is clamped to a fixed dc level and remains on. This mode is used while the timing processor is searching for the horizontal sync.
- Fine clamp mode is enabled after the horizontal lock is achieved. This is enabled to prevent spurious level shifting caused by noise more negative than the sync tip on the input signal. If fine clamp mode is selected, then clamping is only enabled during the sync period.
  - When in bottom level mode, the sync tip of the input signal is set to output code 0 of the A/D converter (ADC).
  - When in mid-level mode, fine clamp restores the dc level of the signal to the mid-range of the ADC.

S-video requires the fine clamp mode on the chroma channel for proper operation. The clamp can be completely disabled using software registers.

### 3.3 Programmable Gain Amplifier and Automatic Gain Control Circuit

The programmable gain amplifier (PGA) and the automatic gain control (AGC) circuit work together to make sure that the input signal is amplified sufficiently to ensure the proper input range for the ADC. The gain is controlled by a 4-bit gain code.

Input video signal amplitude can vary significantly from the nominal level of 1 V<sub>PP</sub> (140 IRE). An AGC circuit adjusts the signal amplitude to utilize the maximum range of the A/D converter without clipping. The AGC adjusts the gain to achieve the desired sync amplitude. The PGA has a range of 0 to 12 dB.

### 3.4 A/D Converter

The ADC has 9 bits of resolution and runs at a maximum speed of 27 MHz. The clock input for the ADC comes from the PLL. The data is aligned to the pixel clock supplied from the PLL and matched in delay. The ADC uses the REFM and REFP terminals as the internal reference generator. For configuration of these terminals, please refer to Figure 5–1.

### 3.5 Composite Processing Block Diagram

The composite processing block process NTSC/PAL signals into the YCbCr color space. Figure 3–1 explains the basic architecture of this processing block.

Figure 3–1 illustrates the luminance/chrominance (Y/C) separation process in the TVP5150 device. The composite video is multiplied by subcarrier signals in the quadrature modulator to generate color difference signals U and V. U and V are then low-pass filtered to achieve the desired bandwidth and to reduce crosstalk, by the color low-pass filters.

An adaptive 4-line comb filter separates UV from Y based on the unique property of color phase shift from line to line. Chroma is remodulated through another quadrature modulator and subtracted from the line-delayed composite video to generate luma. This form of Y/C separation is completely complementary and thus loses no information. However, in some applications, it is desirable to limit the U/V bandwidth to avoid crosstalk. In that case, notch filters can be turned on. To accommodate some viewing preferences, a peaking filter is also available in the luma path. Contrast, brightness, hue, saturation, and sharpness are programmable via I<sup>2</sup>C.

The Y/C separation is bypassed for S-video input. For S-video, the remodulation path is disabled. Since Y and C are already separated at the inputs, the only requirement is to digitize them and enable the same processing as the composite signal after Y/C separation.

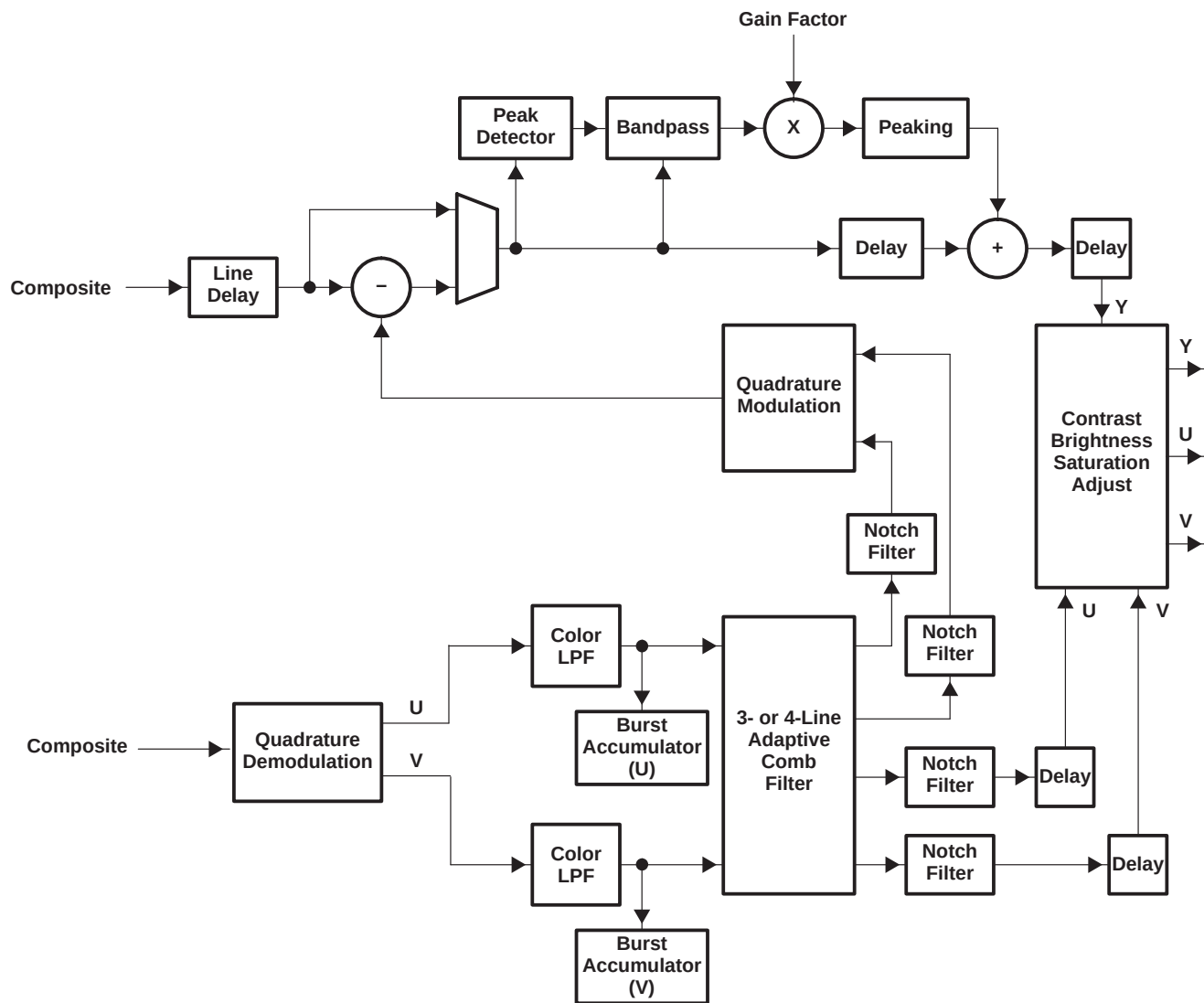


Figure 3-1. Composite Processing Block Diagram

### 3.6 Adaptive Comb Filtering

Y/C separation can be performed using adaptive 4-line (3-H delay), fixed 3-line, fixed 2-line comb filters, or a chroma trap filter. Characteristics of 4-line and 3-line comb filters are shown in Figure 3-2.

The filter frequency plots show that both 4-line and 3-line (with filter coefficients  $[1,3,3,1]/8$  and  $[1,2,1]/4$ ) comb filters have zeros at  $1/2$  of the horizontal line frequency to separate the interleaved Y/C spectrum in NTSC. The 4-line comb filter has less cross-luma and cross-chroma noise due to slightly sharper filter cutoff. The 4-line comb filter with filter coefficients  $[1,1,1,1]/4$  has three zeros at  $1/4$ ,  $2/4$ , and  $3/4$  of the horizontal line frequency. This is to be used for PAL only because of its  $90^\circ$  U/V phase shifting from line to line. The comb filter can be selectively bypassed in the luma or chroma path. If the comb filter is bypassed in the luma path, then chroma trap filters are used. TI's patented adaptive comb filter algorithm reduces artifacts such as hanging dots at color boundaries and detects and properly handles false colors in high frequency luminance images such as a multiburst pattern or circle pattern. Adaptive comb filtering is the recommended mode of operation. The complete comb filter selection is shown in the chrominance control #1 register (see Section 3.22.25).

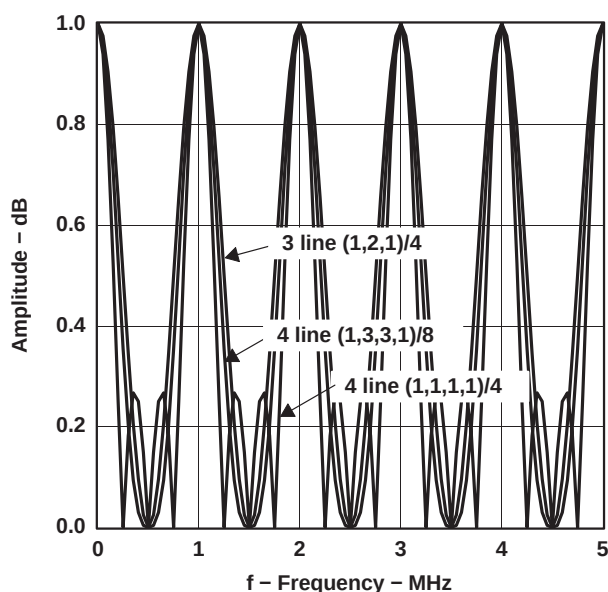


Figure 3-2. Comb Filters Frequency Response

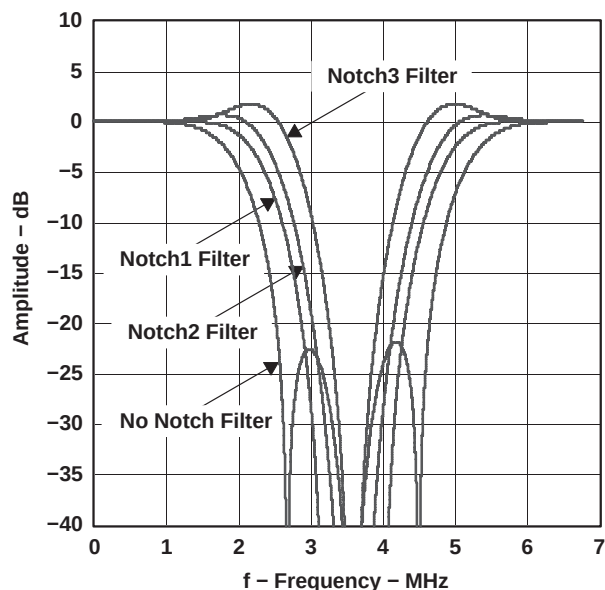


Figure 3-3. Chroma Trap Filter Frequency Response, NTSC ITU-R BT.601 Sampling

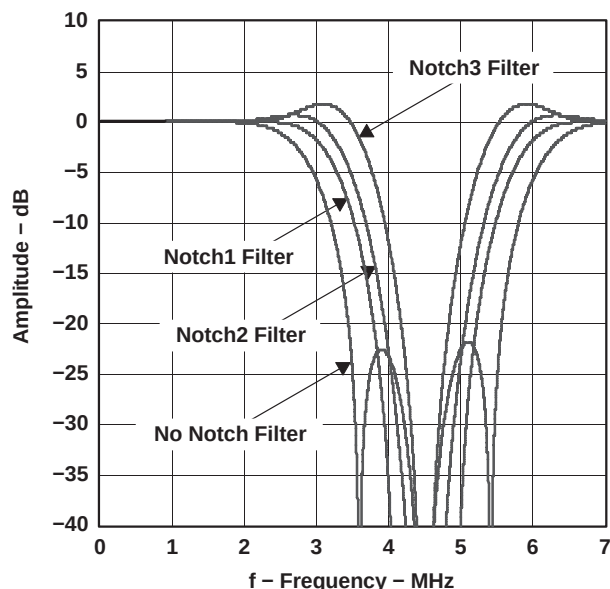


Figure 3-4. Chroma Trap Filter Frequency Response, PAL ITU-R BT.601 Sampling

### 3.7 Color Low-Pass Filter

In some applications, it is desirable to limit the U/V bandwidth to avoid crosstalk. This is especially true in case of nonstandard video signals that have asymmetrical U/V sidebands. In this case, notch filters are provided that limit the bandwidth of the U/V signals.

Notch filters are needed when the comb filtering turns off, due to extreme color transitions in the input image. The response of these notch filters is shown in Figure 3-5. The notch filters have three options that allow three different frequency responses based on the color frequency characteristics of the input video.

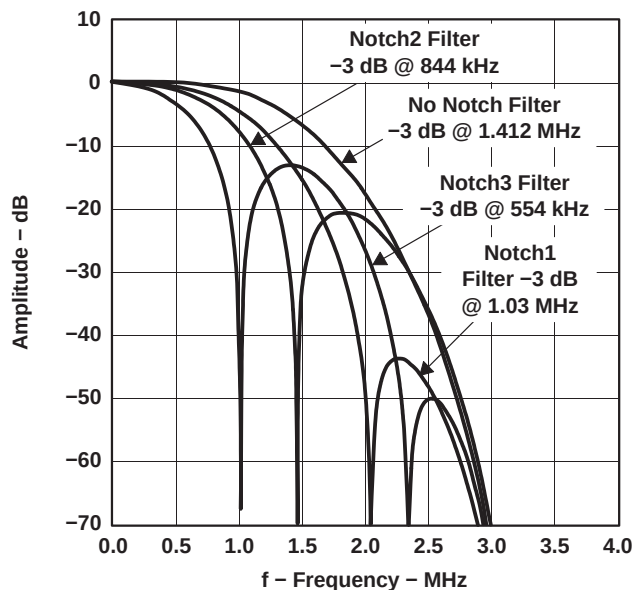


Figure 3-5. Color Low-Pass Filter With Notch Filter Characteristics, NTSC/PAL ITU-R BT.601 Sampling

### 3.8 Luminance Processing

The luma component is derived from the composite signal by subtracting the remodulated chroma information. A line delay exists in this path to compensate for the line delay in the adaptive comb filter in the color processing chain. The luma information is then fed into the peaking circuit, which enhances the high frequency components of the signal as shown in Figure 3–6.

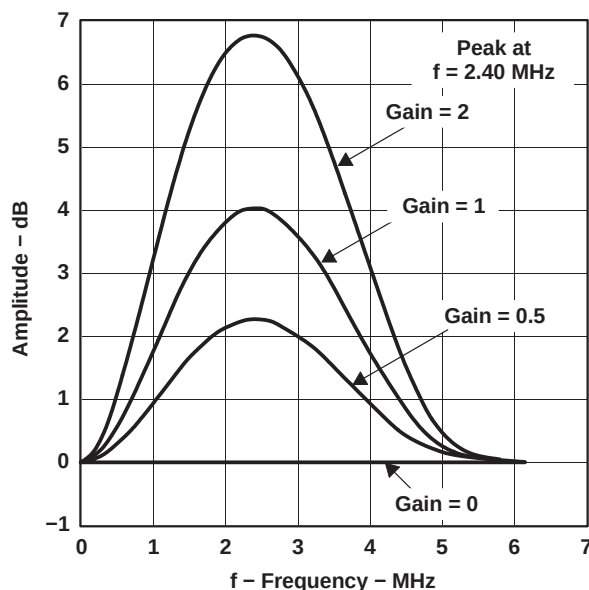


Figure 3–6. Peaking Filter Response, NTSC/PAL ITU–R BT.601 Sampling

### 3.9 Chrominance Processing

For PAL/NTSC formats, the color processing begins with a quadrature demodulator extracting U and V components from the composite signal. The U/V signals then pass through the gain control stage for chroma saturation adjustment. An adaptive comb filter is applied to both U and V to eliminate cross-chrominance noise. Hue control is achieved with phase shift of the digitally controlled oscillator. An automatic color killer circuit is also included in this block. The color killer suppresses the chroma processing when the color burst of the video signal is weak or not present.

### 3.10 Timing Processor

The timing processor is a combination of hardware and software running in the internal microprocessor that serves to control horizontal lock to the input sync pulse edge, AGC and offset adjustment in the analog front end, vertical sync detection, and Macrovision™ detection.

### 3.11 VBI Data Processor

The TVP5150 VBI data processor (VDP) slices various data services like Teletext (WST, NABTS), Closed Caption (CC), wide screen signaling (WSS), etc. These services are acquired by programming the VDP to enable a standard(s) in the vertical blank interval. The results are stored in a FIFO and/or registers. The Teletext results are stored in a FIFO only. Listed in Table 3–1 is a summary of the types of vertical blank interval data supported according to the video standard. It supports ITU–R BT. 601 sampling for each. Thirteen standard modes are currently supported.

**Table 3–1. Data Types Supported by the VDP**

| LINE MODE REGISTER (D0h–FCh) BITS [3:0] | SAMPLING RATE (0Dh) BIT 7 | NAME            | DESCRIPTION                                    |
|-----------------------------------------|---------------------------|-----------------|------------------------------------------------|
| 0000b                                   | x                         | x               | Reserved                                       |
| 0000b                                   | x                         | x               | Reserved                                       |
| 0001b                                   | x                         | x               | Reserved                                       |
| 0001b                                   | 1                         | WST PAL B 6     | Teletext, PAL, System B, ITU–R BT.601          |
| 0010b                                   | x                         | x               | Reserved                                       |
| 0010b                                   | 1                         | WST PAL C 6     | Teletext, PAL, System C, ITU–R BT.601          |
| 0011b                                   | x                         | x               | Reserved                                       |
| 0011b                                   | 1                         | WST, NTSC B 6   | Teletext, NTSC, System B, ITU–R BT.601         |
| 0100b                                   | x                         | x               | Reserved                                       |
| 0100b                                   | 1                         | NABTS, NTSC C 6 | Teletext, NTSC, System C, ITU–R BT.601         |
| 0101b                                   | x                         | x               | Reserved                                       |
| 0101b                                   | 1                         | NABTS, NTSC D 6 | Teletext, NTSC, System D (Japan), ITU–R BT.601 |
| 0110b                                   | x                         | x               | Reserved                                       |
| 0110b                                   | 1                         | CC, PAL 6       | Closed caption PAL, ITU–R BT.601               |
| 0111b                                   | x                         | x               | Reserved                                       |
| 0111b                                   | 1                         | CC, NTSC 6      | Closed caption NTSC, ITU–R BT.601              |
| 1000b                                   | x                         | x               | Reserved                                       |
| 1000b                                   | 1                         | WSS, PAL 6      | Wide-screen signal, PAL, ITU–R BT.601          |
| 1001b                                   | x                         | x               | Reserved                                       |
| 1001b                                   | 1                         | WSS, NTSC 6     | Wide-screen signal, NTSC, ITU–R BT.601         |
| 1010b                                   | x                         | x               | Reserved                                       |
| 1010b                                   | 1                         | VITC, PAL 6     | Vertical interval timecode, PAL, ITU–R BT.601  |
| 1011b                                   | x                         | x               | Reserved                                       |
| 1011b                                   | 1                         | VITC, NTSC 6    | Vertical interval timecode, NTSC, ITU–R BT.601 |
| 1100b                                   | x                         | x               | Reserved                                       |
| 1100b                                   | 1                         | VPS, PAL 6      | Video program system, PAL, ITU–R BT.601        |
| 1101b                                   | x                         | x               | Reserved                                       |
| 1110b                                   | x                         | x               | Reserved                                       |
| 1111b                                   | x                         | Active Video    | Active video/full field                        |

At powerup the host interface is required to program the VDP-configuration RAM (VDP-CRAM) contents with the lookup table (see Section 3.22.54). This is done through port address C3h. Each read from or write to this address will auto increment an internal counter to the next RAM location. To access the VDP-CRAM, the line mode registers (D0h–FCh) must be programmed with FFh to avoid a conflict with the internal microprocessor and the VDP in both writing and reading. Full field mode must also be disabled.

Available VBI lines are from line 6 to line 27 of both field 1 and field 2. Each line can be any VBI mode. When changing modes, the VDP must allow the current transaction to complete through the delays of the VDP before switching the line mode register contents. It must also complete loading of the line mode registers before the next line starts processing. The switch pixel number is set through registers CBh and CCh (see Section 3.22.60).

Output data is available either through the VBI-FIFO (B0h) or through dedicated registers at 90h–AFh, both of which are available through the I<sup>2</sup>C port.

### 3.12 VBI FIFO and Ancillary Data in Video Stream

Sliced VBI data can be output as ancillary data in the video stream in the ITU-R BT.656 mode. VBI data is output during the horizontal blanking period following the line from which the data was retrieved. Table 3–2 shows the header format and sequence of the ancillary data inserted into the video stream. This format is also used to store any VBI data into the FIFO. The size of FIFO is 512 bytes. Therefore, the FIFO can store up to 11 lines of teletext data with the NTSC NABTS standard.

