



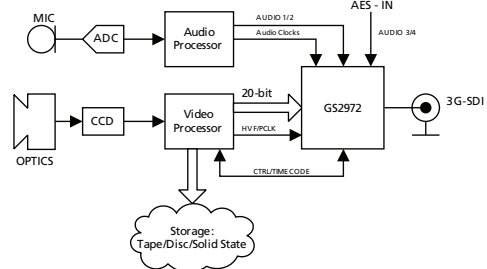
3G/H/SD-SDI Serializer with Complete SMPTE Audio & Video Support

Key Features

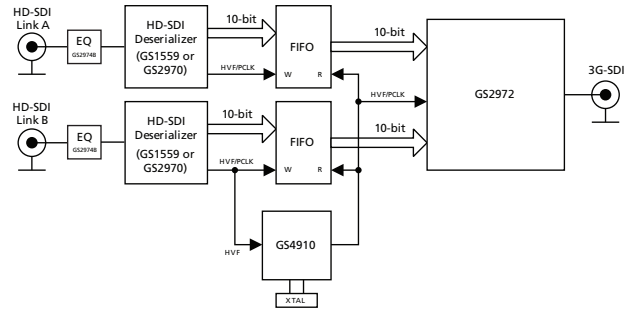
- Operation at 2.970Gb/s, 2.970/1.001Gb/s, 1.485Gb/s, 1.485/1.001Gb/s and 270Mb/s
- Supports SMPTE ST 425 (Level A and Level B), SMPTE ST 424, SMPTE ST 292, SMPTE ST 259-C and DVB-ASI
- Integrated Cable Driver
- Integrated, low-noise VCO
- Integrated Narrow-Bandwidth PLL
- Integrated Audio Embedder for up to 8 channels of 48kHz audio
- Ancillary data insertion
- Optional conversion from SMPTE ST 425 Level A to Level B for 1080p 50/60 4:2:2 10-bit
- Parallel data bus selectable as either 20-bit or 10-bit
- SMPTE video processing including TRS calculation and insertion, line number calculation and insertion, line based CRC calculation and insertion, illegal code re-mapping, SMPTE ST 352 payload identifier generation and insertion
- GSPI host interface
- +1.2V digital core power supply, +1.2V and +3.3V analog power supplies, and selectable +1.8V or +3.3V I/O power supply
- -20°C to +85°C operating temperature range
- Low power operation (typically at 400mW, including Cable Driver)
- Small 11mm x 11mm 100-ball BGA package
- Pb-free and RoHS compliant

Applications

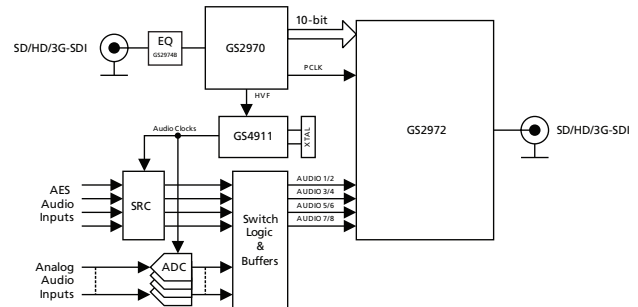
Application: 1080p 50/60 Camera/Camcorder



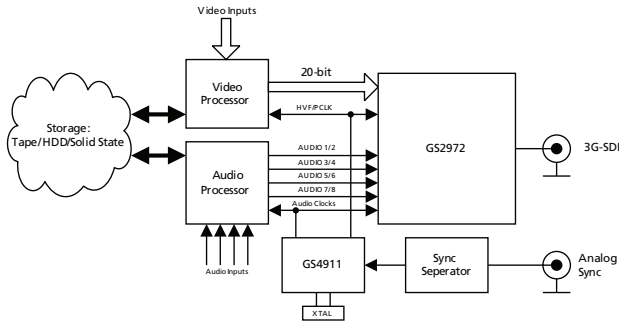
Application: Dual Link (HD-SDI) to Single Link (3G-SDI) Converter



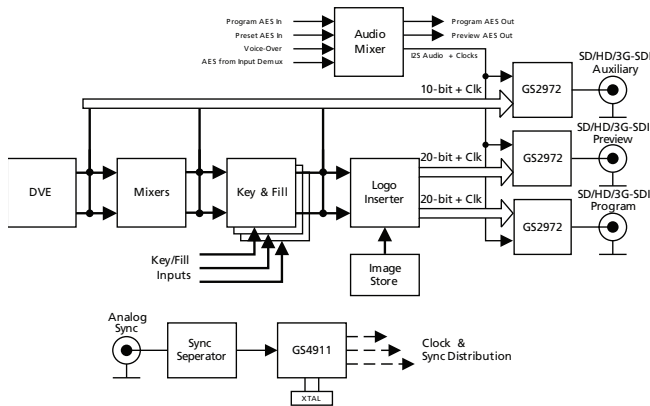
Application: Multi-format Audio Embedder Module



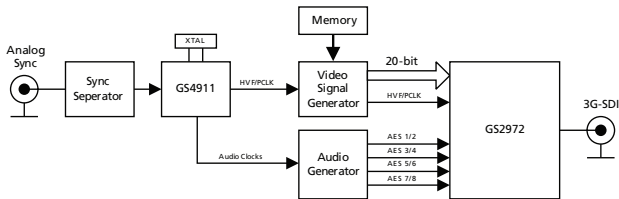
Application: Multi-format Digital VTR/Video Server



Application: Multi-format Presentation Switcher (Output Stage)



Application: 3Gb/s SDI Test Signal Generator



Description

The GS2972 is a complete SDI Transmitter, generating a SMPTE ST 424, SMPTE ST 292, SMPTE ST 259-C or DVB-ASI compliant serial digital output signal.

The integrated Narrow BW PLL allows the device to accept parallel clocks with high input jitter, and still provide a SMPTE compliant serial digital output.

The device can operate in four basic user selectable modes: SMPTE mode, DVB-ASI mode, Data-Through mode, or Standby mode.

In SMPTE mode, the GS2972 performs all SMPTE processing features. Both SMPTE ST 425 Level A and Level B formats are supported with optional conversion from Level A to Level B for 1080p 50/60 4:2:2 10-bit.

In DVB-ASI mode, the device will perform 8b/10b encoding prior to transmission.

In Data-Through mode, all SMPTE and DVB-ASI processing is disabled. The device can be used as a simple parallel to serial converter.

The device can also operate in a lower power Standby mode. In this mode, no signal is generated at the output.

The GS2972 integrates a fully SMPTE-compliant Cable Driver for SMPTE ST 259-C, SMPTE ST 292 and SMPTE ST 424 interfaces. It features automatic dual slew-rate selection, depending on 3Gb/s or HD or SD operational requirements.

In accordance with SMPTE ST 272 and SMPTE ST 299, up to eight channels (two audio groups) of serial digital audio may be embedded into the video data stream. The input audio signal formats supported by the device include AES/EBU, I²S and serial audio. 16, 20 and 24-bit audio formats are supported at 48kHz synchronous for SD modes and 48kHz synchronous or asynchronous in HD, 3Gb/s modes.

Functional Block Diagram

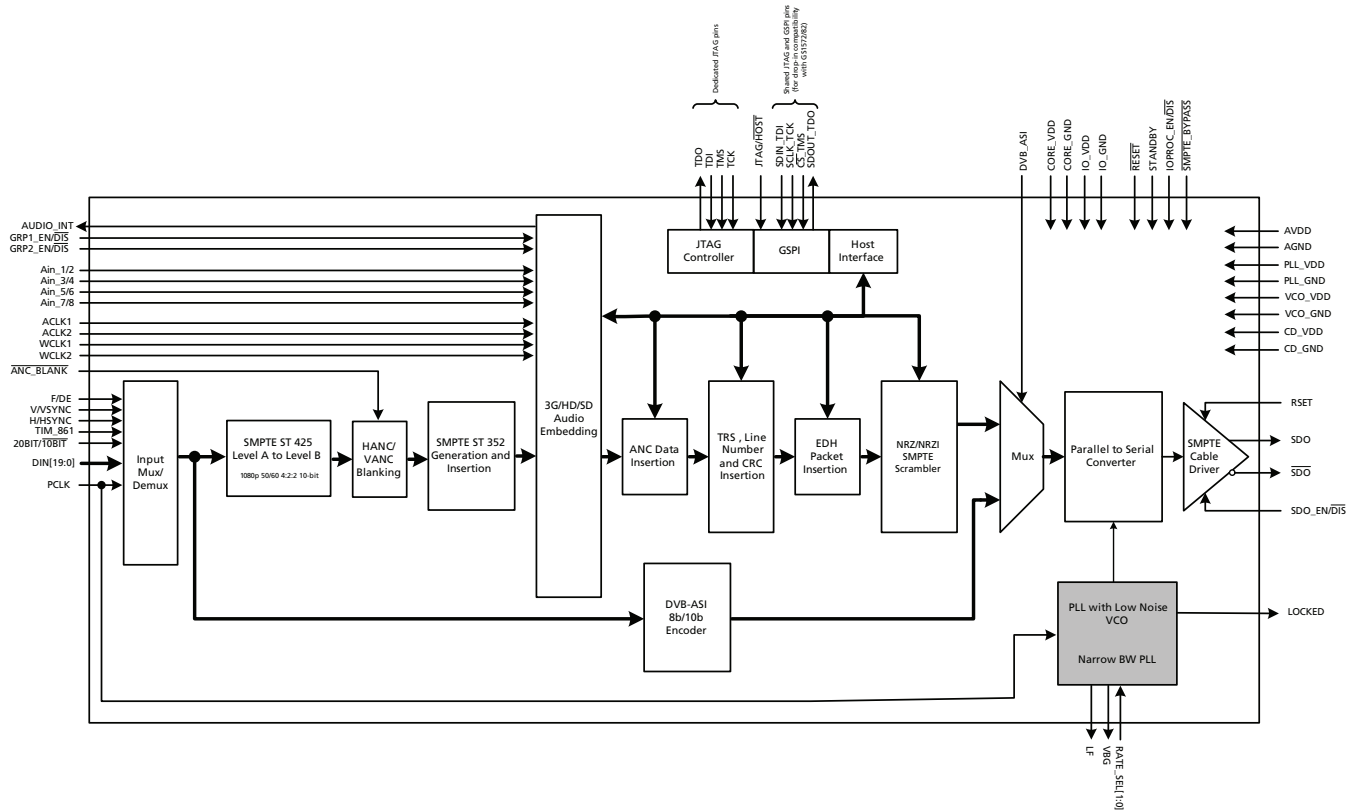


Figure A: GS2972 Functional Block Diagram

Revision History

| Version | ECO | PCN | Date | Changes and/or Modifications |
|---------|--------|-------|----------------|--|
| 9 | 014806 | – | September 2013 | Updates throughout the document. |
| 8 | 011355 | – | February 2013 | Updated to the Semtech Template. |
| 7 | 155820 | 56554 | February 2011 | Added section 4.7.22.2 Blanking Values Following Audio Data Packet Insertion . |
| 6 | 155608 | – | January 2011 | Clarified the function of the ACS_REGEN bit in Section 4.7.11 Audio Channel Status . |
| 5 | 155080 | 56059 | October 2010 | Revised power rating in standby mode. Documented CSUM behaviour in Section 4.8 , Section 4.9.4 and Video Core Configuration and Status Registers . |
| 4 | 153717 | – | March 2010 | Updates throughout entire document. Added Figure 4-2 , Figure 4-3 and Figure 4-4 . Correction to registers 040h to 13Fh in Table 4-34: Video Core Configuration and Status Registers . |
| 3 | 152220 | – | July 2009 | Updated Device Latency numbers in 2.4 AC Electrical Characteristics . Updates to 4.8 ANC Data Insertion . Replaced 7.3 Marking Diagram . |
| 2 | 151320 | – | January 2009 | Correction to timing values in Table 4-1: GS2972 Digital Input AC Electrical Characteristics . |
| 1 | 150803 | – | December 2008 | Converted to Data Sheet. Updates to all sections. |
| 0 | 150717 | – | October 2008 | Converted to Preliminary Data Sheet. |
| D | 149428 | – | August 2008 | Updated Typical Application Circuit . Applied new format to the document. Updates to all sections. |
| C | 148810 | – | February 2008 | Updates to all sections. |
| B | 148770 | – | December 2007 | Updates and revised 5.1 Typical Application Circuit . |
| A | 147987 | – | December 2007 | New Document. |

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1. Pin Out

1.1 Pin Assignment

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|----------|----------|------------|-------------|-------------|--------------|---------------|-----------|-----------|----------|
| A | DIN17 | DIN18 | F/DE | H/HSYNC | CORE_VDD | PLL_VDD | LF | VBG | RSV | A_VDD |
| B | DIN15 | DIN16 | DIN19 | PCLK | CORE_GND | PLL_VDD | VCO_VDD | VCO_GND | A_GND | A_GND |
| C | DIN13 | DIN14 | DIN12 | V/VSNC | CORE_GND | PLL_GND | PLL_GND | PLL_GND | CD_GND | SDO |
| D | DIN11 | DIN10 | STANDBY | SDO_EN/DIS | RSV | RSV | RSV | RSV | CD_GND | SDO |
| E | CORE_VDD | CORE_GND | RATE_SEL0 | RATE_SEL1 | CORE_GND | CORE_GND | TDI | TMS | CD_GND | CD_VDD |
| F | DIN9 | DIN8 | DETECT_TRS | RSV | CORE_GND | CORE_GND | RSV | TDO | CD_GND | RSET |
| G | IO_VDD | IO_GND | TIM_861 | 20bit/10bit | DVB_ASI | SMPTE_BYPASS | IOPROC_EN/DIS | RESET | CORE_GND | CORE_VDD |
| H | DIN7 | DIN6 | ANC_BLANK | LOCKED | GRP2_EN/DIS | GRP1_EN/DIS | AUDIO_INT | JTAG_HOST | IO_GND | IO_VDD |
| J | DIN5 | DIN4 | DIN1 | AIN_5/6 | WCLK2 | AIN_1/2 | WCLK1 | TCK | SDOUT_TDO | SCLK_TCK |
| K | DIN3 | DIN2 | DIN0 | AIN_7/8 | ACLK2 | AIN_3/4 | ACLK1 | CORE_VDD | CS_TMS | SDIN_TDI |

Figure 1-1: Pin Assignment

1.2 Pin Descriptions

Table 1-1: Pin Descriptions

| Pin Number | Name | Timing | Type | Description |
|---|------------|-----------------------|-------|---|
| B3, A2, A1, B2, B1, C2, C1, C3, D1, D2 | DIN[19:10] | | Input | <p>PARALLEL DATA BUS.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> |
| | | | | <p>20-bit mode 20BIT/10BIT = HIGH</p> <p>Data Stream 1/Luma data input in SMPTE mode (SMPTE_BYPASS = HIGH)</p> <p>Data input in data through mode (SMPTE_BYPASS = LOW)</p> |
| | | | | <p>10-bit mode 20BIT/10BIT = LOW</p> <p>Multiplexed Data Stream 1/Luma and Data Stream 2/Chroma data input in SMPTE mode (SMPTE_BYPASS = HIGH)</p> <p>Data input in data through mode (SMPTE_BYPASS = LOW)</p> <p>DVB-ASI data input in DVB-ASI mode (SMPTE_BYPASS = LOW) (DVB_ASI = HIGH)</p> |
| A3 | F/DE | Synchronous with PCLK | Input | <p>PARALLEL DATA TIMING.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>TIM_861 = LOW: Used to indicate the ODD / EVEN field of the video signal when DETECT_TRS is set LOW. The device will set the F bit in all outgoing TRS signals for the entire period that the F input signal is HIGH (IOPROC_EN/DIS must also be HIGH). The F signal should be set HIGH for the entire period of field 2 and should be set LOW for all lines in field 1 and for all lines in progressive scan systems. The F signal is ignored when DETECT_TRS = HIGH.</p> <p>TIM_861 = HIGH: The DE signal is used to indicate the active video period when DETECT_TRS is LOW. DE is HIGH for active data and LOW for blanking. See Section 4.3 and Section 4.3.2 for timing details. The DE signal is ignored when DETECT_TRS = HIGH.</p> |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description | | | | | | | | | | | | | | |
|--------------------------------|-----------------|-----------------------|---------------|---|----------------|-----------------|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|----------------|----------------|--------------|--------------|--------------|
| A4 | H/HSYNC | Synchronous with PCLK | Input | <p>PARALLEL DATA TIMING. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>TIM_861 is LOW: The H signal is used to indicate the portion of the video line containing active video data, when DETECT_TRS is set LOW.</p> <p>Active Line Blanking The H signal should be LOW for the active portion of the video line. The signal goes LOW at the first active pixel of the line, and then goes HIGH after the last active pixel of the line. The H signal should be set HIGH for the entire horizontal blanking period, including both EAV and SAV TRS words, and LOW otherwise.</p> <p>TRS Based Blanking (H_CONFIG = 1_H) The H signal should be set HIGH for the entire horizontal blanking period as indicated by the H bit in the received TRS ID words, and LOW otherwise.</p> <p>TIM_861 = HIGH: The HSYNC signal indicates horizontal timing. See Section 4.3.</p> <p>When DETECT_TRS is HIGH, this pin is ignored at all times. If DETECT_TRS is set HIGH and TIM_861 is set HIGH, the DETECT_TRS feature will take priority.</p> | | | | | | | | | | | | | | |
| A5, E1, G10, K8 | CORE_VDD | | Input Power | Power supply connection for digital core logic. Connect to +1.2V DC digital. | | | | | | | | | | | | | | |
| A6, B6 | PLL_VDD | | Input Power | Power supply pin for PLL. Connect to +1.2V DC analog. | | | | | | | | | | | | | | |
| A7 | LF | | Analog Output | Loop Filter component connection. | | | | | | | | | | | | | | |
| A8 | VBG | | Output | Bandgap voltage filter connection. | | | | | | | | | | | | | | |
| A9, D6, D7, D8, F4 | RSV | | – | These pins are reserved and should be left unconnected. | | | | | | | | | | | | | | |
| A10 | A_VDD | | Input Power | VDD for sensitive analog circuitry. Connect to +3.3VDC analog. | | | | | | | | | | | | | | |
| B4 | PCLK | | Input | <p>PARALLEL DATA BUS CLOCK. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <table border="1"> <tr> <td>3G 20-bit mode</td> <td>PCLK @ 148.5MHz</td> </tr> <tr> <td>3G 10-bit mode DDR</td> <td>PCLK @ 148.5MHz</td> </tr> <tr> <td>HD 20-bit mode</td> <td>PCLK @ 74.25MHz</td> </tr> <tr> <td>HD 10-bit mode</td> <td>PCLK @ 148.5MHz</td> </tr> <tr> <td>SD 20-bit mode</td> <td>PCLK @ 13.5MHz</td> </tr> <tr> <td>SD 10-bit mode</td> <td>PCLK @ 27MHz</td> </tr> <tr> <td>DVB-ASI mode</td> <td>PCLK @ 27MHz</td> </tr> </table> | 3G 20-bit mode | PCLK @ 148.5MHz | 3G 10-bit mode DDR | PCLK @ 148.5MHz | HD 20-bit mode | PCLK @ 74.25MHz | HD 10-bit mode | PCLK @ 148.5MHz | SD 20-bit mode | PCLK @ 13.5MHz | SD 10-bit mode | PCLK @ 27MHz | DVB-ASI mode | PCLK @ 27MHz |
| 3G 20-bit mode | PCLK @ 148.5MHz | | | | | | | | | | | | | | | | | |
| 3G 10-bit mode DDR | PCLK @ 148.5MHz | | | | | | | | | | | | | | | | | |
| HD 20-bit mode | PCLK @ 74.25MHz | | | | | | | | | | | | | | | | | |
| HD 10-bit mode | PCLK @ 148.5MHz | | | | | | | | | | | | | | | | | |
| SD 20-bit mode | PCLK @ 13.5MHz | | | | | | | | | | | | | | | | | |
| SD 10-bit mode | PCLK @ 27MHz | | | | | | | | | | | | | | | | | |
| DVB-ASI mode | PCLK @ 27MHz | | | | | | | | | | | | | | | | | |
| B5, C5, E2, E5, E6, F5, F6, G9 | CORE_GND | | Input Power | GND connection for digital logic. Connect to digital GND. | | | | | | | | | | | | | | |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description |
|----------------|---------------------------------|-----------------------|-------------|---|
| B7 | VCO_VDD | | Input Power | Power pin for VCO. Connect to +1.2V DC analog followed by an RC filter (see Typical Application Circuit on page 120). VCO_VDD is nominally 0.7V. |
| B8 | VCO_GND | | Input Power | Ground connection for VCO. Connect to analog GND. |
| B9, B10 | A_GND | | Input Power | GND pins for sensitive analog circuitry. Connect to analog GND. |
| C4 | VVSYNC | Synchronous with PCLK | Input | <p>PARALLEL DATA TIMING.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>TIM_861 = LOW:</p> <p>The V signal is used to indicate the portion of the video field/frame that is used for vertical blanking, when DETECT_TRS is set LOW.</p> <p>The V signal should be set HIGH for the entire vertical blanking period and should be set LOW for all lines outside of the vertical blanking interval.</p> <p>The V signal is ignored when DETECT_TRS = HIGH.</p> <p>TIM_861 = HIGH:</p> <p>The VSYNC signal indicates vertical timing. See Section 4.3 for timing details.</p> <p>The VSYNC signal is ignored when DETECT_TRS = HIGH.</p> |
| C6, C7, C8 | PLL_GND | | Input Power | Ground connection for PLL. Connect to analog GND. |
| C9, D9, E9, F9 | CD_GND | | Input Power | Ground connection for the serial digital cable driver. Connect to analog GND. |
| C10, D10 | SDO, $\overline{\text{SDO}}$ | | Output | <p>Serial Data Output Signal.</p> <p>Serial digital output signal operating at 2.97Gb/s, 2.97/1.001Gbs, 1.485Gb/s, 1.485 /1.001Gb/s or 270Mb/s.</p> <p>The slew rate of the output is automatically controlled to meet SMPTE ST 424, SMPTE ST 292 and ST 259-C specifications according to the setting of the RATE_SEL0 and RATE_SEL1 pins.</p> |
| D3 | STANDBY | | Input | <p>Power Down input.</p> <p>HIGH to power down device.</p> |
| D4 | SDO_EN/ $\overline{\text{DIS}}$ | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to enable or disable the serial digital output stage.</p> <p>When SDO_EN/$\overline{\text{DIS}}$ is LOW, the serial digital output signals SDO and $\overline{\text{SDO}}$ are disabled and become high impedance.</p> <p>When SDO_EN/$\overline{\text{DIS}}$ is HIGH, the serial digital output signals SDO and $\overline{\text{SDO}}$ are enabled.</p> |
| D5, F7 | RSV | | – | These pins are reserved and should be connected to CORE_GND. |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description | | | | | | | | | | | | |
|---|-------------------------|---|-------------|---|-----------|---------------|-----------|-------------|--------------------|---|-------------|-------------------|---|---|---|---------|
| E3, E4 | RATE_SELO, RATE_SEL1 | | Input | <p>CONTROL SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Used to configure the operating data rate.</p> <table border="1"> <thead> <tr> <th>RATE_SELO</th> <th>RATE_SEL1</th> <th>Data Rate</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1.485 or 1.485/1.001Gb/s</td> </tr> <tr> <td>0</td> <td>1</td> <td>2.97 or 2.97/1.001Gb/s</td> </tr> <tr> <td>1</td> <td>X</td> <td>270Mb/s</td> </tr> </tbody> </table> | RATE_SELO | RATE_SEL1 | Data Rate | 0 | 0 | 1.485 or 1.485/1.001Gb/s | 0 | 1 | 2.97 or 2.97/1.001Gb/s | 1 | X | 270Mb/s |
| RATE_SELO | RATE_SEL1 | Data Rate | | | | | | | | | | | | | | |
| 0 | 0 | 1.485 or 1.485/1.001Gb/s | | | | | | | | | | | | | | |
| 0 | 1 | 2.97 or 2.97/1.001Gb/s | | | | | | | | | | | | | | |
| 1 | X | 270Mb/s | | | | | | | | | | | | | | |
| E7 | TDI | | Input | <p>COMMUNICATION SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Dedicated JTAG pin. Test data in. This pin is used to shift JTAG test data into the device when the JTAG/HOST pin is LOW.</p> | | | | | | | | | | | | |
| E8 | TMS | | Input | <p>COMMUNICATION SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Dedicated JTAG pin. Test mode start. This pin is JTAG Test Mode Start, used to control the operation of the JTAG test when the JTAG/HOST pin is LOW.</p> | | | | | | | | | | | | |
| E10 | CD_VDD | | Input Power | Power for the serial digital cable driver. Connect to +3.3V DC analog. | | | | | | | | | | | | |
| F1, F2, H1, H2, J1, J2, K1, K2, J3, K3 | DIN[9:0] | | Input | <p>PARALLEL DATA BUS. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. In 10-bit mode, these pins are not used.</p> <table border="1"> <thead> <tr> <th>Mode</th> <th>Configuration</th> <th>Impedance</th> </tr> </thead> <tbody> <tr> <td>20-bit mode</td> <td>20BIT/T0BIT = HIGH</td> <td>Data Stream 2/Chroma data input in SMPTE mode SMPTE_BYPASS = HIGH DVB_ASI = LOW Data input in data through mode SMPTE_BYPASS = LOW DVB_ASI = LOW</td> </tr> <tr> <td>10-bit mode</td> <td>20BIT/T0BIT = LOW</td> <td>Not Used in DVB-ASI mode SMPTE_BYPASS = LOW DVB_ASI = HIGH High impedance.</td> </tr> </tbody> </table> | Mode | Configuration | Impedance | 20-bit mode | 20BIT/T0BIT = HIGH | Data Stream 2/Chroma data input in SMPTE mode SMPTE_BYPASS = HIGH DVB_ASI = LOW Data input in data through mode SMPTE_BYPASS = LOW DVB_ASI = LOW | 10-bit mode | 20BIT/T0BIT = LOW | Not Used in DVB-ASI mode SMPTE_BYPASS = LOW DVB_ASI = HIGH High impedance. | | | |
| Mode | Configuration | Impedance | | | | | | | | | | | | | | |
| 20-bit mode | 20BIT/T0BIT = HIGH | Data Stream 2/Chroma data input in SMPTE mode SMPTE_BYPASS = HIGH DVB_ASI = LOW Data input in data through mode SMPTE_BYPASS = LOW DVB_ASI = LOW | | | | | | | | | | | | | | |
| 10-bit mode | 20BIT/T0BIT = LOW | Not Used in DVB-ASI mode SMPTE_BYPASS = LOW DVB_ASI = HIGH High impedance. | | | | | | | | | | | | | | |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description |
|------------|----------------------------------|--------|-------------|--|
| F3 | DETECT_TRS | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to select external HVF timing mode or TRS extraction timing mode.</p> <p>When DETECT_TRS is LOW, the device extracts all internal timing from the supplied H:V:F or CEA-861 timing signals, dependent on the status of the TIM861 pin.</p> <p>When DETECT_TRS is HIGH, the device extracts all internal timing from TRS signals embedded in the supplied video stream.</p> |
| F8 | TDO | | Output | <p>COMMUNICATION SIGNAL OUTPUT.</p> <p>Please refer to the Output Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Dedicated JTAG pin.</p> <p>JTAG Test Data Output.</p> <p>This pin is used to shift results from the device when the JTAG/$\overline{\text{HOST}}$ pin is LOW.</p> |
| F10 | RSET | | Input | <p>An external 1% resistor connected to this input is used to set the $\text{SDO}/\overline{\text{SDO}}$ output signal amplitude.</p> |
| G1, H10 | IO_VDD | | Input Power | <p>Power connection for digital I/O. Connect to +3.3V or +1.8V DC digital.</p> |
| G2, H9 | IO_GND | | Input Power | <p>Ground connection for digital I/O. Connect to digital GND.</p> |
| G3 | TIM_861 | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to select external CEA-861 timing mode.</p> <p>When DETECT_TRS is LOW and TIM-861 is LOW, the device extracts all internal timing from the supplied H:V:F timing signals.</p> <p>When DETECT_TRS is LOW and TIM-861 is HIGH, the device extracts all internal timing from the supplied HSYNC, VSYNC, DE timing signals.</p> <p>When DETECT_TRS is HIGH, the device extracts all internal timing from TRS signals embedded in the supplied video stream.</p> |
| G4 | 20BIT/ $\overline{10\text{BIT}}$ | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to select the input bus width.</p> |
| G5 | DVB_ASI | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to enable/disable the DVB-ASI data transmission.</p> <p>When DVB_ASI is set HIGH and $\overline{\text{SMPTE_BYPASS}}$ is set LOW, then the device will carry out DVB-ASI word alignment, I/O processing and transmission.</p> <p>When $\overline{\text{SMPTE_BYPASS}}$ and DVB_ASI are both set LOW, the device operates in data-through mode.</p> |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description |
|------------|-----------------------------------|--------|--------|--|
| G6 | $\overline{\text{SMPTE_BYPASS}}$ | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to enable / disable all forms of encoding / decoding, scrambling and EDH insertion.</p> <p>When set LOW, the device operates in data through mode (DVB_ASI= LOW), or in DVB-ASI mode (DVB_ASI = HIGH).</p> <p>No SMPTE scrambling takes place and none of the I/O processing features of the device are available when $\overline{\text{SMPTE_BYPASS}}$ is set LOW.</p> <p>When set HIGH, the device carries out SMPTE scrambling and I/O processing.</p> |
| G7 | IOPROC_EN/DIS | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to enable or disable the I/O processing features.</p> <p>When IOPROC_EN/DIS is HIGH, the I/O processing features of the device are enabled. When IOPROC_EN/DIS is LOW, the I/O processing features of the device are disabled.</p> <p>Only applicable in SMPTE mode.</p> |
| G8 | $\overline{\text{RESET}}$ | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Used to reset the internal operating conditions to default settings and to reset the JTAG sequence.</p> <p>Normal mode (JTAG/$\overline{\text{HOST}}$ = LOW).</p> <p>When LOW, all functional blocks will be set to default conditions and all input and output signals become high impedance.</p> <p>When HIGH, normal operation of the device resumes.</p> <p>JTAG test mode (JTAG/$\overline{\text{HOST}}$ = HIGH).</p> <p>When LOW, all functional blocks will be set to default and the JTAG test sequence will be reset.</p> <p>When HIGH, normal operation of the JTAG test sequence resumes.</p> |
| H3 | $\overline{\text{ANC_BLANK}}$ | | Input | <p>CONTROL SIGNAL INPUT.</p> <p>Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>When $\overline{\text{ANC_BLANK}}$ is LOW, the Luma and Chroma input data is set to the appropriate blanking levels during the H and V blanking intervals.</p> <p>When $\overline{\text{ANC_BLANK}}$ is HIGH, the Luma and Chroma data pass through the device unaltered.</p> <p>Only applicable in SMPTE mode.</p> |
| H4 | LOCKED | | Output | <p>STATUS SIGNAL OUTPUT.</p> <p>Please refer to the Output Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>PLL lock indication.</p> <p>HIGH indicates PLL is locked.</p> <p>LOW indicates PLL is not locked.</p> |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description |
|------------|----------------------------------|--------|--------|---|
| H5 | GRP2_EN/ $\overline{\text{DIS}}$ | | Input | Enables Audio Group 2 embedding. Set HIGH to enable. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. |
| H6 | GRP1_EN/ $\overline{\text{DIS}}$ | | Input | Enables Audio Group 1 embedding. Set HIGH to enable. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. |
| H7 | AUDIO_INT | | Output | STATUS SIGNAL OUTPUT. Please refer to the Output Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Summary Interrupt from Audio Processing. This signal is set HIGH by the device to indicate a problem with the audio processing which requires the Host processor to interrogate the interrupt status registers. IO_VDD = +3.3V Drive Strength = 8mA IO_VDD = +1.8V Drive Strength = 4mA Note: By default, out of reset, the AUDIO_INT pin will output the HD_AUDIO_CLOCK, rather than the audio interrupt signal. In order to output the interrupt flags from the audio core as intended, the user must write 0001h to register 0232h. |
| H8 | JTAG/ $\overline{\text{HOST}}$ | | Input | CONTROL SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Used to select JTAG test mode or host interface mode. When JTAG/ $\overline{\text{HOST}}$ is HIGH, the host interface port is configured for JTAG test. When JTAG/ $\overline{\text{HOST}}$ is LOW, normal operation of the host interface port resumes and the separate JTAG pins become the JTAG port. |
| J4 | AIN_5/6 | | Input | Serial Audio Input; Channels 5 and 6. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. |
| J5 | WCLK2 | | Input | 48kHz Word Clock associated with AIN_5/6 and AIN_7/8 (channels 5, 6, 7 and 8). Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. |
| J6 | AIN_1/2 | | Input | Serial Audio Input; Channels 1 and 2. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. |
| J7 | WCLK1 | | Input | 48kHz Word Clock associated with AIN_1/2 and AIN_3/4 (channels 1, 2, 3 and 4). Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description |
|------------|-----------|--------|--------|---|
| J8 | TCK | | Input | <p>COMMUNICATION SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. JTAG Serial Data Clock Signal. This pin is the JTAG clock when the JTAG/$\overline{\text{HOST}}$ pin is LOW.</p> |
| J9 | SDOUT_TDO | | Output | <p>COMMUNICATION SIGNAL OUTPUT. Please refer to the Output Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Shared JTAG/$\overline{\text{HOST}}$ pin. Provided for compatibility with the GS1582. Serial Data Output/Test Data Output. Host Mode (JTAG/$\overline{\text{HOST}}$ = LOW) This pin operates as the host interface serial output, used to read status and configuration information from the internal registers of the device. JTAG Test Mode (JTAG/$\overline{\text{HOST}}$ = HIGH) This pin is used to shift test results and operates as the JTAG test data output, TDO (for new designs, use the dedicated JTAG port). Note: If the host interface is not being used leave this pin unconnected. IO_VDD = +3.3V Drive Strength = 12mA IO_VDD = +1.8V Drive Strength = 4mA</p> |
| J10 | SCLK_TCK | | Input | <p>COMMUNICATION SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility. Shared JTAG/$\overline{\text{HOST}}$ pin. Provided for pin compatibility with GS1582. Serial data clock signal. Host Mode (JTAG/$\overline{\text{HOST}}$ = LOW) SCLK_TCK operates as the host interface burst clock, SCLK. Command and data read/write words are clocked into the device synchronously with this clock. JTAG Test Mode (JTAG/$\overline{\text{HOST}}$ = HIGH) This pin is the TEST MODE START pin, used to control the operation of the JTAG test clock, TCK (for new designs, use the dedicated JTAG port). Note: If the host interface is not being used, tie this pin HIGH.</p> |
| K4 | AIN_7/8 | | Input | Serial Audio Input; Channels 7 and 8. |
| K5 | ACLK2 | | Input | 64 x WCLK associated with AIN_5/6 and AIN_7/8 (channels 5, 6, 7 and 8). |
| K6 | AIN_3/4 | | Input | Serial Audio Input; Channels 3 and 4. |
| K7 | ACLK1 | | Input | 64 x WCLK associated with AIN_1/2 and AIN_3/4 (channels 1, 2, 3 and 4). |

Table 1-1: Pin Descriptions (Continued)

| Pin Number | Name | Timing | Type | Description |
|------------|----------------------|--------|-------|---|
| K9 | $\overline{CS_TMS}$ | | Input | <p>COMMUNICATION SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Chip select / test mode start.</p> <p>JTAG Test mode (JTAG/\overline{HOST} = HIGH) $\overline{CS_TMS}$ operates as the JTAG test mode start, TMS, used to control the operation of the JTAG test, and is active HIGH (for new designs, use the dedicated JTAG port).</p> <p>Host mode (JTAG/\overline{HOST} = LOW), $\overline{CS_TMS}$ operates as the host interface Chip Select, \overline{CS}, and is active LOW.</p> |
| K10 | SDIN_TDI | | Input | <p>COMMUNICATION SIGNAL INPUT. Please refer to the Input Logic parameters in the DC Electrical Characteristics table for logic level threshold and compatibility.</p> <p>Shared JTAG/HOST pin. Provided for pin compatibility with GS1582.</p> <p>Serial data in/test data in.</p> <p>In JTAG mode, this pin is used to shift test data into the device (for new designs, use the dedicated JTAG port).</p> <p>In host interface mode, this pin is used to write address and configuration data words into the device.</p> |

2. Electrical Characteristics

2.1 Absolute Maximum Ratings

Table 2-1: Absolute Maximum Ratings

| Parameter | Value/Units |
|---|---------------------------|
| Supply Voltage, Digital Core (CORE_VDD) | -0.3V to +1.5V |
| Supply Voltage, Digital I/O (IO_VDD) | -0.3V to +3.6V |
| Supply Voltage, Analog +1.2V (PLL_VDD, VCO_VDD) | -0.3V to +1.5V |
| Supply Voltage, Analog +3.3V (CD_VDD, A_VDD) | -0.3V to +3.6V |
| Input Voltage Range (RSET) | -0.3V to (CD_VDD + 0.3)V |
| Input Voltage Range (VBG) | -0.3V to (A_VDD + 0.3)V |
| Input Voltage Range (LF) | -0.3V to (PLL_VDD + 0.3)V |
| Input Voltage Range (digital inputs) | -2.0V to +5.25V |
| Temperature Range | -40°C to +85°C |
| Storage Temperature Range | -40°C to +125°C |
| Peak Reflow Temperature (JEDEC J-STD-020C) | 260°C |
| ESD Sensitivity, HBM (JESD22-A114) | 2kV |

Note: Absolute Maximum Ratings are those values beyond which damage may occur. Functional operation outside of the ranges shown in Table 2-1 is not implied.