**Table 3–2. Ancillary Data Format and Sequence**

| BYTE NO. | D7 (MSB)           | D6 | D5      | D4         | D3       | D2       | D1                 | D0 (LSB) | DESCRIPTION                |                      |  |
|----------|--------------------|----|---------|------------|----------|----------|--------------------|----------|----------------------------|----------------------|--|
| 0        | 0                  | 0  | 0       | 0          | 0        | 0        | 0                  | 0        | Ancillary data preamble    |                      |  |
| 1        | 1                  | 1  | 1       | 1          | 1        | 1        | 1                  | 1        |                            |                      |  |
| 2        | 1                  | 1  | 1       | 1          | 1        | 1        | 1                  | 1        |                            |                      |  |
| 3        | NEP                | EP | 0       | 1          | 0        | DID2     | DID1               | DID0     | Data ID (DID)              |                      |  |
| 4        | NEP                | EP | F5      | F4         | F3       | F2       | F1                 | F0       | Secondary data ID (SDID)   |                      |  |
| 5        | NEP                | EP | N5      | N4         | N3       | N2       | N1                 | N0       | Number of 32 bit data (NN) |                      |  |
| 6        | Video line # [7:0] |    |         |            |          |          |                    |          | Internal Data ID0 (IDID0)  |                      |  |
| 7        | 0                  | 0  | 0       | Data error | Match #1 | Match #2 | Video line # [9:8] |          | Internal Data ID1 (IDID1)  |                      |  |
| 8        | 1. Data            |    |         |            |          |          |                    |          | Data byte                  | 1 <sup>st</sup> word |  |
| 9        | 2. Data            |    |         |            |          |          |                    |          | Data byte                  |                      |  |
| 10       | 3. Data            |    |         |            |          |          |                    |          | Data byte                  |                      |  |
| 11       | 4. Data            |    |         |            |          |          |                    |          | Data byte                  |                      |  |
| :        | :                  |    |         |            |          |          |                    |          | :                          |                      |  |
|          | m-1. Data          |    |         |            |          |          |                    |          | Data byte                  | N <sup>th</sup> word |  |
|          | m. Data            |    |         |            |          |          |                    |          | Data byte                  |                      |  |
|          | NEP                | EP | CS[5:0] |            |          |          |                    |          | Check sum                  |                      |  |
| 4(N+2)   | 1                  | 0  | 0       | 0          | 0        | 0        | 0                  | 0        | Fill byte                  |                      |  |

EP: Even parity for D0–D5      NEP: Negated even parity

DID: 91h: Sliced data of VBI lines of first field  
 53h: Sliced data of line 24 to end of first field  
 55h: Sliced data of VBI lines of second field  
 97h: Sliced data of line 24 to end of second field

SDID: This field holds the data format taken from the line mode register of the corresponding line.

NN: Number of Dwords beginning with byte 8 through 4(N+2). This value is the number of Dwords where each Dword is 4 bytes.

IDID0: Transaction video line number [7:0]

IDID1: Bit 0/1 = Transaction video line number [9:8]  
 Bit 2 = Match 2 flag  
 Bit 3 = Match 1 flag  
 Bit 4 = 1 if an error was detected in the EDC block. 0 if not.

CS: Sum of D0–D7 of DID through last data byte.

Fill byte: Fill bytes make a multiple of 4 bytes from byte 0 to last fill byte. For teletext modes, byte 8 is the sync pattern byte. Byte 9 is 1. Data (the first data byte).

### 3.13 Raw Video Data Output

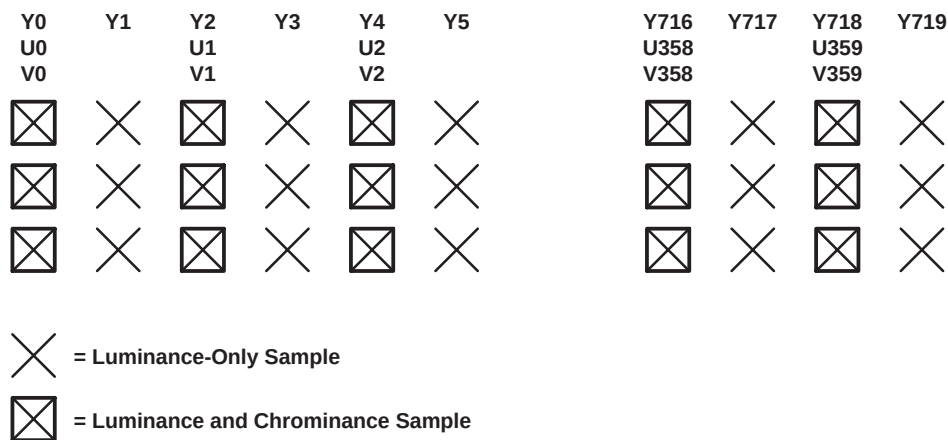
The TVP5150 device can output raw A/D video data at 2x sampling rate for external VBI slicing. This is transmitted as an ancillary data block during the active horizontal portion of the line and during vertical blanking.

### 3.14 Output Formatter

The YUV digital output can be programmed as 8-bit 4:2:2 or 8-bit ITU-R BT.656 parallel interface standard.

**Table 3–3. Summary of Line Frequencies, Data Rates, and Pixel Counts**

| STANDARDS                         | HORIZONTAL LINE RATE (kHz) | PIXELS PER LINE | ACTIVE PIXELS PER LINE | SCLK FREQUENCY (MHz) |
|-----------------------------------|----------------------------|-----------------|------------------------|----------------------|
| NTSC (M, 4.43), ITU-R BT.601      | 15.73426                   | 858             | 720                    | 27.00                |
| PAL (B, D, G, H, I), ITU-R BT.601 | 15.625                     | 864             | 720                    | 27.00                |



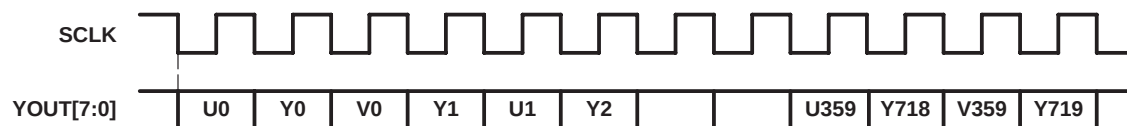
Timing is for 13.5-MHz sampling

**Figure 3–7. 4:2:2 Sampling**

The different formats that are supported and the corresponding sampling frequencies are listed as follows:

| MODES              | DATA CLOCK FREQUENCY | TERMINALS    | EMBEDDED SYNCs, VBI DATA, RAW DATA                              | STANDARDS SUPPORTED        |
|--------------------|----------------------|--------------|-----------------------------------------------------------------|----------------------------|
| 8-bit ITU-R BT.601 | SCLK                 | Y(7–0) YCbCr | Syncs optional<br>VBI optional (edge prog)<br>Raw data optional | NTSC/PAL<br>YUV output     |
| 8-bit 4:2:2        | SCLK                 | Y(7–0) YCbCr | Syncs optional<br>VBI optional (edge prog)<br>Raw data optional | Any standard<br>YUV output |

The following diagram explains the different modes.



Numbering shown is for 13.5-MHz sampling

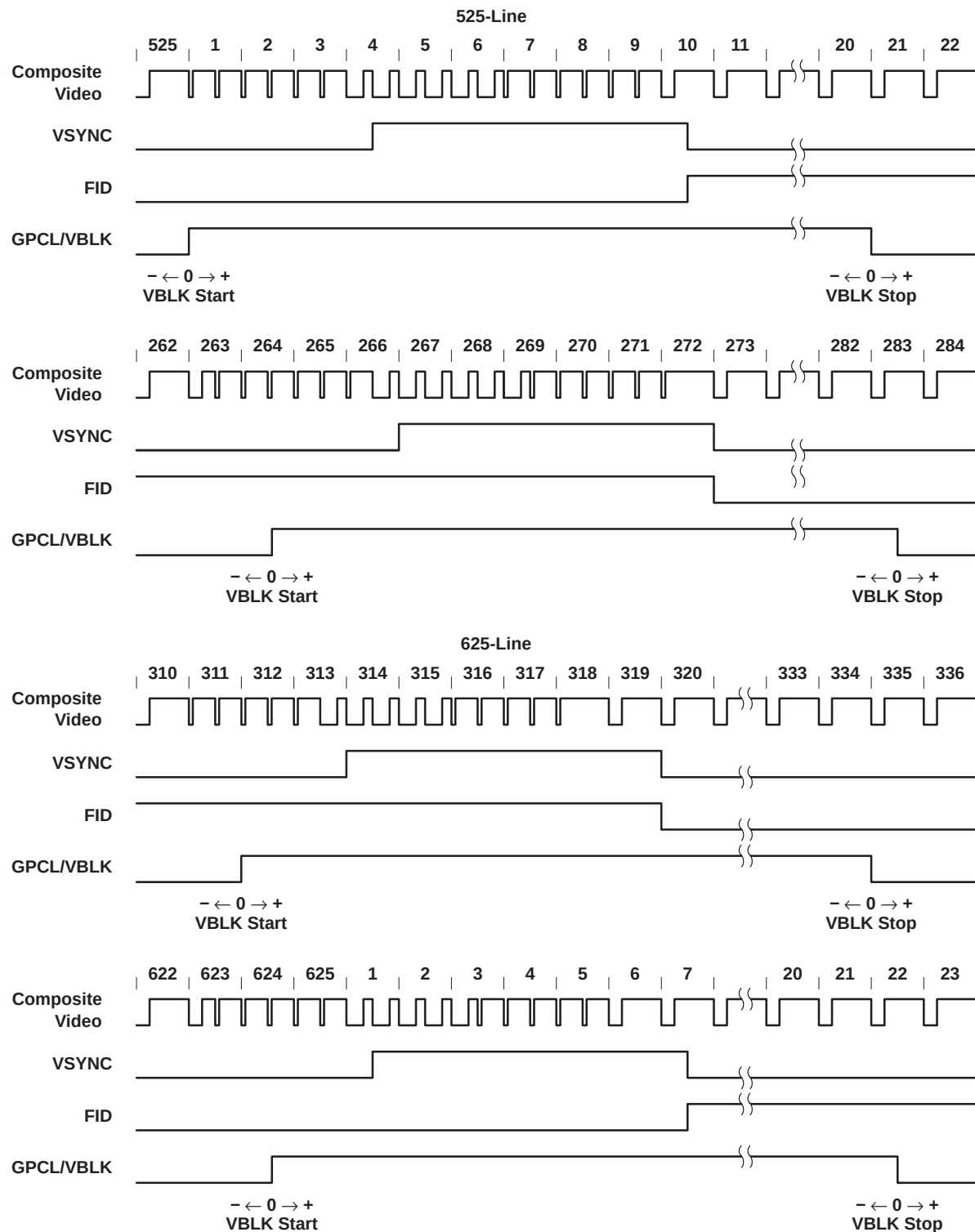
**Figure 3–8. 8-Bit YCbCr 4:2:2 and ITU-R BT.656 Mode Timing**

### 3.15 Synchronization Signals

Nondata stream embedded syncs are provided via the following signals:

- VSYNC (vertical sync)
- FID/VLK (field indicator or vertical lock indicator)
- GPCL/VBLK (general-purpose I/O or vertical blanking indicator)
- PALI/HLK (PAL switch indicator or horizontal lock indicator)
- HSYNC (horizontal sync)
- AVID (active video indicator)

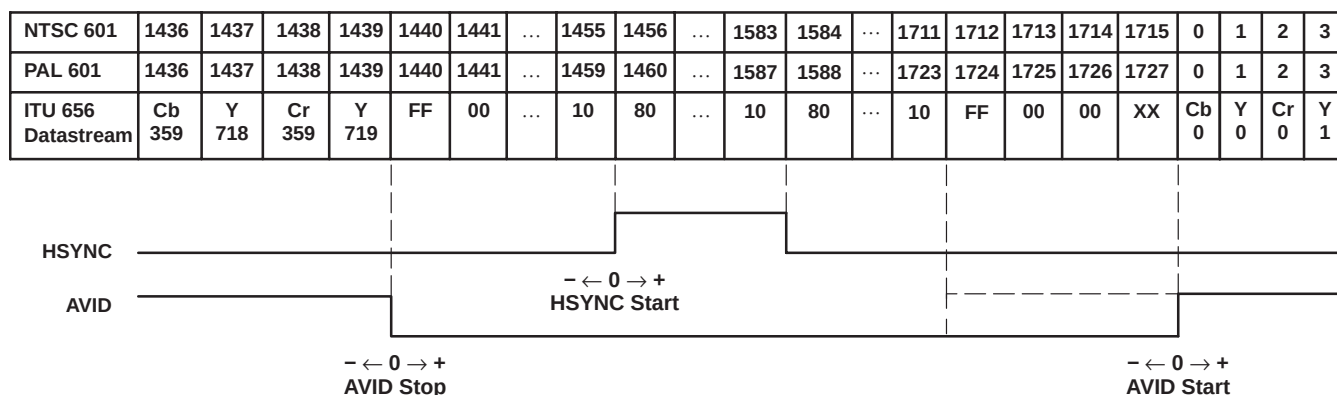
In hardware, VSYNC, FID, PALI, and VBLK are software-set and programmable to the SCLK pixel count. This allows any possible alignment to the internal pixel count and line count. The proper settings for a 525-/625-line video output are given as an example below.



Notes: 1. Line numbering conforms to ITU-R BT.470

**Figure 3–9. 8-bit 4:2:2, Timing With 2x Pixel Clock (SCLK) Reference**

ITU-R BT.656 timing shown without embedded syncs.



NOTE: AVID rising edge occurs 4 SCLK cycles early when in ITU-R BT.656 output mode.

**Figure 3–10. Horizontal Synchronization Signals**

### 3.16 AVID Cropping

AVID or active video cropping provides a means to decrease bandwidth of the video output. This is accomplished by horizontally blanking a number of AVID pulses and by vertically blanking a number of lines per frame. The horizontal AVID cropping is controlled using registers 11h and 12h for start pixels MSB and LSB, respectively.

Registers 13h and 14h provide access to stop pixels MSB and LSB, respectively. The vertical AVID cropping is controlled using the vertical blanking (VBLK) start and stop registers at addresses 18h and 19h. Figure 3–11 shows an AVID application.

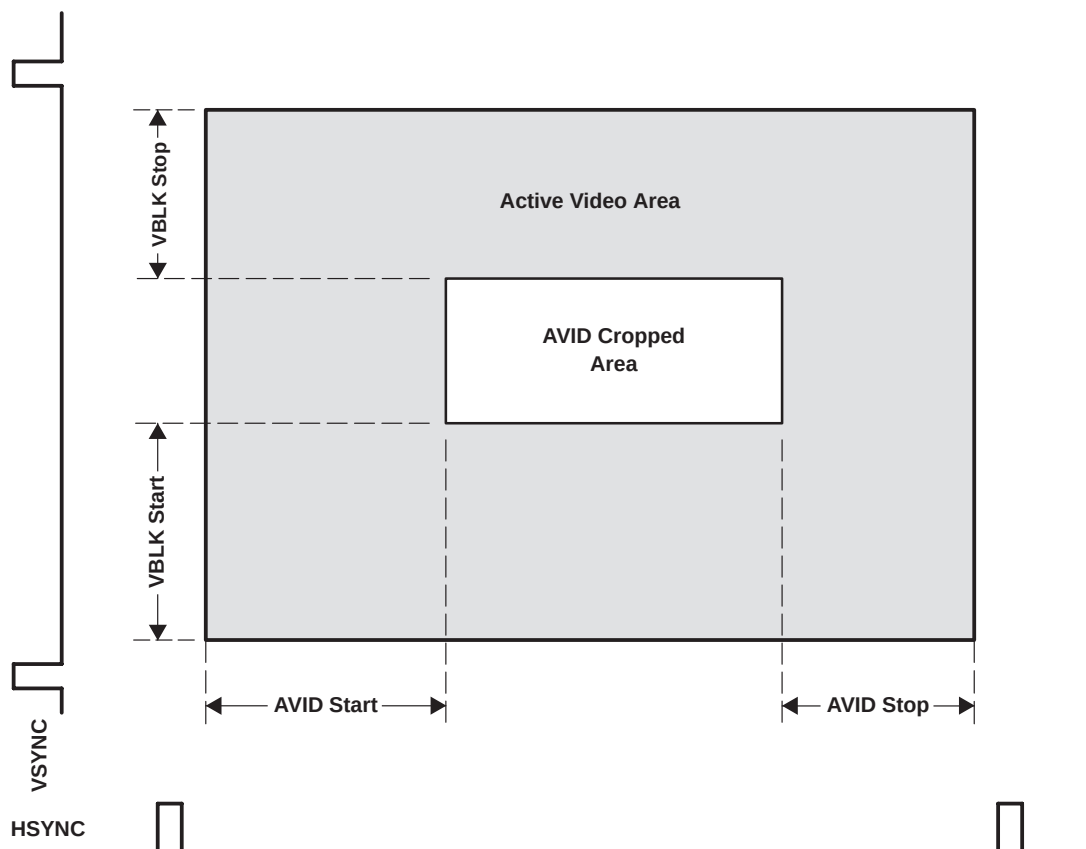


Figure 3–11. AVID Application

### 3.17 Embedded Syncs

Standards with embedded syncs insert SAV and EAV codes into the datastream on the rising and falling edges of AVID. These codes contain the V and F bits which also define vertical timing. F and V are software programmable and change after SAV but before EAV, so that the new value always appears on EAV first. Table 3–4 gives the format of the SAV and EAV codes.

H equals 1 always indicates EAV. H equals 0 always indicates SAV. The alignment of V and F to the line and field counter varies depending on the standard.

The P bits are protection bits:

$$\begin{aligned} P3 &= V \text{ xor } H \\ P2 &= F \text{ xor } H \\ P1 &= F \text{ xor } V \\ P0 &= F \text{ xor } V \text{ xor } H \end{aligned}$$

Table 3–4. EAV and SAV Sequence

|             | 8-BIT DATA |    |    |    |    |    |    |    |
|-------------|------------|----|----|----|----|----|----|----|
|             | D7 (MSB)   | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| Preamble    | 1          | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Preamble    | 0          | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Preamble    | 0          | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Status word | 1          | F  | V  | H  | P3 | P2 | P1 | P0 |

### 3.18 I<sup>2</sup>C Host Interface

The I<sup>2</sup>C standard consists of two signals, serial input/output data line (SDA) and input/output clock line (SCL), which carry information between the devices connected to the bus. A third signal (I2CSEL) is used for slave address selection. Although the I<sup>2</sup>C system can be multimastered, the TVP5150 device functions as a slave device only.

Both SDA and SCL must be connected to a positive supply voltage via a pullup resistor. When the bus is free, both lines are high. The slave address select terminal (I2CSEL) enables the use of two TVP5150 devices tied to the same I<sup>2</sup>C bus. At power up, the status of the I2CSEL is polled. Depending on the write and read addresses to be used for the TVP5150 device, it can either be pulled low or high through a resistor. This terminal is multiplexed with YOUT7 and hence must not be tied directly to ground or V<sub>DD</sub>. Table 3–6 summarizes the terminal functions of the I<sup>2</sup>C-mode host interface.

**Table 3–5. Write Address Selection**

| I2CSEL | WRITE ADDRESS |
|--------|---------------|
| 0      | B8h           |
| 1      | BAh           |

**Table 3–6. I<sup>2</sup>C Terminal Description**

| SIGNAL         | TYPE             | DESCRIPTION             |
|----------------|------------------|-------------------------|
| I2CSEL (YOUT7) | I                | Slave address selection |
| SCL            | I/O (open drain) | Input/output clock line |
| SDA            | I/O (open drain) | Input/output data line  |

Data transfer rate on the bus is up to 400 kbits/s. The number of interfaces connected to the bus is dependent on the bus capacitance limit of 400 pF. The data on the SDA line must be stable during the high period of the SCL except for start and stop conditions. The high or low state of the data line can only change with the clock signal on the SCL line being low. A high-to-low transition on the SDA line while the SCL is high indicates an I<sup>2</sup>C start condition. A low-to-high transition on the SDA line while the SCL is high indicates an I<sup>2</sup>C stop condition.

Every byte placed on the SDA must be 8 bits long. The number of bytes which can be transferred is unrestricted. Each byte must be followed by an acknowledge bit. The acknowledge-related clock pulse is generated by the I<sup>2</sup>C master.

#### 3.18.1 I<sup>2</sup>C Write Operation

Data transfers occur utilizing the following illustrated formats.

An I<sup>2</sup>C master initiates a write operation to the TVP5150 device by generating a start condition (S) followed by the TVP5150 I<sup>2</sup>C address (as shown below), in MSB first bit order, followed by a 0 to indicate a write cycle. After receiving an acknowledge from the TVP5150 device, the master presents the subaddress of the register, or the first of a block of registers it wants to write, followed by one or more bytes of data, MSB first. The TVP5150 device acknowledges each byte after completion of each transfer. The I<sup>2</sup>C master terminates the write operation by generating a stop condition (P).

|                                 |          |
|---------------------------------|----------|
| <b>Step 1</b>                   | <b>0</b> |
| I <sup>2</sup> C Start (master) | S        |

|                                           |          |          |          |          |          |          |          |          |
|-------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 2</b>                             | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C General address (master) | 1        | 0        | 1        | 1        | 1        | 0        | X        | 0        |

|                                      |          |
|--------------------------------------|----------|
| <b>Step 3</b>                        | <b>9</b> |
| I <sup>2</sup> C Acknowledge (slave) | A        |

|                                                  |          |          |          |          |          |          |          |          |
|--------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 4</b>                                    | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C Write register address (master) | addr     | addr     | addr     | addr     | addr     | addr     | addr     | addr     |

|                                      |          |
|--------------------------------------|----------|
| <b>Step 5</b>                        | <b>9</b> |
| I <sup>2</sup> C Acknowledge (slave) | A        |

|                                      |          |          |          |          |          |          |          |          |
|--------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 6</b>                        | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C Write data (master) | Data     | Data     | Data     | Data     | Data     | Data     | Data     | Data     |

|                                      |          |
|--------------------------------------|----------|
| <b>Step 7<sup>†</sup></b>            | <b>9</b> |
| I <sup>2</sup> C Acknowledge (slave) | A        |

|                                |          |
|--------------------------------|----------|
| <b>Step 8</b>                  | <b>0</b> |
| I <sup>2</sup> C Stop (master) | P        |

<sup>†</sup> Repeat steps 6 and 7 until all data have been written.

### 3.18.2 I<sup>2</sup>C Read Operation

The read operation consists of two phases. The first phase is the address phase. In this phase, an I<sup>2</sup>C master initiates a write operation to the TVP5150 device by generating a start condition (S) followed by the TVP5150 I<sup>2</sup>C address, in MSB first bit order, followed by a 0 to indicate a write cycle. After receiving acknowledges from the TVP5150 device, the master presents the subaddress of the register or the first of a block of registers it wants to read. After the cycle is acknowledged, the master terminates the cycle immediately by generating a stop condition (P).

**Table 3–7. Read Address Selection**

| I <sup>2</sup> CSEL | READ ADDRESS |
|---------------------|--------------|
| 0                   | B9h          |
| 1                   | BBh          |

The second phase is the data phase. In this phase, an I<sup>2</sup>C master initiates a read operation to the TVP5150 device by generating a start condition followed by the TVP5150 I<sup>2</sup>C address (as shown below for a read operation), in MSB first bit order, followed by a 1 to indicate a read cycle. After an acknowledge from the TVP5150 device, the I<sup>2</sup>C master receives one or more bytes of data from the TVP5150 device. The I<sup>2</sup>C master acknowledges the transfer at the end of each byte. After the last data byte desired has been transferred from the TVP5150 device to the master, the master generates a not acknowledge followed by a stop.

#### 3.18.2.1 Read Phase 1

|                                 |          |
|---------------------------------|----------|
| <b>Step 1</b>                   | <b>0</b> |
| I <sup>2</sup> C Start (master) | S        |

|                                           |          |          |          |          |          |          |          |          |
|-------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 2</b>                             | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C General address (master) | 1        | 0        | 1        | 1        | 1        | 0        | X        | 0        |

|                                      |          |
|--------------------------------------|----------|
| <b>Step 3</b>                        | <b>9</b> |
| I <sup>2</sup> C Acknowledge (slave) | A        |

|                                                 |          |          |          |          |          |          |          |          |
|-------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 4</b>                                   | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C Read register address (master) | addr     | addr     | addr     | addr     | addr     | addr     | addr     | addr     |

|                                      |          |
|--------------------------------------|----------|
| <b>Step 5</b>                        | <b>9</b> |
| I <sup>2</sup> C Acknowledge (slave) | A        |

|                                |          |
|--------------------------------|----------|
| <b>Step 6</b>                  | <b>0</b> |
| I <sup>2</sup> C Stop (master) | P        |

### 3.18.2.2 Read Phase 2

|                                 |          |
|---------------------------------|----------|
| <b>Step 7</b>                   | <b>0</b> |
| I <sup>2</sup> C Start (master) | S        |

|                                           |          |          |          |          |          |          |          |          |
|-------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 8</b>                             | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C General address (master) | 1        | 0        | 1        | 1        | 1        | 0        | X        | 1        |

|                                      |          |
|--------------------------------------|----------|
| <b>Step 9</b>                        | <b>9</b> |
| I <sup>2</sup> C Acknowledge (slave) | A        |

|                                    |          |          |          |          |          |          |          |          |
|------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>Step 10</b>                     | <b>7</b> | <b>6</b> | <b>5</b> | <b>4</b> | <b>3</b> | <b>2</b> | <b>1</b> | <b>0</b> |
| I <sup>2</sup> C Read data (slave) | Data     | Data     | Data     | Data     | Data     | Data     | Data     | Data     |

|                                           |                |
|-------------------------------------------|----------------|
| <b>Step 11<sup>†</sup></b>                | <b>9</b>       |
| I <sup>2</sup> C Not Acknowledge (master) | $\overline{A}$ |

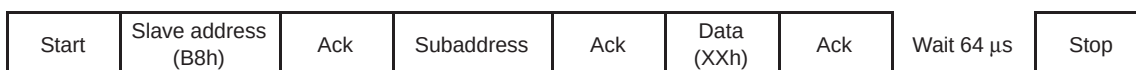
|                                |          |
|--------------------------------|----------|
| <b>Step 12</b>                 | <b>0</b> |
| I <sup>2</sup> C Stop (master) | P        |

<sup>†</sup> Repeat steps 10 and 11 for all bytes read. Master does not acknowledge the last read data received.

### 3.18.2.3 I<sup>2</sup>C Timing Requirements

The TVP5150 device requires delays in the I<sup>2</sup>C accesses to accommodate its internal processor's timing. In accordance with I<sup>2</sup>C specifications, the TVP5150 device holds the I<sup>2</sup>C clock line (SCL) low to indicate the wait period to the I<sup>2</sup>C master. If the I<sup>2</sup>C master is not designed to check for the I<sup>2</sup>C clock line held-low condition, then the maximum delays must always be inserted where required. These delays are of variable length; maximum delays are indicated in the following diagram:

Normal register writing address 00h–8Fh (addresses 90h–FFh do not require delays)

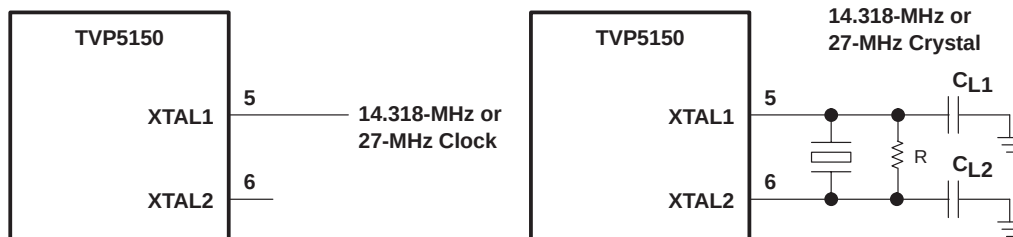


## 3.19 Clock Circuits

An internal line-locked phase-locked loop (PLL) generates the system and pixel clocks. The PLL minimizes jitter and process and environmental variability. It is capable of operating off a single crystal frequency with a high supply rejection ratio. A 14.318-MHz clock is required to drive the PLL. This may be input to the TVP5150 device on terminal 5 (XTAL1), or a crystal of 14.318-MHz fundamental resonant frequency may be connected across terminals 5 and 6 (XTAL2). Figure 3–12 shows the reference clock configurations. For the example crystal circuit shown (a parallel-resonant crystal with 14.318-MHz fundamental frequency), the external capacitors must have the following relationship:

$$C_{L1} = C_{L2} = 2C_L - C_{STRAY}$$

where  $C_{STRAY}$  is the terminal capacitance with respect to ground. Please note that with the crystal oscillator, an external 100-k $\Omega$  resistor can be optionally put across XTAL1 and XTAL2 terminals. Figure 3–12 shows the reference clock configurations.



NOTE: 100-kΩ resistor R is optional

Figure 3-12. Reference Clock Configurations

### 3.20 Genlock Control (GLCO) and Real-Time Control (RTC)

A Genlock control function is provided to support a standard video encoder to synchronize its internal color phase DCO for a clean video line and color lock.

The frequency control word of the internal color subcarrier digital control oscillator (DCO) and the subcarrier phase reset bit are transmitted via terminal 23 (GLCO). The frequency control word is a 23-bit binary number. The frequency of the DCO can be calculated from the following equation:

$$F_{dco} = \frac{F_{ctrl}}{2^{23}} \times F_{sclk}$$

where  $F_{dco}$  is the frequency of the DCO,  $F_{ctrl}$  is the 23-bit DCO frequency control, and  $F_{sclk}$  is the frequency of the SCLK.

#### 3.20.1 TVP5150 Genlock Control Interface

A write of 1 to bit 4 of the chrominance control register at I<sup>2</sup>C subaddress 1Ah causes the subcarrier DCO phase reset bit to be sent on the next scan line on GLCO. The active low reset bit occurs 7 SCLKs after the transmission of the last bit of DCO frequency control. Upon the transmission of the reset bit, the phase of the TVP5150 internal subcarrier DCO is reset to zero.

A Genlock slave device can be connected to the GLCO terminal and use the information on GLCO to synchronize its internal color phase DCO to achieve clean line and color lock.

Figure 3-13 shows the timing diagram of the GLCO mode.

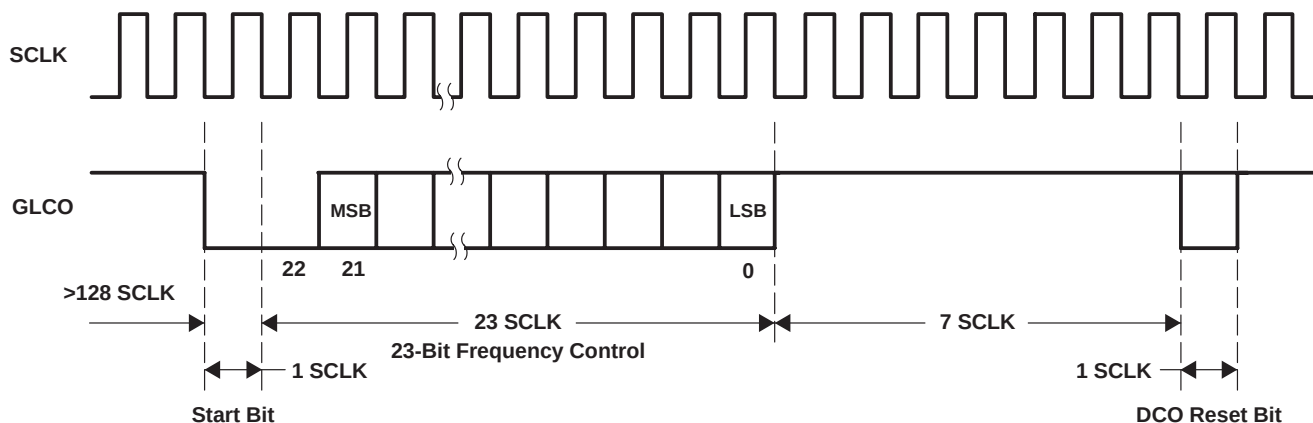


Figure 3-13. GLCO Timing

### 3.20.2 RTC Mode

Figure 3–14 shows the timing diagram of the RTC mode. Clock rate for the RTC mode is 4 times slower than the GLCO clock rate. For PLL frequency control, the upper 22 bits are used. Each frequency control bit is 2 clock cycles long. The active low reset bit occurs 6 CLKs after the transmission of the last bit of PLL frequency control.

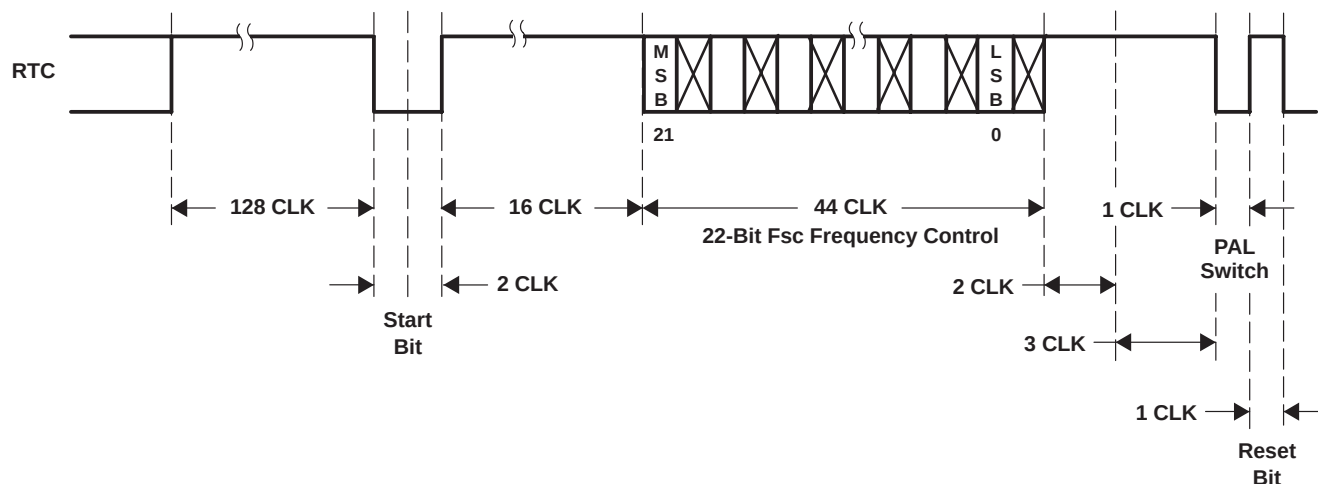


Figure 3–14. RTC Timing

### 3.21 Internal Control Registers

The TVP5150 device is initialized and controlled by a set of internal registers which set all device operating parameters. Communication between the external controller and the TVP5150 device is through I<sup>2</sup>C. Table 3–8 shows the summary of these registers. The reserved registers must not be written. However, reserved bits in the defined registers must be written with 0s. The detailed programming information of each register is described in the following sections.

Table 3–8. Registers Summary

| REGISTER FUNCTION               | ADDRESS | DEFAULT | R/W |
|---------------------------------|---------|---------|-----|
| Video input source selection #1 | 00h     | 00h     | R/W |
| Analog channel controls         | 01h     | 15h     | R/W |
| Operation mode controls         | 02h     | 00h     | R/W |
| Miscellaneous controls          | 03h     | 01h     | R/W |
| Autoswitch mask                 | 04h     | 00h     | R/W |
| Software reset                  | 05h     | 00h     | R/W |
| Color killer threshold control  | 06h     | 10h     | R/W |
| Luminance processing control #1 | 07h     | 20h     | R/W |
| Luminance processing control #2 | 08h     | 00h     | R/W |
| Brightness control              | 09h     | 80h     | R/W |
| Color saturation control        | 0Ah     | 80h     | R/W |
| Hue control                     | 0Bh     | 00h     | R/W |
| Contrast control                | 0Ch     | 80h     | R/W |
| Outputs and data rates select   | 0Dh     | 47h     | R/W |

R = Read only

W = Write only

R/W = Read and write

**Table 3–8. Registers Summary (Continued)**

| REGISTER FUNCTION                  | ADDRESS | DEFAULT | R/W |
|------------------------------------|---------|---------|-----|
| Luminance processing control #3    | 0Eh     | 00h     | R/W |
| Configuration shared pins          | 0Fh     | 08h     | R/W |
| Reserved                           | 10h     |         |     |
| Active video cropping start MSB    | 11h     | 00h     | R/W |
| Active video cropping start LSB    | 12h     | 00h     | R/W |
| Active video cropping stop MSB     | 13h     | 00h     | R/W |
| Active video cropping stop LSB     | 14h     | 00h     | R/W |
| Genlock/RTC                        | 15h     | 01h     | R/W |
| Horizontal sync start              | 16h     | 80h     | R/W |
| Reserved                           | 17h     |         |     |
| Vertical blanking start            | 18h     | 00h     | R/W |
| Vertical blanking stop             | 19h     | 00h     | R/W |
| Chrominance processing control #1  | 1Ah     | 0Ch     | R/W |
| Chrominance processing control #2  | 1Bh     | 14h     | R/W |
| Interrupt reset register B         | 1Ch     | 00h     | R/W |
| Interrupt enable register B        | 1Dh     | 00h     | R/W |
| Interrupt configuration register B | 1Eh     | 00h     | R/W |
| Reserved                           | 1Fh–27h |         |     |
| Video standard                     | 28h     | 00h     | R/W |
| Reserved                           | 29h–7Fh |         |     |
| MSB of device ID                   | 80h     | 51h     | R   |
| LSB of device ID                   | 81h     | 50h     | R   |
| ROM version                        | 82h     | 02h     | R   |
| RAM patch-code version             | 83h     | 10h     | R   |
| Vertical line count MSB            | 84h     |         | R   |
| Vertical line count LSB            | 85h     |         | R   |
| Interrupt status register B        | 86h     |         | R   |
| Interrupt active register B        | 87h     | 00h     | R   |
| Status register #1                 | 88h     |         | R   |
| Status register #2                 | 89h     |         | R   |
| Status register #3                 | 8Ah     |         | R   |
| Status register #4                 | 8Bh     |         | R   |
| Status register #5                 | 8Ch     |         | R   |
| Reserved                           | 8Dh–8Fh |         |     |
| Closed caption data registers      | 90h–93h |         | R   |
| WSS data registers                 | 94h–99h |         | R   |
| VPS data registers                 | 9Ah–A6h |         | R   |
| VITC data registers                | A7h–AFh |         | R   |
| VBI FIFO read data                 | B0h     |         | R   |
| Teletext filter 1                  | B1h–B5h | 00h     | R/W |
| Teletext filter 2                  | B6h–BAh | 00h     | R/W |

R = Read only

W = Write only

R/W = Read and write

**Table 3–8. Registers Summary (Continued)**

| REGISTER FUNCTION                   | ADDRESS | DEFAULT | R/W |
|-------------------------------------|---------|---------|-----|
| Teletext filter enable              | BBh     | 00h     | R/W |
| Reserved                            | BCh–BFh |         |     |
| Interrupt status register A         | C0h     | 00h     | R/W |
| Interrupt enable register A         | C1h     | 00h     | R/W |
| Interrupt configuration             | C2h     | 04h     | R/W |
| VDP configuration RAM data          | C3h     | DCh     | R/W |
| Configuration RAM address low byte  | C4h     | 0Fh     | R/W |
| Configuration RAM address high byte | C5h     | 00h     | R/W |
| VDP status register                 | C6h     |         | R/W |
| FIFO word count                     | C7h     |         | R   |
| FIFO interrupt threshold            | C8h     | 80h     | R/W |
| FIFO reset                          | C9h     | 00h     | W   |
| Line number interrupt               | CAh     | 00h     | R/W |
| Pixel alignment register low byte   | CBh     | 59h     | R/W |
| Pixel alignment register high byte  | CCh     | 03h     | R/W |
| FIFO output control                 | CDh     | 01h     | R/W |
| Automatic initialization            | CEh     | 00h     | R/W |
| Full field enable                   | CFh     | 00h     | R/W |
| Line mode registers                 | D0h–FBh | FFh     | R/W |
| Full field mode register            | FCh     | 7Fh     | R/W |
| Reserved                            | FDh–FFh |         |     |

R = Read only

W = Write only

R/W = Read and write

## 3.22 Register Definitions

### 3.22.1 Video Input Source Selection #1 Register

|         |     |
|---------|-----|
| Address | 00h |
|---------|-----|

| 7        | 6 | 5 | 4 | 3 | 2 | 1                          | 0                 |
|----------|---|---|---|---|---|----------------------------|-------------------|
| Reserved |   |   |   |   |   | Channel 1 source selection | S-video selection |

Channel 1 source selection:

0 = AIP1A selected (default)

1 = AIP1B selected

**Table 3–9. Analog Channel and Video Mode Selection**

|           | INPUT(S) SELECTED  | ADDRESS 00 |       |
|-----------|--------------------|------------|-------|
|           |                    | BIT 1      | BIT 0 |
| Composite | AIP1A (default)    | 0          | 0     |
|           | AIP1B              | 1          | 0     |
| S-Video   | 1A luma, 2A chroma | x          | 1     |

**3.22.2 Analog Channel Controls Register**

|         |     |
|---------|-----|
| Address | 01h |
|---------|-----|

| 7        | 6 | 5 | 4 | 3                        | 2 | 1                      | 0 |
|----------|---|---|---|--------------------------|---|------------------------|---|
| Reserved |   |   | 1 | Automatic offset control |   | Automatic gain control |   |

Automatic offset control:

- 00 = Disabled
- 01 = Automatic offset enabled (default)
- 10 = Reserved
- 11 = Clamping level frozen to the previously set value

Automatic gain control (AGC):

- 00 = Disabled (fixed gain value)
- 01 = AGC enabled (default)
- 10 = Reserved
- 11 = AGC frozen to the previously set value

**3.22.3 Operation Mode Controls Register**

|         |     |
|---------|-----|
| Address | 02h |
|---------|-----|

| 7        | 6 | 5 | 4 | 3 | 2                           | 1        | 0               |
|----------|---|---|---|---|-----------------------------|----------|-----------------|
| Reserved |   |   |   |   | Color subcarrier PLL frozen | Reserved | Power down mode |

Color subcarrier PLL frozen:

- 0 = Color subcarrier PLL increments by the internally generated phase increment. (default)  
GLCO pin outputs the frequency increment.
- 1 = Color subcarrier PLL stops operating.  
GLCO pin outputs the frozen frequency increment.