2.2 Recommended Operating Conditions

Table 2-2: Recommended Operating Conditions

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | Note |
|--------------------------------------|----------------|------------|------|-----|------|-------|------|
| Operating Temperature Range, Ambient | T _A | – | -20 | – | 85 | °C | – |
| Supply Voltage, Digital Core | CORE_VDD | – | 1.14 | 1.2 | 1.26 | V | – |
| Supply Voltage, Digital I/O | IO_VDD | +1.8V mode | 1.71 | 1.8 | 1.89 | V | – |
| | | +3.3V mode | 3.13 | 3.3 | 3.47 | V | – |
| Supply Voltage, PLL | PLL_VDD | – | 1.14 | 1.2 | 1.26 | V | – |
| Supply Voltage, VCO | VCO_VDD | – | – | 0.7 | – | V | 1 |
| Supply Voltage, Analog | A_VDD | – | 3.13 | 3.3 | 3.47 | V | – |
| Supply Voltage, CD | CD_VDD | – | 3.13 | 3.3 | 3.47 | V | – |

Table 2-2: Recommended Operating Conditions (Continued)

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | Note |
|------------------------------|--------|------------|-----|-----|-----|-------|------|
| Operating Temperature Range | – | – | -20 | – | 85 | °C | 2 |
| Functional Temperature Range | – | – | -40 | – | 85 | °C | 2 |

Notes:

1. This is 0.7V rather than 1.2V because there is a voltage drop across an external 105Ω resistor. See [Typical Application Circuit](#).
2. Operating Temperature Range guarantees the parameters given in the [DC Electrical Characteristics](#) and [AC Electrical Characteristics](#). Functional Temperature Range guarantees a device start-up.

2.3 DC Electrical Characteristics

Table 2-3: DC Electrical Characteristics

V_{CC} = +3.3V ±5%, T_A = -20°C to +85°C, unless otherwise shown

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | Note |
|--|------------------|-------------|-----|-----|-----|-------|------|
| System | | | | | | | |
| +1.2V Supply Current | I _{1V2} | 10bit 3G | – | 135 | 200 | mA | – |
| | | 20bit 3G | – | 135 | 200 | mA | – |
| | | 10/20bit HD | – | 100 | 160 | mA | – |
| | | 10/20bit SD | – | 75 | 120 | mA | – |
| | | DVB_ASI | – | 75 | 120 | mA | – |
| +1.8V Supply Current | I _{1V8} | 10bit 3G | – | 15 | 30 | mA | – |
| | | 20bit 3G | – | 15 | 32 | mA | – |
| | | 10/20bit HD | – | 15 | 32 | mA | – |
| | | 10/20bit SD | – | 3 | 10 | mA | – |
| | | DVB_ASI | – | 3 | 10 | mA | – |
| +3.3V Supply Current | I _{3V3} | 10bit 3G | – | 90 | 110 | mA | – |
| | | 20bit 3G | – | 90 | 110 | mA | – |
| | | 10/20bit HD | – | 90 | 110 | mA | – |
| | | 10/20bit SD | – | 70 | 90 | mA | – |
| | | DVB_ASI | – | 70 | 90 | mA | – |
| Total Device Power (IO_VDD = +1.8V) | P _{1D8} | 10bit 3G | – | 400 | 560 | mW | – |
| | | 20bit 3G | – | 400 | 560 | mW | – |
| | | 10/20bit HD | – | 350 | 510 | mW | – |
| | | 10/20bit SD | – | 300 | 450 | mW | – |
| | | DVB_ASI | – | 300 | 450 | mW | – |
| | | Reset | – | 200 | – | mW | – |
| | | Standby | – | 110 | 180 | mW | 1 |

Table 2-3: DC Electrical Characteristics (Continued)

$V_{CC} = +3.3V \pm 5\%$, $T_A = -20^\circ C$ to $+85^\circ C$, unless otherwise shown

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | Note |
|--|--------------------|---|--------------|-----------------------------|--------------|-------|------|
| Total Device Power (IO_VDD = +3.3V) | P _{3D3} | 10bit 3G | – | 430 | 600 | mW | – |
| | | 20bit 3G | – | 450 | 610 | mW | – |
| | | 10/20bit HD | – | 420 | 550 | mW | – |
| | | 10/20bit SD | – | 320 | 450 | mW | – |
| | | DVB_ASI | – | 320 | 450 | mW | – |
| | | Reset | – | 230 | – | mW | – |
| | | Standby | – | 110 | 180 | mW | 1 |
| Digital I/O | | | | | | | |
| Input Logic LOW | V _{IL} | +3.3V or +1.8V operation | IO_VSS-0.3 | – | 0.3 x IO_VDD | V | – |
| Input Logic HIGH | V _{IH} | +3.3V or +1.8V operation | 0.7 x IO_VDD | – | IO_VDD+0.3 | V | – |
| Output Logic LOW | V _{OL} | IOL=5mA, +1.8V operation | – | – | 0.2 | V | – |
| | | IOL=8mA, +3.3V operation | – | – | 0.4 | V | – |
| Output Logic HIGH | V _{OH} | IOH=-5mA, +1.8V operation | 1.4 | – | – | V | – |
| | | IOH=-8mA, +3.3V operation | 2.4 | – | – | V | – |
| Serial Output | | | | | | | |
| Serial Output Common Mode Voltage | V _{CMOUT} | 75Ω load, R _{SET} = 750Ω SD and HD mode | – | CD_VDD - V _{SDD/2} | – | V | – |

Note:

1. Devices manufactured prior 1to April 1, 2011 consume 150mW of power in Standby mode.

2.4 AC Electrical Characteristics

Table 2-4: AC Electrical Characteristics

$V_{CC} = +3.3V \pm 5\%$, $T_A = -20^\circ C$ to $+85^\circ C$, unless otherwise shown

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | Note |
|------------------------------|-------------------|---|------|------|-------|-------|------|
| System | | | | | | | |
| Device Latency | - | 3G bypass (PCLK = 148.5 MHz) | - | 54 | - | PCLK | - |
| | - | 3G SMPTE without audio (PCLK = 148.5 MHz) | - | 95 | - | PCLK | - |
| | - | 3G SMPTE with audio (PCLK = 148.5 MHz) | - | 1106 | - | PCLK | - |
| | - | 3G IOPROC disabled 20-bit mode (PCLK = 148.5MHz) | - | 94 | - | PCLK | - |
| | - | HD bypass (PCLK = 74.25 MHz) | - | 54 | - | PCLK | - |
| | - | HD SMPTE without audio (PCLK = 74.25 MHz) | - | 95 | - | PCLK | - |
| | - | HD SMPTE with audio (PCLK = 74.25 MHz) | - | 1106 | - | PCLK | - |
| | - | HD IOPROC disabled 10-bit mode (PCLK = 74.25MHz) | - | 98 | - | PCLK | - |
| | - | SD bypass (PCLK = 27 MHz) | - | 54 | - | PCLK | - |
| | - | SD SMPTE without audio | - | 112 | - | PCLK | - |
| | - | SD SMPTE with audio | - | 638 | - | PCLK | - |
| | - | SD IOPROC disabled 10-bit mode (PCLK = 27MHz) | - | 94 | - | PCLK | - |
| | - | DVB-ASI | - | 52 | - | PCLK | - |
| | Reset Pulse Width | t_{reset} | - | 1 | - | - | ms |
| Parallel Input | | | | | | | |
| Parallel Clock Frequency | f_{PCLK} | - | 13.5 | - | 148.5 | MHz | - |
| Parallel Clock Duty Cycle | DC_{PCLK} | - | 40 | - | 60 | % | - |
| Input Data Setup Time | t_{su} | 50% levels; +3.3V or +1.8V operation | 1.2 | - | - | ns | 1 |
| Input Data Hold Time | t_{ih} | | 0.8 | - | - | ns | 1 |
| Serial Digital Output | | | | | | | |

Table 2-4: AC Electrical Characteristics (Continued)

V_{CC} = +3.3V ±5%, T_A = -20°C to +85°C, unless otherwise shown

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | Note | |
|--|-----------------------------------|--|---------------|-------------|-----|------------------|------|---|
| Serial Output Data Rate | DR _{SDO} | – | – | 2.97 | – | Gb/s | – | |
| | | – | – | 2.97/1.001 | – | Gb/s | – | |
| | | – | – | 1.485 | – | Gb/s | – | |
| | | – | – | 1.485/1.001 | – | Gb/s | – | |
| | | – | – | 270 | – | Mb/s | – | |
| Serial Output Swing | V _{SDD} | R _{SET} = 750Ω 75Ω load | 750 | 800 | 850 | mV _{pp} | 2 | |
| Serial Output Rise/Fall Time 20% ~ 80% | trf _{SDO} | 3G/HD mode | – | 120 | 135 | ps | – | |
| | trf _{SDO} | SD mode | 400 | 660 | 800 | ps | – | |
| Mismatch in rise/fall time | Δt _r , Δt _f | – | – | – | 35 | ps | – | |
| Duty Cycle Distortion | – | – | – | – | 5 | % | 2 | |
| Overshoot | – | 3G/HD mode | – | 5 | 10 | % | 2 | |
| | – | SD mode | – | 3 | 8 | % | 2 | |
| Output Return Loss | ORL | 1.485GHz - 2.97GHz | – | -12 | – | dB | 3 | |
| | | 5 MHz - 1.485 GHz | – | -18 | – | dB | 3 | |
| Serial Output Intrinsic Jitter | t _{OJ} | Pseudorandom and SMPTE Colour Bars 3G signal | – | 40 | 68 | ps | 4, 6 | |
| | t _{OJ} | Pseudorandom and SMPTE Colour Bars HD signal | – | 50 | 95 | ps | 4, 6 | |
| Serial Output Intrinsic Jitter | t _{OJ} | Pseudorandom and SMPTE Colour Bars SD signal | – | 200 | 400 | ps | 5 | |
| GSPI | | | | | | | | |
| GSPI Input Clock Frequency | f _{SCLK} | – | – | – | 80 | MHz | – | |
| GSPI Input Clock Duty Cycle | DC _{SCLK} | 50% levels +3.3V or +1.8V operation | 40 | 50 | 60 | % | – | |
| GSPI Input Data Setup Time | – | – | 1.5 | – | – | ns | – | |
| GSPI Input Data Hold Time | – | – | 1.5 | – | – | ns | – | |
| GSPI Output Data Hold Time | – | 15pF load | 1.5 | – | – | ns | – | |
| \overline{CS} low before SCLK rising edge | t ₀ | 50% levels +3.3V or +1.8V operation | 1.5 | – | – | ns | – | |
| Time between end of command word (or data in Auto-Increment mode) and the first SCLK of the following data word - write cycle | t ₄ | 50% levels +3.3V or +1.8V operation | PCLK (MHz) | | ns | | ns | – |
| | | | unlocked | 445 | – | – | | |
| | | | 13.5 | 74.2 | – | – | | |
| | | | 27.0 | 37.1 | – | – | | |
| | | | 74.25 | 13.5 | – | – | | |
| | | | 148.5 | 6.7 | – | – | | |

Table 2-4: AC Electrical Characteristics (Continued)

$V_{CC} = +3.3V \pm 5\%$, $T_A = -20^{\circ}C$ to $+85^{\circ}C$, unless otherwise shown

| Parameter | Symbol | Conditions | Min | | Typ | Max | Units | Note |
|--|--------|-------------------------------------|------------|-------|-----|-----|-------|------|
| Time between end of command word (or data in Auto-Increment mode) and the first SCLK of the following data word - read cycle | t_5 | 50% levels +3.3V or +1.8V operation | PCLK (MHz) | ns | | | | |
| | | | unlocked | 1187 | | | | |
| | | | 13.5 | 297 | - | - | ns | - |
| | | | 27.0 | 148.4 | | | | |
| | | | 74.25 | 53.9 | | | | |
| \overline{CS} high after SCLK falling edge | t_7 | 50% levels +3.3V or +1.8V operation | PCLK (MHz) | ns | | | | |
| | | | unlocked | 445 | | | | |
| | | | 13.5 | 74.2 | - | - | ns | - |
| | | | 27.0 | 37.1 | | | | |
| | | | 74.25 | 13.5 | | | | |
| | | | 148.5 | 6.7 | | | | |

Notes:

1. Input setup and hold time is dependent on the rise and fall time on the parallel input. Parallel clock and data with rise time or fall time greater than 500ps require larger setup and hold times.
2. Single Ended into 75Ω external load.
3. ORL depends on board design.
4. Alignment Jitter = measured from 100kHz to serial data rate/10.
5. Alignment Jitter = measured from 1kHz to 27MHz.
6. This is the maximum jitter for a BER of 10-12. The equivalent jitter value as per RP184 is 40ps max.

3. Input/Output Circuits

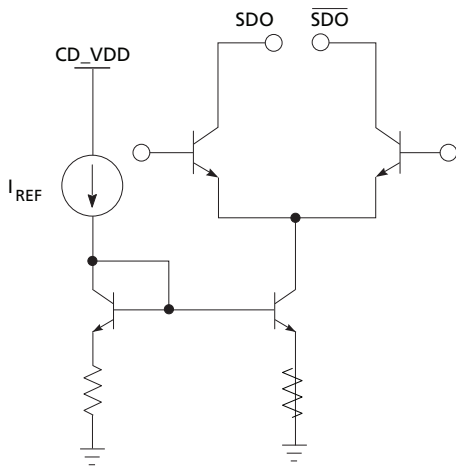


Figure 3-1: Differential Output Stage (SDO/SDO)

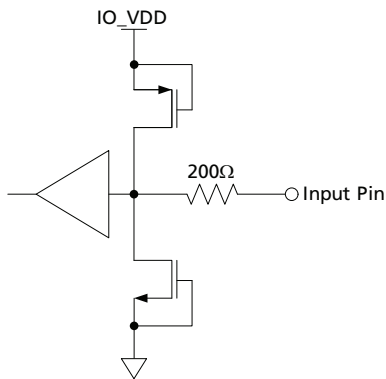


Figure 3-2: Digital Input Pin (20bit/10bit, ANC_BLANK, DETECT_TRS, DVB_ASI, RATE_SELO, SMPTE_BYPASS, RATE_SEL1, TIM_861, F/DE, H/HSYNC, PCLK, V/VSYNC)

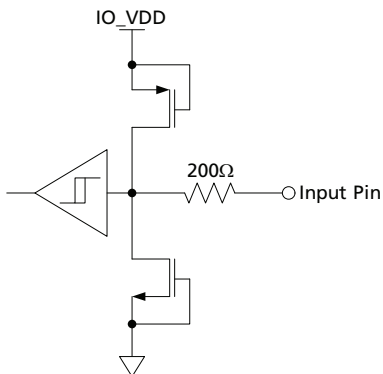


Figure 3-3: Digital Input Pin with Schmitt Trigger (RESET)

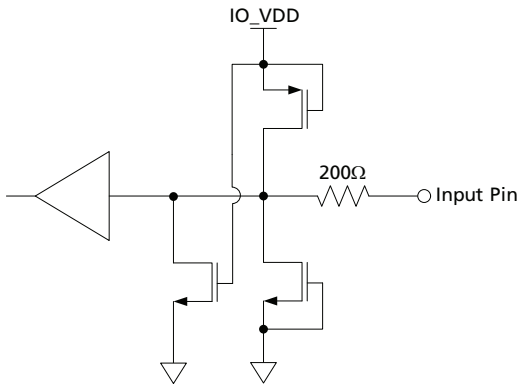


Figure 3-4: Digital Input Pin with weak pull-down - maximum pull-down current <math><110\mu\text{A}</math> (JTAG/HOST, STANDBY, SCLK_TCK, SDIN_TDI, TCK, TDI)

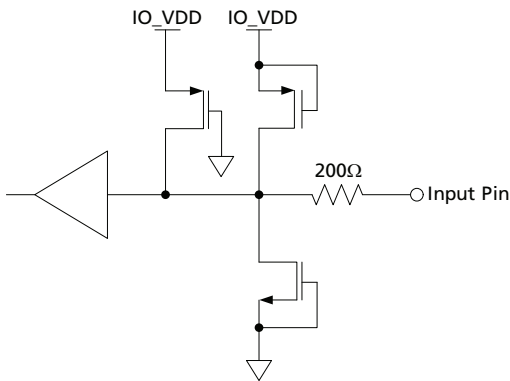


Figure 3-5: Digital Input Pin with weak pull-up - maximum pull-up current <math><110\mu\text{A}</math> (ACLK1, ACLK2, AIN_7/8, AIN_5/6, AIN_3/4, AIN_1/2, CS_TMS, GRP1_EN/DIS, GRP2_EN/DIS, IOPROC_EN/DIS, SDO_EN/DIS, TMS, WCLK1, WCLK2)

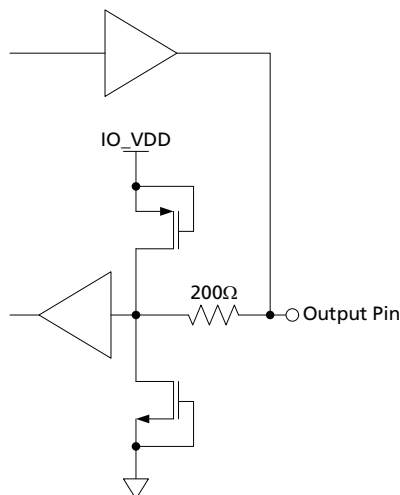


Figure 3-6: Bidirectional Digital Input/Output Pin with programmable drive strength. These pins are configured to input at all times except in test mode. (DIN0, DIN2, DIN3, DIN4, DIN5, DIN6, DIN7, DIN8, DIN9, DIN10, DIN11, DIN12, DIN13, DIN14, DIN15, DIN16, DIN17, DIN18, DIN19, DIN1)

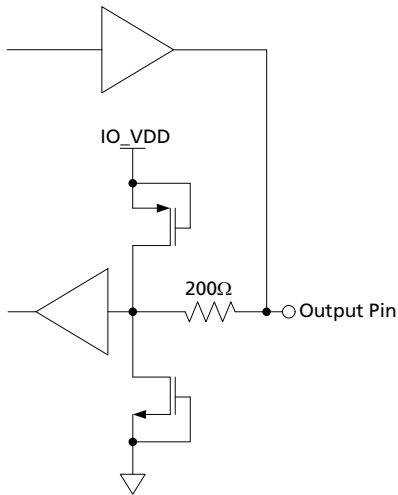


Figure 3-7: Bidirectional Digital Input/Output Pin with programmable drive strength. These pins are configured to output at all times except in reset mode. (LOCKED, AUDIO_INT, SDOUT_TDO, TDO)

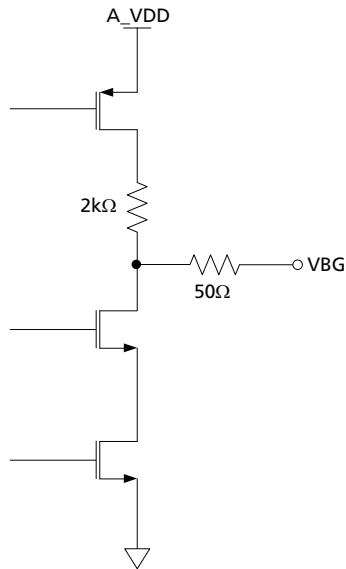


Figure 3-8: VBG

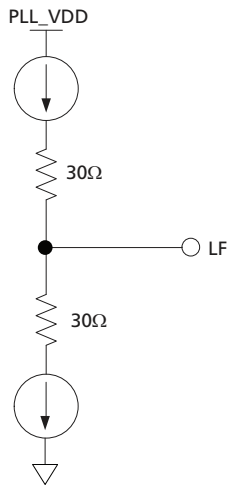


Figure 3-9: Loop Filter

4. Detailed Description

4.1 Functional Overview

The GS2972 is a Multi-Rate Transmitter with integrated SMPTE digital video processing and an integrated Cable Driver and embedded Audio Multiplexer. It provides a complete transmit solution at 2.970Gb/s, 2.970/1.001Gb/s, 1.485Gb/s, 1.485/1.001Gb/s or 270Mb/s.

The device has four basic modes of operation that must be set through external device pins: SMPTE mode, DVB-ASI mode, Data-Through mode and Standby mode.

In SMPTE mode, the device will accept 10-bit multiplexed or 20-bit demultiplexed SMPTE compliant data. By default, the device's additional processing features, including audio embedding, will be enabled in this mode.

In DVB-ASI mode, the GS2972 will accept an 8-bit parallel DVB-ASI compliant transport stream on DIN[17:10]. The serial output data stream will be 8b/10b encoded with stuffing characters added as per the standard.

Data-Through mode allows for the serializing of data not conforming to SMPTE or DVB-ASI streams. No additional processing will be done in this mode.

In addition, the device may be put into Standby, to reduce power consumption.

The serial digital output features a high-impedance mode and adjustable signal swing. The output slew rate is automatically set by the RATE_SEL0 and RATE_SEL1 pin setting.

The GS2972 provides several data processing functions; including generic ANC insertion, SMPTE ST 352 and EDH data packet generation and insertion, automatic video standards detection, and TRS, CRC, ANC data checksum, and line number calculation and insertion. These features are all enabled/disabled collectively using the external I/O processing pin, but may be individually disabled via internal registers accessible through the GSPI host interface.

Finally, the GS2972 contains a JTAG interface for boundary scan test implementations.

4.2 Parallel Data Inputs

Data signal inputs enter the device on the rising edge of PCLK, as shown in Figure 4-1.

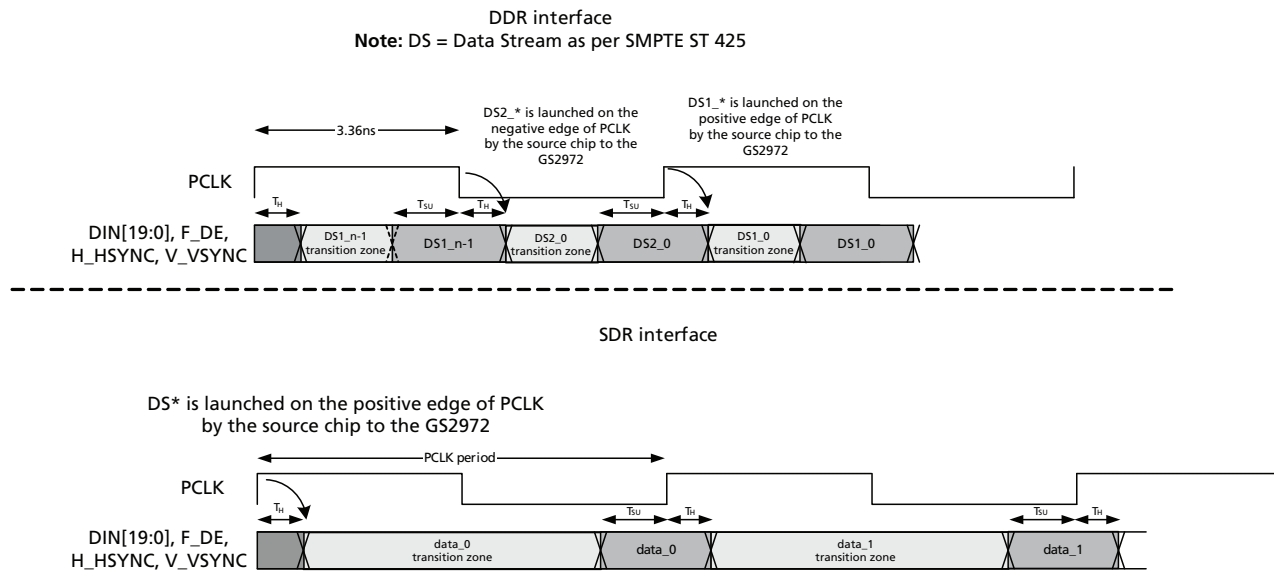


Figure 4-1: GS2972 Video Host Interface Timing Diagrams

Table 4-1: GS2972 Digital Input AC Electrical Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|------------------------|----------|-----------------|-----|-----|-----|-------|
| Input data set-up time | t_{SU} | 50% levels; | 1.2 | - | - | ns |
| Input data hold time | t_{IH} | +1.8V operation | 0.8 | - | - | ns |
| Input data set-up time | t_{SU} | 50% levels; | 1.3 | - | - | ns |
| Input data hold time | t_{IH} | +3.3V operation | 0.8 | - | - | ns |

Table 4-2: GS2972 Input Video Data Format Selections

| Input Data Format | Pin/Register Bit Settings | | | | | DIN[9:0] | DIN[19:10] |
|--------------------------------|---------------------------|------------|------------|---------------|---------|-----------------|-----------------|
| | 20BIT /10BIT | RATE _SEL0 | RATE _SEL1 | SMPTE _BYPASS | DVB_ASI | | |
| 20-bit demultiplexed 3G format | HIGH | LOW | HIGH | HIGH | LOW | Data Stream Two | Data Stream One |
| 20-bit data Input 3G format | HIGH | LOW | HIGH | LOW | LOW | DATA | DATA |
| 20-bit demultiplexed HD format | HIGH | LOW | LOW | HIGH | LOW | Chroma | Luma |

Table 4-2: GS2972 Input Video Data Format Selections (Continued)

| Input Data Format | Pin/Register Bit Settings | | | | | DIN[9:0] | DIN[19:10] |
|-------------------------------------|-------------------------------------|---------------|---------------|---|---------|-------------------|---------------------------------------|
| | $\overline{20BIT}/\overline{10BIT}$ | RATE _SEL0 | RATE _SEL1 | \overline{SMPTE} \overline{BYPASS} | DVB_ASI | | |
| 20-bit data Input HD format | HIGH | LOW | LOW | LOW | LOW | DATA | DATA |
| 20-bit demultiplexed SD format | HIGH | HIGH | X | HIGH | LOW | Chroma | Luma |
| 20-bit data input SD format | HIGH | HIGH | X | LOW | LOW | DATA | DATA |
| 10-bit multiplexed 3G DDR format | LOW | LOW | HIGH | HIGH | LOW | High Impedance | Data Stream One/Data Stream Two |
| 10-bit multiplexed HD format | LOW | LOW | LOW | HIGH | LOW | High Impedance | Luma/Chroma |
| 10-bit data input HD format | LOW | LOW | LOW | LOW | LOW | High Impedance | DATA |
| 10-bit multiplexed SD format | LOW | HIGH | X | HIGH | LOW | High Impedance | Luma/Chroma |
| 10-bit multiplexed SD format | LOW | HIGH | X | LOW | LOW | High Impedance | DATA |
| 10-bit ASI input SD format | LOW | HIGH | X | LOW | HIGH | High Impedance | DVB-ASI data |

The GS2972 is a high performance 3Gb/s capable transmitter. In order to optimize the output jitter performance across all operating conditions, input levels and overshoot at the parallel video data inputs of the device need to be controlled. In order to do this, source series termination resistors should be used to match the impedance of the PCB data trace line. IBIS models can be used to simulate the board effects and then optimize the output drive strength and the termination resistors to allow for the best transition (one that produces minimal overshoot). If this is not viable, Semtech recommends matching the source series resistance to the trace impedance, and then adjusting the output drive strength to the minimum value that will give zero errors.

The above also applies to the PCLK input line. HVF and the Audio inputs should also be well terminated, however due to the lower data rates and transition density it is not as critical.

4.2.1 Parallel Input in SMPTE Mode

When the device is operating in SMPTE mode ($\overline{\text{SMPTE_BYPASS}} = \text{HIGH}$), data must be presented to the input bus in either multiplexed or demultiplexed form, depending on the setting of the $\overline{20\text{BIT}/10\text{BIT}}$ pin.

When operating in 20-bit mode ($\overline{20\text{BIT}/10\text{BIT}} = \text{HIGH}$), the input data format must be word aligned, demultiplexed Luma and Chroma data (SD or HD), or word aligned demultiplexed Data Stream One and Data Stream Two data (3G).

In 3G Level B mode, by default, the device takes Data Stream One input from data port DIN[19:10] and Data Stream Two input from DIN[9:0].

When operating in 10-bit mode ($\overline{20\text{BIT}/10\text{BIT}} = \text{LOW}$), the input data format must be multiplexed Luma (Y) and Chroma (C) data (SD, HD), or multiplexed Data Stream One and Data Stream Two data (3G). C words precede Y words, and Data Stream 2 words precede Data Stream 1 words. In this mode, the data must be presented on the DIN[19:10] pins. The DIN[9:0] inputs are ignored.

In 3G 10-bit mode, the device operates in DDR mode. That is, the input data is sampled on both the rising and falling edges of the PCLK. In 3G mode, Data Stream Two words precede Data Stream One words. The Data Stream Two words are sampled on the rising edge of the input PCLK, and the Data Stream One words are sampled on the following falling edge. H, V and F timing pulses, if used, are sampled on the rising edge of PCLK.

4.2.1.1 Input Data Format in SDTI Mode

SDTI and HD-SDTI are a sub-set of SDI and HD-SDI formats. They may contain SDTI data on any line in the frame. Those lines which contain SDTI or HD-SDTI data are identified with an SDTI or HD-SDTI header packet in the HANC space.

The GS2972 does not differentiate between a signal carrying video and a signal carrying SDTI or HD-SDTI data in SD or HD formats. The user is responsible for ensuring that the headers and data are not corrupted.

4.2.2 Parallel Input in DVB-ASI Mode

The GS2972 is in DVB-ASI mode when the $\overline{\text{SMPTE_BYPASS}}$ pin is set LOW, the DVB_ASI pin is set HIGH, and the RATE_SEL0 pin is set HIGH. In this mode, all SMPTE processing features are disabled.

When operating in DVB-ASI mode, the device must be set to 10-bit mode by setting the $\overline{20\text{BIT}/10\text{BIT}}$ pin LOW. The device will accept 8-bit data words on DIN[17:10], where DIN17 = HIN is the most significant bit of the encoded transport stream data and DIN10 = AIN is the least significant bit. In addition, DIN19 and DIN18 will be configured as the DVB-ASI control signals INSSYNCIN and KIN respectively.

DIN19 = INSSYNCIN

DIN18 = KIN

DIN17-10 = HIN ~ AIN where AIN is the least significant bit of the transport stream data.

4.2.3 Parallel Input in Data-Through Mode

Data-Through mode is enabled when the $\overline{\text{SMPTE_BYPASS}}$ pin and the DVB_ASI pin are LOW.

In this mode, data at the input bus is serialized without any encoding, scrambling or word alignment taking place.

The input data width is controlled by the setting of the $20\text{BIT}/\overline{10\text{BIT}}$ pin as shown in Table 4-2 above.

Note: When in HD 10-bit mode, asserting the $\overline{\text{SMPTE_BYPASS}}$ LOW to put the device in SMPTE-BYPASS mode will create video errors. If the user desires to use the device as a simple serializer in HD 10-bit mode, all video processing features may be disabled by setting the IOPROC_EN/ $\overline{\text{DIS}}$ pin LOW.

4.2.4 Parallel Input Clock (PCLK)

The frequency of the PCLK input signal of the GS2972 is determined by the input data format and operating mode selection.

Table 4-3 below lists the input PCLK rates and input signal formats according to the external selection pins for the GS2972.

Table 4-3: GS2972 PCLK Input Rates

| Input Data Format | Pin Settings | | | | | PCLK Rate |
|----------------------------------|--|-----------|-----------|-----------------------------------|---------|-------------------------|
| | $20\text{BIT}/\overline{10\text{BIT}}$ | RATE_SELO | RATE_SEL1 | $\overline{\text{SMPTE_BYPASS}}$ | DVB-ASI | |
| 20-bit demultiplexed 3G format | HIGH | LOW | HIGH | HIGH | X | 148.5 or 148.5/1.001MHz |
| 20-bit demultiplexed HD format | HIGH | LOW | LOW | HIGH | X | 74.25 or 74.25/1.001MHz |
| 20-bit data Input 3G format | HIGH | LOW | HIGH | LOW | LOW | 148.5 or 148.5/1.001MHz |
| 20-bit data input HD format | HIGH | LOW | LOW | LOW | LOW | 74.25 or 74.25/1.001MHz |
| 20-bit demultiplexed SD format | HIGH | HIGH | X | HIGH | LOW | 13.5MHz |
| 20-bit data input SD format | HIGH | HIGH | X | LOW | LOW | 13.5MHz |
| 10-bit multiplexed 3G DDR format | LOW | LOW | HIGH | HIGH | LOW | 148.5 or 148.5/1.001MHz |
| 10-bit multiplexed HD format | LOW | LOW | LOW | HIGH | LOW | 148.5 or 148.5/1.001MHz |
| 10-bit data input HD format | LOW | LOW | LOW | LOW | LOW | 148.5 or 148.5/1.001MHz |
| 10-bit multiplexed SD format | LOW | HIGH | X | HIGH | X | 27MHz |

Table 4-3: GS2972 PCLK Input Rates (Continued)

| Input Data Format | Pin Settings | | | | | PCLK Rate |
|-----------------------------|--------------|-----------|-----------|--------------|---------|-----------|
| | 20BIT/10BIT | RATE_SELO | RATE_SEL1 | SMPTE_BYPASS | DVB-ASI | |
| 10-bit data input SD format | LOW | HIGH | X | LOW | LOW | 27MHz |
| 10-bit ASI input SD format | LOW | HIGH | X | LOW | HIGH | 27MHz |

4.3 SMPTE Mode

The function of this block is to carry out data scrambling according to SMPTE ST 424/SMPTE ST 292, and to carry out NRZ to NRZI encoding prior to presentation to the parallel to serial converter.

These functions are only enabled when the SMPTE_BYPASS pin is HIGH.

In addition, the GS2972 requires the DVB_ASI pin to be set LOW to enable this feature.

4.3.1 H:V:F Timing

In SMPTE mode, the GS2972 can automatically detect the video standard and generate all internal timing signals. The total line length, active line length, total number of lines per field/frame and total active lines per field/frame are calculated for the received parallel video.

When DETECT_TRS is LOW, the video standard and timing signals are based on the externally supplied H_Blanking, V_Blanking, and F_Digital signals. These signals are supplied by the H/HSYNC, V/VSYNC and F/DE pins respectively. When DETECT_TRS is HIGH, the video standard timing signals will be extracted from the embedded TRS ID words in the parallel input data. Both 8-bit and 10-bit TRS code words will be identified by the device.

Note: I/O processing must be enabled for the device to remap 8-bit TRS words to the corresponding 10-bit value for transmission.

The GS2972 determines the video standard by timing the horizontal and vertical reference information supplied at the H/HSYNC, V/VSYNC, and F/DE input pins, or contained in the TRS ID words of the received video data. Therefore, full synchronization to the received video standard requires at least one complete video frame.

Once synchronization has been achieved, the GS2972 will continue to monitor the received TRS timing or the supplied H, V, and F timing information to maintain synchronization. The GS2972 will lose all timing information immediately following loss of H, V and F.

The H signal timing should also be configured via the H_CONFIG bit of the internal IOPROC register as either active line based blanking or TRS based blanking.

Active line based blanking is enabled when the H_CONFIG bit is set LOW. In this mode, the H input should be HIGH for the entire horizontal blanking period, including the EAV and SAV TRS words. This is the default H timing used by the device.

The timing of these signals is shown in Figure 4-5, Figure 4-6, Figure 4-7, Figure 4-8, Table 4-6, Table 4-7 and Table 4-8.

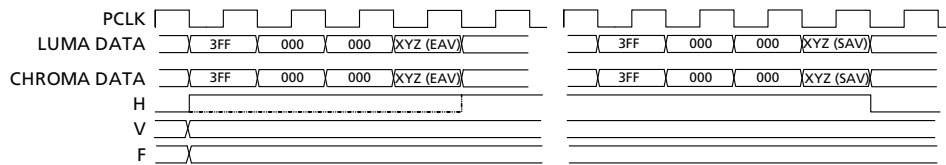


Figure 4-2: H:V:F Output Timing - 3G Level A and HDTV 20-bit Mode

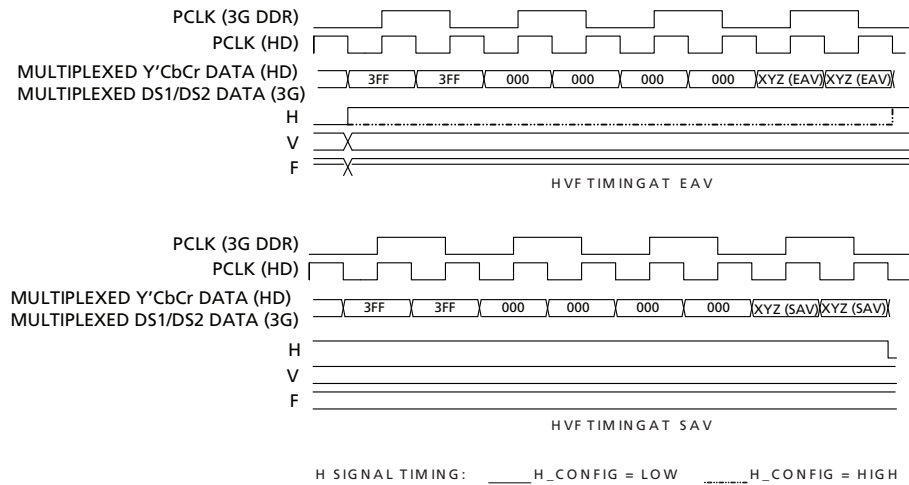


Figure 4-3: H:V:F Output Timing - 3G Level A and HDTV 10-bit Mode 3G Level B 20-bit Mode, each 10-bit stream

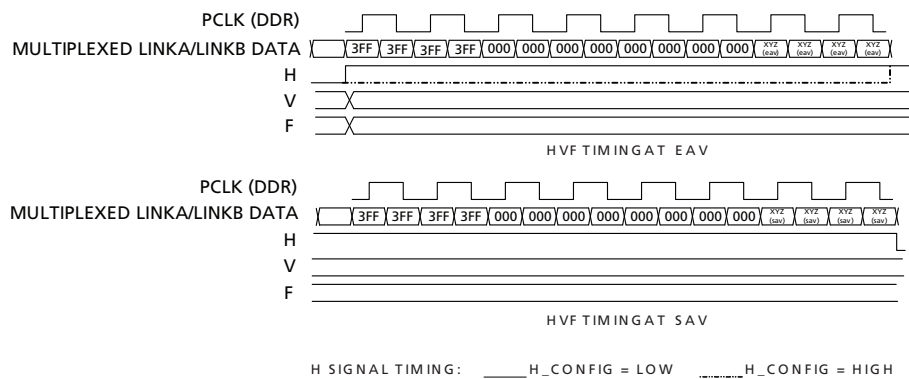


Figure 4-4: H:V:F Output Timing - 3G Level B 10-bit Mode

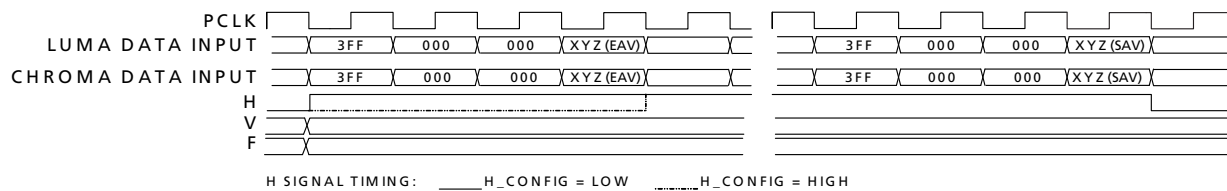


Figure 4-5: H:V:F Input Timing - HD 20-bit Input Mode

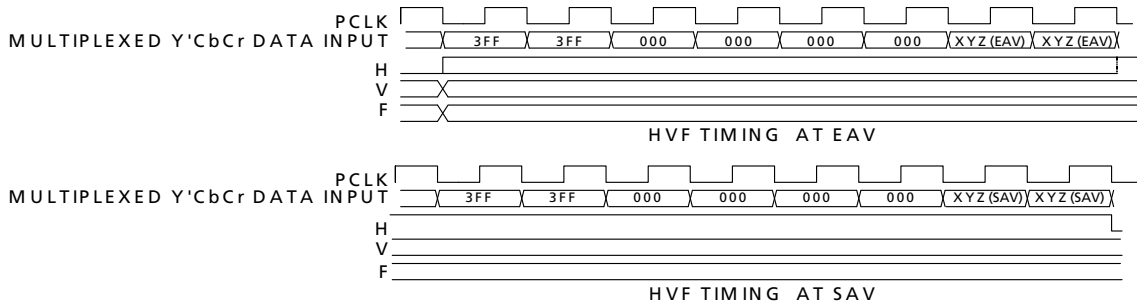


Figure 4-6: H:V:F Input Timing - HD 10-bit Input Mode

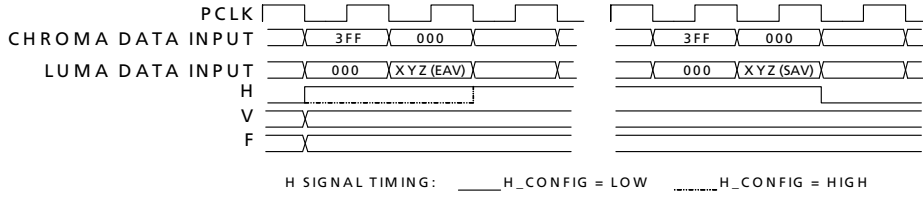


Figure 4-7: H:V:F Input Timing - SD 20-bit Mode

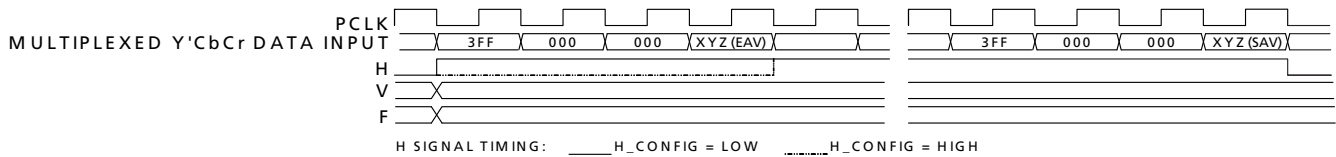


Figure 4-8: H:V:F Input Timing - SD 10-bit Mode

4.3.2 CEA 861 Timing

The GS2972 extracts timing information from externally provided HSYNC, VSYNC, and DE signals when CEA 861 timing mode is selected by setting DETECT_TRS = LOW and TIM_861 = HIGH.

Horizontal sync (H), Vertical sync (V), and Data Enable (DE) timing must be provided via the H/HSYNC, V/VSYNC and F/DE input pins. The host interface register bit H_CONFIG is ignored in CEA 861 input timing mode.

The GS2972 determines the EIA/CEA-861 standard and embeds EAV and SAV TRS words in the output serial video stream.

Video standard detection is not dependent on the HSYNC pulse width or the VSYNC pulse width and therefore the GS2972 tolerates non-standard pulse widths. In addition, the device can compensate for up to ± 1 PCLK cycle of jitter on VSYNC with respect to HSYNC and sample VSYNC correctly.

Note 1: The period between the leading edge of the HSYNC pulse and the leading edge of Data Enable (DE) must follow the timing requirements described in the EIA/CEA-861 specification. The GS2972 embeds TRS words according to this timing relationship to maintain compatibility with the corresponding SMPTE standard.

Note 2: When CEA 861 standards 6 & 7 [720(1440)x480i] are presented to the GS2972, the device embeds TRS words corresponding to the timing defined in SMPTE ST 125 to maintain SMPTE compatibility.

CEA 861 standards 6 & 7 [720(1440)x480i] define the active area on lines 22 to 261 and 285 to 524 inclusive (240 active lines per field). SMPTE ST 125 defines the active area on lines 20 to 263 and 283 to 525 inclusive (244 lines on field 1, 243 lines on field 2).

Therefore, in the first field, the GS2972 adds two active lines above and two active lines below the original active image. In the second field, it adds two lines above and one line below the original active image.

The CEA861 Timing Formats are summarized in [Table 4-4](#), and are shown in [Figure 4-9](#) to [Figure 4-19](#).

Table 4-4: CEA861 Timing Formats

| Format | Parameters |
|--------|--|
| 4 | H:V:DE Input Timing 1280 x 720p @ 59.94/60Hz |
| 5 | H:V:DE Input Timing 1920 x 1080i @ 59.94/60Hz |
| 6&7 | H:V:DE Input Timing 720 (1440) x 480i @ 59.94/60Hz |
| 19 | H:V:DE Input Timing 1280 x 720p @ 50Hz |
| 20 | H:V:DE Input Timing 1920 x 1080i @ 50Hz |
| 21&22 | H:V:DE Input Timing 720 (1440) x 576 @ 50Hz |
| 16 | H:V:DE Input Timing 1920 x 1080p @ 59.94/60Hz |
| 31 | H:V:DE Input Timing 1920 x 1080p @ 50Hz |
| 32 | H:V:DE Input Timing 1920 x 1080p @ 23.94/24Hz |
| 33 | H:V:DE Input Timing 1920 x 1080p @ 25Hz |
| 34 | H:V:DE Input Timing 1920 x 1080p @ 29.97/30Hz |

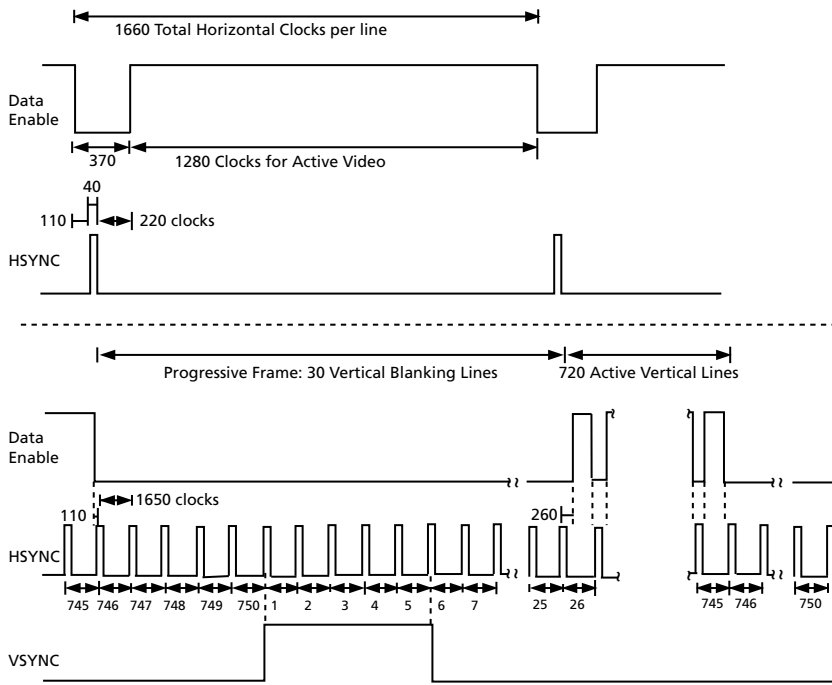


Figure 4-9: H:V:DE Input Timing 1280 x 720p @ 59.94/60 (Format 4)

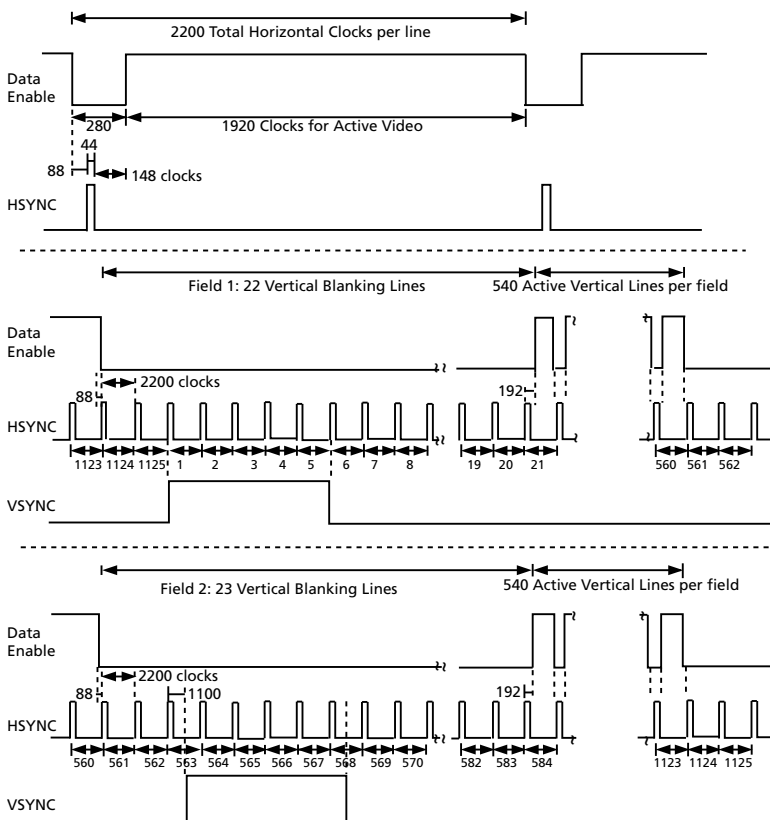


Figure 4-10: H:V:DE Input Timing 1920 x 1080i @ 59.94/60 (Format 5)

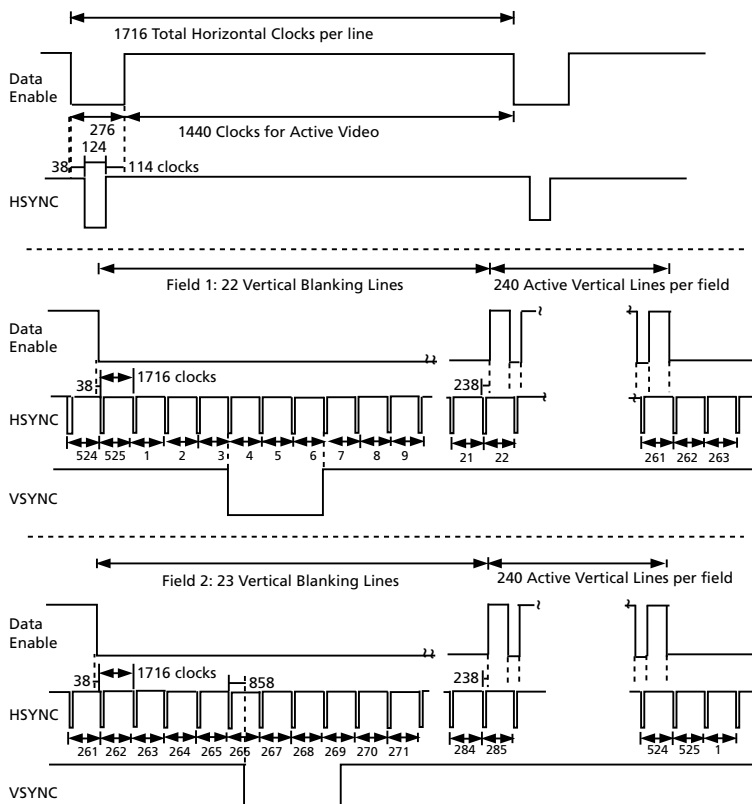


Figure 4-11: H:V:DE Input Timing 720 (1440) x 480i @ 59.94/60 (Format 6&7)

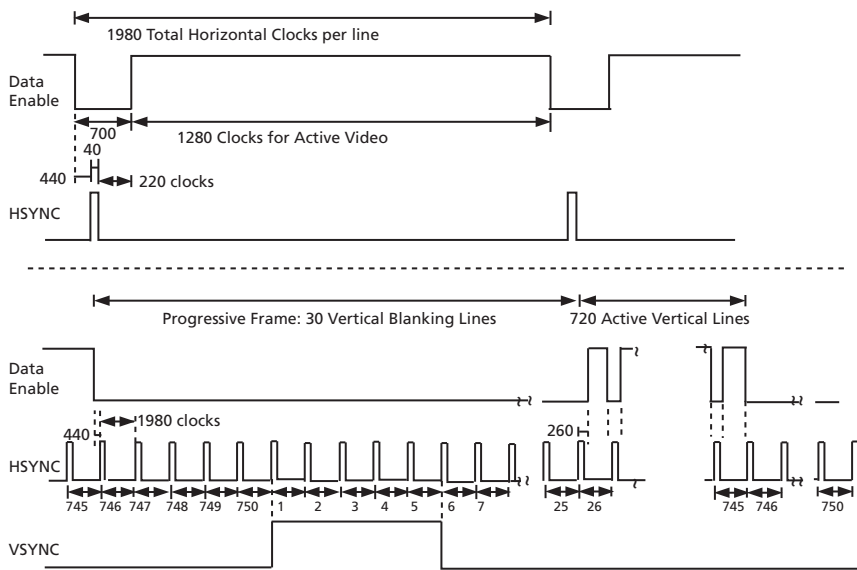


Figure 4-12: H:V:DE Input Timing 1280 x 720p @ 50 (Format 19)

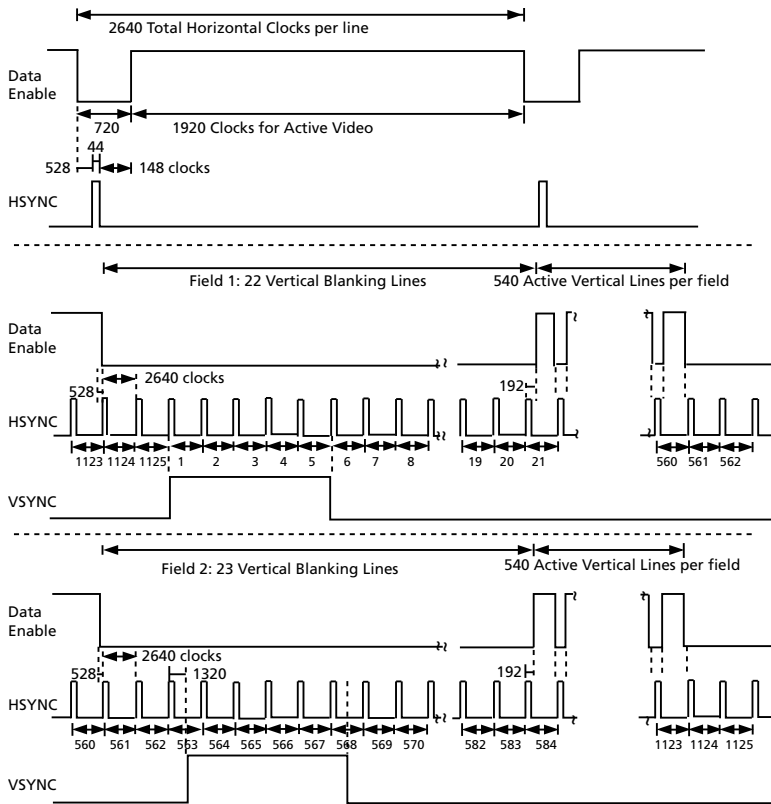


Figure 4-13: H:V:DE Input Timing 1920 x 1080i @ 50 (Format 20)

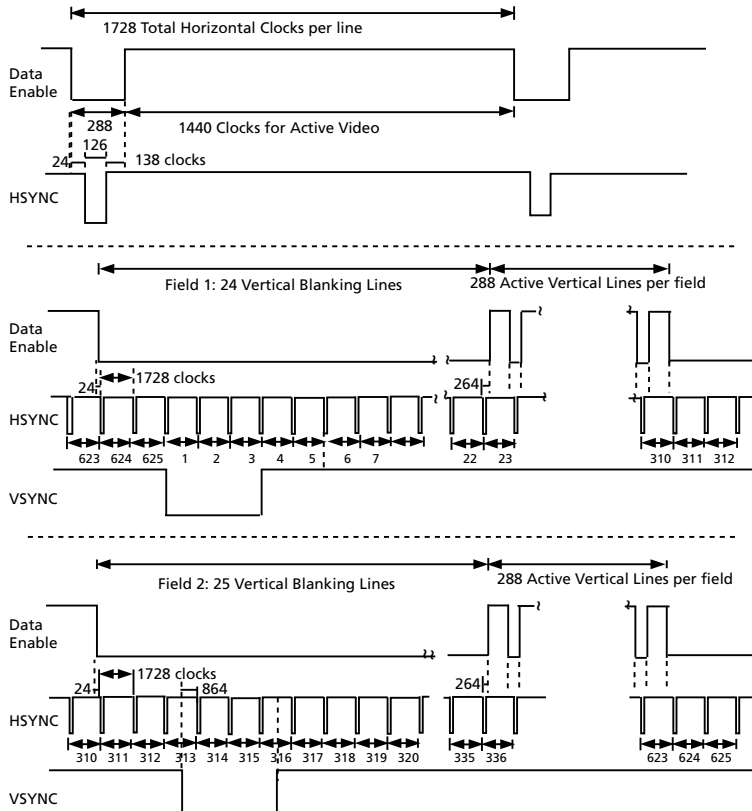


Figure 4-14: H:V:DE Input Timing 720 (1440) x 576 @ 50 (Format 21&22)

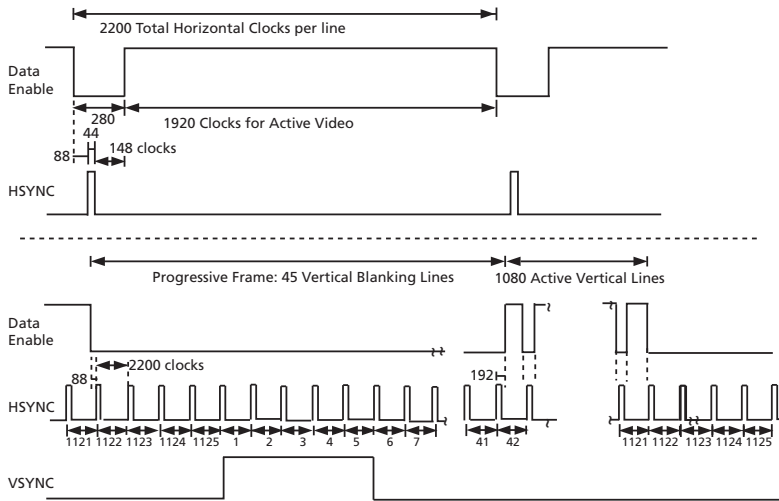


Figure 4-15: H:V:DE Input Timing 1920 x 1080p @ 59.94/60 (Format 16)

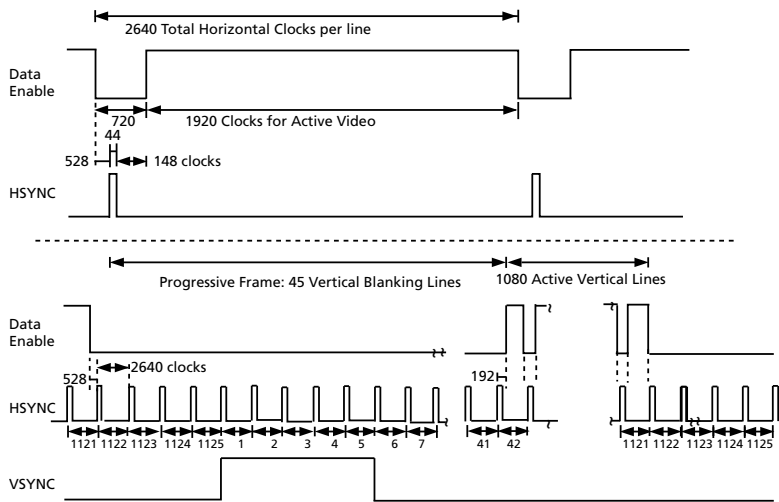


Figure 4-16: H:V:DE Input Timing 1920 x 1080p @ 50 (Format 31)

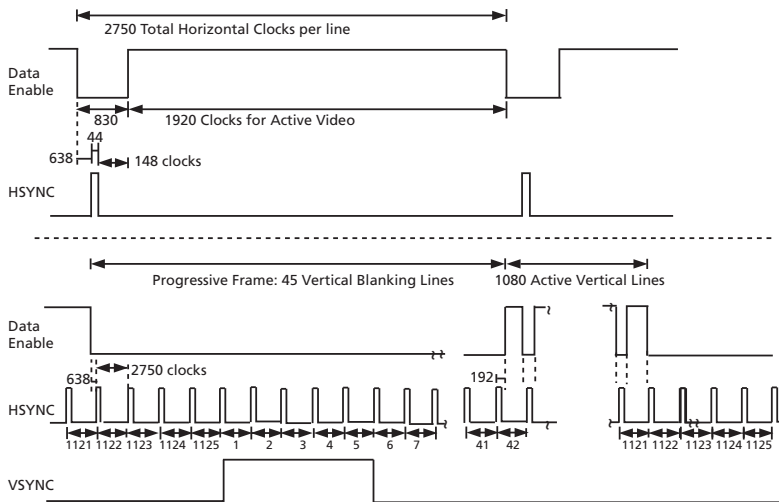


Figure 4-17: H:V:DE Input Timing 1920 x 1080p @ 23.94/24 (Format 32)

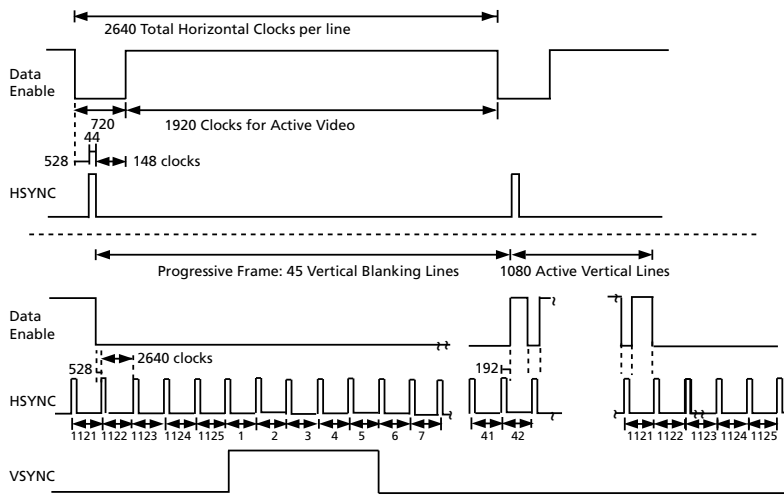


Figure 4-18: H:V:DE Input Timing 1920 x 1080p @ 25 (Format 33)

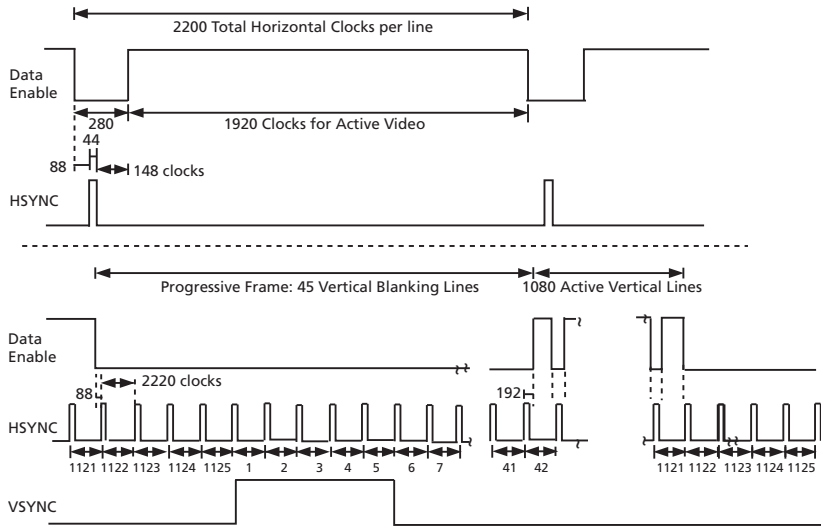


Figure 4-19: H:V:DE Input Timing 1920 x 1080p @ 29.97/30 (Format 34)

4.4 DVB-ASI Mode

When operating in DVB-ASI mode, all SMPTE processing features are disabled, and the device accepts 8-bit transport stream data and control signal inputs on the DIN[19:10] port.