Power down mode:

- 0 = Normal operation (default)
- 1 = Power down mode. A/Ds are turned off and internal clocks are reduced to minimum.

**3.22.4 Miscellaneous Control Register**

|         |     |
|---------|-----|
| Address | 03h |
|---------|-----|

| 7    | 6        | 5                    | 4                  | 3                         | 2                                               | 1                        | 0                   |
|------|----------|----------------------|--------------------|---------------------------|-------------------------------------------------|--------------------------|---------------------|
| VBKO | GPCL pin | GPCL I/O mode select | Lock status (HVLK) | YUV output enable (TVPOE) | HSYNC, VSYNC/PALI, AVID, FID/GLCO output enable | Vertical blanking on/off | Clock output enable |

VBKO (pin 27) function select:

- 0 = GPCL (default)
- 1 = VBLK

GPCL (data is output based on state of bit 5):

- 0 = GPCL outputs 0 (default)
- 1 = GPCL outputs 1

GPCL I/O mode select:

- 0 = GPCL is input (default)
- 1 = GPCL is output

Lock status (HVLK) (configured along with register 0Fh):

- 0 = Terminal VSYNC/PALI outputs. PAL indicator (PALI) signal and terminal FID/GLCO outputs field ID (FID) signal (default) (if terminals are configured to output PALI and FID in register 0Fh)
- 1 = Terminal VSYNC/PALI outputs horizontal lock indicator (HLK) and terminal FID outputs vertical lock indicator (VLK) (if terminals are configured to output PALI and FID in register 0Fh)

These are additional functionalities that are provided for ease of use.

YUV output enable:

- 0 = Y(OUT7:0) high impedance (default)
- 1 = Y(OUT7:0) active

HSYNC, VSYNC/PALI, active video indicator (AVID), and FID/GLCO output enables:

- 0 = HSYNC, VSYNC/PALI, AVID, and FID/GLCO are high-impedance (default).
- 1 = HSYNC, VSYNC/PALI, AVID, and FID/GLCO are active.

Vertical blanking on/off:

- 0 = Vertical blanking (VBLK) off (default)
- 1 = Vertical blanking (VBLK) on

Clock output enable:

- 0 = SCLK output is high impedance.
- 1 = SCLK output is enabled (default).

**Table 3–10. Digital Output Control**

| Terminal 28<br>(AVID) | Register 03h,<br>Bit 3 (TVPOE) | Register C2h,<br>Bit 2 (VDPOE) | YUV Output                 | Notes                                                                                             |
|-----------------------|--------------------------------|--------------------------------|----------------------------|---------------------------------------------------------------------------------------------------|
| 1 during reset        | X                              | X                              | Active after reset         | After reset and before YUV output enable bits are programmed. TVPOE defaults to 1 and VDPOE is 1. |
| 0 during reset        | X                              | X                              | High impedance after reset | After reset and before YUV output enable bits are programmed. TVPOE defaults to 0 and VDPOE is 1. |
| X                     | 0                              | X                              | High impedance             | After both YUV output enable bits are programmed.                                                 |
| X                     | X                              | 0                              | High impedance             | After both YUV output enable bits are programmed.                                                 |
| X                     | 1                              | 1                              | Active                     | After both YUV output enable bits are programmed.                                                 |

### 3.22.5 Autoswitch Mask Register

|         |     |
|---------|-----|
| Address | 04h |
|---------|-----|

| 7        | 6 | 5 | 4        | 3        | 2        | 1        | 0 |
|----------|---|---|----------|----------|----------|----------|---|
| Reserved |   |   | N443_OFF | PALN_OFF | PALM_OFF | Reserved |   |

N443\_OFF:

- 0 = NTSC443 is masked from the autoswitch process. Autoswitch does not switch to NTSC443.
- 1 = Normal operation (default)

PALN\_OFF:

- 0 = PAL-N is masked from the autoswitch process. Autoswitch does not switch to PAL-N.
- 1 = Normal operation (default)

PALM\_OFF:

- 0 = PAL-M is masked from the autoswitch process. Autoswitch does not switch to PAL-M.
- 1 = Normal operation (default)

**3.22.6 Software Reset Register**

|         |     |
|---------|-----|
| Address | 05h |
|---------|-----|

|          |   |   |   |   |   |   |       |
|----------|---|---|---|---|---|---|-------|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0     |
| Reserved |   |   |   |   |   |   | Reset |

Reset:

0 = Normal operation (default)

1 = Reset device

**3.22.7 Color Killer Threshold Control Register**

|         |     |
|---------|-----|
| Address | 06h |
|---------|-----|

|          |                        |   |                        |   |   |   |   |
|----------|------------------------|---|------------------------|---|---|---|---|
| 7        | 6                      | 5 | 4                      | 3 | 2 | 1 | 0 |
| Reserved | Automatic color killer |   | Color killer threshold |   |   |   |   |

Automatic color killer:

00 = Automatic mode (default)

01 = Reserved

10 = Color killer enabled, the UV terminals are forced to a zero color state.

11 = Color killer disabled

Color killer threshold:

11111 = -30 dB (minimum)

10000 = -24 dB (default)

00000 = -18 dB (maximum)

**3.22.8 Luminance Processing Control #1 Register**

|         |     |
|---------|-----|
| Address | 07h |
|---------|-----|

|                  |                      |                    |                                   |                                                           |   |   |   |
|------------------|----------------------|--------------------|-----------------------------------|-----------------------------------------------------------|---|---|---|
| 7                | 6                    | 5                  | 4                                 | 3                                                         | 2 | 1 | 0 |
| Luma bypass mode | Pedestal not present | Disable raw header | Luma bypass during vertical blank | Luminance signal delay with respect to chrominance signal |   |   |   |

Luma bypass mode:

0 = Input video bypasses the chroma trap and comb filters. Chroma outputs are forced to zero (default).

1 = Input video bypasses the whole luma processing. Raw A/D data is output alternatively as UV data and Y data at SCLK rate. The output data is properly clipped to comply to ITU-R BT.601 coding range. Only valid for 8-bit YUV output format (YUV output format = 100 or 111 at register 0Dh).

Pedestal not present:

0 = 7.5 IRE pedestal is present on the analog video input signal (default).

1 = Pedestal is not present on the analog video input signal.

Disable raw header:

0 = Insert 656 ancillary headers for raw data.

1 = Disable 656 ancillary headers and instead force dummy ones (0x40) (default).

Luminance bypass enabled during vertical blanking:

0 = Disabled (default)

1 = Enabled

Luminance bypass occurs for the duration of the vertical blanking as defined by registers 18h and 19h. This feature may be used to prevent distortion of test and data signals present during the vertical blanking interval.

Luma signal delay with respect to chroma signal in pixel clock increments (range –8 to +7 pixel clocks):

1111 = –8 pixel clocks delay  
 1011 = –4 pixel clocks delay  
 1000 = –1 pixel clocks delay  
 0000 = 0 pixel clocks delay (default)  
 0011 = 3 pixel clocks delay  
 0111 = 7 pixel clocks delay

### 3.22.9 Luminance Processing Control #2 Register

|         |     |
|---------|-----|
| Address | 08h |
|---------|-----|

|          |                         |          |          |              |              |          |          |
|----------|-------------------------|----------|----------|--------------|--------------|----------|----------|
| 7        | 6                       | 5        | 4        | 3            | 2            | 1        | 0        |
| Reserved | Luminance filter select | Reserved | Reserved | Peaking gain | Peaking gain | Reserved | Reserved |

Luminance filter select:

0 = Luminance comb filter enabled (default)  
 1 = Luminance chroma trap filter enabled

Peaking gain:

00 = 0 (default)  
 01 = 0.5  
 10 = 1  
 11 = 2

Information on peaking frequency: ITU–R BT.601 sampling rate: all standards—2.6 MHz

### 3.22.10 Brightness Control Register

|         |     |
|---------|-----|
| Address | 09h |
|---------|-----|

|                    |   |   |   |   |   |   |   |
|--------------------|---|---|---|---|---|---|---|
| 7                  | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Brightness control |   |   |   |   |   |   |   |

Brightness control:

1111 1111 = 255 (bright)  
 1000 1011 = 139 (ITU–R BT.601 level)  
 1000 0000 = 128 (default)  
 0000 0000 = 0 (dark)

### 3.22.11 Color Saturation Control Register

|         |     |
|---------|-----|
| Address | 0Ah |
|---------|-----|

|                    |   |   |   |   |   |   |   |
|--------------------|---|---|---|---|---|---|---|
| 7                  | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Saturation control |   |   |   |   |   |   |   |

Saturation control:

1111 1111 = 255 (maximum)  
 1000 0000 = 128 (default)  
 0000 0000 = 0 (no color)

**3.22.12 Hue Control Register**

|         |     |
|---------|-----|
| Address | 0Bh |
|---------|-----|

|             |   |   |   |   |   |   |   |
|-------------|---|---|---|---|---|---|---|
| 7           | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Hue control |   |   |   |   |   |   |   |

Hue control:

0111 1111 = +180 degrees

0000 0000 = 0 degrees (default)

1000 0000 = -180 degrees

**3.22.13 Contrast Control Register**

|         |     |
|---------|-----|
| Address | 0Ch |
|---------|-----|

|                  |   |   |   |   |   |   |   |
|------------------|---|---|---|---|---|---|---|
| 7                | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Contrast control |   |   |   |   |   |   |   |

Contrast control:

1111 1111 = 255 (maximum contrast)

1000 0000 = 128 (default)

0000 0000 = 0 (minimum contrast)

**3.22.14 Outputs and Data Rates Select Register**

|         |     |
|---------|-----|
| Address | 0Dh |
|---------|-----|

|          |                       |                |                      |                   |   |   |   |
|----------|-----------------------|----------------|----------------------|-------------------|---|---|---|
| 7        | 6                     | 5              | 4                    | 3                 | 2 | 1 | 0 |
| Reserved | YUV output code range | UV code format | YUV data path bypass | YUV output format |   |   |   |

YUV output code range:

0 = ITU-R BT.601 coding range (Y ranges from 16 to 235. U and V range from 16 to 240)

1 = Extended coding range (Y, U, and V range from 1 to 254) (default)

UV code format:

0 = Offset binary code (2s complement + 128) (default)

1 = Straight binary code (2s complement)

YUV data path bypass:

00 = Normal operation (default)

01 = Digital composite output pins connected to decimation filter output, decoder function bypassed, data output alternately as Y and UV buses at the SCLK rate.

10 = YUV output pins connected to A/D output, decoder function bypassed, data output at SCLK rate.

11 = Reserved

YUV output format:

000 = 8-bit 4:2:2 YUV with discrete sync output

001 = Reserved

010 = Reserved

011 = Reserved

100 = Reserved

101 = Reserved

110 = Reserved

111 = 8-bit ITU-R BT.656 interface with embedded sync output (default)

**3.22.15 Luminance Processing Control #3 Register**

|         |     |
|---------|-----|
| Address | 0Eh |
|---------|-----|

|          |   |   |   |   |   |                              |   |
|----------|---|---|---|---|---|------------------------------|---|
| 7        | 6 | 5 | 4 | 3 | 2 | 1                            | 0 |
| Reserved |   |   |   |   |   | Luminance trap filter select |   |

Luminance filter stop band bandwidth (MHz):

- 00 = No notch (default)
- 01 = Notch 1
- 10 = Notch 2
- 11 = Notch 3

Luminance filter select [1:0] selects one of the four chroma trap filters to produce luminance signal by removing the chrominance signal from the composite video signal. The stopband of the chroma trap filter is centered at the chroma subcarrier frequency with stopband bandwidth controlled by the two control bits. Please refer to Figure 3–5, for the frequency responses of the filters.

**3.22.16 Configuration Shared Pins**

|         |     |
|---------|-----|
| Address | 0Fh |
|---------|-----|

|          |        |         |         |          |            |                  |           |
|----------|--------|---------|---------|----------|------------|------------------|-----------|
| 7        | 6      | 5       | 4       | 3        | 2          | 1                | 0         |
| Reserved | LOCK23 | LOCK24A | LOCK24B | FID/GLCO | VSYNC/PALI | INTREQ/GPCL/VBLK | SCLK/PCLK |

LOCK23 (pin 23) function select:

- 0 = FID (default, if bit 3 is selected to output FID)
- 1 = Lock indicator (Indicates whether device is locked both horizontally and vertically)

LOCK24A (pin 24) function select:

- 0 = VSYNC (default, if bit 2 is selected to output VSYNC)
- 1 = Lock indicator (Indicates whether device is locked both horizontally and vertically)

LOCK24B (pin 24) function select:

- 0 = PALI (default, if bit 2 is selected to output PALI)
- 1 = Lock indicator (Indicates whether device is locked both horizontally and vertically)

FID/GLCO (pin 23) function select (also refer to register 03h for enhanced functionality):

- 0 = FID
- 1 = GLCO (default)

VSYNC/PALI (pin 24) function select (also refer to register 03h for enhanced functionality):

- 0 = VSYNC (default)
- 1 = PALI

INTREQ/GPCL/VBLK (pin 27) function select:

- 0 = INTREQ (default)
- 1 = GPCL or VBLK depending on bit 7 of register 03h

SCLK/PCLK (pin 9) function select:

- 0 = SCLK (default)
- 1 = PCLK (1x pixel clock frequency)

**3.22.17 Active Video Cropping Start Pixel MSB**

|         |     |
|---------|-----|
| Address | 11h |
|---------|-----|

|                  |   |   |   |   |   |   |   |
|------------------|---|---|---|---|---|---|---|
| 7                | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| AVIDST_MSB [9:2] |   |   |   |   |   |   |   |

Active video cropping start pixel MSB [9:2], set this register first before setting register 12h. The TVP5150 device updates the AVID start values only when register 12h is written to.

**3.22.18 Active Video Cropping Start Pixel LSB**

|         |     |
|---------|-----|
| Address | 12h |
|---------|-----|

|          |   |   |   |   |             |                  |   |
|----------|---|---|---|---|-------------|------------------|---|
| 7        | 6 | 5 | 4 | 3 | 2           | 1                | 0 |
| Reserved |   |   |   |   | AVID active | AVIDST_LSB [1:0] |   |

AVID active:

0 = AVID out active in VBLK (default)

1 = AVID out inactive in VBLK

Active video cropping start pixel LSB [1:0]: The TVP5150 device updates the AVID start values only when this register is written to.

AVID start [9:0] (combined registers 11h and 12h):

01 1111 1111 = 511

00 0000 0001 = 1

00 0000 0000 = 0 (default)

11 1111 1111 = -1

10 0000 0000 = -512

**3.22.19 Active Video Cropping Stop Pixel MSB**

|         |     |
|---------|-----|
| Address | 13h |
|---------|-----|

|                     |   |   |   |   |   |   |   |
|---------------------|---|---|---|---|---|---|---|
| 7                   | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| AVID stop pixel MSB |   |   |   |   |   |   |   |

Active video cropping stop pixel MSB [9:2], set this register first before setting the register 14h. The TVP5150 device updates the AVID stop values only when register 14h is written to.

**3.22.20 Active Video Cropping Stop Pixel LSB**

|         |     |
|---------|-----|
| Address | 14h |
|---------|-----|

|          |   |   |   |   |   |                     |   |
|----------|---|---|---|---|---|---------------------|---|
| 7        | 6 | 5 | 4 | 3 | 2 | 1                   | 0 |
| Reserved |   |   |   |   |   | AVID stop pixel LSB |   |

Active video cropping stop pixel LSB [1:0]: The number of pixels of active video must be an even number. The TVP5150 device updates the AVID stop values only when this register is written to.

AVID stop [9:0] (combined registers 13h and 14h):

01 1111 1111 = 511

00 0000 0001 = 1

00 0000 0000 = 0 (default) (see Figure 3-10)

11 1111 1111 = -1

10 0000 0000 = -512

### 3.22.21 Genlock and RTC Register

|          |     |   |   |   |         |          |           |
|----------|-----|---|---|---|---------|----------|-----------|
| Address  | 15h |   |   |   |         |          |           |
| 7        | 6   | 5 | 4 | 3 | 2       | 1        | 0         |
| Reserved |     |   |   |   | CDTO_SW | Reserved | GLCO/ RTC |

CDTO\_LSB\_Switch (CDTO\_SW):

0 = CDTO\_LSB is forced to 0

1 = CDTO\_LSB is forced to 1 (default)

GLCO/RTC:

0 = GLCO output

1 = RTC output (default)

Figure 3–13 shows the timing of GLCO and Figure 3–14 shows the timing of RTC.

### 3.22.22 Horizontal Sync (HSYNC) Start Register

|             |     |   |   |   |   |   |   |
|-------------|-----|---|---|---|---|---|---|
| Address     | 16h |   |   |   |   |   |   |
| 7           | 6   | 5 | 4 | 3 | 2 | 1 | 0 |
| HSYNC start |     |   |   |   |   |   |   |

HSYNC start:

1111 1111 = –127 x 4 pixel clocks

1111 1110 = –126 x 4 pixel clocks

1111 1101 = –125 x 4 pixel clocks

1000 0000 = 0 pixel clocks (default)

0111 1111 = 1 x 4 pixel clocks

0111 1110 = 2 x 4 pixel clocks

0000 0000 = 128 x 4 pixel clocks

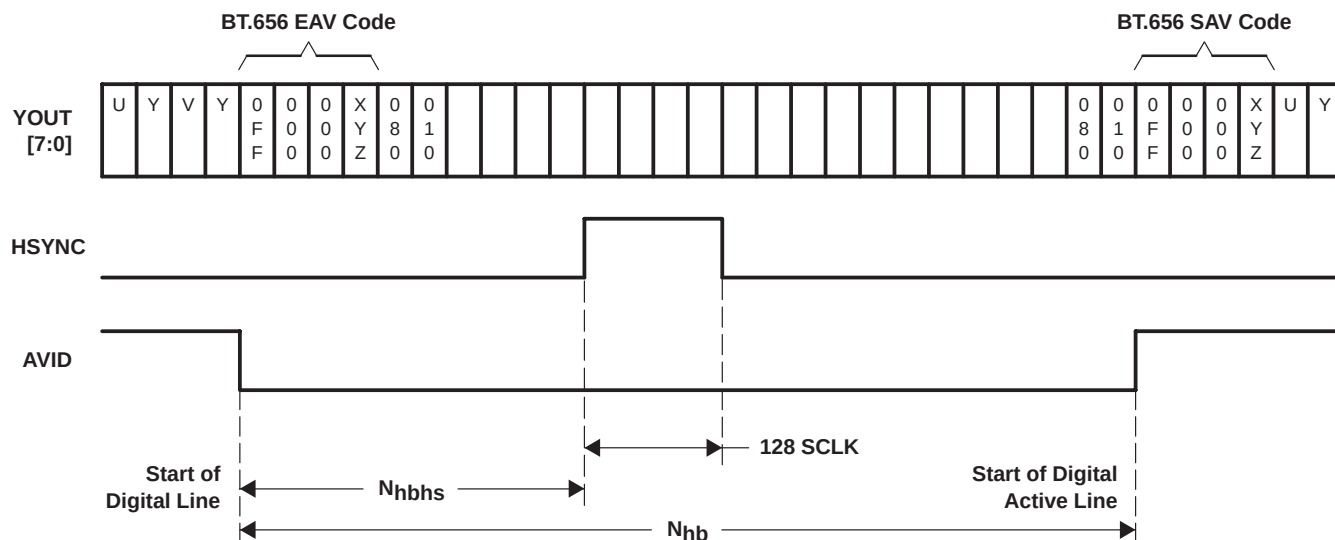


Figure 3–15. Horizontal Sync

Table 3–11. Clock Delays (SCLKs)

| STANDARD | Nhbhs | Nhb |
|----------|-------|-----|
| NTSC 601 | 32    | 272 |
| PAL 601  | 24    | 284 |

Detailed timing information is also available in Section 3.15, *Synchronization Signals*.