This mode is only enabled when $\overline{\text{SMPTE_BYPASS}}$ pin is LOW, DVB_ASI pin is HIGH and the RATE_SEL0 pin is HIGH.

The interface consists of eight data bits and two control signals, INSSYNCIN and KIN.

When INSSYNCIN is set HIGH, the GS2972 inserts K28.5 sync characters into the data stream. This function is used to assist system implementations where the GS2972 may be preceded by a data FIFO.

The FIFO can be fed data at a rate somewhat less than 27MHz. The 'FIFO empty' signal could be used to feed the INSSYNCIN pin, causing the GS2972 to pad the data up to the transmission rate of 27MHz.

When KIN is set HIGH the data input is interpreted as a special character (such as a K28.5 sync character), as defined by the DVB-ASI standard. When KIN is set LOW the input is interpreted as data.

After sync signal insertion, the GS2972 8b/10b encodes the data, generating a 10-bit data stream for the parallel to serial conversion and transmission process.

4.5 Data-Through Mode

The GS2972 may be configured to operate as a simple parallel-to-serial converter. In this mode, the device passes data to the serial output without performing any scrambling or encoding.

Data-through mode is enabled only when both the $\overline{\text{SMPTE_BYPASS}}$ and DVB_ASI pins are set LOW.

4.6 Standby Mode

The STANDBY pin reduces power to a minimum by disabling all circuits except for the register configuration. Upon removal of the signal to the STANDBY pin, the device returns to its previous operating condition within 1 second, without requiring input from the host interface.

In addition, the serial digital output signals becomes high-impedance when the device is powered-down.

4.7 Audio Embedding

The GS2972 includes an Audio Multiplexer, which by default will be active when the Transmitter is configured for SMPTE mode.

Audio embedding is controlled by:

- GRP1_EN/ $\overline{\text{DIS}}$ and GRP2_EN/ $\overline{\text{DIS}}$ pins are set HIGH to enable embedding of their respective groups
- The AUDIO_INS bit in the IOPROC register is set LOW to enable audio embedding
- The IOPROC_EN/ $\overline{\text{DIS}}$ pin is set HIGH to enable audio embedding

In non-SMPTE modes, the Audio Multiplexer will be powered down to reduce power.

Note: When audio is embedded by the GS2972, if either of the GRP1_EN/ $\overline{\text{DIS}}$ or GRP2_EN/ $\overline{\text{DIS}}$ pins are toggled, the output video stream is lost. For example: With a 3Gb/s SDI Level A input signal as the source, and either AES or I²S mode audio embedded; if one of the audio groups is disabled, there is no a longer valid video signal present at the output.

Toggling the audio disable pins on the fly must be avoided. The user has to set the pins before resetting the chip, and not change the setting during normal operation. The audio may be enabled or disabled during the operation of the chip by writing to the Host Interface registers. SD audio group embedding may be enabled, or disabled, by writing to ACT1...ACT8 bits of register 40Fh. HD/3G audio group embedding may be enabled, or disabled, by writing to ACT1...ACT8 bits of register 80Eh.

4.7.1 Serial Audio Data Inputs

The GS2972 supports the insertion of up to 8 channels of embedded audio, in two groups of 4 channels.

Each audio group has a dedicated audio group enable input pin; a Word Clock (WCLK) input pin operating at 48kHz; an Audio Clock input pin (ACLK) operating at 3.072MHz (64 x WCLK); and two serial digital audio input pins (AIN_1/2, etc.), supporting one stereo audio signal pair per pin.

The Serial Audio Data Inputs for each audio group are listed in [Table 4-5](#).

Table 4-5: Serial Audio Input Pin Description

| Pin Name | Description |
|----------------------------------|---|
| Audio Group 1 | |
| GRP1_EN/ $\overline{\text{DIS}}$ | Enable Input for Audio Group 1 |
| AIN_1/2 | Serial Audio Input; Channels 1 and 2 |
| AIN_3/4 | Serial Audio Input; Channels 3 and 4 |
| ACLK1 | 64 x WCLK associated with AIN_1/2 and AIN_3/4 (channels 1, 2, 3 and 4) |
| WCLK1 | 48kHz Word Clock associated with AIN_1/2 and AIN_3/4 (channels 1, 2, 3 and 4) |

Table 4-5: Serial Audio Input Pin Description (Continued)

| Pin Name | Description |
|----------------------------------|---|
| Audio Group 2 | |
| GRP2_EN/ $\overline{\text{DIS}}$ | Enable Input for Audio Group 2 |
| AIN_5/6 | Serial Audio Input; Channels 5 and 6 |
| AIN_7/8 | Serial Audio Input; Channels 7 and 8 |
| ACLK2 | 64 x WCLK associated with AIN_5/6 and AIN_7/8 (channels 5, 6, 7 and 8) |
| WCLK2 | 48kHz Word Clock associated with AIN_5/6 and AIN_7/8 (channels 5, 6, 7 and 8) |

The serial audio input signals and WCLK input signals will enter the device on the rising edge of ACLK as shown in Figure 4-20.

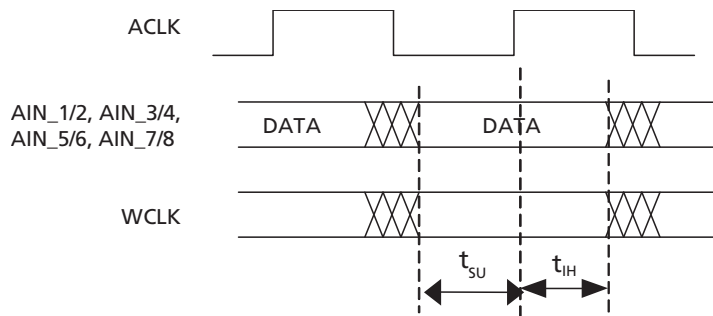


Figure 4-20: ACLK to Data and Control Signal Input Timing

Table 4-6: GS2972 Serial Audio Data Inputs - AC Electrical Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|------------------------|----------|---|-----|-----|-----|-------|
| Input data set-up time | t_{SU} | 50% levels; +3.3V or +1.8V operation | 1.3 | – | – | ns |
| Input data hold time | t_{IH} | | 0.8 | – | – | ns |

When GRP1_EN/ $\overline{\text{DIS}}$ and GRP2_EN/ $\overline{\text{DIS}}$ are set HIGH, the respective audio group is enabled, and the audio input signals associated with that group are processed and embedded into the video data stream.

When GRP1_EN/ $\overline{\text{DIS}}$ and GRP2_EN/ $\overline{\text{DIS}}$ are set LOW, the respective audio group is disabled and the audio input signals associated with that group are ignored. In addition, all functional logic associated with audio insertion for the disabled audio group is placed in a static operating mode, such that system power is reduced while the device configuration is retained.

4.7.2 Serial Audio Data Format Support

The GS2972 supports the following serial audio data formats:

- I²S Audio (default)
- AES/EBU
- Serial Audio, Left Justified, MSB First
- Serial Audio, Left Justified, LSB First
- Serial Audio, Right Justified, MSB First
- Serial Audio, Right Justified, LSB First

By default (at power up or after system reset), the I²S data format is enabled.

The audio format can be different for both audio groups. Normally, AIN_1/2 and AIN_3/4 are embedded in Audio Group A, and AIN_5/6 and AIN_7/8 are embedded in Audio Group B. As well, the audio formats can be different within the same group.

Under normal conditions:

AMA sets the audio format for AIN_1/2
 AMB sets the audio format for AIN_3/4
 AMC sets the audio format for AIN_5/6
 AMD sets the audio format for AIN_7/8

Note: These four formats can all be set to different modes if desired.

Table 4-7 shows the audio input formats for the GS2972. Note that the same values apply for AMB + LSB_FIRSTB, AMC + LSB_FIRSTC and AMD + LSB_FIRSTD.

Table 4-7: Audio Input Formats

| AMA[1:0] (Address 40Bh for SD, Address 80Ah for HD/3G) | LSB_FIRSTA (Address 40Fh for SD, Address 80Eh for HD/3G) | Audio Input Formats |
|--|--|--|
| 00 | X | AES/EBU audio input |
| 01 | 0 | Serial audio input: Left Justified; MSB first |
| 01 | 1 | Serial audio input: Left Justified; LSB first |
| 10 | 0 | Serial audio input: Right Justified; MSB first |
| 10 | 1 | Serial audio input: Right Justified; LSB first |
| 11 | X | I ² S (default) |

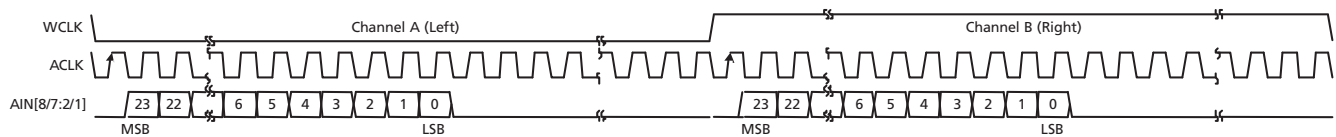


Figure 4-21: I²S Audio Input Format

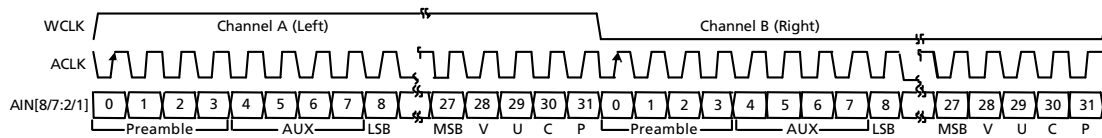


Figure 4-22: AES/EBU Audio Input Format

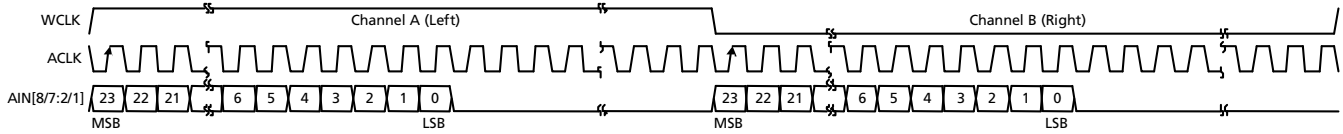


Figure 4-23: Serial Audio, Left Justified, MSB First

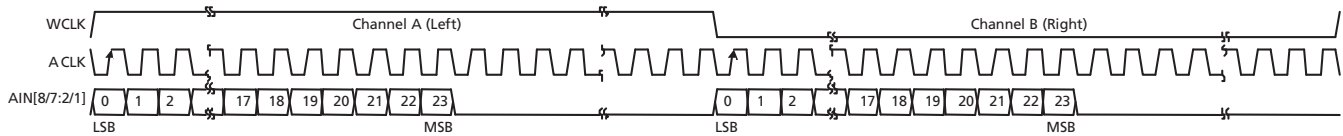


Figure 4-24: Serial Audio, Left Justified, LSB First

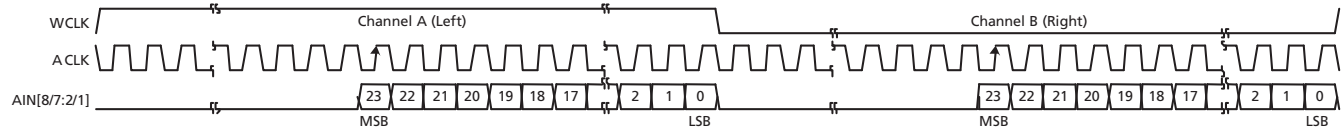


Figure 4-25: Serial Audio, Right Justified, MSB First

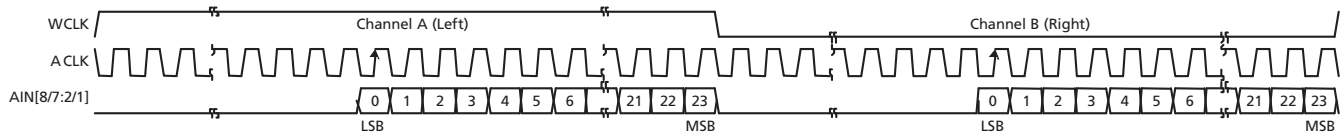


Figure 4-26: Serial Audio, Right Justified, LSB First

4.7.3 3G Mode

When the GS2972 is operating in 3G mode, 8 channels of audio in 4 pairs can be embedded in the serial output signal, according to SMPTE ST 299.

The 8 channels are in 2 groups, which are selectable via the host interface from the four groups allowed by SMPTE ST 299. The default is Group One and Group Two.

SMPTE ST 425 describes different mappings for the video signal, each with its own locations for audio data and control packets:

4.7.3.1 Level A Signals:

SMPTE ST 425 Level A describes a single video signal carried in a 3G bit stream.

The bit stream is made of two multiplexed virtual streams, Data Stream One and Data Stream Two.

Data Stream One carries audio control packets in the same way that the Y channel carries audio control packets in SMPTE ST 292 HD signals, but at twice the rate.

Data Stream Two carries audio data packets in the same way that the C channel carries audio data packets in SMPTE ST 292 HD signals, but at twice the rate.

For Level A signals with mappings 2 (1080i/p, 720p 4:4:4 10-bit), 3 (1080i/p 4:4:4 12-bit) or 4 (1080i/p, 720p 4:2:2 12-bit), the audio data packets are embedded at the full rate of 148.5MHz, but the clock phase bits are calculated assuming the original PCLK signal of 74.25MHz. This factor of two must be taken into consideration when calculating the clock bits.

SMPTE ST 425 requires SMPTE ST 352 payload packets to be embedded in both Data Stream One and Data Stream Two.

4.7.3.2 Level B Signals:

SMPTE ST 425 Level B describes the carriage of two SMPTE ST 292 signals in a single 3G bit stream. It also applies to a SMPTE ST 372 dual link signal.

The two signals are designated Link A and Link B. Each can carry audio data in the same way that a SMPTE ST 292 bit stream carries audio data.

The GS2972 is capable of embedding audio data onto either Link A or Link B of the Level B signal. The default will be Link A.

Link A and Link B are presented to the GS2972 as 10-bit signals at a 148.5MHz PCLK rate.

4.7.4 HD Mode

When the GS2972 is operating in HD mode, 8 channels of audio in 4 pairs are embedded in the serial output signal, according to SMPTE ST 299.

The 8 channels will be in 2 groups, which are selectable via the host interface from the 4 groups allowed by SMPTE ST 299. The default group is Group One and Group Two.

4.7.5 SD Mode

When the GS2972 is operating in SD mode, eight channels of audio in four pairs are embedded in the serial output signal, according to SMPTE ST 272. The eight channels will be in two groups, which are selectable via the host interface from the four groups allowed by SMPTE ST 272. The default group is Group One and Group Two.

4.7.6 Audio Embedding Operating Modes

Audio Embedding operates in one of three distinct modes:

1. Normal Mode (Default)

All previously embedded audio packets are deleted from the video stream. Arbitrary packets, SDTI packets and SMPTE ST 352 packets are not deleted. Up to two audio groups can be added to the video output. SDTI packets and SMPTE ST 352 packets are placed before the audio packets. Arbitrary packets are placed after the audio packets.

2. Cascade Mode

No previously embedded packets are deleted from the video stream. Up to two audio groups can be added to the video output. The added audio groups will not replace existing embedded audio groups. The added audio packets are appended to the last packet in the video input.

3. Group Replacement Mode

All packets associated with the groups being replaced are deleted. Up to two audio groups can be added to the video output. The added audio groups replace any embedded audio groups with the same group number. This will not affect any of the other audio groups, and they will remain in the data stream. The embedded audio groups are sorted in ascending order by audio group number. SDTI packets and SMPTE ST 352 packets are placed before the audio packets. Arbitrary packets are placed after the audio packets. The operating mode is selected using a combination of the EN_CASCADE and the AGR bits in the host interface, as stated in [Table 4-8](#) below.

Table 4-8: GS2972 Audio Operating Mode Selection

| Control Signals | Operating Mode |
|---------------------|------------------------|
| EN_CASCADE=0, AGR=0 | Normal Mode |
| EN_CASCADE=1, AGR=0 | Cascade Mode |
| EN_CASCADE=0, AGR=1 | Group Replacement Mode |
| EN_CASCADE=1, AGR=1 | Group Replacement Mode |

4.7.7 Audio Packet Detection

The input video stream to the GS2972 may already contain embedded audio packets.

The GS2972 detects these embedded packets, and signals their presence to the host interface. Register 404h is used for SD, register 803h is used for HD/3G.

4.7.8 Audio Packet Deletion

In **Normal Mode** (default), the GS2972 deletes all audio packets from the input video data stream.

In **Cascade Mode**, the GS2972 does not delete any audio packets from the input video data stream.

In **Group Replacement Mode**, the GS2972 does not delete any audio packets from the input video data stream.

In all operating modes, the GS2972 deletes all audio packets from the input video stream if any embedded audio packets do not fully comply with the SMPTE ST 291 standard.

4.7.9 Audio Packet Detection and Deletion

In SD modes, the first Ancillary Data Flag (ADF) must always be contiguous after the EAV words. For HD mode, the first ADF must always be contiguous after the two line CRC words.

Ancillary data packets with non-audio data ID words, such as arbitrary, EDH (SD only), SDTI header and SMPTE ST 352, are not deleted from the data stream. On lines where SMPTE ST 352 or SDTI header packets exist, the audio data packets must be contiguous from the ST 352 and SDTI packets. If this is not the case, all existing audio data and control packets will be deleted.

When CASCADE is set HIGH, all pre-existing audio data and control packets remain in the video stream.

When the AGR bit in the host interface is set HIGH, Audio Group Replacement mode is selected. In this mode, existing audio data and control packets are not deleted from the data stream.

In cases where the ADF is not placed immediately after the CRC or EAV words, or there are gaps between the packets, the audio core deletes all existing audio data and control packets, regardless of the CASCADE or AGR setting. [Figure 4-27](#) shows an example of correct and incorrect placement of ancillary data packets for SD Mode.



Correct placement of Ancillary Data within HANC Space



HANC with space between EAV and Ancillary Data (Audio Packets will be deleted)

Figure 4-27: Ancillary Data Packet Placement Example for SD Mode

4.7.10 Audio Mute (Default Off)

The GS2972 mutes all of the input channels when the MUTE_ALL host interface bit is set HIGH.

The GS2972 mutes any individual audio inputs as commanded by the following host interface fields:

- MUTE1 - Mute input channel 1
- MUTE2 - Mute input channel 2
- MUTE3 - Mute input channel 3
- MUTE4 - Mute input channel 4
- MUTE5 - Mute input channel 5
- MUTE6 - Mute input channel 6
- MUTE7 - Mute input channel 7
- MUTE8 - Mute input channel 8

4.7.11 Audio Channel Status

The GS2972 adds audio channel status to those audio input channels that do not use the AES/EBU format.

The Audio Channel Status block complies with the AES3-1992 (ANSI S4.40-1992) standard.

The GS2972 uses the ACSR[183:0] host interface field as the source of audio channel status for those input channels that do not use the AES/EBU format.

The GS2972 replaces the Audio Channel Status block in all eight channels as commanded by the ACS_REGEN host interface bit. The status block information is supplied by the ACSR[183:0] host interface field.

The ACS_REGEN bit (SD core register 403h, HD/3G core register 802h) is set in two states:

ACS_REGEN = 0 -> Incoming Audio Channel Status is passed through the device to the output. For I²S audio formats, the transmitter will embed default audio channel status to the output stream.

ACS_REGEN = 1 -> Channel Status is based on user-defined data stored in the ACSR. With ACS_REGEN = 1, the GS2972 will serialize user-defined information to the output data. The user-defined data is applied to the output when the following steps are followed, and the time that the new status boundary occurs for the audio channel.

Audio channel status replacement follows the same procedure when replacing audio channel status for either AES or I²S audio formats.

To replace audio channel status, the following procedure should be used:

1. Write the desired ACS data to the ACSR [183:0] (SD Core registers 420h-42Ch, HD/3G Core registers 820h-82Ch).
2. Set ACS_REGEN bit = 1.
3. The Audio Channel Status on the serialized output will now contain the user defined ACS data.

To replace audio channel status on the fly, the following procedure should be used:

1. Write the desired ACS data to the ACSR [183:0] (SD Core registers 420h-42Ch, HD/3G Core registers 820h-82Ch)
2. Set ACS_REGEN bit = 1, if ACS_REGEN is already set, re-write ACS_REGEN = 1 again.
3. The Audio Channel Status on the serialized output will now contain the user-defined ACS data.

The GS2972 automatically calculates the CRC required for the Audio Channel Status block.

4.7.12 Audio Crosspoint

The GS2972 is capable of mapping any input channel to any Primary or Secondary group channel.

Each group channel specifies the audio source using a 3-bit selector defined below in Table 4-9:

Table 4-9: GS2972 SD Audio Crosspoint Channel Selection

| Audio Source | SD Selector | HD/3G Selector |
|-----------------|-------------|----------------|
| Input channel 1 | 000 | 000 |
| Input channel 2 | 001 | 001 |
| Input channel 3 | 010 | 010 |
| Input channel 4 | 011 | 011 |
| Input channel 5 | 100 | 100 |
| Input channel 6 | 101 | 101 |
| Input channel 7 | 110 | 110 |
| Input channel 8 | 111 | 111 |

Each Primary and Secondary group channel specifies the audio source using the following host interface fields:

Table 4-10: Audio Source Host Interface Fields

| Host Interface Field | Description | Default |
|----------------------|---|---------|
| GPA_CH1_SRC[2:0] | Primary Group Channel 1 Source Selector | 000 |
| GPA_CH2_SRC[2:0] | Primary Group Channel 2 Source Selector | 001 |
| GPA_CH3_SRC[2:0] | Primary Group Channel 3 Source Selector | 010 |
| GPA_CH4_SRC[2:0] | Primary Group Channel 4 Source Selector | 011 |
| GPB_CH1_SRC[2:0] | Secondary Group Channel 1 Source Selector | 100 |
| GPB_CH2_SRC[2:0] | Secondary Group Channel 2 Source Selector | 101 |
| GPB_CH3_SRC[2:0] | Secondary Group Channel 3 Source Selector | 110 |
| GPB_CH4_SRC[2:0] | Secondary Group Channel 4 Source Selector | 111 |

Audio channels can be paired only when both channels are derived from the same Word Clock and are synchronous.

The same audio channel cannot be used in both Primary and Secondary groups at the same time.

The GS2972 asserts the XPOINT_ERROR host interface bit if any audio channel is programmed to be included in both the Primary and Secondary groups.

4.7.13 Audio Word Clock

When the GS2972 combines two stereo pair inputs into one audio group, the format allows for only one Word Clock, or sampling clock.

For the Primary group, the GS2972 uses the Word Clock associated with the source selected by the GPA_WCLK_SRC[2:0] host interface field. If in SD mode, address 40Ch. If in HD/3G mode, address 80Bh.

For the Secondary group, the GS2972 uses the Word Clock associated with the source selected by the GPB_WCLK_SRC[2:0] host interface field. If in SD mode, address 40Dh. If in HD/3G mode, address 80Ch.

For proper operation, the combined Stereo Pair inputs must have identical Word Clocks. WCLK is not required for AES/EBU audio.

4.7.14 Channel & Group Activation

The GS2972 embeds Primary group packets when any of the following host interface bits are set and the associated audio group enable pin is HIGH:

- ACT1 Embed Primary group audio channel 1
- ACT2 Embed Primary group audio channel 2
- ACT3 Embed Primary group audio channel 3
- ACT4 Embed Primary group audio channel 4

If none of the bits are set, then no audio will be embedded.

The GS2972 will embed Secondary group packets when any of the following host interface bits are set and the associated audio group enable pin is HIGH:

- ACT5 Embed Secondary group audio channel 1
- ACT6 Embed Secondary group audio channel 2
- ACT7 Embed Secondary group audio channel 3
- ACT8 Embed Secondary group audio channel 4

When an embedded packet contains one or more channels with the ACTx bit set to zero, the GS2972 replaces the data for those channels with null samples (all bits set to zero).

In the default state, the GS2972 embeds all audio channels in accordance with the setting of the respective audio group enable pins of the device.

4.7.15 Audio FIFO - SD

Each input channel has a First In First Out (FIFO) buffer that can hold up to 52 samples.

Samples are added (written) to the FIFO as they are received from the audio inputs.

Samples are removed (read) from the FIFO as they are embedded in audio data packets and audio extended packets.

After power up, reset or clear, the FIFO is in the start-up state where it will output zeroes until it has accumulated the start-up count of 26 samples.

When the start-up state ends, the buffer operates as a normal FIFO, and expects to receive an equal number of read and write operations over the period of five frames. At the end of five frames, the FIFO still has 26 samples in the buffer.

When the FIFO does not receive an equal number of read and write operations, the FIFO checks for the overflow and underflow conditions.

When a sample is required for embedding into a packet and the FIFO is holding less than 6 samples, the GS2972 prevents the underflow condition by repeating the last sample without removing a sample from the FIFO. Therefore, a sample will be duplicated.

When an input sample is received and the FIFO has room for less than six more samples, the GS2972 prevents the overflow condition by discarding the sample. Therefore, a sample will be dropped.

If 28 consecutive samples are duplicated or dropped, the audio FIFO is cleared and placed into the start-up state.

If the CLEAR_AUDIO host interface bit is set, the audio FIFO is cleared and put into the start-up state.

When the detected video standard changes, the audio FIFO is cleared and put into the start-up state.

The buffer size and start-up count can be reduced using the OS_SEL host interface field, as seen in [Table 4-11](#) below:

Table 4-11: GS2972 SD Audio Buffer Size Selection

| Address OS_SEL[1:0] | Buffer Size | Start-Up Count |
|---------------------|----------------------|----------------|
| 00 | 52 samples (default) | 26 samples |
| 01 | 24 samples | 12 samples |
| 10 | 12 samples | 6 samples |
| 11 | Reserved | Reserved |

4.7.16 Audio FIFO - HD and 3G

For HD and 3G formats, the audio FIFO block is a maximum of seven samples deep. According to SMPTE ST 299, audio samples are multiplexed immediately in the next HANC region after the audio sample occurs. A buffer size of seven samples takes into account that there are no samples after the switching line (for one line) and the worst-case video standard of 720p/24, plus a one-sample safety margin.

Due to the sample distribution used in HD video standards and the size of the buffer in HD mode, no checking is made for buffer underflow/overflow conditions. The pointers should maintain a variable offset between 0 and 6.

4.7.17 Five-frame Sequence Detection - SD

The GS2972 detects the frame sequence that describes the sample distribution for synchronous audio.

The frame sequence is used in the generation of audio control packets; where the Audio Frame Number (AFN) field describes the position of the current frame within the frame sequence.

The frame sequence is also used in the generation of Audio Sample Distribution for formats with 525 lines. Each frame has 1602 samples or 1601 samples, depending upon the frame sequence.

The GS2972 sets the AFN of the Primary group control packets to zero, unless the AFNA_AUTO host interface bit (400h bit 7) is set to produce automatic AFN generation.

The Multiplexer sets the AFN of the Secondary group control packets to zero unless the AFNB_AUTO host interface bit (800h bit 10) is set to produce automatic AFN generation.

When the frame rate is 25Hz, every frame has 1920 samples and the AFN is always set to one.

When the frame rate is 29.97Hz, an even number of samples (8008) are distributed over five frames in the following sequence:

1602 1601 1602 1601 1602

The GS2972 sets the AFN field to a number between one and five, depending on where the current frame lies within the sequence.

The GS2972 adds the offset specified in the AFN_OFS host interface field (400h bits 6-4) to the generated AFN. The result of the addition wraps around such that the AFN will always be in the range of one to five.

4.7.17.1 525-Line Audio Sample Distribution

As per the SMPTE ST 272 standard, the following sample distribution allows the embedding of 16 channels (4 audio groups) of 24-bit sampled audio into the HANC of 525-line based video formats.

The sample distribution is established for Group One and then offset by one line for each subsequent group. The sample distribution is as follows (start line is 12):

$$\{[3]^{(10+G)}, ([4],[3]^{15})^{15}, [4],[3]^{(11-G)}, [0],[3]^{(3+G)}, ([4],[3]^{15})^{15}, [4/3],[3]^{12}, [4],[3]^{(4-G)}, [0]\}^5$$

[#] = Number of samples / line

[4/3] = One line with either 3 or 4 samples depending on five-frame sequence

(#) = Number of times to repeat the sequence. When this # is 0, no samples are inserted

G = Audio group number from 1 to 4

{...}⁵ = 5-frame sequence as shown in Table 4-12:

Table 4-12: GS2972 SD Audio Five Frame Sequence Sample Count

| Frame | Number of Samples |
|-------|-------------------|
| 1 | 1602 |
| 2 | 1601 |
| 3 | 1602 |
| 4 | 1601 |
| 5 | 1602 |

The following tables show the audio sample distribution for each of the four audio groups.

Each distribution has 525 lines.

Each distribution has 1602 samples or 1601 samples, based on the frame number in the five-frame sequence.

When 1602 samples are required in a frame, the [4/3] term represents a line with four samples.

When 1601 samples are required in a frame, the [4/3] term represents a line with three samples.

Table 4-13: GS2972 SD Audio Group 1 Audio Sample Distribution - 525 line

| | $[3]^{(6)}, [4],[3]^{(3)}$ | $[0],[3]^{(11)}$ | $([4],[3]^{15})^{15}$ | $[4],[3]^{(10)}$ | $[0],[3]^{(4)}$ | $([4],[3]^{15})^{15}$ | $[4/3],[3]^{(6)}$ |
|---------|----------------------------|------------------|-----------------------|------------------|-----------------|-----------------------|-------------------|
| Samples | 31 | 33 | 735 | 34 | 12 | 735 | 22/21 |
| Lines | 10 | 12 | 240 | 11 | 5 | 240 | 7 |

Table 4-14: GS2972 SD Audio Group 2 Audio Sample Distribution - 525 line

| | [3] ⁽⁷⁾ ,[4],[3] ⁽²⁾ | [0],[3] ⁽¹²⁾ | ([4],[3] ¹⁵) ¹⁵ | [4],[3] ⁽⁹⁾ | [0],[3] ⁽⁵⁾ | ([4],[3] ¹⁵) ¹⁵ | [4/3],[3] ⁽⁵⁾ |
|---------|--|-------------------------|--|------------------------|------------------------|--|--------------------------|
| Samples | 31 | 36 | 735 | 31 | 15 | 735 | 19/18 |
| Lines | 10 | 13 | 240 | 10 | 6 | 240 | 6 |

Table 4-15: GS2972 SD Audio Group 3 Audio Sample Distribution - 525 line

| | [3] ⁽⁸⁾ ,[4],[3] ⁽¹⁾ | [0],[3] ⁽¹³⁾ | ([4],[3] ¹⁵) ¹⁵ | [4],[3] ⁽⁸⁾ | [0],[3] ⁽⁶⁾ | ([4],[3] ¹⁵) ¹⁵ | [4/3],[3] ⁽⁴⁾ |
|---------|--|-------------------------|--|------------------------|------------------------|--|--------------------------|
| Samples | 31 | 39 | 735 | 28 | 21 | 735 | 16/15 |
| Lines | 10 | 14 | 240 | 9 | 7 | 240 | 5 |

Table 4-16: GS2972 SD Audio Group 4 Audio Sample Distribution - 525 line

| | [3] ⁽⁹⁾ ,[4],[3] ⁽⁰⁾ | [0],[3] ⁽¹⁴⁾ | ([4],[3] ¹⁵) ¹⁵ | [4],[3] ⁽⁷⁾ | [0],[3] ⁽⁷⁾ | ([4],[3] ¹⁵) ¹⁵ | [4/3],[3] ⁽³⁾ |
|---------|--|-------------------------|--|------------------------|------------------------|--|--------------------------|
| Samples | 31 | 42 | 735 | 25 | 21 | 735 | 13/12 |
| Lines | 10 | 15 | 240 | 8 | 8 | 240 | 4 |

4.7.17.2 625-Line Audio Sample Distribution

The GS2972 uses the following sample distribution to maximize the available space in the Ancillary Data region.