### 3.22.23 Vertical Blanking Start Register

|         |     |
|---------|-----|
| Address | 18h |
|---------|-----|

|                         |   |   |   |   |   |   |   |
|-------------------------|---|---|---|---|---|---|---|
| 7                       | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Vertical blanking start |   |   |   |   |   |   |   |

Vertical blanking (VBLK) start:

0111 1111 = 127 lines after start of vertical blanking interval

0000 0001 = 1 line after start of vertical blanking interval

0000 0000 = Same time as start of vertical blanking interval (default) (see Figure 3–9)

1000 0001 = 1 line before start of vertical blanking interval

1111 1111 = 128 lines before start of vertical blanking interval

Vertical blanking is adjustable with respect to the standard vertical blanking intervals. The setting in this register determines the timing of the GPCL/VBLK signal when it is configured to output vertical blank (see register 03h). The setting in this register also determines the duration of the luma bypass function (see register 07h).

### 3.22.24 Vertical Blanking Stop Register

|         |     |
|---------|-----|
| Address | 19h |
|---------|-----|

|                        |   |   |   |   |   |   |   |
|------------------------|---|---|---|---|---|---|---|
| 7                      | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Vertical blanking stop |   |   |   |   |   |   |   |

Vertical blanking (VBLK) stop:

0111 1111 = 127 lines after stop of vertical blanking interval

0000 0001 = 1 line after stop of vertical blanking interval

0000 0000 = Same time as stop of vertical blanking interval (default) (see Figure 3–9)

1000 0001 = 1 line before stop of vertical blanking interval

1111 1111 = 128 lines before stop of vertical blanking interval

Vertical blanking is adjustable with respect to the standard vertical blanking intervals. The setting in this register determines the timing of the GPCL/VBLK signal when it is configured to output vertical blank (see register 03h). The setting in this register also determines the duration of the luma bypass function (see register 07h).

### 3.22.25 Chrominance Control #1 Register

|         |     |
|---------|-----|
| Address | 1Ah |
|---------|-----|

|          |   |   |                 |                                               |                                     |                              |   |
|----------|---|---|-----------------|-----------------------------------------------|-------------------------------------|------------------------------|---|
| 7        | 6 | 5 | 4               | 3                                             | 2                                   | 1                            | 0 |
| Reserved |   |   | Color PLL reset | Chrominance adaptive comb filter enable (ACE) | Chrominance comb filter enable (CE) | Automatic color gain control |   |

Color PLL reset:

0 = Color PLL not reset (default)

1 = Color PLL reset

Color PLL phase is reset to zero and the color PLL reset bit then immediately returns to zero. When this bit is set, the subcarrier PLL phase reset bit is transmitted on terminal 23 (GLCO) on the next line (NTSC or PAL).

Chrominance adaptive comb filter enable (ACE):

0 = Disable  
1 = Enable (default)

Chrominance comb filter enable (CE):

0 = Disable  
1 = Enable (default)

Automatic color gain control (ACGC):

00 = ACGC enabled (default)  
01 = Reserved  
10 = ACGC disabled  
11 = ACGC frozen to the previously set value

### 3.22.26 Chrominance Control #2 Register

|         |     |
|---------|-----|
| Address | 1Bh |
|---------|-----|

|                                    |   |   |   |          |     |                           |   |
|------------------------------------|---|---|---|----------|-----|---------------------------|---|
| 7                                  | 6 | 5 | 4 | 3        | 2   | 1                         | 0 |
| Chrominance comb filter mode [3:0] |   |   |   | Reserved | WCF | Chrominance filter select |   |

Chrominance comb filter mode [3:0] (CM[3:0]): Chrominance control #2 register 1Bh, bits 7–4

| ACE            | CE | CM[3] | CM[2]          | CM[1]          | CM[0]          | COMB FILTER SELECTION                                                     |
|----------------|----|-------|----------------|----------------|----------------|---------------------------------------------------------------------------|
| 0              | 0  | X     | X              | X              | X              | Comb filter disabled                                                      |
| 0              | 1  | 0     | 0              | 0              | X              | Fixed 3-line comb filter with (1, 2, 1)/4 coefficients                    |
| 0              | 1  | 0     | 0              | 1              | X              | Fixed 3-line comb filter with (1, 0, 1)/2 coefficients                    |
| 0              | 1  | 1     | 0              | X              | X              | Fixed 2-line comb filter                                                  |
| 0              | 1  | 0     | 1              | 0              | X              | Fixed 4-line (1, 1, 1, 1)/4 comb filter                                   |
| 0              | 1  | 0     | 1              | 1              | X              | Fixed 4-line (1, 3, 3, 1)/8 comb filter                                   |
| 0              | 1  | 1     | 1              | X              | X              | Fixed 2-line comb filter                                                  |
| 1              | X  | X     | 0              | 0              | 0              | Adaptive between 3-line (1, 2, 1)/4 and 2-line comb filter                |
| 1 <sup>†</sup> | X  | X     | 0 <sup>†</sup> | 0 <sup>†</sup> | 1 <sup>†</sup> | Adaptive between 3-line (1, 2, 1)/4 comb filter and no comb filter        |
| 1              | X  | X     | 0              | 1              | 0              | Adaptive between 3-line (1, 0, 1)/2 comb filter and 2-line comb filter    |
| 1              | X  | X     | 0              | 1              | 1              | Adaptive between 3-line (1, 0, 1)/2 comb filter and no comb filter        |
| 1              | X  | X     | 1              | 0              | 0              | Adaptive between 4-line (1, 1, 1, 1)/4 and 2-line comb filter             |
| 1 <sup>‡</sup> | X  | X     | 1 <sup>‡</sup> | 0 <sup>‡</sup> | 1 <sup>‡</sup> | Adaptive between 4-line (1, 1, 1, 1)/4 comb filter and no comb filter     |
| 1              | X  | X     | 1              | 1              | 0              | Adaptive between 4-line (1, 3, 3, 1)/8 comb filter and 2-line comb filter |
| 1              | X  | X     | 1              | 1              | 1              | Adaptive between 4-line (1, 3, 3, 1)/8 comb filter and no comb filter     |

<sup>†</sup> Indicates default settings for NTSC

<sup>‡</sup> Indicates default settings for PAL mode

Wideband chroma filter (WCF):

0 = Disable  
1 = Enable (default)

Chrominance filter select:

00 = No notch (default)  
01 = Notch 1  
10 = Notch 2  
11 = Notch 3

Chrominance output bandwidth (MHz):

| WCF | FILTER SELECT | NTSC ITU-R BT.601 | PAL ITU-R BT.601 |
|-----|---------------|-------------------|------------------|
| 0   | 00            | 1.2214            | 1.2214           |
|     | 01            | 0.8782            | 0.8782           |
|     | 10            | 0.7297            | 0.7297           |
|     | 11            | 0.4986            | 0.4986           |
| 1   | 00            | 1.4170            | 1.4170           |
|     | 01            | 1.0303            | 1.0303           |
|     | 10            | 0.8438            | 0.8438           |
|     | 11            | 0.5537            | 0.5537           |

### 3.22.27 Interrupt Reset Register B

|         |     |
|---------|-----|
| Address | 1Ch |
|---------|-----|

| 7                             | 6                                | 5                   | 4                        | 3                              | 2                        | 1                      | 0                    |
|-------------------------------|----------------------------------|---------------------|--------------------------|--------------------------------|--------------------------|------------------------|----------------------|
| Software initialization reset | Macrovision detect changed reset | Command ready reset | Field rate changed reset | Line alternation changed reset | Color lock changed reset | H/V lock changed reset | TV/VCR changed reset |

Software initialization reset:

- 0 = No effect (default)
- 1 = Reset software initialization bit

Macrovision detect changed reset:

- 0 = No effect (default)
- 1 = Reset macrovision detect changed bit

Command ready reset:

- 0 = No effect (default)
- 1 = Reset command ready bit

Field rate changed reset:

- 0 = No effect (default)
- 1 = Reset field rate changed bit

Line alternation changed reset:

- 0 = No effect (default)
- 1 = Reset line alternation changed bit

Color lock changed reset:

- 0 = No effect (default)
- 1 = Reset color lock changed bit

H/V lock changed reset:

- 0 = No effect (default)
- 1 = Reset H/V lock changed bit

TV/VCR changed reset [TV/VCR mode is determined by counting the total number of lines/frame. The mode switches to VCR for nonstandard number of lines]:

- 0 = No effect (default)
- 1 = Reset TV/VCR changed bit

Interrupt reset register B is used by the external processor to reset the interrupt status bits in interrupt status register B. Bits loaded with a 1 allow the corresponding interrupt status bit to reset to 0. Bits loaded with a 0 have no effect on the interrupt status bits.

### 3.22.28 Interrupt Enable Register B

|         |     |
|---------|-----|
| Address | 1Dh |
|---------|-----|

| 7                                       | 6                          | 5                    | 4                  | 3                        | 2                  | 1                | 0              |
|-----------------------------------------|----------------------------|----------------------|--------------------|--------------------------|--------------------|------------------|----------------|
| Software initialization occurred enable | Macrovision detect changed | Command ready enable | Field rate changed | Line alternation changed | Color lock changed | H/V lock changed | TV/VCR changed |

Software initialization occurred enable:

- 0 = Disabled (default)
- 1 = Enabled

Macrovision detect changed:

- 0 = Disabled (default)
- 1 = Enabled

Command ready enable:

- 0 = Disabled (default)
- 1 = Enabled

Field rate changed:

- 0 = Disabled (default)
- 1 = Enabled

Line alternation changed:

- 0 = Disabled (default)
- 1 = Enabled

Color lock changed:

- 0 = Disabled (default)
- 1 = Enabled

H/V lock changed:

- 0 = Disabled (default)
- 1 = Enabled

TV/VCR changed:

- 0 = Disabled (default)
- 1 = Enabled

Interrupt enable register B is used by the external processor to mask unnecessary interrupt sources for interrupt B. Bits loaded with a 1 allow the corresponding interrupt condition to generate an interrupt on the external pin. Conversely, bits loaded with a 0 mask the corresponding interrupt condition from generating an interrupt on the external pin. This register only affects the external pin, it does not affect the bits in the interrupt status register. A given condition can set the appropriate bit in the status register and not cause an interrupt on the external pin. To determine if this device is driving the interrupt pin either AND interrupt status register B with interrupt enable register B or check the state of interrupt B in the interrupt B active register.

**3.22.29 Interrupt Configuration Register B**

|         |     |
|---------|-----|
| Address | 1Eh |
|---------|-----|

|          |   |   |   |   |   |   |                      |
|----------|---|---|---|---|---|---|----------------------|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0                    |
| Reserved |   |   |   |   |   |   | Interrupt polarity B |

Interrupt polarity B:

0 = Interrupt B is active low (default).

1 = Interrupt B is active high.

Interrupt polarity B must be same as interrupt polarity A bit at bit 0 of the interrupt configuration register A at address C2h.

Interrupt configuration register B is used to configure the polarity of interrupt B on the external interrupt pin. When the interrupt B is configured for active low, the pin is driven low when active and high-impedance when inactive (open-collector). Conversely, when the interrupt B is configured for active high, it is driven high-impedance for active and driven low for inactive.

**3.22.30 Video Standard Register**

|         |     |
|---------|-----|
| Address | 28h |
|---------|-----|

|          |   |   |   |                |   |   |   |
|----------|---|---|---|----------------|---|---|---|
| 7        | 6 | 5 | 4 | 3              | 2 | 1 | 0 |
| Reserved |   |   |   | Video standard |   |   |   |

Video standard:

- 0000 = Autoswitch mode (default)
- 0001 = Reserved
- 0010 = (M) NTSC ITU-R BT.601
- 0011 = Reserved
- 0100 = (B, G, H, I, N) PAL ITU-R BT.601
- 0101 = Reserved
- 0110 = (M) PAL ITU-R BT.601
- 0111 = Reserved
- 1000 = (Combination-N) ITU-R BT.601
- 1001 = Reserved
- 1010 = NTSC 4.43 ITU-R BT.601
- 1011 = Reserved
- 1100 = Reserved

With the autoswitch code running, the user can force the device to operate in a particular video standard mode and sample rate by writing the appropriate value into this register.

**3.22.31 MSB of Device ID Register**

|         |     |
|---------|-----|
| Address | 80h |
|---------|-----|

|                  |   |   |   |   |   |   |   |
|------------------|---|---|---|---|---|---|---|
| 7                | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| MSB of device ID |   |   |   |   |   |   |   |

This register identifies the MSB of the device ID. Value = 0x51.

**3.22.32 LSB of Device ID Register**

|         |     |
|---------|-----|
| Address | 81h |
|---------|-----|

|                  |   |   |   |   |   |   |   |
|------------------|---|---|---|---|---|---|---|
| 7                | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| LSB of device ID |   |   |   |   |   |   |   |

This register identifies the LSB of the device ID. Value = 0x50.

**3.22.33 ROM Version Register**

|         |     |
|---------|-----|
| Address | 82h |
|---------|-----|

|                                          |   |   |   |   |   |   |   |
|------------------------------------------|---|---|---|---|---|---|---|
| 7                                        | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ROM version: 0x01 for 1.0, 0x20 for 2.00 |   |   |   |   |   |   |   |

Value = 0x02

**3.22.34 RAM Patch Code Version Register**

|         |     |
|---------|-----|
| Address | 83h |
|---------|-----|

|                                                                                      |   |   |   |   |   |   |   |
|--------------------------------------------------------------------------------------|---|---|---|---|---|---|---|
| 7                                                                                    | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RAM patch code version: 0x10 for combined version 2-1, 0x20 for combined version 2-2 |   |   |   |   |   |   |   |

Value = 0x10

**3.22.35 Vertical Line Count MSB Register**

|         |     |
|---------|-----|
| Address | 84h |
|---------|-----|

|          |   |   |   |   |   |                         |   |
|----------|---|---|---|---|---|-------------------------|---|
| 7        | 6 | 5 | 4 | 3 | 2 | 1                       | 0 |
| Reserved |   |   |   |   |   | Vertical line count MSB |   |

Vertical line count bits [9:8]

**3.22.36 Vertical Line Count LSB Register**

|         |     |
|---------|-----|
| Address | 85h |
|---------|-----|

|                         |   |   |   |   |   |   |   |
|-------------------------|---|---|---|---|---|---|---|
| 7                       | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Vertical line count LSB |   |   |   |   |   |   |   |

Vertical line count bits [7:0]

Registers 84h and 85h can be read and combined to extract the current vertical line count. This can be used with nonstandard video signals such as a VCR in fast-forward or rewind modes to synchronize the downstream video circuitry.

**3.22.37 Interrupt Status Register B**

|         |     |
|---------|-----|
| Address | 86h |
|---------|-----|

|                         |                            |          |                    |                          |                    |                  |                |
|-------------------------|----------------------------|----------|--------------------|--------------------------|--------------------|------------------|----------------|
| 7                       | 6                          | 5        | 4                  | 3                        | 2                  | 1                | 0              |
| Software initialization | Macrovision detect changed | Reserved | Field rate changed | Line alternation changed | Color lock changed | H/V lock changed | TV/VCR changed |

Software initialization:

0 = Software initialization is not ready (default).

1 = Software initialization is ready.

Macrovision detect changed:

0 = Macrovision detect status has not changed (default).

1 = Macrovision detect status has changed.

Field rate changed:

0 = Field rate has not changed (default).

1 = Field rate has changed.

Line alternation changed:

- 0 = Line alteration has not changed (default).
- 1 = Line alternation has changed.

Color lock changed:

- 0 = Color lock status has not changed (default).
- 1 = Color lock status has changed.

H/V lock changed:

- 0 = H/V lock status has not changed (default).
- 1 = H/V lock status has changed.

TV/VCR changed:

- 0 = TV/VCR status has not changed (default).
- 1 = TV/VCR status has changed.

Interrupt status register B is polled by the external processor to determine the interrupt source for interrupt B. After an interrupt condition is set, it can be reset by writing to the interrupt reset register B at subaddress 1Ch with a 1 in the appropriate bit.

### 3.22.38 Interrupt Active Register B

|         |     |
|---------|-----|
| Address | 87h |
|---------|-----|

|          |   |   |   |   |   |   |             |
|----------|---|---|---|---|---|---|-------------|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0           |
| Reserved |   |   |   |   |   |   | Interrupt B |

Interrupt B:

- 0 = Interrupt B is not active on the external terminal (default).
- 1 = Interrupt B is active on the external terminal.

The interrupt active register B is polled by the external processor to determine if interrupt B is active.

### 3.22.39 Status Register #1

|         |     |
|---------|-----|
| Address | 88h |
|---------|-----|

|                          |                         |                   |                  |                              |                           |                             |               |
|--------------------------|-------------------------|-------------------|------------------|------------------------------|---------------------------|-----------------------------|---------------|
| 7                        | 6                       | 5                 | 4                | 3                            | 2                         | 1                           | 0             |
| Peak white detect status | Line-alternating status | Field rate status | Lost lock detect | Color subcarrier lock status | Vertical sync lock status | Horizontal sync lock status | TV/VCR status |

Peak white detect status:

- 0 = Peak white is not detected.
- 1 = Peak white is detected.

Line-alternating status:

- 0 = Nonline alternating
- 1 = Line alternating

Field rate status:

- 0 = 60 Hz
- 1 = 50 Hz

Lost lock detect:

0 = No lost lock since status register #1 was last read.  
 1 = Lost lock since status register #1 was last read.

Color subcarrier lock status:

0 = Color subcarrier is not locked.  
 1 = Color subcarrier is locked.

Vertical sync lock status:

0 = Vertical sync is not locked.  
 1 = Vertical sync is locked.

Horizontal sync lock status:

0 = Horizontal sync is not locked.  
 1 = Horizontal sync is locked.

TV/VCR status [TV/VCR mode is determined by counting the total number of lines/frame. The mode switches to VCR for nonstandard number of lines]:

0 = TV  
 1 = VCR

### 3.22.40 Status Register #2

|         |     |
|---------|-----|
| Address | 89h |
|---------|-----|

| 7        | 6                     | 5                   | 4                     | 3                            | 2        | 1                     | 0 |
|----------|-----------------------|---------------------|-----------------------|------------------------------|----------|-----------------------|---|
| Reserved | Weak signal detection | PAL switch polarity | Field sequence status | AGC and offset frozen status | Reserved | Macrovision detection |   |

Weak signal detection:

0 = No weak signal  
 1 = Weak signal mode

PAL switch polarity of first line of odd field:

0 = PAL switch is 0  
 1 = PAL switch is 1

Field sequence status:

0 = Even field  
 1 = Odd field

AGC and offset frozen status:

0 = AGC and offset are not frozen.  
 1 = AGC and offset are frozen.

Macrovision detection:

00 = No copy protection  
 01 = AGC pulses/pseudo-syncs present  
 10 = AGC pulses/pseudo-syncs and 2-line color striping present  
 11 = AGC pulses/pseudo-syncs and 4-line color striping present

**3.22.41 Status Register #3**

|         |     |
|---------|-----|
| Address | 8Ah |
|---------|-----|

|          |   |   |   |   |   |   |   |
|----------|---|---|---|---|---|---|---|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| AGC gain |   |   |   |   |   |   |   |

AGC gain:

0000 0000 = -6 dB

0100 0000 = -3 dB

1000 0000 = 0 dB

1100 0000 = 3 dB

1111 1111 = 6 dB

**3.22.42 Status Register #4**

|         |     |
|---------|-----|
| Address | 8Bh |
|---------|-----|

|                                      |   |   |   |   |   |   |   |
|--------------------------------------|---|---|---|---|---|---|---|
| 7                                    | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Subcarrier to horizontal (SCH) phase |   |   |   |   |   |   |   |

SCH (color PLL subcarrier phase at 50% of the falling edge of horizontal sync of line one of odd field; step size  $360^\circ/256$ ):

0000 0000 =  $0.00^\circ$

0000 0001 =  $1.41^\circ$

0000 0010 =  $2.81^\circ$

1111 1110 =  $357.2^\circ$

1111 1111 =  $358.6^\circ$

**3.22.43 Status Register #5**

|         |     |
|---------|-----|
| Address | 8Ch |
|---------|-----|

|                 |          |   |   |                |   |               |   |
|-----------------|----------|---|---|----------------|---|---------------|---|
| 7               | 6        | 5 | 4 | 3              | 2 | 1             | 0 |
| Autoswitch mode | Reserved |   |   | Video standard |   | Sampling rate |   |

This register contains information about the detected video standard and the sampling rate at which the device is currently operating. When autoswitch code is running, this register must be tested to determine which video standard has been detected.