Note: the following formula starts from line 1:

$$[3]^6, [0],[3](G-1), ([4],[3]^{11})^{25}, [4],[3](12-G), [0],[3](G-1), ([4],[3]^{11})^{24}, [4],[3](17-G)$$

- [#] represents one line with # samples
- (#) represents the number of times to repeat the line sequence
- [3](0) represents no lines and no samples
- G is the audio group number from one to four

The following tables show the audio sample distribution for each of the four audio groups:

Each distribution has 625 lines.

Each distribution has 1920 samples.

Table 4-17: GS2972 SD Audio Group 1 Audio Sample Distribution - 625 line

| | [3] ⁶ | [0],[3] ⁽⁰⁾ | ([4],[3] ¹¹) ²⁵ | [4],[3] ⁽¹¹⁾ | [0],[3] ⁽⁰⁾ | ([4],[3] ¹¹) ²⁴ | [4],[3] ⁽¹⁶⁾ |
|---------|------------------|------------------------|--|-------------------------|------------------------|--|-------------------------|
| Samples | 18 | 0 | 925 | 37 | 0 | 888 | 52 |
| Lines | 6 | 1 | 300 | 12 | 1 | 288 | 17 |

Table 4-18: GS2972 SD Audio Group 2 Audio Sample Distribution - 625 line

| | [3] ⁶ | [0],[3] ⁽¹⁾ | ([4],[3] ¹¹) ²⁵ | [4],[3] ⁽¹⁰⁾ | [0],[3] ⁽¹⁾ | ([4],[3] ¹¹) ²⁴ | [4],[3] ⁽¹⁵⁾ |
|---------|------------------|------------------------|--|-------------------------|------------------------|--|-------------------------|
| Samples | 18 | 3 | 925 | 34 | 3 | 888 | 49 |
| Lines | 6 | 2 | 300 | 11 | 2 | 288 | 16 |

Table 4-19: GS2972 SD Audio Group 3 Audio Sample Distribution - 625 line

| | [3] ⁶ | [0],[3] ⁽²⁾ | ([4],[3] ¹¹) ²⁵ | [4],[3] ⁽⁹⁾ | [0],[3] ⁽²⁾ | ([4],[3] ¹¹) ²⁴ | [4],[3] ⁽¹⁴⁾ |
|---------|------------------|------------------------|--|------------------------|------------------------|--|-------------------------|
| Samples | 18 | 6 | 925 | 31 | 6 | 888 | 46 |
| Lines | 6 | 3 | 300 | 10 | 3 | 288 | 15 |

Table 4-20: GS2972 SD Audio Group 4 Audio Sample Distribution - 625 line

| | [3] ⁶ | [0],[3] ⁽³⁾ | ([4],[3] ¹¹) ²⁵ | [4],[3] ⁽⁸⁾ | [0],[3] ⁽³⁾ | ([4],[3] ¹¹) ²⁴ | [4],[3] ⁽¹³⁾ |
|---------|------------------|------------------------|--|------------------------|------------------------|--|-------------------------|
| Samples | 18 | 9 | 925 | 28 | 9 | 888 | 43 |
| Lines | 6 | 4 | 300 | 9 | 4 | 288 | 14 |

4.7.18 Frame Sequence Detection - HD/3G

The GS2972 detects the frame sequence that describes the sample distribution for synchronous audio.

The frame sequence is only used in the generation of audio control packets; where the Audio Frame Number (AFN) field describes the position of the current frame within the frame sequence.

The GS2972 sets the AFN of the Primary group control packets to zero when the ASXA host interface bit is set for asynchronous audio. The GS2972 sets the AFN of the Primary group control packets to zero, unless the AFNA_AUTO host interface bit is set to produce automatic AFN generation.

The GS2972 sets the AFN of the Secondary group control packets to zero, when the ASXB host interface bit is set for asynchronous audio. The GS2972 sets the AFN of the Secondary group control packets to zero, unless the AFNB_AUTO host interface bit is set to produce automatic AFN generation.

The GS2972 sets the AFN to one when every frame has the same number of samples:

Frame Rate 23.976Hz - Each frame has exactly 2002 samples

Frame Rate 24.000Hz - Each frame has exactly 2000 samples

Frame Rate 25.000Hz - Each frame has exactly 1920 samples

Frame Rate 30.000Hz - Each frame has exactly 1600 samples

Frame Rate 50.000Hz - Each frame has exactly 960 samples

Frame Rate 60.000Hz - Each frame has exactly 800 samples

When the frame rate is 29.97Hz, an even number of samples (8008) are distributed over five frames in the following sequence:

1602 1601 1602 1601 1602

When the frame rate is 59.94Hz, an even number of samples (4004) are distributed over five frames in the following sequence:

801 800 801 801 801

The GS2972 sets the AFN field to a number between one and five, depending on where the current frame lies within the sequence.

The GS2972 adds the offset specified in the AFN_OFS host interface field to the generated AFN. The result of the addition wraps around such that the AFN will always be in the range of one to five.

4.7.19 ECC Error Detection and Correction

The GS2972 generates the error detection and correction fields in the audio data packets.

The error detection and correction complies with SMPTE ST 299.

4.7.20 Audio Control Packet Insertion - SD

The GS2972 embeds audio control packets associated with the Primary Group audio and the Secondary Group audio.

The Primary Group audio to be embedded is specified using the IDA[1:0] host interface field (Address 400h).

The Secondary Group audio to be embedded is specified using the IDB[1:0] host interface field.

The Primary Group audio control packets is embedded as commanded by the CTRA_ON host interface bit. (Default is ON)

The Secondary Group audio control packets is embedded as commanded by the CTRB_ON host interface bit. (Default is ON)

The Primary Group audio control packets is replaced as commanded by the CTR_AGR host interface bit. (Default is OFF)

The Secondary Group audio control packets is replaced as commanded by the CTR_AGR and ONE_AGR host interface bits. (Default is OFF)

The contents of the Primary Group audio control packet is specified using the following host interface fields:

- AFNA_AUTO Primary Group audio frame number generation.
- EBIT1A Primary Group delay valid flag for channel 1.
- DEL1A[25:0] Primary Group delay for channel 1.
- EBIT2A Primary Group delay valid flag for channel 2.
- DEL2A[25:0] Primary Group delay for channel 2.
- EBIT3A Primary Group delay valid flag for channel 3.
- DEL3A[25:0] Primary Group delay for channel 3.
- EBIT4A Primary Group delay valid flag for channel 4.
- DEL4A[25:0] Primary Group delay for channel 4.

The contents of the Secondary Group audio control packet is specified using the following host interface fields:

- AFNB_AUTO Secondary Group audio frame number generation.
- EBIT1B Secondary Group delay valid flag for channel 1.
- DEL1B[25:0] Secondary Group delay for channel 1.
- EBIT2B Secondary Group delay valid flag for channel 2.
- DEL2B[25:0] Secondary Group delay for channel 2.
- EBIT3B Secondary Group delay valid flag for channel 3.
- DEL3B[25:0] Secondary Group delay for channel 3.
- EBIT4B Secondary Group delay valid flag for channel 4.
- DEL4B[25:0] Secondary Group delay for channel 4.

4.7.21 Audio Control Packet Insertion - HD and 3G

The GS2972 embeds audio control packets associated with the Primary Group audio and the Secondary Group audio.

The Primary Group audio to be embedded is specified using the IDA[1:0] host interface field. (Default is 00 in NORMAL mode).

The Secondary Group audio to be embedded is specified using the IDB[1:0] host interface field. (Default is 01 in NORMAL mode).

The Primary Group audio control packets are embedded as commanded by the CTRA_ON host interface bit. (Default is 1).

The Secondary Group audio control packets are embedded as commanded by the CTRB_ON host interface bit. (Default is 1).

The Primary Group audio control packets are replaced as commanded by the CTR_AGR host interface bit. (Default is 0).

The Secondary Group audio control packets are replaced as commanded by the CTR_AGR and ONE_AGR host interface bits. (Default is 0).

The Primary Group audio control packets are not embedded or replaced unless one or more of the ACT1, ACT2, ACT3 or ACT4 host interface bits are set.

The Secondary Group audio control packets are not embedded or replaced unless one or more of the ACT5, ACT6, ACT7 or ACT8 host interface bits are set.

The contents of the Primary Group audio control packet is specified using the following host interface fields:

- AFNA_AUTO - Primary Group audio frame number auto-generation.
- ASXA - Primary Group asynchronous mode.
- DEL1_2A[25:0] - Primary Group audio delay for channels 1 and 2.
- DEL3_4A[25:0] - Primary Group audio delay for channels 3 and 4.

The contents of the Secondary Group audio control packet is specified using the following host interface fields:

- AFNB_AUTO - Secondary Group audio frame number auto-generation.
- ASXB - Secondary Group asynchronous mode.
- DEL1_2B[25:0] - Secondary Group audio delay for channels 1 and 2.
- DEL3_4B[25:0] - Secondary Group audio delay for channels 3 and 4.

4.7.22 Audio Data Packet Insertion

In Normal Mode, the GS2972 embeds audio data packets into a space where all pre-existing embedded audio data packets have been removed.

In Cascade Mode, the GS2972 embeds audio data packets contiguously after all of the pre-existing audio data packets. The GS2972 does not replace any pre-existing audio data packets with new audio packets, even if the new audio packets have the same group number. In this situation, the new audio data packets are appended to the last packet, and there is an illegal mix of different groups using the same group number. This condition will be indicated by the following host interface bits:

- ◆ MUX_ERRA: Set in Cascade Mode when Primary Group audio data packets are added to video that already contains audio data packets with the same group number
- ◆ MUX_ERRB: Set in Cascade Mode when Secondary Group audio data packets are added to video that already contains audio data packets with the same group number

In Group Replacement Mode the GS2972 embeds audio data packets and sorts all of the embedded audio data packets in order of group number. If there are any pre-existing audio data packets with the same group number as the new audio packets, then the pre-existing packets will be replaced.

In Group Replacement Mode the GS2972 replaces only the Primary Group audio if the ONE_AGR host interface bit is set.

The GS2972 deletes arbitrary data packets if there is not enough room in the horizontal ancillary data space to embed the selected audio data packets.

The GS2972 does not embed audio data packets when there is insufficient room in the horizontal ancillary data space after deleting arbitrary data packets.

4.7.22.1 Audio Data Packet Insertion - SD only

The GS2972 embeds the audio channels specified by the ACT[8:1] host interface fields.

The GS2972 detects and preserves embedded EDH packets.

The GS2972 generates extended packets for 24-bit audio when the AUDIO_24BIT host interface bit is set.

4.7.22.2 Blanking Values Following Audio Data Packet Insertion

For 3G Level A, Level B dual-stream, and Level B dual-link Y'C_BC_R 4:2:2 10-bit formats, the audio insertion block will insert blanking data in accordance with the original video format.

For all other video formats (for example: RGB 4:4:4 10-bit or 12-bit, Y'C_BC_R 12-bit), the audio block will insert blanking values of 200h and 040h, which may not match the blanking data of the original format.

4.7.23 Audio Interrupt Control

The GS2972 will assert the interrupt signal when an internal interrupt condition becomes true and the type of interrupt is enabled.

The following host interface bits enable the various interrupt sources:

Table 4-21: Audio Interrupt Control – Host Interface Bit Description

| Bit Name | Description | Bit Address (SD) | Bit Address (HD&3G) |
|--------------|--|------------------|---------------------|
| EN_NO_VIDEO | Asserts interrupt when video format is unknown | 40Eh-14 | 80Dh-14 |
| EN_ACPG1_DET | Asserts interrupt when ACPG1_DET flag is set | 40Eh-4 | 80Dh-4 |
| EN_ACPG2_DET | Asserts interrupt when ACPG2_DET flag is set | 40Eh-5 | 80Dh-5 |
| EN_ACPG3_DET | Asserts interrupt when ACPG3_DET flag is set | 40Eh-6 | 80Dh-6 |
| EN_ACPG4_DET | Asserts interrupt when ACPG4_DET flag is set | 40Eh-7 | 80Dh-7 |
| EN_ADPG1_DET | Asserts interrupt when ADPG1_DET flag is set | 40Eh-0 | 80Dh-0 |
| EN_ADPG2_DET | Asserts interrupt when ADPG2_DET flag is set | 40Eh-1 | 80Dh-1 |
| EN_ADPG3_DET | Asserts interrupt when ADPG3_DET flag is set | 40Eh-2 | 80Dh-2 |
| EN_ADPG4_DET | Asserts interrupt when ADPG4_DET flag is set | 40Eh-3 | 80Dh-3 |
| EN_AES_ERRA | Asserts interrupt when AES_ERRA flag is set | 40Eh-8 | 80Dh-8 |
| EN_AES_ERRB | Asserts interrupt when AES_ERRB flag is set | 40Eh-9 | 80Dh-9 |
| EN_AES_ERRC | Asserts interrupt when AES_ERRC flag is set | 40Eh-10 | 80Dh-10 |
| EN_AES_ERRD | Asserts interrupt when AES_ERRD flag is set | 40Eh-11 | 80Dh-11 |
| EN_MUX_ERRA | Asserts interrupt when MUX_ERRA flag is set | 40Eh-12 | 80Dh-12 |
| EN_MUX_ERRB | Asserts interrupt when MUX_ERRB flag is set | 40Eh-13 | 80Dh-13 |

By default, the interrupts are all disabled.

4.8 ANC Data Insertion

Horizontal or vertical ancillary data words may be inserted on up to four different lines per video frame.

Up to 512 data words may be inserted per frame with all Data Words - including the ANC packet ADF, DBN, DCNT, DID, SDID and CSUM words - being provided by the user via host interface configuration.

The CSUM word is re-calculated and inserted by the [ANC Data Checksum Calculation and Insertion](#) function.

Note that any value may be used for the CSUM word, provided that it is outside the protected ranges from 000h to 003h and from 3FCh to 3FFh. If a CSUM value in either of these ranges is used, it will not be corrected by the device.

The GS2972 does not provide error checking or correction to the ANC data provided by user via the host interface. It is the responsibility of the user to ensure that all data provided for insertion is fully standard compliant.

In 3G Level A mode, ancillary data packets are inserted into Data Stream One or Data Stream Two as selected by the host interface. The default insertion will be in Data Stream One. See address 02Dh, STREAM_TYPE1_LINE_X.

In 3G Level B mode, ancillary data packets are inserted into the Y or C video stream of Link A or Link B as selected by the user in the host interface. The default insertion will be in the Y video stream of Link A. For Link A or Link B, see Register 02Dh. For Y or C, see Registers 026h, 028h, 02Ah and 02Ch.

In HD mode, ANC data packets are inserted into the Y or C video stream, as selected via the host interface. The default insertion will be in the Y stream. For Y or C, see Registers 026h, 028h, 02Ah and 02Ch.

In SD mode, the ANC data packets are inserted into the multiplexed CbYCr data stream.

ANC data insertion only takes place if the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH and SMPTE_BYPASS is HIGH.

In addition to this, the GS2972 requires the ANC_INS bit to be set LOW in the IOPROC register.

The ANC_PACKET_BANK register (040h - 13Fh) is used to program the ANC data words for ANC data insertion.

4.8.1 ANC Insertion Operating Modes

User selection of one of the two operating modes is provided through host interface configuration, using the ANC_INS_MODE register bit (see [Table 4-34: Video Core Configuration and Status Registers](#)).

The supported operating modes are Concatenated mode and Separate Line operating mode.

By default (at power up or after system reset), the Separate Line operating mode is enabled.

Ancillary data packets are programmed into the ANC_PACKET_BANK host register at addresses 040h to 13Fh.

4.8.1.1 Separate Line Operating Mode

In Separate Line mode, it is possible to insert horizontal or vertical ancillary data on up to four lines per video frame. In Separate Line mode, the ANC_PACKET_BANK bits are separated in four sections. Each section consists of 64 x 16-bit registers.

ANC_PACKET_BANK_1 uses registers 040h to 07Fh. ANC_PACKET_BANK_2 uses registers 080h to 0BFh. ANC_PACKET_BANK_3 uses registers 0C0h to 0FFh.

ANC_PACKET_BANK_4 uses registers 100h to 13Fh. HANC or VANC can be specified, independently of each other, on a per-line basis. 025h FIRST_LINE_NUMBER, 027h SECOND_LINE_NUMBER, 029h THIRD_LINE_NUMBER and 02Bh FOURTH_LINE_NUMBER. For each of the four video lines, up to 128 x 8-bit HANC or VANC data words can be inserted. Separate Line mode is selected by setting the ANC_INS_MODE bit in the host interface LOW. By default, at power up, Separate Line mode is selected.

The lines on which ancillary data is to be inserted is programmed in the host register addresses 025h to 02Ch.

For HD formats, the stream into which the ancillary data is to be inserted (Luma or Chroma) is also programmed in these register addresses.

The non-zero video line numbers on which to insert the ancillary data, the ancillary data type (HANC or VANC), and the total number of words to insert per line must be provided via the host interface (see [Section 4.14](#)). At power up, or after system reset, all ancillary data insertion line numbers and total number of words default to zero.

If the total number of Data Words specified per line exceeds 128 only the first 128 Data Words will be inserted, the rest will be ignored.

The data words are programmed as two 8-bit values per address, starting at host interface address 040h in the ANC_PACKET_BANK register (see [Table 4-34](#)).

The device automatically converts the provided 8-bit Data Words into the 10-bit data, formatted according to SMPTE ST 291 prior to insertion.

4.8.1.2 Concatenated Operating Mode

In Concatenated mode, it is possible to insert up to 512 8-bit horizontal or vertical ancillary Data Words on one line per video frame. Concatenated Line mode can be selected by setting the ANC_INS_MODE bit in the host interface HIGH. By default, at power up, Separate Line mode is selected.

In Concatenated mode, only the FIRST_LINE registers of the host interface need to be programmed (addresses 025h and 026h). See [Table 4-34](#).

The non-zero video line number on which to insert the ancillary data, the ancillary data type (HANC or VANC), and the total number of words to insert must be provided via the host interface. At power up, or after system reset, the ancillary data insertion line number and total number of words default to zero.

If the total number of data words specified exceeds 512 only the first 512 Data Words will be inserted, the rest will be ignored.

The data words are programmed as two 8-bit values per address, starting at host interface address 040h in the ANC_PACKET_BANK register. See [Table 4-34](#).

The device automatically converts the provided 8-bit data words into the 10-bit data formatted according to SMPTE ST 291 prior to insertion.

4.8.2 3G ANC Insertion

4.8.2.1 Level A Mode

When operating in 3G (RATE_SEL0 = LOW, RATE_SEL1 = HIGH) Level A mode, the GS2972 inserts VANC or HANC data packets into Data Stream One (default) or Data Stream Two.

The data stream for insertion is selectable for each of the ANC insertion lines selected via the host interface. Data Stream One is selected when the STREAM_TYPE_1 bit in the register associated with the insertion line is set LOW (default). Data Stream Two is selected when the STREAM_TYPE_1 bit associated with the insertion line is set HIGH.

ANC data should be placed in DS1 first in Level A mode, and only in DS2 as an overflow if DS1 is full. Data insertion starts at the first available location in the HANC space following any audio and pre-existing arbitrary data packets.

All Data Words identified by the user are inserted in a contiguous fashion starting at the first available data space. HANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS SAV code, regardless of the number of Data Words actually inserted. The rest of the packet will be ignored.

Vertical Ancillary data (VANC), is inserted into the data stream on the video line(s) defined by the user. Data insertion starts at the first active pixel immediately following the last word of the TRS SAV code.

All Data Words identified by the user are inserted in a contiguous fashion, starting at the first active pixel. VANC data insertion terminates when all data words identified by the user have been inserted; or by the start of the four word TRS EAV code, regardless of the number of Data Words actually inserted.

The total number of Data Words to be inserted and the line number on which the ANC data insertion takes place is provided by the user via the host interface as part of the configuration of the ANC data insertion function.

The user data for insertion is provided via the host interface register STREAM_TYPE_1 (02Dh).

4.8.2.2 Level B Mode

When operating in 3G (RATE_SEL0 = LOW, RATE_SEL1 = HIGH) Level B mode, the GS2972 inserts VANC or HANC data packets into either the Y or C data stream of Data Stream One (default) or Data Stream Two, as selected by the STREAM_TYPE_1 bit in the host interface on a per line basis.

By default (at power up or after system reset), all ANC data insertion takes place in the Y data stream of Data Stream One.

The user can select between the Y or C data stream for insertion on a per line basis in Separate Line mode. The Y data stream is selected when the STREAM_TYPE_0 bit is LOW (default). The C data stream is selected when the STREAM_TYPE_0 bit is HIGH.

The user can select between the Y or C data stream for insertion on a single line basis in Concatenated mode. The Y data stream is selected when the STREAM_TYPE_0 bit is LOW (default). The C data stream is selected when the STREAM_TYPE_0 bit is HIGH.

Horizontal Ancillary data (HANC), is inserted into the Y or C data stream on the video line(s) defined by the user.

Data insertion starts at the first available location in the HANC space following any audio and pre-existing arbitrary data packets. All Data Words identified by the user are inserted in a contiguous fashion, starting at the first available data space.

HANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS SAV code, regardless of the number of data words actually inserted.

Vertical Ancillary data (VANC), is inserted into the Y or C data stream on the video line(s) defined by the user.

Data insertion starts at the first active pixel immediately following the last word of the TRS SAV code. All Data Words identified by the user are inserted in a contiguous fashion starting at the first active pixel.

VANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS EAV code, regardless of the number of Data Words actually inserted.

The total number of data words to be inserted and line number on which ANC data insertion takes place is provided by the user via the host interface as part of the configuration of the ANC data insertion function.

The user data for insertion is provided via the host interface. STREAM_TYPE_1 = address 02Dh, STREAM_TYPE_0 for the four lines of insertion is at addresses 026h (bit 14), 028h (bit 14), 02Ah (bit 14) and 02Ch (bit 14).

4.8.3 HD ANC Insertion

When operating in HD mode (RATE_SEL0 = LOW, RATE_SEL1 = LOW), the GS2972 inserts VANC or HANC data packets into either the Y data stream or C data stream.

By default (at power up or after system reset), all ANC data insertion takes place in the Y data stream.

The user can select between Y or C data stream for insertion on a per line basis in Separate Line mode. The Y data stream is selected when the STREAM_TYPE_0 bit is LOW (default). The C data stream is selected when the STREAM_TYPE_0 bit is HIGH.

The user can select between Y or C data stream for insertion on a single line basis in Concatenated mode. The Y data stream is selected when the STREAM_TYPE_0 bit is LOW (default). The C data stream is selected when the STREAM_TYPE_0 bit is HIGH.

Horizontal Ancillary data (HANC), is inserted into the Y or C data stream on the video line(s) defined by the user.

Data insertion starts at the first available location in the HANC space, following any audio and pre-existing arbitrary data packets. All Data Words identified by the user are inserted in a contiguous fashion starting at the first available data space.

HANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS SAV code, regardless of the number of Data Words actually inserted.

Vertical Ancillary data (VANC), is inserted into the Y or C data stream on the video line(s) defined by the user.

Data insertion starts at the first active pixel immediately following the last word of the TRS SAV code. All Data Words identified by the user are inserted in a contiguous fashion, starting at the first active pixel.

VANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS EAV code, regardless of the number of Data Words actually inserted.

The total number of Data Words to be inserted and the line number on which ANC data insertion takes place is provided by the user via the host interface as part of the configuration of the ANC data insertion function.

The user data for insertion is provided via host interface configuration.

STREAM_TYPE_1 = address 02Dh, STREAM_TYPE_0 for the four lines of insertion is at addresses 026h (bit 14), 028h (bit 14), 02Ah (bit 14) and 02Ch (bit 14).

4.8.4 SD ANC Insertion

When operating in SD mode (RATE_SELO = HIGH), the GS2972 inserts VANC or HANC data packets into the multiplexed CbYCr data stream.

Horizontal Ancillary data (HANC), is inserted on the video line(s) defined by the user.

Data insertion starts at the first available location in the HANC space following any audio and pre-existing arbitrary data packets. All Data Words identified by the user are inserted in a contiguous fashion, starting at the first available data space.

HANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS SAV code, regardless of the number of Data Words actually inserted.

For the case where HANC data insertion is required on the same line as the EDH packet, data insertion is terminated by the start of the EDH packet, regardless of the number of Data Words actually inserted.

Vertical Ancillary data (VANC), is inserted into the data stream on the video line(s) defined by the user.

Data insertion starts at the first active Cb pixel immediately following the last word of the TRS SAV code. All data words identified by the user are inserted in a contiguous fashion, starting at the first active pixel.

VANC data insertion terminates when all Data Words identified by the user have been inserted; or by the start of the four word TRS EAV code, regardless of the number of Data Words actually inserted.

The total number of data words to be inserted and the line number on which ANC data insertion takes place is provided by the user via the host interface as part of the configuration of the ANC data insertion function.

The user data for insertion is provided via host interface configuration.

STREAM_TYPE_1 = address 02Dh, STREAM_TYPE_0 for the four lines of insertion is at addresses 026h (bit 14), 028h (bit 14), 02Ah (bit 14) and 02Ch (bit 14).

4.9 Additional Processing Functions

The GS2972 contains a number of signal processing features. These features are only enabled in SMPTE mode of operation ($\overline{\text{SMPTE_BYPASS}} = \text{HIGH}$), and when I/O processing is enabled ($\overline{\text{IOPROC_EN/DIS}} = \text{HIGH}$).

Signal processing features include:

- TRS generation and insertion
- Line number calculation and insertion
- Line based CRC calculation and insertion
- Illegal code re-mapping
- SMPTE ST 352 payload identifier packet insertion
- ANC checksum calculation and correction
- EDH generation and insertion
- Audio Embedding
- SMPTE ST 372 conversion

To enable these features in the GS2972, the $\overline{\text{SMPTE_BYPASS}}$ pin must be HIGH, the $\overline{\text{IOPROC_EN/DIS}}$ pin must be HIGH and the individual feature must be enabled via bits set in the IOPROC register of the host interface. By default, all of the processing features are enabled, except for SMPTE ST 372 conversion.

4.9.1 Video Format Detection

By using the timing parameters extracted from the received TRS signals, or the supplied external timing signals, the GS2972 calculates the video format.

The total samples per line, active samples per line, total lines per field/frame, and active lines per field/frame are measured and reported to the user via the four RASTER_STRUC_X registers in the host interface.

These line and sample count registers are updated once per frame at the end of line 12.

The RASTER_STRUC_X registers also contain two status bits: STD_LOCK and $\overline{\text{INT/PROG}}$.

The STD_LOCK bit is set HIGH whenever the automatic video format detection circuit has achieved full synchronization.

The $\overline{\text{INT/PROG}}$ bit is set LOW if the detected video standard is Progressive, and is set HIGH if the detected video standard is Interlaced.

The Gennum video standard code (VD_STD), as used in the GS2972, GS1582 and GS1572, is included in [Table 4-22](#) for reference purposes.

Table 4-22: Supported Video Standards

| SMPTE STANDARD | ACTIVE VIDEO AREA | LENGTH OF HANC | LENGTH OF ACTIVE VIDEO | TOTAL SAMPLES | SMPTE ST 352 LINES | Gennum VD_STD [4:0] | RATE_SEL1 |
|----------------------|---|-------------------------|------------------------|---------------|----------------------|---------------------|-----------|
| ST 428.1 | 2048x1080/24 (1:1) | 690 | 2048 | 2750 | 10 | 1Ch | 1 |
| ST 428.1 | 2048x1080/25 (1:1) | 580 | 2048 | 2640 | 10 | 1Ch | 1 |
| ST 425 (3G) 4:2:2 | 1920x1080/60 (1:1) | 268 | 1920 | 2200 | 10 (18) ¹ | 0Bh | 1 |
| | 1920x1080/50 (1:1) | 708 | 1920 | 2640 | 10 (18) ¹ | 0Dh | 1 |
| ST 425 (3G) 4:4:4 | 1920x1080/60 (2:1) or 1920x1080/30 (PsF) | 268 ² | 1920 ² | 2200 | 10, 572 | 0Ah | 1 |
| | 1920x1080/50 (2:1) or 1920x1080/25 (PsF) | 708 ² | 1920 ² | 2640 | 10, 572 | 0Ch | 1 |
| | 1280x720/60 (1:1) | 358 ² | 1280 ² | 1650 | 10 (13) ¹ | 00h | 1 |
| | 1280x720/50 (1:1) | 688 ² | 1280 ² | 1980 | 10 (13) ¹ | 04h | 1 |
| | 1920x1080/30 (1:1) | 268 ² | 1920 ² | 2200 | 10 (18) ¹ | 0Bh | 1 |
| | 1920x1080/25 (1:1) | 708 ² | 1920 ² | 2640 | 10 (18) ¹ | 0Dh | 1 |
| | 1280x720/25 (1:1) | 2668 ² | 1280 ² | 3960 | 10 (13) ¹ | 06h | 1 |
| | 1920x1080/24 (1:1) | 818 ² | 1920 ² | 2750 | 10 (18) ¹ | 10h | 1 |
| | 1280x720/24 (1:1) | 2833 ² | 1280 ² | 4125 | 10 (13) ¹ | 08h | 1 |
| ST 260 (HD) | 1920x1035/60 (2:1) | 268 | 1920 | 2200 | 10, 572 | 15h | 0 |
| ST 295 (HD) | 1920x1080/50 (2:1) | 444 | 1920 | 2376 | 10, 572 | 14h | 0 |
| ST 274 (HD) | 1920x1080/60 (2:1) or 1920x1080/30 (PsF) | 268 | 1920 | 2200 | 10, 572 | 0Ah | 0 |
| | 1920x1080/50 (2:1) or 1920x1080/25 (PsF) | 708 | 1920 | 2640 | 10, 572 | 0Ch | 0 |
| | 1920x1080/30 (1:1) | 268 | 1920 | 2200 | 10 (18) ¹ | 0Bh | 0 |
| | 1920x1080/25 (1:1) | 708 | 1920 | 2640 | 10 (18) ¹ | 0Dh | 0 |
| | 1920x1080/24 (1:1) | 818 | 1920 | 2750 | 10 (18) ¹ | 10h | 0 |
| | 1920x1080/24 (PsF) | 818 | 1920 | 2750 | 10, 572 | 11h | 0 |
| | 1920x1080/25 (1:1) – EM | 324 | 2304 | 2640 | 10 (18) ¹ | 0Eh | 0 |
| | 1920x1080/25 (PsF) – EM | 324 | 2304 | 2640 | 10, 572 | 0Fh | 0 |
| | 1920x1080/24 (1:1) – EM | 338 | 2400 | 2750 | 10 (18) ¹ | 12h | 0 |
| | | 1920x1080/24 (PsF) – EM | 338 | 2400 | 2750 | 10, 572 | 13h |

Table 4-22: Supported Video Standards (Continued)

| SMPTE STANDARD | ACTIVE VIDEO AREA | LENGTH OF HANC | LENGTH OF ACTIVE VIDEO | TOTAL SAMPLES | SMPTE ST 352 LINES | Genum VD_STD [4:0] | RATE_SEL1 |
|-------------------|---|----------------|------------------------|---------------|----------------------|--------------------|-----------|
| ST 296 (HD) | 1280x720/30 (1:1) | 2008 | 1280 | 3300 | 10 (13) ¹ | 02h | 0 |
| | 1280x720/30 (1:1) – EM | 408 | 2880 | 3300 | 10 (13) ¹ | 03h | 0 |
| | 1280x720/50 (1:1) | 688 | 1280 | 1980 | 10 (13) ¹ | 04h | 0 |
| | 1280x720/50 (1:1) – EM | 240 | 1728 | 1980 | 10 (13) ¹ | 05h | 0 |
| | 1280x720/25 (1:1) | 2668 | 1280 | 3960 | 10 (13) ¹ | 06h | 0 |
| | 1280x720/25 (1:1) – EM | 492 | 3456 | 3960 | 10 (13) ¹ | 07h | 0 |
| | 1280x720/24 (1:1) | 2833 | 1280 | 4125 | 10 (13) ¹ | 08h | 0 |
| | 1280x720/24 (1:1) – EM | 513 | 3600 | 4125 | 10 (13) ¹ | 09h | 0 |
| | 1280x720/60 (1:1) | 358 | 1280 | 1650 | 10 (13) ¹ | 00h | 0 |
| | 1280x720/60 (1:1) – EM | 198 | 1440 | 1650 | 10 (13) ¹ | 01h | 0 |
| ST 125 (SD) | 1440x487/60 (2:1) (Or dual link progressive) | 268 | 1440 | 1716 | 13, 276 | 16h | X |
| | 1440x507/60 (2:1) | 268 | 1440 | 1716 | 13, 276 | 17h | X |
| | 525-line 487 generic | – | – | 1716 | 13, 276 | 19h | X |
| | 525-line 507 generic | – | – | 1716 | 13, 276 | 18h | X |
| ITU-R BT.656 (SD) | 1440x576/50 (2:1) (Or dual link progressive) | 280 | 1440 | 1728 | 9, 322 | 18h | X |
| | 625-line generic (EM) | – | – | 1728 | 9, 322 | 1Ah | X |
| Unknown HD | RATE_SEL0 = 0 | – | – | – | – | 1Dh | |
| Unknown SD | RATE_SEL0 = 1 | – | – | – | – | 1Eh | X |
| Unknown 3G | RATE_SEL0 = 0 | – | – | – | – | 1Fh | 1 |

Notes:

1. The Line Numbers in brackets refer to version zero SMPTE ST 352 packet locations, if they are different from version 1.
2. The part may provide full or limited functionality with standards that are not included in this table. Please consult a Semtech technical representative.

By default (at power up or after system reset), the four RASTER_STRUC_X, STD_LOCK and INT/PROG registers are set to zero. These registers are also cleared when the SMPTE_BYPASS pin is LOW, or the LOCKED pin is LOW.

Note 1: The Line Numbers in brackets refer to Version zero SMPTE ST 352 packet locations, if they are different from the Version one locations.

Note 2: 3G formats cannot be fully determined from these measurements. Their detailed information will be derived from SMPTE ST 352 packets, which must be in the video stream as a mandatory requirement of the SMPTE ST 424 specification, as described below.

4.9.2 3G Format Detection

Format detection is more difficult for 3G signals, as there are two levels of signal (Level A and Level B) and multiple mappings within each level. Timing information is not sufficient to fully decode the video format.

For this reason SMPTE ST 352 video payload identifier packets are mandatory for all SMPTE ST 424 serial signals.

Note: The only exception is when the SMPTE ST 425 mapping is Level B twin SMPTE ST 292 streams, and one or both of the SMPTE ST 292 streams carries HD-SDTI data. In this case the HD-SDTI header packets are used for payload identification.

4.9.2.1 Level A and Level B Signals:

The GS2972 uses SMPTE ST 352 packets to determine the video format. The SMPTE ST 352 packets used for format detection will either be:

- When the 352_INS (address 000h bit 6) bit is LOW, then if either bit 6 or 7 of address 20Ah are HIGH, the format is 3G Level B. If both are LOW, then it will look at the information programmed at address 00Ah VIDEO_FORMAT_OUT_DS1_X. See SMPTE ST 425 Standard for details.
- When the bit is HIGH, the format is 3G Level A.

Extraction of SMPTE ST 352 packets cannot be done in 3G Level B.

The GS2972 uses the programmed SMPTE ST 352 packets if the 352_INS register bit in the IOPROC register is HIGH.

If there are no SMPTE ST 352 packets embedded in the input signal, and the user does not embed SMPTE ST 352 packets from the host interface, the GS2972 assumes an input signal of 1080p/50 or 1080p/59.94. The GS2972 uses information from the RASTER_STRUC_X registers to select between these two frame rates.

For Level B inputs, the GS2972 does not extract the SMPTE ST 352 packets from the parallel input. The only source of SMPTE ST 352 packets in Level B mode, to be used for format detection and for embedding in the output data streams, is from the user programmed registers in the host interface.

Note: If proper SMPTE video is applied and then removed from the input, the device does not flag that the H_LOCK, V_LOCK, VD_SDT etc. has changed (been lost). This is the case for either TRS detect or HVF modes. This problem occurs only when the video data is removed, but not the PCLK. Usually, when a video signal is removed, it includes the clock, the video data, as well as the H, V, F as a whole. So the scenario is not likely to occur.

4.9.3 ANC Data Blanking

The GS2972 can blank the video input data during the H and V blanking periods. This function will be enabled by setting the $\overline{\text{ANC_BLANK}}$ pin LOW.

This function is only available when the device is operating in SMPTE mode ($\overline{\text{SMPTE_BYPASS}} = \text{HIGH}$).

In this mode, input video data in the horizontal and vertical blanking periods will be replaced by SMPTE compliant blanking values.

The blanking function will operate only on the video input signal and will remove all ancillary data already embedded in the input video stream.

In SD mode, SAV and EAV code words already embedded in the input video stream will be protected and will not be blanked.

In HD and 3G modes, SAV and EAV code words, line numbers and line based CRC's already embedded in the input video stream will be protected and will not be blanked.

The above two statements are really implementation specific, and are provided only to ensure that the "Detect TRS" function for timing generation is supported by the device, even when the blanking function is enabled.

From a system perspective, use of the input blanking function is not recommended unless TRS, line number and CRC generation and insertion functions are enabled.

The active image area will not be blanked.

The input blanking function will not blank any of the ancillary data, TRS words, line numbers, CRC's, EDH, SMPTE ST 352 payload identifiers or audio control and data packets inserted by the device itself.

4.9.4 ANC Data Checksum Calculation and Insertion

The GS2972 calculates checksums for all detected ancillary data packets and audio data presented to the device.

ANC data checksum insertion only takes place if the $\text{IOPROC_EN}/\overline{\text{DIS}}$ pin is HIGH, the $\overline{\text{SMPTE_BYPASS}}$ is HIGH and the ANC_CSUM_INS bit is set LOW in the IOPROC register.

Note: The device will correct any CSUM value outside the protected ranges from 000h to 003h and from 3FCh to 3FFh. If a CSUM value in either of these ranges is presented to the device, it will not be corrected.

4.9.5 TRS Generation and Insertion

The GS2972 is capable of generating and inserting TRS codes.

TRS word generation and insertion are performed in accordance with the timing parameters generated by the timing circuits, which is locked to the externally provided H:V:F or CEA-861 signals, or the TRS signals embedded in the input data stream. The GS2972 will overwrite the TRS signals if they're already embedded. When a 3G Level A signal is applied to the GS2972, and when the CONV_372 (bit 9 address 000h) is set LOW (Level A to Level B conversion), TRS will be inserted according to 3G Level B format.

10-bit TRS code words are inserted at all times.

The insertion of TRS ID words only take place if the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH and the SMPTE_BYPASS pin is HIGH.

In addition to this, the GS2972 requires the TRS_INS bit to be set LOW in the IOPROC register.

If the TIM_861 pin is HIGH, then the timing circuits are locked to CEA-861 timing.

4.9.6 HD and 3G Line Number Calculation and Insertion

The GS2972 is capable of line number generation and insertion, in accordance with the relevant HD video standard, as determined by the automatic video standard detector. Line numbers are inserted into both the Y and C channels.

Note: Line number generation and insertion only occurs in HD and 3G modes (RATE_SELO = LOW).

The insertion of line numbers only take place if the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH and SMPTE_BYPASS pin is HIGH.

In addition to this, the GS2972 requires the LNUM_INS bit to be set LOW in the IOPROC register.

4.9.7 Illegal Code Re-Mapping

The GS2972 detects and corrects illegal code words within the active picture area.

All codes within the active picture (outside the horizontal and vertical blanking periods), between the values of 3FCh and 3FFh are re-mapped to 3FBh. All codes within the active picture area between the values of 000h and 003h are remapped to 004h.

8-bit TRS code words are re-mapped to 10-bit values.

The illegal code re-mapping will only take place if the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH and SMPTE_BYPASS is HIGH.

In addition to this, the GS2972 requires the ILLEGAL_WORD_REMAP bit to be set LOW in the IOPROC register.

Note: Due to the architecture of the GS2972 serializer, illegal code words appearing in the middle of a line that look like TRS sequences will be treated as such by the device.

For example, any sequence in the middle of a line that produces 3FFh 000h 000h followed by another 10-bit word will be treated as a TRS, even if that following word does not match the XYZh code words allowed by SMPTE.

To avoid this issue, any groupings of words that look like TRS sequence must be kept out of the active picture portion of the video line or it will not be remapped.

4.9.8 SMPTE ST 352 Payload Identifier Packet Insertion

When enabled by the SMPTE_352M_INS bit in the IOPROC register, new SMPTE ST 352 payload identifier packets are inserted into the data stream. These packets are supplied by the user via the host interface. Setting the SMPTE_352M_INS bit LOW enables this insertion.

The device will automatically calculate the checksum and generate Version One compliant ST 352 ancillary data preambles: DID, SDID, DBN, DC.

The SMPTE ST 352 packet is inserted into the data stream according to the line number and sample position rules defined in the 2002 standard.

For HDTV video systems the SMPTE ST 352 packet is placed in the Y channel only.

By default (at power up or after system reset), the four VIDEO_FORMAT_IN_DS1 registers and the four VIDEO_FORMAT_OUT_DS1 registers are set to zero.

4.9.8.1 3G SMPTE ST 352 Payload Identifier Packet Insertion

When enabled by the SMPTE_352M_INS bit in the IOPROC register (000h), new SMPTE ST 352 payload identifier packets are inserted into the data streams. Setting this bit LOW enables insertion.

Insertion of SMPTE ST 352 packets into each data stream is controlled by the status format describing bit, SDTI_TDM_DS1 and SDTI_TDM_DS2 for Data Stream One and Data Stream Two. If SDTI_TDM_DS1 (default LOW) is set HIGH by the user, the GS2972 does not insert SMPTE ST 352 packets into Data Stream One. Similarly, SMPTE ST 352 packets are inserted in Data Stream Two only if SDTI_TDM_DS2 is set LOW. This allows the user to individually disable SMPTE ST 352 packets where the data stream is carrying an HD-SDTI or TDM signal, which must not have SMPTE ST 352 packets embedded.

Note: The user must ensure that there is sufficient space in the horizontal blanking interval for the insertion of the SMPTE ST 352 packets. If the FIRST_AVAIL_POSITION bit in the host interface registers is set HIGH (by default), the SMPTE ST 352 packets are inserted in the first available position following any existing ancillary data. If the FIRST_AVAIL_POSITION CSR bit is set LOW, then the packets are inserted immediately after the EAV/CRC1. If the first available position is HIGH and there is insufficient space, ST 352 packets will not be inserted.

If there are pre-existing ST 352 packets, they will be overwritten, independent of the setting of the FIRST_AVAIL_POSITION CSR bit.

4.9.9 Line Based CRC Generation and Insertion (HD/3G)

When operating in HD mode (RATE_SEL0 pin = LOW, RATE_SEL1 pin = LOW), the GS2972 generates and inserts line based CRC words into both the Y and C channels of the data stream.

When operating in 3G (RATE_SEL0 pin = LOW, RATE_SEL1 pin = HIGH) Level A mode, the GS2972 generates and inserts line based CRC words into both Data Stream One and Data Stream Two.

When operating in 3G (RATE_SEL0 pin = LOW, RATE_SEL1 pin = HIGH) Level B mode, the GS2972 generates and inserts line based CRC words into both Y and C channels of both Link A and Link B.

The line based CRC insertion only takes place if the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH and $\overline{\text{SMPTE_BYPASS}}$ is HIGH.

In addition to this, the GS2972 requires the EDH_CRC_INS bit to be set LOW in the IOPROC register.

4.9.10 EDH Generation and Insertion

When operating in SD mode, the GS2972 generates and inserts EDH packets into the data stream.

The EDH packet generation and insertion only takes place if the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH, $\overline{\text{SMPTE_BYPASS}}$ pin is HIGH, the RATE_SEL0 pin is HIGH and the EDH_CRC_INS bit is set LOW in the IOPROC register.

Calculation of both Full Field (FF) and Active Picture (AP) CRCs is carried out by the device.

EDH error flags EDH, EDA, IDH, IDA and UES for ancillary data, full field and active picture are also inserted.

- When the EDH_CRC_UPDATE bit of the host interface is set LOW, these flags are sourced from the ANC_EDH_FLAG, FF_EDH_FLAG and AP_EDH_FLAG registers of the device, where they are programmed by the application layer
- When the EDH_CRC_UPDATE bit of the host interface is set HIGH, incoming EDH flags are preserved and inserted in the outgoing EDH packets. In this mode the ANC_EDH_FLAG, FF_EDH_FLAG and AP_EDH_FLAG registers contain the incoming EDH flags, and will be read only

The GS2972 generates all of the required EDH packet data including all ancillary data preambles: DID, DBN, DC, reserved code words and checksum.

The prepared EDH packet is inserted at the appropriate line of the video stream (in accordance with RP165). The start pixel position of the inserted packet is based on the SAV position of that line, such that the last byte of the EDH packet (the checksum) is placed in the sample immediately preceding the start of the SAV TRS word.

Note 1: When the EDH_CRC_UPDATE bit of the host interface is set LOW, it is the responsibility of the application interface to ensure that the EDH flag registers are updated regularly (once per field).

Note 2: It is also the responsibility of the application interface to ensure that there is sufficient space in the horizontal blanking interval for the EDH packet to be inserted.

4.9.11 GS2972 3G/HD HANC Space Considerations when Embedding Audio

Standards having more than 1024 HANC words in the blanking can potentially re-transmit pre-embedded packets twice in CASCADE or AGR modes.

Here is the list of standards at risk:

(1920x1080/24/1:1, 444) = 1648 words in HANC (2048x1080/25/1:1, 444) = 1172 words in HANC

(2048x1080/24/1:1, 444) = 1392 words in HANC

(1280x720/24/1:1, 444) = 5678 words in HANC

(1280x720/23.98/1:1, 444) = 5678 words in HANC

(1280x720/25/1:1, 444) = 5348 words in HANC

(1280x720/50/1:1, 444) = 1388 words in HANC

(1920x1080/23.98/1:1, 444) = 1648 words in HANC

(1920x1080/50/2:1, 444) = 1428 words in HANC

(1920x1080/25/1:1, 444) = 1428 words in HANC

(1920x1080/25/PsF, 444) = 1428 words in HANC

(1280x720/30/1:1, 422) = 2008 words in HANC

(1280x720/29.97/1:1, 422) = 2008 words in HANC

(1280x720/25/1:1, 422) = 2668 words in HANC

(1280x720/24/1:1, 422) = 2833 words in HANC

(1280x720/23.98/1:1, 422) = 2833 words in HANC

Note: For all of the standards listed above, Semtech recommends using the GS2972 as the source of any ancillary data packets. If packets already exist in the video coming in to the GS2972, Semtech recommends deleting all ANC packets if this problem is to be avoided.

4.9.12 SMPTE ST 372 Conversion

When the IOPROC_EN/ $\overline{\text{DIS}}$ pin is HIGH and the CONV_372 bit in the IOPROC register is LOW, the GS2972 converts SMPTE ST 425 Level A mapping 1 (1080P 4:2:2) to Level B SMPTE ST 372 dual link prior to serialization.

4.9.13 Processing Feature Disable

The GS2972 contains an IOPROC register. This register contains one bit for each processing feature, allowing the user to enable/disable each process individually.

By default (at power up or after system reset), all of the IOPROC register bits are LOW, except for the SMPTE ST 372 conversion.

To disable an individual processing feature, the application interface must set the corresponding bit HIGH in the IOPROC register. To enable these features, the IOPROC_EN/DIS pin must be HIGH, and the individual feature must be enabled by setting bits LOW in the IOPROC register of the host interface.

The I/O processing functions supported by the GS2972 are shown in [Table 4-25](#) below.

Table 4-23: IOPROC Register Bits

| I/O Processing Feature | IOPROC Register Bit |
|---|---------------------------------|
| TRS insertion | TRS_INS (000h Bit 0) |
| Y and C line number insertion | LNUM_INS (000h Bit 1) |
| Y and C line based CRC insertion | CRC_INS (000h Bit 2) |
| Ancillary data checksum correction | ANC_CSUM_INS (000h Bit 3) |
| EDH CRC error calculation and insertion | EDH_CRC_INS (000h Bit 4) |
| Illegal word re-mapping | ILLEGAL_WORD_REMAP (000h Bit 5) |
| SMPTE ST 352 packet insertion | SMPTE_352M_INS (000h Bit 6) |
| SMPTE ST 372 conversion | CONV_372 (000h Bit 9) |
| Audio embedding | AUDIO_EMBED (000h Bit 10) |

4.10 SMPTE ST 352 Data Extraction

If there are no SMPTE ST 352 packets embedded in the input signal, the GS2972 will raise an error flag in the “NO_352_ERR” bit.

If there are ST 352 packets present in the stream, the GS2972 reports the extracted SMPTE ST 352 packets in the VIDEO_FORMAT_352_IN registers in the host interface. The user can use this information, along with the RASTER_STRUC_X registers, to determine the video format.

If there is a conflict between the numbers in the RASTER_STRUC_X registers and the format defined in the SMPTE ST 352 packets, the GS2972 will raise a TIMING_ERR flag via the host interface.

Note: SMPTE ST 352 packets will not be present in an HD-SDTI input stream, and will not be embedded in an output HD-SDTI serial stream. This is controlled by the user as described in [Section 4.9.8.1](#).

By default (at power up or after system reset), the VIDEO_FORMAT_352_IN registers are set to zero (undefined video format). These registers are also cleared when the SMPTE_BYPASS pin is set LOW, or the LOCKED pin is LOW. The SMPTE ST 352 packet should be received once per field for interlaced systems and once per frame for progressive video systems. If the packet is not received for two complete video frames, the VIDEO_FORMAT_352_IN registers are cleared to zero.

Table 4-24: SMPTE ST 352 Packet Data

| Register Name | Bit | Bit Name | Description | R/W | Default |
|----------------------------|------|-----------------------------------|--|-----|---------|
| VIDEO_FORMAT_352_IN_WORD_2 | 15-8 | VIDEO_FORMAT_IN_DS1_4 (Byte 4) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| | 7-0 | VIDEO_FORMAT_IN_DS1_3 (Byte 3) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| VIDEO_FORMAT_352_IN_WORD_1 | 15-8 | VIDEO_FORMAT_IN_DS1_2 (Byte 2) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| | 7-0 | VIDEO_FORMAT_IN_DS1_1 (Byte 1) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| VIDEO_FORMAT_352_IN_WORD_4 | 15-8 | VIDEO_FORMAT_IN_DS2_4 (Byte 4) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| | 7-0 | VIDEO_FORMAT_IN_DS2_3 (Byte 3) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| VIDEO_FORMAT_352_IN_WORD_3 | 15-8 | VIDEO_FORMAT_IN_DS2_2 (Byte 2) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |
| | 7-0 | VIDEO_FORMAT_IN_DS2_1 (Byte 1) | Data will be available in this register when Video Payload Identification Packets are detected in the data stream. | R | 0 |

4.11 Serial Clock PLL

An internal VCO provides the transmission clock rates for the GS2972.

The power supply to the VCO is provided to the VCO_VDD/VCO_GND pins of the device.

This VCO is locked to the input PCLK via an on-chip PLL and Charge Pump.

Internal division ratios for the PCLK are determined by the setting of the RATE_SEL0 pin, the RATE_SEL1 pin and the 20BIT/ $\overline{10BIT}$ pin as shown in Table 4-25:

Table 4-25: PCLK and Serial Digital Clock Rates

| External Pin Setting | | | Supplied PCLK Rate | Serial Digital Output Rate |
|----------------------|-----------|---------------------------|-------------------------------|----------------------------|
| RATE_SEL0 | RATE_SEL1 | 20BIT/ $\overline{10BIT}$ | | |
| LOW | HIGH | HIGH | 148.5 or 148.5/1.001MHz | 2.97 or 2.97/1.001 Gb/s |
| LOW | HIGH | LOW | 148.5 or 148.5/1.001MHz (DDR) | 2.97 or 2.97/1.001 Gb/s |
| LOW | LOW | HIGH | 74.25 or 74.25/1.001MHz | 1.485 or 1.485/1.001Gb/s |
| LOW | LOW | LOW | 148.5 or 148.5/1.001MHz | 1.485 or 1.485/1.001Gb/s |
| HIGH | X | HIGH | 13.5MHz | 270Mb/s |
| HIGH | LOW | LOW | 27MHz | 270Mb/s |

As well as generating the serial digital output clock signals, the PLL is also responsible for generating all internal clock signals required by the device.

4.11.1 PLL Bandwidth

Table 4-26 shows the GS2972 PLL loop bandwidth variations. PLL bandwidth is a function of the external loop filter resistor and the charge pump current. We recommend using a 200 Ω loop filter resistor, however, this value can be varied from 100 Ω to 380 Ω , depending on application. Values other than 200 Ω are not guaranteed. As the resistor is changed, the bandwidth will scale proportionately (for example, a change from a 200 Ω to 300 Ω resistor will cause a 50% increase in bandwidth). The charge pump current is preset to 100 μ A and should not be changed. The external loop filter capacitor does not affect the PLL loop bandwidth. The external loop filter capacitor affects PLL loop settling time, phase margin and noise. It is selectable from 1 μ F to 33 μ F. However, it should be kept at 10 μ F for optimal performance. A smaller capacitor results in shorter lock time but less stability. A larger capacitor results in longer lock time but more stability. Narrower loop bandwidths require a larger capacitor to be stable. In other words, a small loop filter resistor requires a larger loop capacitor.

Table 4-26: GS2972 PLL Bandwidth

| Mode | PCLK Frequency (MHz) | Filter Resistor (Ω) | Charge Pump Current (μ A) | Bandwidth (kHz) |
|------|----------------------|------------------------------|--------------------------------|-----------------|
| SD | 13.50 | 200 | 100 | 4.78 |
| SD | 27.00 | 200 | 100 | 9.57 |
| HD | 74.25 | 200 | 100 | 26.32 |
| HD | 148.50 | 200 | 100 | 52.63 |
| 3G | 148.50 | 200 | 100 | 52.63 |

4.11.2 Lock Detect

The Lock Detect block controls the serial digital output signal and indicates to the application layer the lock status of the device.

The LOCKED output pin is provided to indicate the device operating status.

The LOCKED output signal is set HIGH by the lock detect block under the following conditions (see [Table 4-27](#)):

Table 4-27: GS2972 Lock Detect Indication

| $\overline{\text{RESET}}$ | PLL Lock | $\overline{\text{SMPTE_BYPASS}}$ | DVB_ASI | RATE_SELO |
|---------------------------|----------|-----------------------------------|---------|-----------|
| HIGH | HIGH | HIGH | LOW | X |
| HIGH | HIGH | LOW | HIGH | HIGH |
| HIGH | HIGH | LOW | LOW | X |

Any other combination of signal states not included in the above table results in the LOCKED pin being LOW.

Note: When the LOCKED pin is LOW, the serial digital output is in the muted state.

4.12 Serial Digital Output

The GS2972 has a single, low-impedance current mode differential output driver, capable of driving at least 800mV into a 75Ω single-ended load.

The output signal amplitude, or swing, will be user-configurable using an external resistor on the RSET pin.

The serial digital output data rate supports SMPTE ST 424, SMPTE ST 292, SMPTE ST 259-C and DVB-ASI operation. This is summarized in [Table 4-28](#):

Table 4-28: Serial Digital Output - Serial Output Data Rate

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-------------------------|--------|-----------------------|-----|--------------------|-----|-------|
| Serial Output Data Rate | BRSDO | SMPTE ST 424 signal | – | 2.97, 2.97/1.001 | – | Gb/s |
| | | SMPTE ST 292 signal | – | 1.485, 1.485/1.001 | – | Gb/s |
| | | SMPTE ST 259-C signal | – | 270 | – | Mb/s |
| | | DVB-ASI signal | – | 270 | – | Mb/s |

The SDO and $\overline{\text{SDO}}$ pins of the device provide the serial digital output.

Compliance with all requirements defined in [Section 4.12.1](#) through [Section 4.12.4](#) is guaranteed when measured across a 75Ω terminated load at the output of 1m of Belden 1694A cable, including the effects of the Semtech recommended ORL matching network, BNC and coaxial cable connection, except where otherwise stated.

[Figure 4-28](#) illustrates this requirement, which is in accordance with the measurement methodology defined in SMPTE ST 424, SMPTE ST 292 and SMPTE ST 259-C.

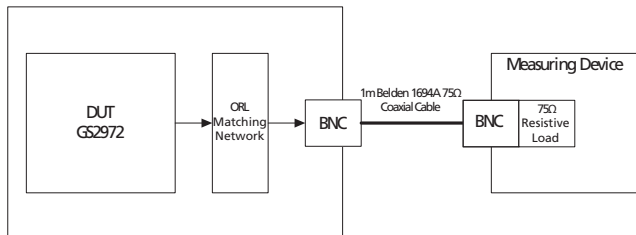


Figure 4-28: ORL Matching Network, BNC and Coaxial Cable Connection

4.12.1 Output Signal Interface Levels

The Serial Digital Output signals (SDO and $\overline{\text{SDO}}$ pins), of the device meet the amplitude requirements as defined in SMPTE ST 424 for an unbalanced generator (single-ended).

The signal amplitude is controlled to better than +/-7% of the nominal level defined in SMPTE ST 424, when an external 750 Ω 1% resistor is connected between the RSET pin of the device and VCC.

The output signal amplitude can be reduced to less than 1/10th of the nominal amplitude, defined above, by increasing the value of the resistor connected between the RSET pin of the device and VCC.

These requirements are met across all ambient temperature and power supply operating conditions described in [Section 2](#).

The output amplitude of the GS2972 can be adjusted by changing the value of the R_{SET} resistor as shown in [Table 4-29](#). For a 800mV_{pp} output a value of 750 Ω is required. A \pm 1% SMT resistor should be used.

The R_{SET} resistor is part of the high speed output circuit of the GS2972. The resistor should be placed as close as possible to the RSET pin. In addition, an anti-pad should be used underneath the resistor.

Table 4-29: R_{SET} Resistor Value vs. Output Swing

| R _{SET} Resistor Values (Ω) | Output Swing (mV _{pp}) |
|---|----------------------------------|
| 995 | 608 |
| 824 | 734 |
| 750 | 800 |
| 680 | 884 |

4.12.2 Overshoot/Undershoot

The serial digital output signal overshoot and undershoot is controlled to be less than 7% of the output signal amplitude, when operating as an unbalanced generator (single-ended).

This requirement is met for nominal signal amplitudes as defined by SMPTE ST 292.

This requirement is met regardless of the output slew rate setting of the device.

This requirement is met across all ambient temperature and power supply operating conditions described in [Section 2](#).

This requirement is summarized in [Table 4-30](#):

Table 4-30: Serial Digital Output - Overshoot/Undershoot

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-------------------------------------|--------|------------|-----|-----|-----|-------|
| Serial output overshoot /undershoot | – | – | – | 0 | 7 | % |

4.12.3 Slew Rate Selection

The GS2972 supports two user-selectable output slew rates.

Control of the slew rate is determined by the setting of the RATE_SELO input pin.

When this pin is set HIGH, the output slew rate matches the requirements as defined by the SMPTE ST 259-C standard.

When this pin is set LOW, the output slew rate is better than the requirements as defined by the SMPTE ST 424 standard.

These requirements is met across all ambient temperature and power supply operating conditions described in [Section 2](#).

This requirement is summarized in [Table 4-31](#):

Table 4-31: Serial Digital Output - Rise/Fall Time

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---|-------------------|----------------------------|-----|-----|-----|-------|
| Serial Output Rise/Fall Time 20% ~ 80% | SDO _{TR} | SMPTE ST 292/ST 424 signal | – | – | 135 | ps |
| | | SMPTE ST 259-C signal | 400 | – | 800 | ps |

4.12.4 Serial Digital Output Mute

When the SDO_EN/ $\overline{\text{DIS}}$ pin is LOW, the serial digital output signals of the device become high-impedance, reducing system power.

The serial digital output is also placed in the high-impedance state when the LOCKED pin is LOW, or when the STANDBY pin is HIGH.

4.13 GSPI Host Interface

Note: When using more than one Semtech serializer or deserializer (SerDes) in the same design, carefully read this section to see how the GSPI ports of multiple ICs should be connected to each other. Unlike some previous devices, the SDO pin of these SerDes ICs is a non-clocked, loop-through of SDIN (allowing for multiple devices to be connected to the GSPI chain). The SDO pin of multiple SerDes ICs should not be bussed together, as was the case with some older generations of SerDes ICs.

The GSPI, or Gennum Serial Peripheral Interface, is a 4-wire interface provided to allow the application layer to access additional status information through configuration registers in the GS2972.

The GSPI comprises a Serial Data Input signal (SDIN), Serial Data Output signal (SDOUT), an active-low Chip Select (\overline{CS}) and a Burst Clock (SCLK).

Because these pins can be shared with the JTAG interface port for compatibility with the GS1582, an additional control signal pin JTAG/ \overline{HOST} is provided.

When JTAG/ \overline{HOST} is LOW, the GSPI interface is enabled. When JTAG/ \overline{HOST} is HIGH, the JTAG interface is enabled.

When operating in GSPI mode, the SCLK, SDIN, and \overline{CS} signals are provided by the application interface. The SDO pin is a non-clocked loop-through of SDIN, and may be connected to the SDIN of another device, allowing multiple devices to be connected to the GSPI chain. The interface is illustrated in Figure 4-29 below.

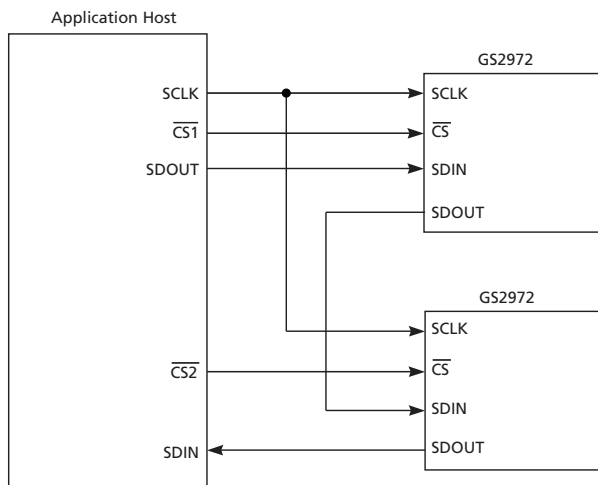


Figure 4-29: GSPI Application Interface Connection

All read or write access to the GS2972 is initiated and terminated by the application host processor. Each access always begins with a Command/Address Word followed by a data read to or written from the GS2972.

4.13.1 Command Word Description

The Command Word consists of a 16-bit word transmitted MSB first and contains a read/write bit, an Auto-Increment bit and a 12-bit address. Figure 4-30 shows the command word format and bit configurations.

Command Words are clocked into the GS2972 on the rising edge of the Serial Clock SCLK, which operates in a burst fashion.

When the Auto-Increment bit is set LOW, each Command Word must be followed by only one Data Word to ensure proper operation. If the Auto-Increment bit is set HIGH, the following Data Word will be written into the address specified in the Command Word, and subsequent data words will be written into incremental addresses from the previous Data Word. This facilitates multiple address writes without sending a Command Word for each Data Word.

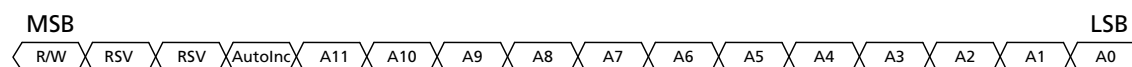


Figure 4-30: Command Word Format

4.13.2 Data Read or Write Access

Serial data is transmitted or received MSB first synchronous with the rising edge of the Serial Clock, SCLK. The Chip Select (\overline{CS}) signal must be active LOW a minimum of 1.5ns (t_0 in Figure 4-32) before the first clock edge to ensure proper operation.

During a Read sequence (Command Word R/W bit set HIGH), a wait state of 148ns ($4 \times 1/fPCLK$, t_5 in Figure 4-32) is required between writing the Command Word and reading the following Data Word. The read bits are clocked out on the negative edges of SCLK.

Note 1: Where several devices are connected to the GSPI chain, only one $\overline{CS_TMS}$ may be asserted during a read sequence.

During a Write sequence (Command Word R/W bit set LOW), a wait state of 37ns ($1 \times 1/fPCLK$, t_4 in Figure 4-32) is required between the Command Word and the following Data Word. This wait state must also be maintained between successive Command Word/Data Word write sequences. When Auto-increment mode is selected (AutoInc = 1), the wait state must be maintained between successive Data Words after the initial Command Word/Data Word sequence.

During the write sequence, all command and following Data Words input at the SDIN pin are output at the SDOOUT pin as is.

When several devices are connected to the GSPI chain, data can be written simultaneously to all the devices which have \overline{CS} set LOW.

Note 2: If the application interface performs a Read or Write access after power-up, prior to the application of a valid serial video input signal, the SCLK frequency must not exceed 10MHz.

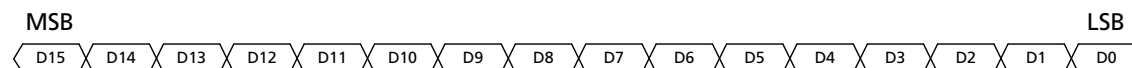


Figure 4-31: Data Word Format

4.13.3 GSPI Timing

Write and Read Mode timing for the GSPI interface is as shown in the following diagrams:

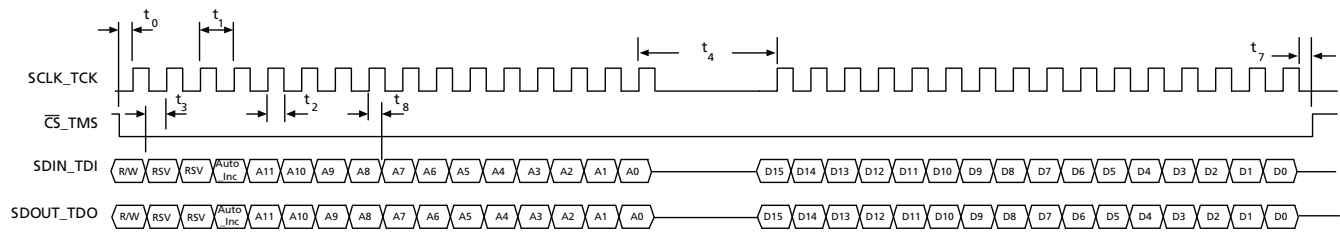


Figure 4-32: Write Mode

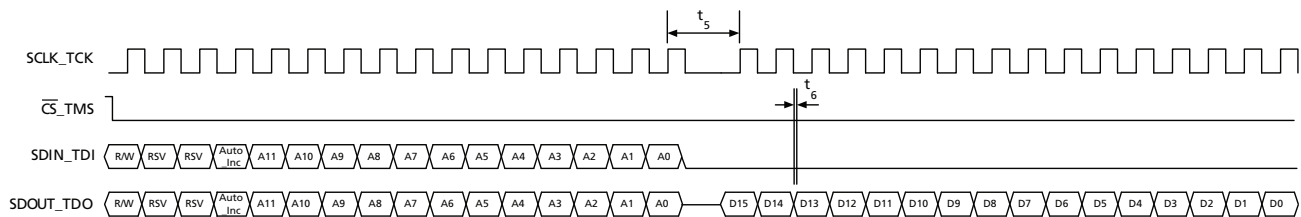


Figure 4-33: Read Mode

SDIN_TDI to SDOUT_TDO combinational path for daisy chain connection of multiple GS2972 devices.