Autoswitch mode:

0 = Stand-alone (forced video standard) mode

1 = Autoswitch mode

Video standard:

| VIDEO STANDARD [3:1] |      |      | SR    | VIDEO STANDARD                   |
|----------------------|------|------|-------|----------------------------------|
| BIT 3                | BIT2 | BIT1 | BIT 0 |                                  |
| 0                    | 0    | 0    | 0     | Reserved                         |
| 0                    | 0    | 0    | 1     | (M) NTSC ITU-R BT.601            |
| 0                    | 0    | 1    | 0     | Reserved                         |
| 0                    | 0    | 1    | 1     | (B, G, H, I, N) PAL ITU-R BT.601 |
| 0                    | 1    | 0    | 0     | Reserved                         |
| 0                    | 1    | 0    | 1     | (M) PAL ITU-R BT.601             |
| 0                    | 1    | 1    | 0     | Reserved                         |
| 0                    | 1    | 1    | 1     | (Combination-N) ITU-R BT.601     |
| 1                    | 0    | 0    | 0     | Reserved                         |
| 1                    | 0    | 0    | 1     | NTSC 4.43 ITU-R BT.601           |
| 1                    | 0    | 1    | 0     | Reserved                         |
| 1                    | 0    | 1    | 1     | Reserved                         |

Sampling rate (SR):

0 = Reserved

1 = ITU-R BT.601

### 3.22.44 Closed Caption Data Registers

|         |         |
|---------|---------|
| Address | 90h–93h |
|---------|---------|

| Address | 7                             | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------|-------------------------------|---|---|---|---|---|---|---|
| 90h     | Closed caption field 1 byte 1 |   |   |   |   |   |   |   |
| 91h     | Closed caption field 1 byte 2 |   |   |   |   |   |   |   |
| 92h     | Closed caption field 2 byte 1 |   |   |   |   |   |   |   |
| 93h     | Closed caption field 2 byte 2 |   |   |   |   |   |   |   |

These registers contain the closed caption data arranged in bytes per field.

### 3.22.45 WSS Data Registers

|         |         |
|---------|---------|
| Address | 94h–99h |
|---------|---------|

NTSC

| ADDRESS | 7   | 6   | 5   | 4   | 3   | 2   | 1   | 0   | BYTE               |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|--------------------|
| 94h     |     |     | b5  | b4  | b3  | b2  | b1  | b0  | WSS field 1 byte 1 |
| 95h     | b13 | b12 | b11 | b10 | b9  | b8  | b7  | b6  | WSS field 1 byte 2 |
| 96h     |     |     | b19 | b18 | b17 | b16 | b15 | b14 | WSS field 1 byte 3 |
| 97h     |     |     | b5  | b4  | b3  | b2  | b1  | b0  | WSS field 2 byte 1 |
| 98h     | b13 | b12 | b11 | b10 | b9  | b8  | b7  | b6  | WSS field 2 byte 2 |
| 99h     |     |     | b19 | b18 | b17 | b16 | b15 | b14 | WSS field 2 byte 3 |

These registers contain the wide screen signaling (WSS) data for NTSC.

Bits 0–1 represent word 0, aspect ratio

Bits 2–5 represent word 1, header code for word 2

Bits 6–13 represent word 2, copy control

Bits 14–19 represent word 3, CRC

## PAL

| ADDRESS | 7        | 6  | 5   | 4   | 3   | 2   | 1  | 0  | BYTE               |
|---------|----------|----|-----|-----|-----|-----|----|----|--------------------|
| 94h     | b7       | b6 | b5  | b4  | b3  | b2  | b1 | b0 | WSS field 1 byte 1 |
| 95h     |          |    | b13 | b12 | b11 | b10 | b9 | b8 | WSS field 1 byte 2 |
| 96h     | b7       | b6 | b5  | b4  | b3  | b2  | b1 | b0 | WSS field 2 byte 1 |
| 97h     |          |    | b13 | b12 | b11 | b10 | b9 | b8 | WSS field 2 byte 2 |
| 98h     | Reserved |    |     |     |     |     |    |    |                    |
| 99h     | Reserved |    |     |     |     |     |    |    |                    |

PAL:

- Bits 0–3 represent group 1, aspect ratio
- Bits 4–7 represent group 2, enhanced services
- Bits 8–10 represent group 3, subtitles
- Bits 11–13 represent group 4, others

**3.22.46 VPS Data Registers**

|         |         |
|---------|---------|
| Address | 9Ah–A6h |
|---------|---------|

| ADDRESS | 7           | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------|-------------|---|---|---|---|---|---|---|
| 9Ah     | VPS byte 1  |   |   |   |   |   |   |   |
| 9Bh     | VPS byte 2  |   |   |   |   |   |   |   |
| 9Ch     | VPS byte 3  |   |   |   |   |   |   |   |
| 9Dh     | VPS byte 4  |   |   |   |   |   |   |   |
| 9Eh     | VPS byte 5  |   |   |   |   |   |   |   |
| 9Fh     | VPS byte 6  |   |   |   |   |   |   |   |
| A0h     | VPS byte 7  |   |   |   |   |   |   |   |
| A1h     | VPS byte 8  |   |   |   |   |   |   |   |
| A2h     | VPS byte 9  |   |   |   |   |   |   |   |
| A3h     | VPS byte 10 |   |   |   |   |   |   |   |
| A4h     | VPS byte 11 |   |   |   |   |   |   |   |
| A5h     | VPS byte 12 |   |   |   |   |   |   |   |
| A6h     | VPS byte 13 |   |   |   |   |   |   |   |

These registers contain the entire VPS data line except the clock run-in code or the start code.

**3.22.47 VITC Data Registers**

|         |         |
|---------|---------|
| Address | A7h–AFh |
|---------|---------|

| ADDRESS | 7                           | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------|-----------------------------|---|---|---|---|---|---|---|
| A7h     | VITC byte 1, frame byte 1   |   |   |   |   |   |   |   |
| A8h     | VITC byte 2, frame byte 2   |   |   |   |   |   |   |   |
| A9h     | VITC byte 3, seconds byte 1 |   |   |   |   |   |   |   |
| AAh     | VITC byte 4, seconds byte 2 |   |   |   |   |   |   |   |
| ABh     | VITC byte 5, minutes byte 1 |   |   |   |   |   |   |   |
| ACH     | VITC byte 6, minutes byte 2 |   |   |   |   |   |   |   |
| ADh     | VITC byte 7, hour byte 1    |   |   |   |   |   |   |   |
| Aeh     | VITC byte 8, hour byte 2    |   |   |   |   |   |   |   |
| AFh     | VITC byte 9, CRC            |   |   |   |   |   |   |   |

These registers contain the VITC data.

### 3.22.48 VBI FIFO Read Data Register

|         |     |
|---------|-----|
| Address | B0h |
|---------|-----|

|                |   |   |   |   |   |   |   |
|----------------|---|---|---|---|---|---|---|
| 7              | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| FIFO read data |   |   |   |   |   |   |   |

This address is provided to access VBI data in the FIFO through the host port. All forms of teletext data come directly from the FIFO, while all other forms of VBI data can be programmed to come from the registers or from the FIFO. Current status of the FIFO can be found at address C6h and the number of bytes in the FIFO is located at address C7h. If the host port is to be used to read data from the FIFO, then the output formatter must be disabled at address CDh bit 0. The format used for the VBI FIFO is shown in Section 3.12.

### 3.22.49 Teletext Filter and Mask Registers

|         |         |
|---------|---------|
| Address | B1h–BAh |
|---------|---------|

| ADDRESS | 7               | 6 | 5 | 4 | 3                  | 2 | 1 | 0 |
|---------|-----------------|---|---|---|--------------------|---|---|---|
| B1h     | Filter 1 Mask 1 |   |   |   | Filter 1 Pattern 1 |   |   |   |
| B2h     | Filter 1 Mask 2 |   |   |   | Filter 1 Pattern 2 |   |   |   |
| B3h     | Filter 1 Mask 3 |   |   |   | Filter 1 Pattern 3 |   |   |   |
| B4h     | Filter 1 Mask 4 |   |   |   | Filter 1 Pattern 4 |   |   |   |
| B5h     | Filter 1 Mask 5 |   |   |   | Filter 1 Pattern 5 |   |   |   |
| B6h     | Filter 2 Mask 1 |   |   |   | Filter 2 Pattern 1 |   |   |   |
| B7h     | Filter 2 Mask 2 |   |   |   | Filter 2 Pattern 2 |   |   |   |
| B8h     | Filter 2 Mask 3 |   |   |   | Filter 2 Pattern 3 |   |   |   |
| B9h     | Filter 2 Mask 4 |   |   |   | Filter 2 Pattern 4 |   |   |   |
| BAh     | Filter 2 Mask 5 |   |   |   | Filter 2 Pattern 5 |   |   |   |

For an NABTS system, the packet prefix consists of five bytes. Each byte contains four data bits (D[3:0]) interlaced with four Hamming protection bits (H[3:0]):

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|-------|-------|-------|-------|-------|-------|-------|-------|
| D[3]  | H[3]  | D[2]  | H[2]  | D[1]  | H[1]  | D[0]  | H[0]  |

Only the data portion D[3:0] from each byte is applied to a teletext filter function with corresponding pattern bits P[3:0] and mask bits M[3:0]. Hamming protection bits are ignored by the filter.

For a WST system (PAL or NTSC), the packet prefix consists of two bytes so that two patterns are used. Patterns 3, 4, and 5 are ignored.

The mask bits enable filtering using the corresponding bit in the pattern register. For example, a 1 in the LSB of mask 1 means that the filter module must compare the LSB of nibble 1 in the pattern register to the first data bit on the transaction. If these match, then a true result is returned. A 0 in a bit of mask 1 means that the filter module must ignore that data bit of the transaction. If all 0s are programmed in the mask bits, then the filter matches all patterns returning a true result (default 00h).

Pattern and mask for each byte and filter are referred as <1,2><P,M><1,2,3,4,5> where:

- <1,2> identifies the filter 1 or 2
- <P,M> identifies the pattern or mask
- <1,2,3,4,5> identifies the byte number

**3.22.50 Teletext Filter Control Register**

|         |     |
|---------|-----|
| Address | BBh |
|---------|-----|

| 7        | 6 | 5 | 4            | 3 | 2    | 1                   | 0                   |
|----------|---|---|--------------|---|------|---------------------|---------------------|
| Reserved |   |   | Filter logic |   | Mode | TTX filter 2 enable | TTX filter 1 enable |

Filter logic: allows different logic to be applied when combining the decision of filter 1 and filter 2 as follows:

00 = NOR (Default)

01 = NAND

10 = OR

11 = AND

Mode:

0 = Teletext WST PAL mode B (2 header bytes) (default)

1 = Teletext NABTS NTSC mode C (5 header bytes)

TTX filter 2 enable:

0 = Disabled (default)

1 = Enabled

TTX filter 1 enable:

0 = Disabled (default)

1 = Enabled

If the filter matches or if the filter mask is all 0s, then a true result is returned.

**3.22.51 Interrupt Status Register A**

|         |     |
|---------|-----|
| Address | C0h |
|---------|-----|

| 7                    | 6              | 5                        | 4                   | 3        | 2                        | 1              | 0              |
|----------------------|----------------|--------------------------|---------------------|----------|--------------------------|----------------|----------------|
| Lock state interrupt | Lock interrupt | Cycle complete interrupt | Bus error interrupt | Reserved | FIFO threshold interrupt | Line interrupt | Data interrupt |

The interrupt status register A can be polled by the host processor to determine the source of an interrupt. After an interrupt condition is set it can be reset by writing to this register with a 1 in the appropriate bit(s).

Lock state interrupt:

0 = TVP5150 is not locked to the video signal.

1 = TVP5150 is locked to the video signal.

Lock interrupt:

0 = A transition has not occurred on the lock signal.

1 = A transition has occurred on the lock signal.

Cycle complete interrupt:

0 = Read or write cycle in progress

1 = Read or write cycle complete

Bus error interrupt:

0 = No bus error

1 = PHI interface detected an illegal access

FIFO threshold interrupt:

- 0 = The amount of data in the FIFO has not yet crossed the threshold programmed at address C8h.
- 1 = The amount of data in the FIFO has crossed the threshold programmed at address C8h.

Line interrupt:

- 0 = The video line number has not yet been reached.
- 1 = The video line number programmed in address CAh has occurred.

Data interrupt:

- 0 = No data is available.
- 1 = VBI data is available either in the FIFO or in the VBI data registers.

### 3.22.52 Interrupt Enable Register A

|         |     |
|---------|-----|
| Address | C1h |
|---------|-----|

| 7        | 6                     | 5                               | 4                          | 3        | 2                               | 1                     | 0                     |
|----------|-----------------------|---------------------------------|----------------------------|----------|---------------------------------|-----------------------|-----------------------|
| Reserved | Lock interrupt enable | Cycle complete interrupt enable | Bus error interrupt enable | Reserved | FIFO threshold interrupt enable | Line interrupt enable | Data interrupt enable |

The interrupt enable register A is used by the host processor to mask unnecessary interrupt sources. Bits loaded with a 1 allow the corresponding interrupt condition to generate an interrupt on the external pin. Conversely, bits loaded with a 0 mask the corresponding interrupt condition from generating an interrupt on the external pin. This register only affects the interrupt on the external terminal, it does not affect the bits in interrupt status register A. A given condition can set the appropriate bit in the status register and not cause an interrupt on the external terminal. To determine if this device is driving the interrupt terminal either perform a logical AND of interrupt status register A with interrupt enable register A, or check the state of the interrupt A bit in the interrupt configuration register at address C2h.

Lock interrupt enable:

- 0 = Disabled (default)
- 1 = Enabled

Cycle complete interrupt enable:

- 0 = Disabled (default)
- 1 = Enabled

Bus error interrupt enable:

- 0 = Disabled (default)
- 1 = Enabled

FIFO threshold interrupt enable:

- 0 = Disabled (default)
- 1 = Enabled

Line interrupt enable:

- 0 = Disabled (default)
- 1 = Enabled

Data interrupt enable:

- 0 = Disabled (default)
- 1 = Enabled

**3.22.53 Interrupt Configuration Register A**

|         |     |
|---------|-----|
| Address | C2h |
|---------|-----|

| 7        | 6 | 5 | 4 | 3 | 2                  | 1           | 0                    |
|----------|---|---|---|---|--------------------|-------------|----------------------|
| Reserved |   |   |   |   | YUV enable (VDPOE) | Interrupt A | Interrupt polarity A |

YUV enable (VDPOE):

- 0 = YUV pins are high impedance.
- 1 = YUV pins are active if other conditions are met (default).

Interrupt A (read-only):

- 0 = Interrupt A is not active on the external pin (default).
- 1 = Interrupt A is active on the external pin.

Interrupt polarity A:

- 0 = Interrupt A is active low (default).
- 1 = Interrupt A is active high.

Interrupt configuration register A is used to configure the polarity of the external interrupt terminal. When interrupt A is configured as active low, the terminal is driven low when active and high-impedance when inactive (open collector). Conversely, when the terminal is configured as active high, it is driven high when active and driven low when inactive.

**3.22.54 VDP Configuration RAM Register**

|         |         |
|---------|---------|
| Address | C3h–C5h |
|---------|---------|

| Address | 7                  | 6 | 5 | 4 | 3 | 2 | 1 | 0             |
|---------|--------------------|---|---|---|---|---|---|---------------|
| C3h     | Configuration data |   |   |   |   |   |   |               |
| C4h     | RAM address (7:0)  |   |   |   |   |   |   |               |
| C5h     | Reserved           |   |   |   |   |   |   | RAM address 8 |

The configuration RAM data is provided to initialize the VDP with initial constants. The configuration RAM is 512 bytes organized as 32 different configurations of 16 bytes each. The first 12 configurations are defined for the current VBI standards. An additional 2 configurations can be used as a custom programmed mode for unique standards like Gemstar.

Address C3h is used to read or write to the RAM. The RAM internal address counter is automatically incremented with each transaction. Addresses C5h and C4h make up a 9-bit address to load the internal address counter with a specific start address. This can be used to write a subset of the RAM for only those standards of interest. Registers D0h–FBh must all be programmed with FFh, before writing or reading the configuration RAM. Full field mode (CFh) must be disabled as well.

The suggested RAM contents are shown below. All values are hexadecimal.

Table 3–12. VBI Configuration RAM

| Index           | Address | 0            | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | A  | B | C | D | E  | F |
|-----------------|---------|--------------|----|----|----|----|----|----|----|----|----|----|---|---|---|----|---|
| Reserved        | 000     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| Reserved        | 010     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| Reserved        | 020     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| WST PAL B 6     | 030     | AA           | AA | FF | FF | 27 | 2E | 20 | 2B | A6 | 72 | 10 | 0 | 0 | 0 | 10 | 0 |
| Reserved        | 040     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| WST PAL C 6     | 050     | AA           | AA | FF | FF | E7 | 2E | 20 | 22 | A6 | 98 | 0D | 0 | 0 | 0 | 10 | 0 |
| Reserved        | 060     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| WST NTSC 6      | 070     | AA           | AA | FF | FF | 27 | 2E | 20 | 23 | 69 | 93 | 0D | 0 | 0 | 0 | 10 | 0 |
| Reserved        | 080     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| NABTS, NTSC 6   | 090     | AA           | AA | FF | FF | E7 | 2E | 20 | 22 | 69 | 93 | 0D | 0 | 0 | 0 | 15 | 0 |
| Reserved        | 0A0     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| NABTS, NTSC-J 6 | 0B0     | AA           | AA | FF | FF | A7 | 2E | 20 | 23 | 69 | 93 | 0D | 0 | 0 | 0 | 10 | 0 |
| Reserved        | 0C0     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| CC, PAL 6       | 0D0     | AA           | 2A | FF | 3F | 04 | 51 | 6E | 02 | A6 | 7B | 09 | 0 | 0 | 0 | 27 | 0 |
| Reserved        | 0E0     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| CC, NTSC 6      | 0F0     | AA           | 2A | FF | 3F | 04 | 51 | 6E | 02 | 69 | 8C | 09 | 0 | 0 | 0 | 27 | 0 |
| Reserved        | 100     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| WSS, PAL 6      | 110     | 5B           | 55 | C5 | FF | 0  | 71 | 6E | 42 | A6 | CD | 0F | 0 | 0 | 0 | 3A | 0 |
| Reserved        | 120     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| WSS, NTSC C     | 130     | 38           | 00 | 3F | 00 | 0  | 71 | 6E | 43 | 69 | 7C | 08 | 0 | 0 | 0 | 39 | 0 |
| Reserved        | 140     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| VITC, PAL 6     | 150     | 0            | 0  | 0  | 0  | 0  | 8F | 6D | 49 | A6 | 85 | 08 | 0 | 0 | 0 | 4C | 0 |
| Reserved        | 160     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| VITC, NTSC 6    | 170     | 0            | 0  | 0  | 0  | 0  | 8F | 6D | 49 | 69 | 94 | 08 | 0 | 0 | 0 | 4C | 0 |
| Reserved        | 180     | Reserved     |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| VPS, PAL 6      | 190     | AA           | AA | FF | FF | BA | CE | 2B | 0D | A6 | DA | 0B | 0 | 0 | 0 | 60 | 0 |
| Custom          | 1A0     | Programmable |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |
| Custom          | 1B0     | Programmable |    |    |    |    |    |    |    |    |    |    |   |   |   |    |   |

**3.22.55 VDP Status Register**

|         |     |
|---------|-----|
| Address | C6h |
|---------|-----|

| 7               | 6          | 5             | 4                    | 3                    | 2             | 1             | 0              |
|-----------------|------------|---------------|----------------------|----------------------|---------------|---------------|----------------|
| FIFO full error | FIFO empty | TTX available | CC field 1 available | CC field 2 available | WSS available | VPS available | VITC available |

The VDP status register indicates whether data is available in either the FIFO or data registers, and status information about the FIFO. Reading data from the corresponding register does not clear the status flags automatically. These flags are only reset by writing a 1 to the respective bit. However, bit 6 is updated automatically.