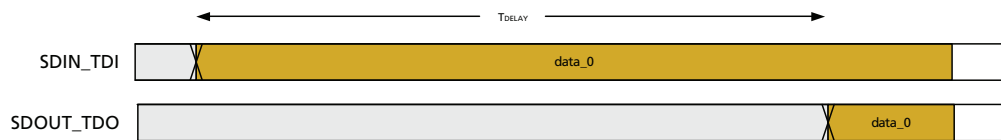


Figure 4-34: GSPI Time Delay

Table 4-32: GSPI Time Delay

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|------------|-------------|--------------------------------|-----|-----|------|-------|
| Delay time | t_{DELAY} | 50% levels; +1.8V operation | – | – | 10.5 | ns |
| Delay time | t_{DELAY} | 50% levels; +3.3V operation | – | – | 8.7 | ns |

Table 4-33: GSPI AC Characteristics

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|--|--------|--------------------------------------|-------|-----|-----|-------|
| \overline{CS} low before SCLK rising edge | t_0 | | 1.5 | – | – | ns |
| SCLK period | t_1 | | 12.5 | – | – | ns |
| SCLK duty cycle | t_2 | | 40 | 50 | 60 | % |
| Input data setup time | t_3 | | 1.5 | – | – | ns |
| Time between end of Command Word (or data in Auto-Increment mode) and the first SCLK of the following Data Word – write cycle. | t_4 | PCLK (MHz) | ns | | | |
| | | unlocked | 445 | | | |
| | | 13.5 | 74.2 | – | – | ns |
| | | 27.0 | 37.1 | | | |
| | | 74.25 | 13.5 | | | |
| Time between end of Command Word (or data in Auto-Increment mode) and the first SCLK of the following Data Word – read cycle. | t_5 | 50% levels; +3.3V or +1.8V operation | | | | |
| | | PCLK (MHz) | ns | | | |
| | | unlocked | 1187 | | | |
| | | 13.5 | 297 | – | – | ns |
| | | 27.0 | 148.5 | | | |
| Output hold time (15pF load) | t_6 | | | | | |
| | | 1.5 | | – | – | ns |
| | | PCLK (MHz) | ns | | | |
| | | unlocked | 445 | | | |
| | | 74.2 | 74.2 | – | – | ns |
| \overline{CS} HIGH after last SCLK rising edge | t_7 | | | | | |
| | | 37.10 | 37.1 | | | |
| | | 74.25 | 13.5 | | | |
| | | 148.5 | 6.7 | | | |
| | | | | | | |
| Input data hold time | t_8 | | 1.5 | – | – | ns |

Note: If the application interface performs a Read or Write access after power-up, prior to the application of a valid serial video input signal, the SCLK frequency must not exceed 10MHz.

4.14 Host Interface Register Maps

4.14.1 Video Core Registers

Table 4-34: Video Core Configuration and Status Registers

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------|---|-----|---|-----|---------|
| 000h | IOPROC | RSVD | 15 | Reserved. | R | 0 |
| | | DELAY_LINE_ENABLE | 14 | HIGH - enables the delay line. LOW - disables the delay line. | R/W | 0 |
| | | AUDIO_LEVELB_STREAM_2_1B | 13 | HIGH - embeds audio on the DS2 of a 3G Level B signal. LOW - embeds audio on the DS1 of a 3G Level B signal. | R/W | 0 |
| | | EDH_CRC_UPDATE | 12 | HIGH - preserve incoming EDH flags and insert into outgoing EDH packets. LOW - embed flags from 003 in EDH packet. | R/W | 0 |
| | | ANC_INS | 11 | HIGH - disable ancillary data insertion. LOW - embeds ANC packet stored at 040h to 13Fh according to parameters at 005h to 02Dh. | R/W | 0 |
| | | AUDIO_EMBED | 10 | HIGH - disable audio embedding. LOW - enables audio embedding. | R/W | 0 |
| | | CONV_372 | 9 | HIGH - disable Level A-B conversion. LOW - enable Level A-B conversion. | R/W | 1 |
| | | H_CONFIG | 8 | Chooses H configuration; LOW - Active-line based blanking is enabled. HIGH - SMPTE H timing. | R/W | 0 |
| | | RSVD | 7 | Reserved. | R/W | 0 |
| | | SMPTE_352M_INS | 6 | HIGH - disables insertion of SMPTE ST 352 packets. LOW - enables insertion of SMPTE ST 352 packets | R/W | 0 |
| | | ILLEGAL_WORD_REMAP | 5 | HIGH - disables illegal word remapping. | R/W | 0 |
| | | EDH_CRC_INS | 4 | HIGH - disables EDH CRC error correction and insertion. | R/W | 0 |
| | | ANC_CSUM_INS | 3 | HIGH - disables insertion of ancillary data checksums. | R/W | 0 |
| CRC_INS | 2 | HIGH - disables insertion of HD/3G CRC words. | R/W | 0 | | |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------|---------------|------|---|-----|---------|
| 000h | IOPROC | LNUM_INS | 1 | HIGH = disables insertion of HD/3G line numbers. | R/W | 0 |
| | | TRS_INS | 0 | HIGH = disables insertion of TRS words. | R/W | 0 |
| 001h | ERROR_STAT | RSVD | 15-7 | Reserved. | R | 0 |
| | | TRS_PERR | 6 | TRS protection error. LOW - No errors in TRS. HIGH - Errors in TRS. | R | 0 |
| | | Y1_EDH_CS_ERR | 5 | Same as CS_ERR but only updates its state when packet being inspected is an EDH packet. | R | 0 |
| | | Y1_CS_ERR | 4 | HIGH indicates that a checksum error is detected. It is updated every time a \overline{CS} word is present on the output. Note: This bit will not be set for CSUM values in the protected ranges (from 000h to 003h and from 3FCh to 3FFh). | R | 0 |
| | | FORMAT_ERR | 3 | HIGH indicates standard is not recognized for 861D conversion. | R | 0 |
| | | TIMING_ERR | 2 | HIGH indicates that the RASTER measurements do not line up with the extracted ST 352 packet information. | R | 0 |
| | | NO_352M_ERR | 1 | HIGH indicates no ST 352 packet embedded in incoming video. | R | 0 |
| | | LOCK_ERR | 0 | HIGH indicates PLL lock error indication. | R | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------|-------------|-----|--|-----|---------|
| | | RSVD | 15 | Reserved. | R | 0 |
| | | ANC_UES_EXT | 14 | Ancillary data - unknown error status flag. | R | 0 |
| | | ANC_IDA_EXT | 13 | Ancillary data - internal error detected already flag. | R | 0 |
| | | ANC_IDH_EXT | 12 | Ancillary data - internal error detected here flag. | R | 0 |
| | | ANC_EDA_EXT | 11 | Ancillary data - error detected already flag. | R | 0 |
| | | ANC_EDH_EXT | 10 | Ancillary data - error detected here flag. | R | 0 |
| | | FF_UES_EXT | 9 | EDH Full Field - unknown error status flag. | R | 0 |
| | | FF_IDA_EXT | 8 | EDH Full Field - internal error detected already flag. | R | 0 |
| 002h | EDH_FLAG_EXT | FF_IDH_EXT | 7 | EDH Full Field - internal error detected here flag. | R | 0 |
| | | FF_EDA_EXT | 6 | EDH Full Field - error detected already flag. | R | 0 |
| | | FF_EDH_EXT | 5 | EDH Full Field - error detected here flag. | R | 0 |
| | | AP_UES_EXT | 4 | EDH Active Picture - unknown error status flag. | R | 0 |
| | | AP_IDA_EXT | 3 | EDH Active Picture - internal error detected already flag. | R | 0 |
| | | AP_IDH_EXT | 2 | EDH Active Picture - internal error detected here flag. | R | 0 |
| | | AP_EDA_EXT | 1 | EDH Active Picture - error detected already flag. | R | 0 |
| | | AP_EDH_EXT | 0 | EDH Active Picture - error detected here flag. | R | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|------------|---------------|--|-------|--|-----|---------|
| 003h | EDH_FLAG_PGM | RSVD | 15 | Reserved. | R | 0 |
| | | ANC_UES_PGM | 14 | Ancillary data - unknown error status flag. | R | 0 |
| | | ANC_IDA_PGM | 13 | Ancillary data - internal error detected already flag. | R/W | 0 |
| | | ANC_IDH_PGM | 12 | Ancillary data - internal error detected here flag. | R/W | 0 |
| | | ANC_EDA_PGM | 11 | Ancillary data - error detected already flag. | R/W | 0 |
| | | ANC_EDH_PGM | 10 | Ancillary data - error detected here flag. | R/W | 0 |
| | | FF_UES_PGM | 9 | EDH Full Field - unknown error status flag. | R/W | 0 |
| | | FF_IDA_PGM | 8 | EDH Full Field - internal error detected already flag. | R/W | 0 |
| | | FF_IDH_PGM | 7 | EDH Full Field - internal error detected here flag. | R/W | 0 |
| | | FF_EDA_PGM | 6 | EDH Full Field - error detected already flag. | R/W | 0 |
| | | FF_EDH_PGM | 5 | EDH Full Field - error detected here flag. | R/W | 0 |
| | | AP_UES_PGM | 4 | EDH Active Picture - unknown error status flag. | R/W | 0 |
| | | AP_IDA_PGM | 3 | EDH Active Picture - internal error detected already flag. | R/W | 0 |
| | | AP_IDH_PGM | 2 | EDH Active Picture - internal error detected here flag. | R/W | 0 |
| | | AP_EDA_PGM | 1 | EDH Active Picture - error detected already flag. | R/W | 0 |
| AP_EDH_PGM | 0 | EDH Active Picture - error detected here flag. | R/W | 0 | | |
| 004h | DATA_FORMAT | RSVD | 15-10 | Reserved. | R | 0 |
| | | VD_STD | 9-5 | Detected video standard. | R | 0 |
| | | INT/ <u>PROGB</u> | 4 | HIGH = interlaced signal LOW = progressive signal | R | 0 |
| | | CONV_372_LOCKED | 3 | Convert 372 lock indication. Active HIGH. | R | 0 |
| | | STD_LOCK | 2 | Standard lock indication. Active HIGH. | R | 0 |
| | | V_LOCK | 1 | Vertical lock indication. Active HIGH. | R | 0 |
| | | H_LOCK | 0 | Horizontal lock indication. Active HIGH. | R | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|------------------------------|------------------------|------|---|-----|---------|
| 005h | RSVD | RSVD | 15-0 | Reserved. | R | 0 |
| | | RSVD | 15-6 | Reserved. | R | 0 |
| 006h | VSD_FORCE | VSD_FORCE | 5 | Use the CSR register STD value rather than the flywheels STD value. Active HIGH. | R/W | 0 |
| | | VID_STD_FORCE | 4-0 | Force VID STD CSR. | R/W | 0 |
| 007h | EDH_STATUS | RSVD | 15-2 | Reserved. | R | 0 |
| | | FF_CRC_V | 1 | Full Field extracted V bit. | R | 0 |
| | | AP_CRC_V | 0 | Active Picture extracted V bit. | R | 0 |
| 008h | FIRST_AVAIL_POSITION | RSVD | 15-1 | Reserved. | R | 0 |
| | | FIRST_AVAIL_POSITION | 0 | HIGH - ST 352 insertion occurs on first available ANC space. LOW - insert ST 352 packets right after EAV/CRC1. | R/W | 1 |
| 009h | RESERVED | RESERVED_7 | 15-0 | Reserved. | R | 0 |
| 00Ah | VIDEO_FORMAT_3_52_OUT_WORD_1 | VIDEO_FORMAT_OUT_DS1_2 | 15-8 | SMPTE ST 352 DS1 embedded packet - byte 2. | R/W | 0 |
| | | VIDEO_FORMAT_OUT_DS1_1 | 7-0 | SMPTE ST 352 DS1 embedded packet - byte 1. | R/W | 0 |
| 00Bh | VIDEO_FORMAT_3_52_OUT_WORD_2 | VIDEO_FORMAT_OUT_DS1_4 | 15-8 | SMPTE ST 352 DS1 embedded packet - byte 4. | R/W | 0 |
| | | VIDEO_FORMAT_OUT_DS1_3 | 7-0 | SMPTE ST 352 DS1 embedded packet - byte 3. | R/W | 0 |
| 00Ch | VIDEO_FORMAT_3_52_OUT_WORD_3 | VIDEO_FORMAT_OUT_DS2_2 | 15-8 | SMPTE ST 352 DS2 embedded packet - byte 2. | R/W | 0 |
| | | VIDEO_FORMAT_OUT_DS2_1 | 7-0 | SMPTE ST 352 DS2 embedded packet - byte 1. | R/W | 0 |
| 00Dh | VIDEO_FORMAT_3_52_OUT_WORD_4 | VIDEO_FORMAT_OUT_DS2_4 | 15-8 | SMPTE ST 352 DS2 embedded packet - byte 4. | R/W | 0 |
| | | VIDEO_FORMAT_OUT_DS2_3 | 7-0 | SMPTE ST 352 DS2 embedded packet - byte 3. | R/W | 0 |
| 00Eh | VIDEO_FORMAT_3_52_IN_WORD_1 | VIDEO_FORMAT_IN_DS1_2 | 15-8 | SMPTE ST 352 DS1 extracted packet - byte 2. | R | 0 |
| | | VIDEO_FORMAT_IN_DS1_1 | 7-0 | SMPTE ST 352 DS1 extracted packet - byte 1. | R | 0 |
| 00Fh | VIDEO_FORMAT_3_52_IN_WORD_2 | VIDEO_FORMAT_IN_DS1_4 | 15-8 | SMPTE ST 352 DS1 extracted packet - byte 4. | R | 0 |
| | | VIDEO_FORMAT_IN_DS1_3 | 7-0 | SMPTE ST 352 DS1 extracted packet - byte 3. | R | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|-----------------|-----------------------------------|------------------------|-------|---|-----|---------|
| 010h | VIDEO_FORMAT_3 52_IN_WORD_3 | VIDEO_FORMAT_IN_DS2_2 | 15-8 | SMPTE ST 352 DS2 extracted packet - byte 2. | R | 0 |
| | | VIDEO_FORMAT_IN_DS2_1 | 7-0 | SMPTE ST 352 DS2 extracted packet - byte 1. | R | 0 |
| 011h | VIDEO_FORMAT_3 52_IN_WORD_4 | VIDEO_FORMAT_IN_DS2_4 | 15-8 | SMPTE ST 352 DS2 extracted packet - byte 4. | R | 0 |
| | | VIDEO_FORMAT_IN_DS2_3 | 7-0 | SMPTE ST 352 DS2 extracted packet - byte 3. | R | 0 |
| 012h | RASTER_STRUC_1 | RSVD | 15-11 | Reserved. | R | 0 |
| | | LINES_PER_FRAME | 10-0 | Total lines per frame. | R | 0 |
| 013h | RASTER_STRUC_2 | RSVD | 15-14 | Reserved. | R | 0 |
| | | WORDS_PER_LINE | 13-0 | Total words per line. | R | 0 |
| 014h | RASTER_STRUC_3 | RSVD | 15-13 | Reserved. | R | 0 |
| | | ACTIVE_WORDS_PER_LINE | 12-0 | Words per active line. | R | 0 |
| 015h | RASTER_STRUC_4 | RSVD | 15-11 | Reserved. | R | 0 |
| | | ACTIVE_LINES_PER_FIELD | 10-0 | Active lines per frame. | R | 0 |
| 016h to 023h | RSVD | RSVD | 15-0 | Reserved. | R | 0 |
| | | RSVD | 15-2 | Reserved. | R | 0 |
| 024h | FIRST_LINE _NUMBER_ _STATUS | PACKET_MISSED | 1 | ANC data packet could not be inserted in its entirety. HIGH - ANC packet cannot be inserted in it's entirety. | R | 0 |
| | | RW_CONFLICT | 0 | Same RAM address was read and written to at the same time. HIGH - one of the addresses from 040h to 13Fh was read and written to at the same time. | R | 0 |
| 025h | FIRST_LINE_ NUMBER | RSVD | 15-12 | Reserved. | R | 0 |
| | | ANC_INS_MODE | 11 | ANC data insertion mode. HIGH - Concatenate LOW - Separate | R/W | 0 |
| | | FIRST_LINE_NUMBER | 10-0 | First line number to insert ANC packet on. | R/W | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|-----------------------------|--------------------------------|-------|--|-----|---------|
| 026h | FIRST_LINE_NUMBER_OF_WORDS | FIRST_LINE_NUMBER_ANC_TYPE | 15 | ANC region to insert packet in HIGH - VANC, LOW - HANC. | R/W | 0 |
| | | FIRST_LINE_NUMBER_STREAM_TYPE | 14 | Stream to insert packet in HIGH - C stream, LOW - Y stream. | R/W | 0 |
| | | RSVD | 13-10 | Reserved. | R | 0 |
| | | FIRST_LINE_NUMBER_OF_WORDS | 9-0 | Total number of words in ANC packet to be inserted in first line. | R/W | 0 |
| 027h | SECOND_LINE_NUMBER | RSVD | 15-11 | Reserved. | R | 0 |
| | | SECOND_LINE_NUMBER | 10-0 | Second line number to insert ANC packet on in Separate Line mode. | R/W | 0 |
| 028h | SECOND_LINE_NUMBER_OF_WORDS | SECOND_LINE_NUMBER_ANC_TYPE | 15 | ANC region to insert packet in. HIGH - VANC, LOW - HANC. | R/W | 0 |
| | | SECOND_LINE_NUMBER_STREAM_TYPE | 14 | Stream to insert packet in. HIGH - C stream, LOW - Y stream. | R/W | 0 |
| | | RSVD | 13-10 | Reserved. | R | 0 |
| | | SECOND_LINE_NUMBER_OF_WORDS | 9-0 | Total number of words in ANC packet to be inserted in second line. | R/W | 0 |
| 029h | THIRD_LINE_NUMBER | RSVD | 15-11 | Reserved. | R | 0 |
| | | THIRD_LINE_NUMBER | 10-0 | Third line number to insert ANC packet on in Separate Line mode. | R/W | 0 |
| 02Ah | THIRD_LINE_NUMBER_OF_WORDS | THIRD_LINE_NUMBER_ANC_TYPE | 15 | ANC region to insert packet in. HIGH - VANC, LOW - HANC. | R/W | 0 |
| | | THIRD_LINE_NUMBER_STREAM_TYPE | 14 | Stream to insert packet in. HIGH - C stream, LOW - Y stream. | R/W | 0 |
| | | RSVD | 13-10 | Reserved. | R | 0 |
| | | THIRD_LINE_NUMBER_OF_WORDS | 9-0 | Total number of words in ANC packet to be inserted in third line. | R/W | 0 |
| 02Bh | FOURTH_LINE_NUMBER | RSVD | 15-11 | Reserved. | R | 0 |
| | | FOURTH_LINE_NUMBER | 10-0 | Fourth line number to insert ANC packet on in Separate Line mode. | R/W | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|-----------------------------|--------------------------------|-------|---|-----|---------|
| 02Ch | FOURTH_LINE_NUMBER_OF_WORDS | FOURTH_LINE_NUMBER_ANC_TYPE | 15 | ANC region to insert packet in HIGH - VANC, LOW - HANC. | R/W | 0 |
| | | FOURTH_LINE_NUMBER_STREAM_TYPE | 14 | Stream to insert packet in. HIGH - C stream, LOW - Y stream. | R/W | 0 |
| | | RSVD | 13-10 | Reserved. | R | 0 |
| | | FOURTH_LINE_NUMBER_OF_WORDS | 9-0 | Total number of words in ANC packet to be inserted in fourth line. | R/W | 0 |
| 02Dh | STREAM_TYPE_1 | RSVD | 15-5 | Reserved. | R | 0 |
| | | EDH_LINE_CHECK_EN | 4 | HIGH - ANC block will not insert data into the EDH region of the HANC space. LOW - ANC block will insert data into the EDH region. | R/W | 1 |
| | | STREAM_TYPE1_LINE_4 | 3 | HIGH - data for the fourth line in separate mode is inserted into Data Stream Two. LOW - Data Stream One. Parameter only applicable for 3G. | R/W | 0 |
| | | STREAM_TYPE1_LINE_3 | 2 | HIGH - data for the third line in separate mode is inserted into Data Stream Two. LOW - Data Stream One. Parameter only applicable for 3G. | R/W | 0 |
| | | STREAM_TYPE1_LINE_2 | 1 | HIGH - data for the second line in separate mode is inserted into Data Stream Two. LOW - Data Stream One. Parameter only applicable for 3G. | R/W | 0 |
| 02Eh to 03Fh | RSVD | RSVD | 15-0 | Reserved. | R | 0 |
| | | RSVD | 15-0 | Reserved. | R | 0 |
| 040h to 07Fh | ANC_PACKET_BANK_1 | ANC_PACKET_BANK | 15-0 | First bank of user-defined 8-bit ancillary data. Bit 15 - 8: 2nd byte (MSB to LSB) Bit 7 - 0: 1st byte (MSB to LSB) See 4.8 ANC Data Insertion. | – | – |
| 080h to 0BFh | ANC_PACKET_BANK_2 | ANC_PACKET_BANK | 15-0 | Second bank of user-defined 8-bit ancillary data. Bit 15 - 8: 2nd byte (MSB to LSB) Bit 7 - 0: 1st byte (MSB to LSB) See 4.8 ANC Data Insertion. | – | – |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|-------------------|-----------------|------|---|-----|---------|
| 0C0h to 0FFh | ANC_PACKET_BANK_3 | ANC_PACKET_BANK | 15-0 | Third bank of user-defined 8-bit ancillary data. Bit 15 - 8: 2nd byte (MSB to LSB) Bit 7 - 0: 1st byte (MSB to LSB) See 4.8 ANC Data Insertion. | – | – |
| 100h to 13Fh | ANC_PACKET_BANK_4 | ANC_PACKET_BANK | 15-0 | Fourth bank of user-defined 8-bit ancillary data. Bit 15 - 8: 2nd byte (MSB to LSB) Bit 7 - 0: 1st byte (MSB to LSB) See 4.8 ANC Data Insertion. | – | – |
| 140h to 209h | RSVD | RSVD | – | Reserved. | R | 0 |
| | | RSVD | 15-8 | Reserved. | R | 0 |
| 20Ah | SDTI_TDM | SDTI_TDM_DS2 | 7 | HIGH indicates an SDTI type signal on input for Data Stream Two. | R/W | 0 |
| | | SDTI_TDM_DS1 | 6 | HIGH indicates an SDTI type signal on input for Data Stream One. | R/W | 0 |
| | | RSVD | 5-0 | Reserved. | R | 0 |
| 20Bh to 20Ch | RSVD | RSVD | – | Reserved. | R | 0 |
| | | RSVD | 15-9 | Reserved. | R | 0 |
| 20Dh | LEVELB_INDICATION | LEVEL_B | 8 | HIGH indicates level B detected. Only relevant for 3G input streams. | R | 0 |
| | | RSVD | 7-0 | Reserved. | R | 0 |
| | | RSVD | 15-6 | Reserved. | R/W | 0 |
| | | AUDIO_INT_DS | 5-4 | Drive strength value for AUDIO_INT pin. 00: 4mA; 01: 6mA; 10: 8mA(+1.8V), 10mA(+3.3V); 11: 10mA(+1.8V), 12mA(+3.3V) | R/W | 0 |
| 20Eh | DRIVE_STRENGTH | LOCKED_DS | 3-2 | Drive strength value for LOCKED pin. 00: 4mA; 01: 6mA; 10: 8mA(+1.8V), 10mA(+3.3V); 11: 10mA(+1.8V), 12mA(+3.3V) | R/W | 0 |
| | | SDOUT_TDO_DS | 1-0 | Drive strength value for SDOUT_TDO pin. 00: 4mA; 01: 6mA; 10: 8mA(+1.8V), 10mA(+3.3V); 11: 10mA(+1.8V), 12mA(+3.3V) | R/W | 2 |
| 20Fh | RSVD | RSVD | 15-0 | Reserved. | R/W | 0 |

Table 4-34: Video Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|-----------------|----------|-------|---|-----|---------|
| 210h | DRIVE_STRENGTH2 | TDO_DS | 15-14 | Drive strength value for TDO pin. 00: 4mA; 01: 6mA; 10: 8mA(+1.8V), 10mA(+3.3V); 11: 10mA(+1.8V), 12mA(+3.3V) | R/W | 0 |
| | | RSVD | 13-0 | Reserved. | R/W | 0 |
| 211h to 232h | RSVD | RSVD | 15-0 | Reserved. | R | 0 |