FIFO full error:

- 0 = No FIFO full error
- 1 = FIFO was full during a write to FIFO.

The FIFO full error flag is set when the current line of VBI data can not enter the FIFO. For example, if the FIFO has only 10 bytes left and teletext is the current VBI line, the FIFO full error flag is set, but no data is written because the entire teletext line will not fit. However, if the next VBI line is closed caption requiring only 2 bytes of data plus the header, this goes into the FIFO. Even if the full error flag is set.

FIFO empty:

- 0 = FIFO is not empty.
- 1 = FIFO is empty.

TTX available:

- 0 = Teletext data is not available.
- 1 = Teletext data is available.

CC field 1 available:

- 0 = Closed caption data from field 1 is not available.
- 1 = Closed caption data from field 1 is available.

CC field 2 available:

- 0 = Closed caption data from field 2 is not available.
- 1 = Closed caption data from field 2 is available.

WSS available:

- 0 = WSS data is not available.
- 1 = WSS data is available.

VPS available:

- 0 = VPS data is not available.
- 1 = VPS data is available.

VITC available:

- 0 = VITC data is not available.
- 1 = VITC data is available.

**3.22.56 FIFO Word Count Register**

|         |     |
|---------|-----|
| Address | C7h |
|---------|-----|

| 7               | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------------|---|---|---|---|---|---|---|
| Number of words |   |   |   |   |   |   |   |

This register provides the number of words in the FIFO. 1 word equals 2 bytes.

### 3.22.57 FIFO Interrupt Threshold Register

|         |     |
|---------|-----|
| Address | C8h |
|---------|-----|

|                 |   |   |   |   |   |   |   |
|-----------------|---|---|---|---|---|---|---|
| 7               | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Number of words |   |   |   |   |   |   |   |

This register is programmed to trigger an interrupt when the number of words in the FIFO exceeds this value (default 80h). This interrupt must be enabled at address C1h. 1 word equals 2 bytes.

### 3.22.58 FIFO Reset Register

|         |     |
|---------|-----|
| Address | C9h |
|---------|-----|

|          |   |   |   |   |   |   |   |
|----------|---|---|---|---|---|---|---|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Any data |   |   |   |   |   |   |   |

Writing any data to this register resets the FIFO and clears any data present.

### 3.22.59 Line Number Interrupt Register

|         |     |
|---------|-----|
| Address | CAh |
|---------|-----|

|                |                |             |   |   |   |   |   |
|----------------|----------------|-------------|---|---|---|---|---|
| 7              | 6              | 5           | 4 | 3 | 2 | 1 | 0 |
| Field 1 enable | Field 2 enable | Line number |   |   |   |   |   |

This register is programmed to trigger an interrupt when the video line number matches this value in bits 5:0. This interrupt must be enabled at address C1h. The value of 0 or 1 does not generate an interrupt.

Field 1 enable:

- 0 = Disabled (default)
- 1 = Enabled

Field 2 enable:

- 0 = Disabled (default)
- 1 = Enabled

Line number: (default 00h)

### 3.22.60 Pixel Alignment Registers

|         |         |
|---------|---------|
| Address | CBh–CCh |
|---------|---------|

|         |                    |   |   |   |   |   |                    |   |
|---------|--------------------|---|---|---|---|---|--------------------|---|
| Address | 7                  | 6 | 5 | 4 | 3 | 2 | 1                  | 0 |
| CBh     | Switch pixel [7:0] |   |   |   |   |   |                    |   |
| CCh     | Reserved           |   |   |   |   |   | Switch pixel [9:8] |   |

These registers form a 10-bit horizontal pixel position from the falling edge of sync, where the VDP controller initiates the program from one line standard to the next line standard. For example, the previous line of teletext to the next line of closed caption. This value must be set so that the switch occurs after the previous transaction has cleared the delay in the VDP, but early enough to allow the new values to be programmed before the current settings are required.

The default value is 0x1E and has been tested with every standard supported here. A new value is needed only if a custom standard is in use.

**3.22.61 FIFO Output Control Register**

|         |     |
|---------|-----|
| Address | CDh |
|---------|-----|

|          |   |   |   |   |   |   |                    |
|----------|---|---|---|---|---|---|--------------------|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0                  |
| Reserved |   |   |   |   |   |   | Host access enable |

This register is programmed to allow I<sup>2</sup>C access to the FIFO or allowing all VDP data to go out the video port.

Host access enable:

0 = Output FIFO data to the video output Y[9:2] (default)

1 = Allow I<sup>2</sup>C access to the FIFO data

**3.22.62 Automatic Initialization Register**

|         |     |
|---------|-----|
| Address | CEh |
|---------|-----|

|          |   |   |   |   |                 |            |          |
|----------|---|---|---|---|-----------------|------------|----------|
| 7        | 6 | 5 | 4 | 3 | 2               | 1          | 0        |
| Reserved |   |   |   |   | Auto initialize | Auto clock | Reserved |

This register enables the VDP to preprogram the line mode registers for the most common standards based on the video standard, that is, PAL, NTSC.

Auto initialize:

0 = Disable initialization of teletext and closed caption standards (default)

1 = Enable initialization of teletext and closed caption standards

Auto clock:

0 = Do not update bit 0 (default)

1 = Enable VDP to update bit 0

**3.22.63 Full Field Enable Register**

|         |     |
|---------|-----|
| Address | CFh |
|---------|-----|

|          |   |   |   |   |   |   |                   |
|----------|---|---|---|---|---|---|-------------------|
| 7        | 6 | 5 | 4 | 3 | 2 | 1 | 0                 |
| Reserved |   |   |   |   |   |   | Full field enable |

This register enables the full field mode. In this mode, all lines outside the vertical blank area and all lines in the line mode registers programmed with FFh are sliced with the definition of register FCh. Values other than FFh in the line mode registers allow a different slice mode for that particular line.

Full field enable:

0 = Disable full field mode (default)

1 = Enable full field mode

**3.22.64 Line Mode Registers**

|         |         |
|---------|---------|
| Address | D0h–FBh |
|---------|---------|

| ADDRESS | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0               |
|---------|---|---|---|---|---|---|---|-----------------|
| D0h     |   |   |   |   |   |   |   | Line 6 Field 1  |
| D1h     |   |   |   |   |   |   |   | Line 6 Field 2  |
| D2h     |   |   |   |   |   |   |   | Line 7 Field 1  |
| D3h     |   |   |   |   |   |   |   | Line 7 Field 2  |
| D4h     |   |   |   |   |   |   |   | Line 8 Field 1  |
| D5h     |   |   |   |   |   |   |   | Line 8 Field 2  |
| D6h     |   |   |   |   |   |   |   | Line 9 Field 1  |
| D7h     |   |   |   |   |   |   |   | Line 9 Field 2  |
| D8h     |   |   |   |   |   |   |   | Line 10 Field 1 |
| D9h     |   |   |   |   |   |   |   | Line 10 Field 2 |
| DAh     |   |   |   |   |   |   |   | Line 11 Field 1 |
| DBh     |   |   |   |   |   |   |   | Line 11 Field 2 |
| DCh     |   |   |   |   |   |   |   | Line 12 Field 1 |
| DDh     |   |   |   |   |   |   |   | Line 12 Field 2 |
| DEh     |   |   |   |   |   |   |   | Line 13 Field 1 |
| DFh     |   |   |   |   |   |   |   | Line 13 Field 2 |
| E0h     |   |   |   |   |   |   |   | Line 14 Field 1 |
| E1h     |   |   |   |   |   |   |   | Line 14 Field 2 |
| E2h     |   |   |   |   |   |   |   | Line 15 Field 1 |
| E3h     |   |   |   |   |   |   |   | Line 15 Field 2 |
| E4h     |   |   |   |   |   |   |   | Line 16 Field 1 |
| E5h     |   |   |   |   |   |   |   | Line 16 Field 2 |
| E6h     |   |   |   |   |   |   |   | Line 17 Field 1 |
| E7h     |   |   |   |   |   |   |   | Line 17 Field 2 |
| E8h     |   |   |   |   |   |   |   | Line 18 Field 1 |
| E9h     |   |   |   |   |   |   |   | Line 18 Field 2 |
| EAh     |   |   |   |   |   |   |   | Line 19 Field 1 |
| EBh     |   |   |   |   |   |   |   | Line 19 Field 2 |
| ECh     |   |   |   |   |   |   |   | Line 20 Field 1 |
| EDh     |   |   |   |   |   |   |   | Line 20 Field 2 |
| EEh     |   |   |   |   |   |   |   | Line 21 Field 1 |
| EFh     |   |   |   |   |   |   |   | Line 21 Field 2 |
| F0h     |   |   |   |   |   |   |   | Line 22 Field 1 |
| F1h     |   |   |   |   |   |   |   | Line 22 Field 2 |
| F2h     |   |   |   |   |   |   |   | Line 23 Field 1 |
| F3h     |   |   |   |   |   |   |   | Line 23 Field 2 |
| F4h     |   |   |   |   |   |   |   | Line 24 Field 1 |
| F5h     |   |   |   |   |   |   |   | Line 24 Field 2 |
| F6h     |   |   |   |   |   |   |   | Line 25 Field 1 |
| F7h     |   |   |   |   |   |   |   | Line 25 Field 2 |
| F8h     |   |   |   |   |   |   |   | Line 26 Field 1 |
| F9h     |   |   |   |   |   |   |   | Line 26 Field 2 |
| FAh     |   |   |   |   |   |   |   | Line 27 Field 1 |
| FBh     |   |   |   |   |   |   |   | Line 27 Field 2 |

These registers program the specific VBI standard at a specific line in the video field.

Bit 7:

- 0 = Disable filtering of null bytes in closed caption modes
- 1 = Enable filtering of null bytes in closed caption modes (default)

In teletext modes, bit 7 enables the data filter function for that particular line. If it is set to 0, then the data filter passes all data on that line.

Bit 6:

- 0 = Send VBI data to registers only.
- 1 = Send VBI data to FIFO and the registers. Teletext data only goes to FIFO. (default)

Bit 5:

- 0 = Allow VBI data with errors in the FIFO
- 1 = Do not allow VBI data with errors in the FIFO (default)

Bit 4:

- 0 = Do not enable error detection and correction
- 1 = Enable error detection and correction (when bits [3:0] = 1 2, 3, and 4 only) (default)

Bits [3:0]:

- 0000 = Reserved
- 0001 = WST PAL B
- 0010 = WST PAL C
- 0011 = WST NTSC
- 0100 = NABTS NTSC
- 0101 = TTX NTSC
- 0110 = CC PAL
- 0111 = CC NTSC
- 1000 = WSS PAL
- 1001 = WSS NTSC
- 1010 = VITC PAL
- 1011 = VITC NTSC
- 1100 = VPS PAL
- 1101 = Custom 1
- 1110 = Custom 2
- 1111 = Active video (VDP off) (default)

A value of FFh in the line mode registers is required for any line to be sliced as part of the full field mode.

### 3.22.65 Full Field Mode Register

|         |     |
|---------|-----|
| Address | FCh |
|---------|-----|

|                 |   |   |   |   |   |   |   |
|-----------------|---|---|---|---|---|---|---|
| 7               | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Full field mode |   |   |   |   |   |   |   |

This register programs the specific VBI standard for full field mode. It can be any VBI standard. Individual line settings take priority over the full field register. This allows each VBI line to be programmed independently but have the remaining lines in full field mode. The full field mode register has the same definitions as the line mode registers (default 7Fh).

## 4 Electrical Characteristics

### 4.1 Absolute Maximum Ratings Over Operating Free-Air Temperature Range (unless otherwise noted)<sup>†</sup>

|                                                       |                                  |                 |
|-------------------------------------------------------|----------------------------------|-----------------|
| Supply voltage range:                                 | IOV <sub>DD</sub> to DGND        | –0.5 V to 4.5 V |
|                                                       | DV <sub>DD</sub> to DGND         | –0.5 V to 2.3 V |
|                                                       | PLL_AV <sub>DD</sub> to PLL_AGND | –0.5 V to 2.3 V |
|                                                       | CH1_AV <sub>DD</sub> to CH1_AGND | –0.5 V to 2.3 V |
| Digital input voltage range, V <sub>I</sub> to DGND   |                                  | –0.5 V to 4.5 V |
| Input voltage range, XTAL1 to PLL_GND                 |                                  | –0.5 V to 2.3 V |
| Analog input voltage range A <sub>I</sub> to CH1_AGND |                                  | –0.2 V to 2.0 V |
| Digital output voltage range, V <sub>O</sub> to DGND  |                                  | –0.5 V to 4.5 V |
| Operating free-air temperature, T <sub>A</sub>        |                                  | 0°C to 70°C     |
| Storage temperature, T <sub>stg</sub>                 |                                  | –65°C to 150°C  |

<sup>†</sup> Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 4.2 Recommended Operating Conditions

|                      |                                              | MIN                      | NOM | MAX                      | UNIT |
|----------------------|----------------------------------------------|--------------------------|-----|--------------------------|------|
| IODV <sub>DD</sub>   | Digital I/O supply voltage                   | 3.0                      | 3.3 | 3.6                      | V    |
| DV <sub>DD</sub>     | Digital supply voltage                       | 1.65                     | 1.8 | 1.95                     | V    |
| PLL_AV <sub>DD</sub> | Analog PLL supply voltage                    | 1.65                     | 1.8 | 1.95                     | V    |
| CH1_AV <sub>DD</sub> | Analog core supply voltage                   | 1.65                     | 1.8 | 1.95                     | V    |
| V <sub>I(P-P)</sub>  | Analog input voltage (ac-coupling necessary) | 0                        |     | 0.75                     | V    |
| V <sub>IH</sub>      | Digital input voltage high                   | 0.7 IOV <sub>DD</sub>    |     |                          | V    |
| V <sub>IL</sub>      | Digital input voltage low                    |                          |     | 0.3 IOV <sub>DD</sub>    | V    |
| V <sub>IH XTAL</sub> | XTAL input voltage high                      | 0.7 PLL_AV <sub>DD</sub> |     |                          | V    |
| V <sub>IL XTAL</sub> | XTAL input voltage low                       |                          |     | 0.3 PLL_AV <sub>DD</sub> | V    |
| I <sub>OH</sub>      | High-level output current                    |                          |     | 2                        | mA   |
| I <sub>OL</sub>      | Low-level output current                     |                          |     | –2                       | mA   |
| I <sub>OH SCLK</sub> | SCLK high-level output current               |                          |     | 4                        | mA   |
| I <sub>OL SCLK</sub> | SCLK low-level output current                |                          |     | –4                       | mA   |
| T <sub>A</sub>       | Operating free-air temperature               | 0                        |     | 70                       | °C   |

#### 4.2.1 Crystal Specifications

| CRYSTAL SPECIFICATIONS | MIN | NOM      | MAX | UNIT |
|------------------------|-----|----------|-----|------|
| Frequency              |     | 14.31818 |     | MHz  |
| Frequency tolerance    |     | ±50      |     | ppm  |

### 4.3 Electrical Characteristics

DV<sub>DD</sub> = 1.8 V, PLL\_AV<sub>DD</sub> = 1.8 V, CH1\_AV<sub>DD</sub> = 1.8 V, IOV<sub>DD</sub> = 3.3 V

For minimum/maximum values: T<sub>A</sub> = 0°C to 70°C, and for typical values: T<sub>A</sub> = 25°C unless otherwise noted

### 4.3.1 DC Electrical Characteristics

| PARAMETER                                           | TEST CONDITIONS<br>(see Note 1) | MIN            | TYP             | MAX      | UNIT          |
|-----------------------------------------------------|---------------------------------|----------------|-----------------|----------|---------------|
| $I_{DD}(IO\_D)$ Digital I/O supply current          | Color bar input                 |                | 6               |          | mA            |
| $I_{DD}(D)$ Digital core supply current             | Color bar input                 |                | 21              |          | mA            |
| $I_{DD}(PLL\_A)$ Analog PLL supply current          | Color bar input                 |                | 6               |          | mA            |
| $I_{DD}(CH1\_A)$ Analog PLL supply current          | Color bar input                 |                | 25              |          | mA            |
| $P_{TOT}$ Total power dissipation, normal mode      | Color bar input                 |                | 113             | 150      | mW            |
| $P_{DOWN}$ Total power dissipation, power-down mode | Color bar input                 |                | 0.9             |          | mW            |
| $C_i$ Input capacitance                             | By design                       |                | 8               |          | pF            |
| $V_{OH}$ Output voltage high                        | $I_{OH} = 2\text{ mA}$          | 0.8 $IOV_{DD}$ |                 |          | V             |
| $V_{OL}$ Output voltage low                         | $I_{OL} = -2\text{ mA}$         |                | 0.22 $IOV_{DD}$ |          | V             |
| $V_{OH\_SCLK}$ SCLK output voltage high             | $I_{OH} = 2\text{ mA}$          | 0.8 $IOV_{DD}$ |                 |          | V             |
| $V_{OL\_SCLK}$ SCLK output voltage low              | $I_{OL} = -4\text{ mA}$         |                | 0.22 $IOV_{DD}$ |          | V             |
| $I_{IH}$ High-level input current (see Note 2)      | $V_I = V_{IH}$                  |                |                 | $\pm 20$ | $\mu\text{A}$ |
| $I_{IL}$ Low-level input current (see Note 2)       | $V_I = V_{IL}$                  |                |                 | $\pm 20$ | $\mu\text{A}$ |

NOTES: 1. Measured with a load of 15 pF.

2. YOUT7 is a bidirectional terminal with an internal pulldown resistor. This terminal may sink more than the specified current when in the RESET mode.

### 4.3.2 Analog Processing and A/D Converters

| PARAMETER                                    | TEST CONDITIONS                         | MIN | TYP       | MAX  | UNIT       |
|----------------------------------------------|-----------------------------------------|-----|-----------|------|------------|
| $Z_i$ Input impedance, analog video inputs   | By design                               |     | 500       |      | k $\Omega$ |
| $C_i$ Input capacitance, analog video inputs | By design                               |     | 10        |      | pF         |
| $V_i(pp)$ Input voltage range                | $C_{coupling} = 0.1\text{ }\mu\text{F}$ | 0   |           | 0.75 | V          |
| $\Delta G$ Gain control range                |                                         | 0   |           | 12   | dB         |
| DNL DC differential nonlinearity             | A/D only                                |     | $\pm 0.5$ |      | LSB        |
| INL DC integral nonlinearity                 | A/D only                                |     | $\pm 1$   |      | LSB        |
| $F_r$ Frequency response                     | 6 MHz                                   |     | -0.9      | -3   | dB         |
| SNR Signal-to-noise ratio                    | 6 MHz, 1.0 $V_{P-P}$                    |     | 50        |      | dB         |
| NS Noise spectrum                            | 50% flat field                          |     | 50        |      | dB         |
| DP Differential phase                        |                                         |     | 1.5       |      | °          |
| DG Differential gain                         |                                         |     | 0.5%      |      |            |

### 4.3.3 Timing

#### 4.3.3.1 Clocks, Video Data, Sync Timing

| PARAMETER                                              | TEST CONDITIONS<br>(see NOTE 2) | MIN | TYP | MAX | UNIT |
|--------------------------------------------------------|---------------------------------|-----|-----|-----|------|
| Duty cycle PCLK, SCLK                                  |                                 |     | 50% |     |      |
| $t_1$ Delay time, SCLK falling edge to digital outputs | See Note 3 (by design)          |     | 2.8 | 8   | ns   |

NOTES: 3.  $C_L = 15$  pF

4. All outputs are 3.3 V.

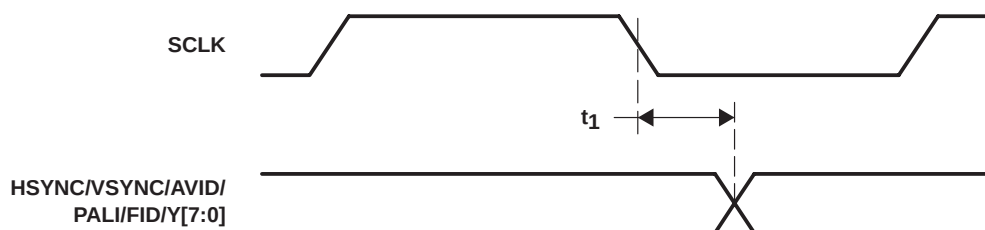
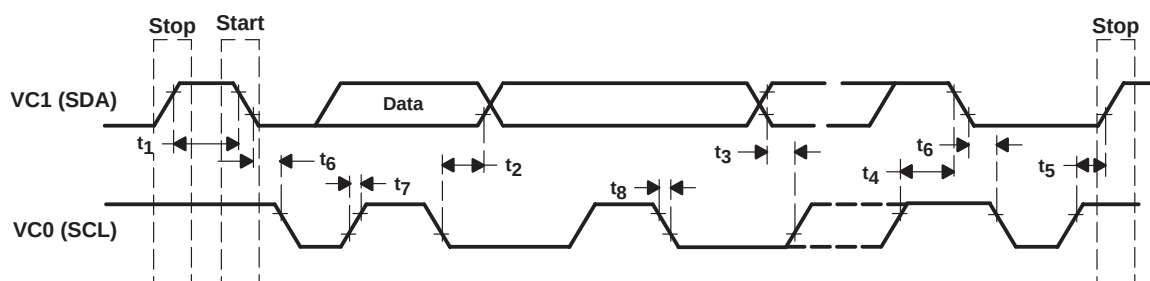


Figure 4–1. Clocks, Video Data, and Sync Timing

#### 4.3.3.2 I<sup>2</sup>C Host Port Timing

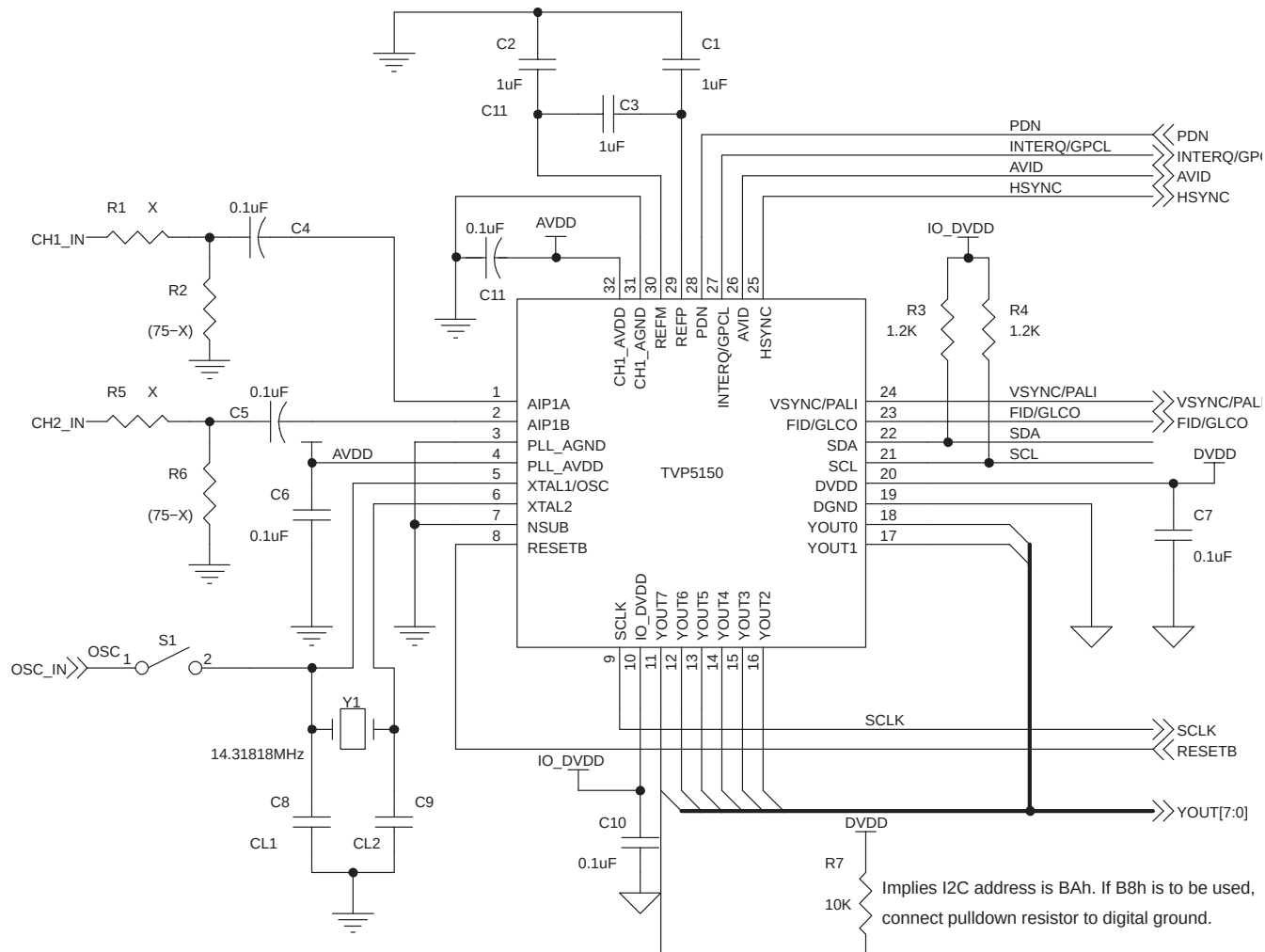
| PARAMETER                                         | TEST CONDITIONS | MIN | TYP | MAX | UNIT    |
|---------------------------------------------------|-----------------|-----|-----|-----|---------|
| $t_1$ Bus free time between STOP and START        |                 | 1.3 |     |     | $\mu$ s |
| $t_2$ Setup time for a (repeated) START condition |                 | 0.6 |     |     | $\mu$ s |
| $t_3$ Hold time (repeated) START condition        |                 | 0.6 |     |     | $\mu$ s |
| $t_4$ Setup time for a STOP condition             |                 | 0.6 |     |     | ns      |
| $t_5$ Data setup time                             |                 | 100 |     |     | ns      |
| $t_6$ Data hold time                              |                 | 0   |     | 0.9 | $\mu$ s |
| $t_7$ Rise time VC1(SDA) and VC0(SCL) signal      |                 | 250 |     |     | ns      |
| $t_8$ Fall time VC1(SDA) and VC0(SCL) signal      |                 |     | 250 |     | ns      |
| $C_b$ Capacitive load for each bus line           |                 |     |     | 400 | pF      |
| $f_{I2C}$ I <sup>2</sup> C clock frequency        |                 |     |     | 400 | kHz     |

Figure 4–2. I<sup>2</sup>C Host Port Timing

## 5 Application Information

### 5.1 Application Example

NOTE:  $X$  and  $(75 - X)$  is used since the maximum P-P signal allowed is 0.75V. Hence for a 140IRE signal, the signal must be divided by approximately half. Change  $X$  depending on the input signal range.



NOTE: The use of INTERQ/GPCL/AVID/HSYNC and VSYNC is optional. These are outputs and can be left floating. When OSC is connected through S1, remove the caps for the crystal. PDN needs to be high, if device has to be always operational. RESETB is operational only when PDN is high. This allows an active low reset to the device. CL1 and CL2 typical values used are 27 pF.

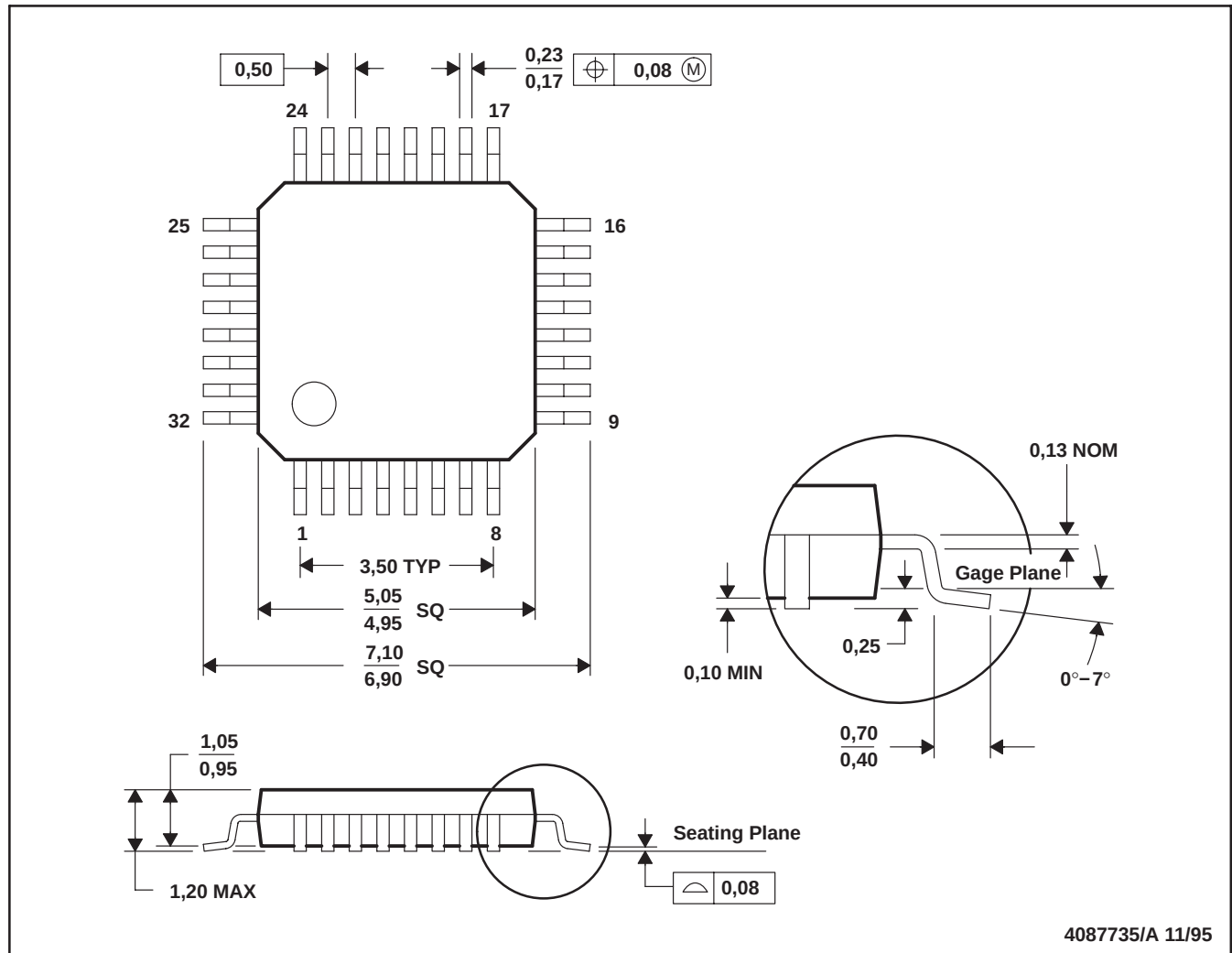
Figure 5-1. Application Example

## 6 Mechanical Data

The TVP5150 device is available in the 32-terminal PQFP package (PBS). The following figure shows the mechanical dimensions for the PBS package.

**PBS (S-PQFP-G32)**

**PLASTIC QUAD FLATPACK**



- NOTES: A. All linear dimensions are in millimeters.  
B. This drawing is subject to change without notice.

## PACKAGING INFORMATION

| Orderable part number | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier   | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-----------------------|---------------|----------------------|-----------------|-------------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TVP5150PBS            | NRND          | Production           | TQFP (PBS)   32 | 250   JEDEC TRAY (10+1) | Yes         | NIPDAU                               | Level-3-260C-168 HR               | 0 to 70      | TVP5150             |
| TVP5150PBS.A          | NRND          | Production           | TQFP (PBS)   32 | 250   JEDEC TRAY (10+1) | Yes         | NIPDAU                               | Level-3-260C-168 HR               | 0 to 70      | TVP5150             |
| TVP5150PBSR           | NRND          | Production           | TQFP (PBS)   32 | 1000   LARGE T&R        | Yes         | NIPDAU                               | Level-3-260C-168 HR               | 0 to 70      | TVP5150             |
| TVP5150PBSR.A         | NRND          | Production           | TQFP (PBS)   32 | 1000   LARGE T&R        | Yes         | NIPDAU                               | Level-3-260C-168 HR               | 0 to 70      | TVP5150             |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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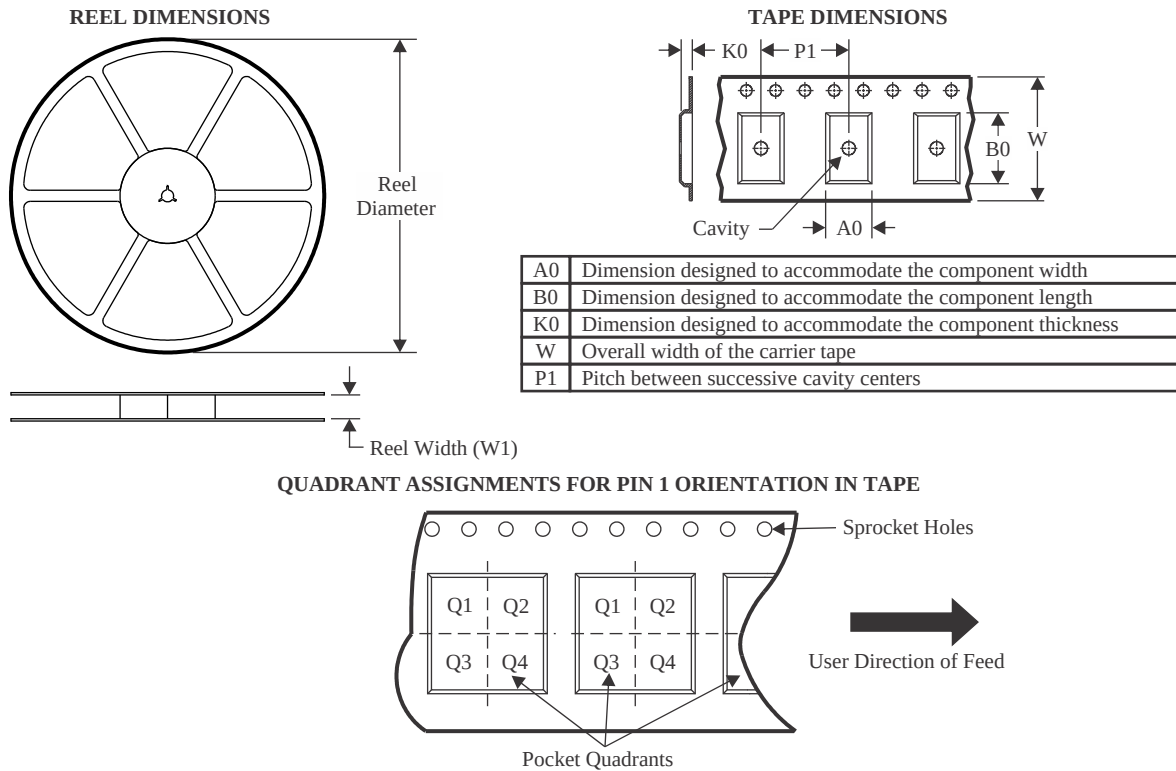
**OTHER QUALIFIED VERSIONS OF TVP5150 :**

- Automotive : [TVP5150-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

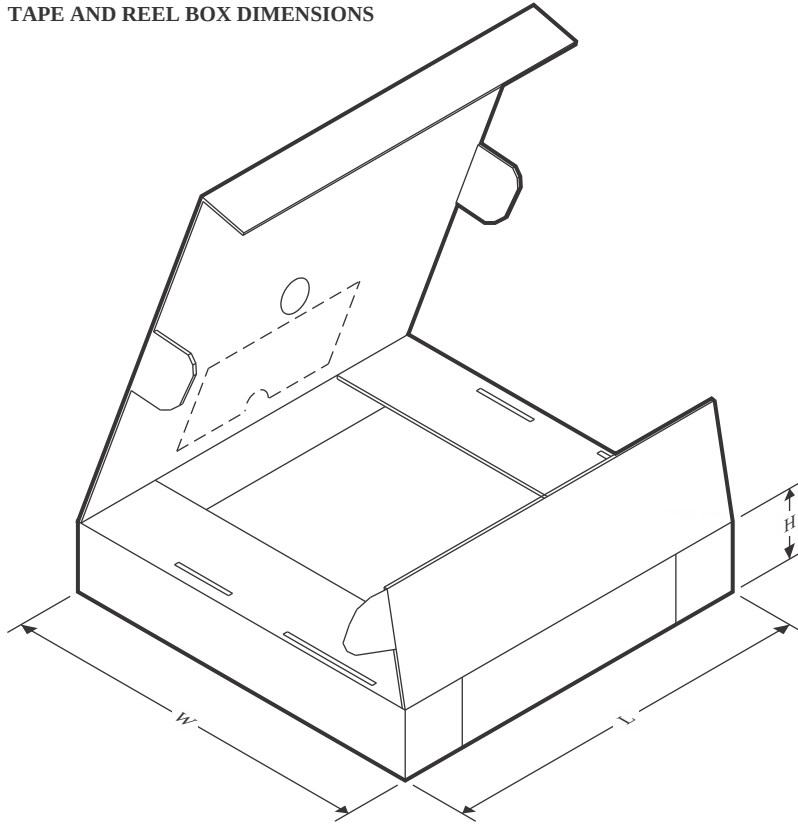
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TVP5150PBSR | TQFP         | PBS             | 32   | 1000 | 330.0              | 16.4               | 7.2     | 7.2     | 1.5     | 12.0    | 16.0   | Q2            |

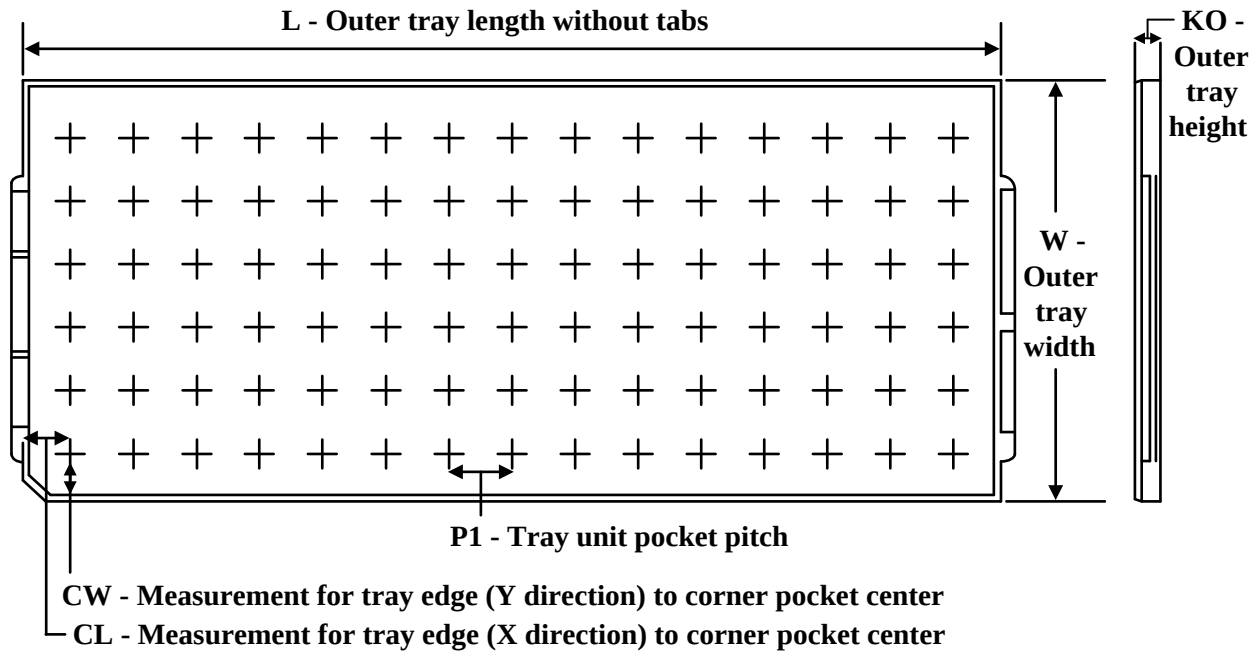
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TVP5150PBSR | TQFP         | PBS             | 32   | 1000 | 367.0       | 367.0      | 38.0        |

## TRAY



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

\*All dimensions are nominal

| Device       | Package Name | Package Type | Pins | SPQ | Unit array matrix | Max temperature (°C) | L (mm) | W (mm) | K0 (μm) | P1 (mm) | CL (mm) | CW (mm) |
|--------------|--------------|--------------|------|-----|-------------------|----------------------|--------|--------|---------|---------|---------|---------|
| TVP5150PBS   | PBS          | TQFP         | 32   | 250 | 10 X 25           | 150                  | 315    | 135.9  | 7620    | 12.2    | 11.1    | 11.25   |
| TVP5150PBS.A | PBS          | TQFP         | 32   | 250 | 10 X 25           | 150                  | 315    | 135.9  | 7620    | 12.2    | 11.1    | 11.25   |

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