4.14.2 SD Audio Core

Table 4-35: SD Audio Core Configuration and Status Registers

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------|-------------|-----|--|-----|---------|
| 400h | CFG_AUD | CTR_AGR | 15 | Selects replacement of audio control packets. LOW - Do not replace audio control packets HIGH - Replace all audio control packets | R/W | 0 |
| | | AGR | 14 | Selects Audio Group Replacement operating mode. Active HIGH. | R/W | 0 |
| | | ONE_AGR | 13 | Specifies the replacement of just the primary group. LOW - Replace both the primary and secondary groups HIGH - Replace only the primary group | R/W | 0 |
| | | CTRB_ON | 12 | Specifies the embedding of the secondary group audio control packets. Active HIGH. | R/W | 1 |
| | | CLEAR_AUDIO | 11 | Clears all audio FIFO buffers and puts them in the start-up state. Active HIGH. | R/W | 0 |
| | | AFNB_AUTO | 10 | Enables Secondary group audio frame number generation. Active HIGH. | R/W | 1 |
| | | CTRA_ON | 9 | Specifies the embedding of primary group audio control packets. Active HIGH. | R/W | 1 |
| | | AUDIO_24BIT | 8 | Specifies the sample size for embedded audio. HIGH - 24-bit LOW - 20-bit/16-bit | R/W | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|--------------------|----------------|------|---|-----|---------|
| 400h | CFG_AUD | AFNA_AUTO | 7 | Enables Primary group audio frame number generation. Active HIGH. | R/W | 1 |
| | | AFN_OFS | 6-4 | Offset to add to generated Audio Frame Number. Must be in the range of 0 to 4. | R/W | 0 |
| | | IDB | 3-2 | Specifies the secondary audio group to embed. Note: Should IDA and IDB be set to the same value, they automatically revert to their default values. | R/W | 1 |
| | | IDA | 1-0 | Specifies the primary audio group to embed. Note: Should IDA and IDB be set to the same value, they automatically revert to their default values. | R/W | 0 |
| 401h | FIFO_BUF_SIDE | RSVD | 15-3 | Reserved. | R | 0 |
| | | OFFSET_DISABLE | 2 | Set to disable staggering of secondary group audio sample distribution by one line. Active HIGH. | R/W | 0 |
| | | OS_SEL | 1-0 | Specifies the audio FIFO buffer size. 00-52 samples deep, 26 sample start-up count 01-24 samples deep, 12 sample start-up count 10-12 samples deep, 6 sample start-up count 11-Reserved | R/W | 0 |
| 402h | AES_EBU_ERR_STATUS | RSVD | 15-4 | Reserved. | R | 0 |
| | | AES_ERRD | 3 | Stereo Pair D (7&8) audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | AES_ERRC | 2 | Stereo Pair C (5&6) audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | AES_ERRB | 1 | Stereo Pair B (3&4) audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | AES_ERRA | 0 | Stereo Pair A (1&2) audio input parity error when using AES format. Automatically cleared when read. | R | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|--------------------|-----------------|-------|--|-----|---------|
| 403h | CHANNEL_STAT_REGEN | RSVD | 15-1 | Reserved. | R | 0 |
| | | ACS_REGEN | 0 | Specifies that Audio Channel Status of all channels should be replaced with ACSR[183:0] field. LOW: Do not replace Channel Status HIGH: Replace Channel Status of all channels | R/W | 0 |
| 404h | PACKET_DET_STATUS | RSVD | 15-14 | Reserved. | R | 0 |
| | | AXPG4_DET | 13 | Set while Group 4 audio extended packets are detected. | R | 0 |
| | | AXPG3_DET | 12 | Set while Group 3 audio extended packets are detected. | R | 0 |
| | | AXPG2_DET | 11 | Set while Group 2 audio extended packets are detected. | R | 0 |
| | | AXPG1_DET | 10 | Set while Group 1 audio extended packets are detected. | R | 0 |
| | | ACPG4_DET | 9 | Set while Group 4 audio control packets are detected. | R | 0 |
| | | ACPG3_DET | 8 | Set while Group 3 audio control packets are detected. | R | 0 |
| | | ACPG2_DET | 7 | Set while Group 2 audio control packets are detected. | R | 0 |
| | | ACPG1_DET | 6 | Set while Group 1 audio control packets are detected. | R | 0 |
| | | ADPG4_DET | 5 | Set while Group 4 audio data packets are detected. | R | 0 |
| | | ADPG3_DET | 4 | Set while Group 3 audio data packets are detected. | R | 0 |
| | | ADPG2_DET | 3 | Set while Group 2 audio data packets are detected. | R | 0 |
| | | ADPG1_DET | 2 | Set while Group 1 audio data packets are detected. | R | 0 |
| | | ACS_APPLY_WAITB | 1 | Set while the GS2972 is waiting for a status boundary in the Secondary group before applying the ACSR[183:0] data to that group. | R | 0 |
| | | ACS_APPLY_WAITA | 0 | ACS_APPLY_WAITA: Set while the GS2972 is waiting for a status boundary in Primary group before applying the ACSR[183:0] data. | R | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|---------------------|---|-------|---|-----|---------|
| 405h | AES_EBU_ERR_STATUS1 | RSVD | 15-6 | Reserved. | R | 0 |
| | | FINAL_HELD_ASD_ERR | 5 | Final audio sample distribution error. | R | 0 |
| | | HELD_ASD_ERR | 4 | Audio sample distribution error. | R | 0 |
| | | HELD_AES_ERR | 3-0 | AES received errors for the 4 audio lines. | R | 0 |
| 406h | CASCADE | RSVD | 15-1 | Reserved. | R | 0 |
| | | EN_CASCADE | 0 | If HIGH, puts the GS2972 into cascade mode. This bit is only effective if the AGR bit = LOW. | R/W | 0 |
| 407h to 40Ah | RSVD | RSVD | 15-0 | Reserved. | R | 0 |
| 40Bh | SERIAL_AUDIO_FORMAT | AMD | 15-14 | Audio input format selector for Stereo Pair D input channels 7 and 8. 00: AES/EBU 01: Serial Left Justified 10: Serial Right Justified 11: I ² S | R/W | 3 |
| | | AMC | 13-12 | Audio input format selector for Stereo Pair C input channels 5 and 6. (See above for decoding). | R/W | 3 |
| | | AMB | 11-10 | Audio input format selector for Stereo Pair B input channels 3 and 4. (See above for decoding). | R/W | 3 |
| | | AMA | 9-8 | Audio input format selector for Stereo Pair A input channels 1 and 2. (See above for decoding). | R/W | 3 |
| | | MUTE8 | 7 | Audio input channel 8 mute enable. Active HIGH. | R/W | 0 |
| | | MUTE7 | 6 | Audio input channel 7 mute enable. Active HIGH. | R/W | 0 |
| | | MUTE6 | 5 | Audio input channel 6 mute enable. Active HIGH. | R/W | 0 |
| | | MUTE5 | 4 | Audio input channel 5 mute enable. Active HIGH. | R/W | 0 |
| | | MUTE4 | 3 | Audio input channel 4 mute enable. Active HIGH. | R/W | 0 |
| | | MUTE3 | 2 | Audio input channel 3 mute enable. Active HIGH. | R/W | 0 |
| | | MUTE2 | 1 | Audio input channel 2 mute enable. Active HIGH. | R/W | 0 |
| MUTE1 | 0 | Audio input channel 1 mute enable. Active HIGH. | R/W | 0 | | |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------------|--------------|-------|---|-----|---------|
| 40Ch | CHANNEL_XP_ GRPA | RSVD | 15 | Reserved. | R | 0 |
| | | GPA_WCLK_SRC | 14-12 | Primary Audio group word clock source selector. Input channel 1 000 Input channel 2 001 Input channel 3 010 Input channel 4 011 Input channel 5 100 Input channel 6 101 Input channel 7 110 Input channel 8 111 | R/W | 0 |
| | | GPA_CH4_SRC | 11-9 | Primary Audio group channel 4 source selector. 011. | R/W | 3 |
| | | GPA_CH3_SRC | 8-6 | Primary Audio group channel 3 source selector. 010. | R/W | 2 |
| | | GPA_CH2_SRC | 5-3 | Primary Audio group channel 2 source selector. 001. | R/W | 1 |
| | | GPA_CH1_SRC | 2-0 | Primary Audio group channel 1 source selector. 000 - Input channel | R/W | 0 |
| 40Dh | CHANNEL_XP_ GRPB | RSVD | 15 | Reserved. | R | 0 |
| | | GPB_WCLK_SRC | 14-12 | Secondary Audio group word clock source selector. | R/W | 4 |
| | | GPB_CH4_SRC | 11-9 | Secondary Audio group channel 4 source selector. | R/W | 7 |
| | | GPB_CH3_SRC | 8-6 | Secondary Audio group channel 3 source selector. | R/W | 6 |
| | | GPB_CH2_SRC | 5-3 | Secondary Audio group channel 2 source selector. | R/W | 5 |
| | | GPB_CH1_SRC | 2-0 | Secondary Audio group channel 1 source selector. | R/W | 4 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|----------------|--------------|-----|---|-----|---------|
| 40Eh | INTERRUPT_MASK | EN_ASD_ERR | 15 | Asserts ASD error flag. | R/W | 0 |
| | | EN_NO_VIDEO | 14 | Mask bit when the video format is unknown. | R/W | 0 |
| | | EN_MUX_ERRB | 13 | Asserts AUDIO_INT when the MUX_ERRB flag is set. | R/W | 0 |
| | | EN_MUX_ERRA | 12 | Asserts AUDIO_INT when the MUX_ERRA flag is set. | R/W | 0 |
| | | EN_AES_ERRD | 11 | Asserts AUDIO_INT when the AES_ERRD flag is set. | R/W | 0 |
| | | EN_AES_ERRC | 10 | Asserts AUDIO_INT when the AES_ERRC flag is set. | R/W | 0 |
| | | EN_AES_ERRB | 9 | Asserts AUDIO_INT when the AES_ERRB flag is set. | R/W | 0 |
| | | EN_AES_ERRA | 8 | Asserts AUDIO_INT when the AES_ERRA flag is set. | R/W | 0 |
| | | EN_ACPG4_DET | 7 | Asserts AUDIO_INT when the ACPG4_DET flag is set. | R/W | 0 |
| | | EN_ACPG3_DET | 6 | Asserts AUDIO_INT when the ACPG3_DET flag is set. | R/W | 0 |
| | | EN_ACPG2_DET | 5 | Asserts AUDIO_INT when the ACPG2_DET flag is set. | R/W | 0 |
| | | EN_ACPG1_DET | 4 | Asserts AUDIO_INT when the ACPG1_DET flag is set. | R/W | 0 |
| | | EN_ADPG4_DET | 3 | Asserts AUDIO_INT when the ADPG4_DET flag is set. | R/W | 0 |
| | | EN_ADPG3_DET | 2 | Asserts AUDIO_INT when the ADPG3_DET flag is set. | R/W | 0 |
| | | EN_ADPG2_DET | 1 | Asserts AUDIO_INT when the ADPG2_DET flag is set. | R/W | 0 |
| | | EN_ADPG1_DET | 0 | Asserts AUDIO_INT when the ADPG1_DET flag is set. | R/W | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|----------------|------------|-------|--|-----|---------|
| | | RSVD | 15-13 | Reserved. | R | 0 |
| | | MUTE_ALL | 12 | Mutes all input audio channels. | R/W | 0 |
| | | LSB_FIRSTD | 11 | Causes the fourth stereo pair serial input formats to use LSB first. Used in conjunction with AMD, and only relevant when AMD is 01 or 10 Figure 4-16 to 4-19. | R/W | 0 |
| | | LSB_FIRSTC | 10 | Causes the third stereo pair serial input formats to use LSB first. Used in conjunction with AMC and only relevant when AMC is 01 or 10 Figure 4-16 to 4-19. | R/W | 0 |
| | | LSB_FIRSTB | 9 | Causes the second stereo pair serial input formats to use LSB first. Used in conjunction with AMB and only relevant when AMD is 01 or 10 Figure 4-16 to 4-19. | R/W | 0 |
| | | LSB_FIRSTA | 8 | Causes the first stereo pair serial input formats to use LSB first. Used in conjunction with AMA and only relevant when AMA is 01 or 10 Figure 4-16 to 4-19. | R/W | 0 |
| 40Fh | ACTIVE_CHANNEL | ACT8 | 7 | Specifies embedding of secondary audio group channel 8. Active HIGH. | R/W | 1 |
| | | ACT7 | 6 | Specifies embedding of secondary audio group channel 7. Active HIGH. | R/W | 1 |
| | | ACT6 | 5 | Specifies embedding of secondary audio group channel 6. Active HIGH. | R/W | 1 |
| | | ACT5 | 4 | Specifies embedding of secondary audio group channel 5. Active HIGH. | R/W | 1 |
| | | ACT4 | 3 | Specifies embedding of primary audio group channel 4. Active HIGH. | R/W | 1 |
| | | ACT3 | 2 | Specifies embedding of primary audio group channel 3. Active HIGH. | R/W | 1 |
| | | ACT2 | 1 | Specifies embedding of primary audio group channel 2. Active HIGH. | R/W | 1 |
| | | ACT1 | 0 | Specifies embedding of primary audio group channel 1. Active HIGH. | R/W | 1 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|----------------------|--------------|------|--|-----|---------|
| | | RSVD | 15-3 | Reserved. | R | 0 |
| 410h | XPOINT_ERROR | MUX_ERRB | 2 | Set in Cascade mode when the incoming video contains packets with the same group number as the Secondary Group. | R | 0 |
| | | MUX_ERRA | 1 | Set in Cascade mode when the incoming video contains packets with the same group number as the Primary Group. | R | 0 |
| | | XPOINT_ERROR | 0 | Set when the crosspoint switch is configured to put the same audio channel in both Primary and Secondary Groups. | R | 0 |
| 411h to 41Fh | RSVD | RSVD | – | Reserved. | R | 0 |
| 420h | CHANNEL_STATUS_REG_1 | RSVD | 15-8 | Reserved. | R | 0 |
| | | ACSR_BYTE_1 | 7-0 | Audio channel status block byte 1. | R/W | 133 |
| 421h | CHANNEL_STATUS_REG_2 | RSVD | 15-8 | Reserved. | R | 0 |
| | | ACSR_BYTE_2 | 7-0 | Audio channel status block byte 2. | R/W | 8 |
| 422h | CHANNEL_STATUS_REG_3 | ACSR_BYTE_4 | 15-8 | Audio channel status block byte 4. | R/W | 0 |
| | | ACSR_BYTE_3 | 7-0 | Audio channel status block byte 3. | R/W | 44 |
| 423h | CHANNEL_STATUS_REG_4 | ACSR_BYTE_6 | 15-8 | Audio channel status block byte 6. | R/W | 0 |
| | | ACSR_BYTE_5 | 7-0 | Audio channel status block byte 5. | R/W | 0 |
| 424h | CHANNEL_STATUS_REG_5 | ACSR_BYTE_8 | 15-8 | Audio channel status block byte 8. | R/W | 0 |
| | | ACSR_BYTE_7 | 7-0 | Audio channel status block byte 7. | R/W | 0 |
| 425h | CHANNEL_STATUS_REG_6 | ACSR_BYTE_10 | 15-8 | Audio channel status block byte 10. | R/W | 0 |
| | | ACSR_BYTE_9 | 7-0 | Audio channel status block byte 9. | R/W | 0 |
| 426h | CHANNEL_STATUS_REG_7 | ACSR_BYTE_12 | 15-8 | Audio channel status block byte 12. | R/W | 0 |
| | | ACSR_BYTE_11 | 7-0 | Audio channel status block byte 11. | R/W | 0 |
| 427h | CHANNEL_STATUS_REG_8 | ACSR_BYTE_14 | 15-8 | Audio channel status block byte 14. | R/W | 0 |
| | | ACSR_BYTE_13 | 7-0 | Audio channel status block byte 13. | R/W | 0 |
| 428h | CHANNEL_STATUS_REG_9 | ACSR_BYTE_16 | 15-8 | Audio channel status block byte 16. | R/W | 0 |
| | | ACSR_BYTE_15 | 7-0 | Audio channel status block byte 15. | R/W | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|-----------------------|--------------|------|---|-----|---------|
| 429h | CHANNEL_STATUS_REG_10 | ACSR_BYTE_18 | 15-8 | Audio channel status block byte 18. | R/W | 0 |
| | | ACSR_BYTE_17 | 7-0 | Audio channel status block byte 17. | R/W | 0 |
| 42Ah | CHANNEL_STATUS_REG_11 | ACSR_BYTE_20 | 15-8 | Audio channel status block byte 20. | R/W | 0 |
| | | ACSR_BYTE_19 | 7-0 | Audio channel status block byte 19. | R/W | 0 |
| 42Bh | CHANNEL_STATUS_REG_12 | ACSR_BYTE_22 | 15-8 | Audio channel status block byte 22. | R/W | 0 |
| | | ACSR_BYTE_21 | 7-0 | Audio channel status block byte 21. | R/W | 0 |
| 42Ch | CHANNEL_STATUS_REG_13 | RSVD | 15-8 | Reserved. | R/W | 0 |
| | | ACSR_BYTE_23 | 7-0 | Audio channel status block byte 23. | R/W | 0 |
| 42Dh to 43Fh | RSVD | RSVD | – | Reserved. | R | 0 |
| | | RSVD | 15-9 | Reserved. | R | 0 |
| 440h | AUDIO_CTRL_GRP_REG_1 | DEL1A_BYTE_1 | 8-1 | Primary Audio group delay data for channel 1 byte 1. | R/W | 0 |
| | | EBIT1A | 0 | Primary Audio group delay data for channel 1. HIGH - indicates delay specified at DEL1A_BYTE_1 is valid. See SMPTE ST 272 for additional information. | R/W | 0 |
| 441h | AUDIO_CTRL_GRP_REG_2 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1A_BYTE_2 | 8-0 | Primary Audio group delay data for channel 1 byte 2. | R/W | 0 |
| 442h | AUDIO_CTRL_GRP_REG_3 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1A_BYTE_3 | 8-0 | Primary Audio group delay data for channel 1 byte 3. | R/W | 0 |
| 443h | AUDIO_CTRL_GRP_REG_4 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL2A_BYTE_1 | 8-1 | Primary Audio group delay data for channel 2 byte 1. | R/W | 0 |
| 444h | AUDIO_CTRL_GRP_REG_5 | EBIT2A | 0 | Primary Audio group delay data valid flag for channel 2. | R/W | 0 |
| | | RSVD | 15-9 | Reserved. | R | 0 |
| 445h | AUDIO_CTRL_GRP_REG_6 | DEL2A_BYTE_2 | 8-0 | Primary Audio group delay data for channel 2 byte 2. | R/W | 0 |
| | | RSVD | 15-9 | Reserved. | R | 0 |
| 445h | AUDIO_CTRL_GRP_REG_6 | DEL2A_BYTE_3 | 8-0 | Primary Audio group delay data for channel 2 byte 3. | R/W | 0 |
| | | RSVD | 15-9 | Reserved. | R | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|----------------------------|--------------|------|--|-----|---------|
| 446h | AUDIO_CTRL_ GRPA_REG_7 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3A_BYTE_1 | 8-1 | Primary Audio group delay data for channel 3 byte 1. | R/W | 0 |
| | | EBIT3A | 0 | Primary Audio group delay data valid flag for channel 3. | R/W | 0 |
| 447h | AUDIO_CTRL_ GRPA_REG_8 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3A_BYTE_2 | 8-0 | Primary Audio group delay data for channel 3 byte 2. | R/W | 0 |
| 448h | AUDIO_CTRL_ GRPA_REG_9 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3A_BYTE_3 | 8-0 | Primary Audio group delay data for channel 3 byte 3. | R/W | 0 |
| 449h | AUDIO_CTRL_ GRPA_REG_10 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL4A_BYTE_1 | 8-1 | Primary Audio group delay data for channel 4 byte 1. | R/W | 0 |
| | | EBIT4A | 0 | Primary Audio group delay data valid flag for channel 4. | R/W | 0 |
| 44Ah | AUDIO_CTRL_ GRPA_REG_11 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL4A_BYTE_2 | 8-0 | Primary Audio group delay data for channel 4 byte 2. | R/W | 0 |
| 44Bh | AUDIO_CTRL_ GRPA_REG_12 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL4A_BYTE_3 | 8-0 | Primary Audio group delay data for channel 4 byte 3. | R/W | 0 |
| 44Ch | AUDIO_CTRL_ GRPB_REG_1 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1B_BYTE_1 | 8-1 | Secondary Audio group delay data for channel 1 byte 1. | R/W | 0 |
| | | EBIT1B | 0 | Secondary Audio group delay data valid flag for channel 1. | R/W | 0 |
| 44Dh | AUDIO_CTRL_ GRPB_REG_2 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1B_BYTE_2 | 8-0 | Secondary Audio group delay data for channel 1 byte 2. | R/W | 0 |
| 44Eh | AUDIO_CTRL_ GRPB_REG_3 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1B_BYTE_3 | 8-0 | Secondary Audio group delay data for channel 1 byte 3. | R/W | 0 |
| 44Fh | AUDIO_CTRL_ GRPB_REG_4 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL2B_BYTE_1 | 8-1 | Secondary Audio group delay data for channel 2 byte 1. | R/W | 0 |
| | | EBIT2B | 0 | Secondary Audio group delay data valid flag for channel 2. | R/W | 0 |

Table 4-35: SD Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|------------------------|--------------|------|--|-----|---------|
| 450h | AUDIO_CTRL_GRPB_REG_5 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL2B_BYTE_2 | 8-0 | Secondary Audio group delay data for channel 2 byte 2. | R/W | 0 |
| 451h | AUDIO_CTRL_GRPB_REG_6 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL2B_BYTE_3 | 8-0 | Secondary Audio group delay data for channel 2 byte 3. | R/W | 0 |
| 452h | AUDIO_CTRL_GRPB_REG_7 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3B_BYTE_1 | 8-1 | Secondary Audio group delay data for channel 3 byte 1. | R/W | 0 |
| | | EBIT3B | 0 | Secondary Audio group delay data valid flag for channel 3. | R/W | 0 |
| 453h | AUDIO_CTRL_GRPB_REG_8 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3B_BYTE_2 | 8-0 | Secondary Audio group delay data for channel 3 byte 2. | R/W | 0 |
| 454h | AUDIO_CTRL_GRPB_REG_9 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3B_BYTE_3 | 8-0 | Secondary Audio group delay data for channel 3 byte 3. | R/W | 0 |
| 455h | AUDIO_CTRL_GRPB_REG_10 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL4B_BYTE_1 | 8-1 | Secondary Audio group delay data for channel 4 byte 1. | R/W | 0 |
| | | EBIT4B | 0 | Secondary Audio group delay data valid flag for channel 4. | R/W | 0 |
| 456h | AUDIO_CTRL_GRPB_REG_11 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL4B_BYTE_2 | 8-0 | Secondary Audio group delay data for channel 4 byte 2. | R/W | 0 |
| 457h | AUDIO_CTRL_GRPB_REG_12 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL4B_BYTE_3 | 8-0 | Secondary Audio group delay data for channel 4 byte 3. | R/W | 0 |

4.14.3 HD and 3G Audio Core Registers

Table 4-36: HD and 3G Audio Core Configuration and Status Registers

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------|-----------|------|--|------|-----------|
| 800h | CFG_AUD | CTR_AGR | 15 | Selects replacement of audio control packets. | R/W | 0 |
| | | | | LOW - Do not replace audio control packets HIGH - Replace all audio control packets | | |
| | | AGR | 14 | Selects Audio Group Replacement operating mode. Active HIGH. | R/W | 0 |
| | | ONE_AGR | 13 | Specifies the replacement of just the primary group. LOW - Replace both the primary and secondary groups. HIGH - Replace only the primary group. | R/W | 0 |
| | | CTRB_ON | 12 | Specifies the embedding of the secondary group audio control packets. Active HIGH. | R/W | 1 |
| | | ASXB | 11 | Secondary Group asynchronous mode. Active HIGH. | R/W | 0 |
| | | AFNB_AUTO | 10 | Enables Secondary group audio frame number generation. Active HIGH. | R/W | 1 |
| | | CTRA_ON | 9 | Specifies the embedding of primary group audio control packets. Active HIGH. | R/W | 1 |
| | | ASXA | 8 | Primary Group asynchronous mode. | R/W | 0 |
| | | AFNA_AUTO | 7 | Enables Primary group audio frame number generation. | R/W | 1 |
| | | ANF_OFS | 6-4 | Offset to add to generated Audio Frame Number. Must be in the range of 0 to 4. | R/W | 0 |
| | | 801h | RSVD | RSVD | 15-0 | Reserved. |
| | | | | | | |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------------|-----------------|-------|--|-----|---------|
| 802h | CHANNEL_STAT_REGREN | RSVD | 15-1 | Reserved. | R | 0 |
| | | ACS_REGEN | 0 | Specifies that Audio Channel Status of all channels should be replaced with ACSR[183:0] field. LOW: Do not replace Channel Status HIGH: Replace Channel Status of all channels | R/W | 0 |
| 803h | PACKET_DET_STATUS | RSVD | 15-14 | Reserved. | R | 0 |
| | | AES_ERRD | 13 | Stereo Pair D audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | AES_ERRC | 12 | Stereo Pair C audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | AES_ERRB | 11 | Stereo Pair B audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | AES_ERRA | 10 | Stereo Pair A audio input parity error when using AES format. Automatically cleared when read. | R | 0 |
| | | ACPG4_DET | 9 | Set while Group 4 audio control packets are detected. | R | 0 |
| | | ACPG3_DET | 8 | Set while Group 3 audio control packets are detected. | R | 0 |
| | | ACPG2_DET | 7 | Set while Group 2 audio control packets are detected. | R | 0 |
| | | ACPG1_DET | 6 | Set while Group 1 audio control packets are detected. | R | 0 |
| | | ADPG4_DET | 5 | Set while Group 4 audio data packets are detected. | R | 0 |
| | | ADPG3_DET | 4 | Set while Group 3 audio data packets are detected. | R | 0 |
| 803h | PACKET_DET_STATUS | ADPG2_DET | 3 | Set while Group 2 audio data packets are detected. | R | 0 |
| | | ADPG1_DET | 2 | Set while Group 1 audio data packets are detected. | R | 0 |
| 803h | PACKET_DET_STATUS | ACS_APPLY_WAITB | 1 | Set while the GS2972 is waiting for a status boundary in the Secondary group before applying the ACSR[183:0] data to that group. | R | 0 |
| | | ACS_APPLY_WAITA | 0 | ACS_APPLY_WAITA: Set while the multiplexer is waiting for a status boundary in Primary group before applying the ACSR[183:0] data. | R | 0 |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|---------------------|--------------|-------|---|-----|---------|
| 804h | AES_EBU_ERR_STATUS | RSVD | 15-4 | Reserved. | R | 0 |
| | | HELD_AES_ERR | 3-0 | AES received errors for the 4 audio lines. | R | 0 |
| 805h | CASCADE | RSVD | 15-1 | Reserved. | R | 0 |
| | | EN_CASCADE | 0 | If HIGH, puts the GS2972 into cascade mode. This bit is only effective if the AGR bit is LOW. | R/W | 0 |
| 806h to 809h | RSVD | RSVD | 15-0 | Reserved. | R | 0 |
| 80Ah | SERIAL_AUDIO_FORMAT | AMD | 15-14 | Audio input format selector for Stereo Pair D input channels 7 and 8. 00: AES/EBU 01: Serial Left Justified 10: Serial Right Justified 11: I ² S | R/W | 3 |
| | | AMC | 13-12 | Audio input format selector for Stereo Pair C input channels 5 and 6. (See above for decoding). | R/W | 3 |
| | | AMB | 11-10 | Audio input format selector for Stereo Pair B input channels 3 and 4. (See above for decoding). | R/W | 3 |
| | | AMA | 9-8 | Audio input format selector for Stereo Pair A input channels 1 and 2. (See above for decoding). | R/W | 3 |
| | | MUTE8 | 7 | Audio input channel 8 mute enable. | R/W | 0 |
| | | MUTE7 | 6 | Audio input channel 7 mute enable. | R/W | 0 |
| | | MUTE6 | 5 | Audio input channel 6 mute enable. | R/W | 0 |
| | | MUTE5 | 4 | Audio input channel 5 mute enable. | R/W | 0 |
| | | MUTE4 | 3 | Audio input channel 4 mute enable. | R/W | 0 |
| | | MUTE3 | 2 | Audio input channel 3 mute enable. | R/W | 0 |
| | | MUTE2 | 1 | Audio input channel 2 mute enable. | R/W | 0 |
| 80Ah | | MUTE1 | 0 | Audio input channel 1 mute enable. | R/W | 0 |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|---------------------|--------------|-------|---|-----|---------|
| 80Bh | CHANNEL_XP_ GRPA | RSVD | 15 | Reserved. | R | 0 |
| | | GPA_WCLK_SRC | 14-12 | Primary Audio group word clock source selector. | R/W | 0 |
| | | GPA_CH4_SRC | 11-9 | Primary Audio group channel 4 source selector. | R/W | 3 |
| | | GPA_CH3_SRC | 8-6 | Primary Audio group channel 3 source selector. | R/W | 2 |
| | | GPA_CH2_SRC | 5-3 | Primary Audio group channel 2 source selector. | R/W | 1 |
| | | GPA_CH1_SRC | 2-0 | Primary Audio group channel 1 source selector. | R/W | 0 |
| 80Ch | CHANNEL_XP_ GRPB | RSVD | 15 | Reserved. | R | 0 |
| | | GPB_WCLK_SRC | 14-12 | Secondary Audio group word clock source selector. | R/W | 4 |
| | | GPB_CH4_SRC | 11-9 | Secondary Audio group channel 4 source selector. | R/W | 7 |
| | | GPB_CH3_SRC | 8-6 | Secondary Audio group channel 3 source selector. | R/W | 6 |
| | | GPB_CH2_SRC | 5-3 | Secondary Audio group channel 2 source selector. | R/W | 5 |
| | | GPB_CH1_SRC | 2-0 | Secondary Audio group channel 1 source selector. | R/W | 4 |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|----------------|---|-----|---|-----|---------|
| 80Dh | INTERRUPT_MASK | RSVD | 15 | Reserved. | R | 0 |
| | | EN_NO_VIDEO | 14 | Asserts AUDIO_INT mask bit when the video format is unknown i.e. when NO_VIDEO register bit is set. | R/W | 0 |
| | | EN_MUX_ERRB | 13 | Asserts AUDIO_INT when the MUX_ERRB flag is set. | R/W | 0 |
| | | EN_MUX_ERRA | 12 | Asserts AUDIO_INT when the MUX_ERRA flag is set. | R/W | 0 |
| | | EN_AES_ERRD | 11 | Asserts AUDIO_INT when the AES_ERRD flag is set. | R/W | 0 |
| | | EN_AES_ERRC | 10 | Asserts AUDIO_INT when the AES_ERRC flag is set. | R/W | 0 |
| | | EN_AES_ERRB | 9 | Asserts AUDIO_INT when the AES_ERRB flag is set. | R/W | 0 |
| | | EN_AES_ERRA | 8 | Asserts AUDIO_INT when the AES_ERRA flag is set. | R/W | 0 |
| | | EN_ACPG4_DET | 7 | Asserts AUDIO_INT when the ACPG4_DET flag is set. | R/W | 0 |
| | | EN_ACPG3_DET | 6 | Asserts AUDIO_INT when the ACPG3_DET flag is set. | R/W | 0 |
| | | EN_ACPG2_DET | 5 | Asserts AUDIO_INT when the ACPG2_DET flag is set. | R/W | 0 |
| | | EN_ACPG2_DET | 5 | Asserts AUDIO_INT when the ACPG2_DET flag is set. | R/W | 0 |
| | | EN_ACPG1_DET | 4 | Asserts AUDIO_INT when the ACPG1_DET flag is set. | R/W | 0 |
| | | EN_ADPG4_DET | 3 | Asserts AUDIO_INT when the ADPG4_DET flag is set. | R/W | 0 |
| | | EN_ADPG3_DET | 2 | Asserts AUDIO_INT when the ADPG3_DET flag is set. | R/W | 0 |
| EN_ADPG2_DET | 1 | Asserts AUDIO_INT when the ADPG2_DET flag is set. | R/W | 0 | | |
| EN_ADPG1_DET | 0 | Asserts AUDIO_INT when the ADPG1_DET flag is set. | R/W | 0 | | |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|----------------|--------------|-------|--|-----|---------|
| 80Eh | ACTIVE_CHANNEL | RSVD | 15-13 | Reserved. | R | 0 |
| | | MUTE_ALL | 12 | Mutes all input audio channels. | R/W | 0 |
| | | LSB_FIRSTD | 11 | Causes the fourth stereo pair serial input formats to use LSB first. | R/W | 0 |
| | | LSB_FIRSTC | 10 | Causes the third stereo pair serial input formats to use LSB first. | R/W | 0 |
| | | LSB_FIRSTB | 9 | Causes the second stereo pair serial input formats to use LSB first. | R/W | 0 |
| | | LSB_FIRSTA | 8 | Causes the first stereo pair serial input formats to use LSB first. | R/W | 0 |
| | | ACT8 | 7 | Specifies embedding of secondary audio group channel 8. Active HIGH. | R/W | 1 |
| | | ACT7 | 6 | Specifies embedding of secondary audio group channel 7. Active HIGH. | R/W | 1 |
| | | ACT6 | 5 | Specifies embedding of secondary audio group channel 6. Active HIGH. | R/W | 1 |
| | | ACT5 | 4 | Specifies embedding of secondary audio group channel 5. Active HIGH. | R/W | 1 |
| | | ACT4 | 3 | Specifies embedding of secondary audio group channel 4. Active HIGH. | R/W | 1 |
| | | ACT3 | 2 | Specifies embedding of secondary audio group channel 3. Active HIGH. | R/W | 1 |
| | | ACT2 | 1 | Specifies embedding of secondary audio group channel 2. Active HIGH. | R/W | 1 |
| | | ACT1 | 0 | Specifies embedding of secondary audio group channel 1. Active HIGH. | R/W | 1 |
| 80Fh | XPOINT_ERROR | RSVD | 15-3 | Reserved. | R | 0 |
| | | MUX_ERRB | 2 | Set in Cascade mode when the incoming video contains packets with the same group number as the Secondary Group. | R | 0 |
| | | MUX_ERRA | 1 | Set in Cascade mode when the incoming video contains packets with the same group number as the Primary Group. | R | 0 |
| | | XPOINT_ERROR | 0 | Set when the crosspoint switch is configured to put the same audio channel in both Primary and Secondary Groups. | R | 0 |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|--------------|-----------------------|----------------|------|--|-----|---------|
| 810h to 81Fh | RSVD | RSVD | – | Reserved. | R | 0 |
| 820h | CHANNEL_STATUS_REG_1 | RSVD | 15-8 | Reserved. | R | 0 |
| | | ACSR_BYTE_1 | 7-0 | Audio channel status block byte 1. | R/W | 133 |
| 821h | CHANNEL_STATUS_REG_2 | RSVD | 15-8 | Reserved. | R | 0 |
| | | ACSR_BYTE_2 | 7-0 | Audio channel status block byte 2. | R/W | 8 |
| 822h | CHANNEL_STATUS_REG_3 | ACSR_BYTE_4 | 15-8 | Audio channel status block byte 4. | R/W | 0 |
| | | ACSR_BYTE_3 | 7-0 | Audio channel status block byte 3. | R/W | 44 |
| 823h | CHANNEL_STATUS_REG_4 | ACSR_BYTE_6 | 15-8 | Audio channel status block byte 6. | R/W | 0 |
| | | ACSR_BYTE_5 | 7-0 | Audio channel status block byte 5. | R/W | 0 |
| 824h | CHANNEL_STATUS_REG_5 | ACSR_BYTE_8 | 15-8 | Audio channel status block byte 8. | R/W | 0 |
| | | ACSR_BYTE_7 | 7-0 | Audio channel status block byte 7. | R/W | 0 |
| 825h | CHANNEL_STATUS_REG_6 | ACSR_BYTE_10 | 15-8 | Audio channel status block byte 10. | R/W | 0 |
| | | ACSR_BYTE_9 | 7-0 | Audio channel status block byte 9. | R/W | 0 |
| 826h | CHANNEL_STATUS_REG_7 | ACSR_BYTE_12 | 15-8 | Audio channel status block byte 12. | R/W | 0 |
| | | ACSR_BYTE_11 | 7-0 | Audio channel status block byte 11. | R/W | 0 |
| 827h | CHANNEL_STATUS_REG_8 | ACSR_BYTE_14 | 15-8 | Audio channel status block byte 14. | R/W | 0 |
| | | ACSR_BYTE_13 | 7-0 | Audio channel status block byte 13. | R/W | 0 |
| 828h | CHANNEL_STATUS_REG_9 | ACSR_BYTE_16 | 15-8 | Audio channel status block byte 16. | R/W | 0 |
| | | ACSR_BYTE_15 | 7-0 | Audio channel status block byte 15. | R/W | 0 |
| 829h | CHANNEL_STATUS_REG_10 | ACSR_BYTE_18 | 15-8 | Audio channel status block byte 18. | R/W | 0 |
| | | ACSR_BYTE_17 | 7-0 | Audio channel status block byte 17. | R/W | 0 |
| 82Ah | CHANNEL_STATUS_REG_11 | ACSR_BYTE_20 | 15-8 | Audio channel status block byte 20. | R/W | 0 |
| | | ACSR_BYTE_19 | 7-0 | Audio channel status block byte 19. | R/W | 0 |
| 82Bh | CHANNEL_STATUS_REG_12 | ACSR_BYTE_22 | 15-8 | Audio channel status block byte 22. | R/W | 0 |
| | | ACSR_BYTE_21 | 7-0 | Audio channel status block byte 21. | R/W | 0 |
| 82Ch | CHANNEL_STATUS_REG_13 | RSVD | 15-8 | Reserved. | R | 0 |
| | | ACSR_BYTE_23 | 7-0 | Audio channel status block byte 23. | R/W | 0 |
| 82Dh to 83Fh | RSVD | RSVD | – | Reserved. | R | 0 |
| 840h | AUDIO_CTRL_GRP_REG_1 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1_2A_BYTE_1 | 8-1 | Primary Audio group delay data for channel 1 & 2. | R/W | 0 |
| | | EBIT1_2A | 0 | Primary Audio group delay data valid flag for channel 1 & 2. | R/W | 0 |

Table 4-36: HD and 3G Audio Core Configuration and Status Registers (Continued)

| Address | Register Name | Bit Name | Bit | Description | R/W | Default |
|---------|-----------------------|----------------|------|--|-----|---------|
| 841h | AUDIO_CTRL_GRPA_REG_2 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1_2A_BYTE_2 | 8-0 | Primary Audio group delay data for channel 1 & 2. | R/W | 0 |
| 842h | AUDIO_CTRL_GRPA_REG_3 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1_2A_BYTE_3 | 8-0 | Primary Audio group delay data for channel 1 & 2. | R/W | 0 |
| 843h | AUDIO_CTRL_GRPA_REG_4 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3_4A_BYTE_1 | 8-1 | Primary Audio group delay data for channel 3 & 4. | R/W | 0 |
| | | EBIT3_4A | 0 | Primary Audio group delay data valid flag for channel 3 & 4. | R/W | 0 |
| 844h | AUDIO_CTRL_GRPA_REG_5 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3_4A_BYTE_2 | 8-0 | Primary Audio group delay data for channel 3 & 4. | R/W | 0 |
| 845h | AUDIO_CTRL_GRPA_REG_6 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3_4A_BYTE_3 | 8-0 | Primary Audio group delay data for channel 3 & 4. | R/W | 0 |
| 846h | AUDIO_CTRL_GRPB_REG_1 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1_2B_BYTE_1 | 8-1 | Secondary Audio group delay data for channel 1 & 2. | R/W | 0 |
| | | EBIT1_2B | 0 | Secondary Audio group delay data valid flag for channel 1 & 2. | R/W | 0 |
| 847h | AUDIO_CTRL_GRPB_REG_2 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1_2B_BYTE_2 | 8-0 | Secondary Audio group delay data for channel 1 & 2. | R/W | 0 |
| 848h | AUDIO_CTRL_GRPB_REG_3 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL1_2B_BYTE_3 | 8-0 | Secondary Audio group delay data for channel 1 & 2. | R/W | 0 |
| 849h | AUDIO_CTRL_GRPB_REG_4 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3_4B_BYTE_1 | 8-1 | Secondary Audio group delay data for channel 3 & 4. | R/W | 0 |
| | | EBIT3_4B | 0 | Secondary Audio group delay data for channel 3 & 4. | R/W | 0 |
| 84Ah | AUDIO_CTRL_GRPB_REG_5 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3_4B_BYTE_2 | 8-0 | Secondary Audio group delay data for channel 3 & 4. | R/W | 0 |
| 84Bh | AUDIO_CTRL_GRPB_REG_6 | RSVD | 15-9 | Reserved. | R | 0 |
| | | DEL3_4B_BYTE_3 | 8-0 | Secondary Audio group delay data for channel 3 & 4. | R/W | 0 |

4.15 JTAG ID Codeword

The Platform ID for the 297X family is 0Fh.

The part number field of the JTAG ID codeword for the GS2972 is set to 0F01h.

4.16 JTAG Test Operation

When the JTAG/ $\overline{\text{HOST}}$ pin is HIGH, the GSPI host interface port is configured for JTAG test operation.

In this mode the SCLK, SDIN, SDOOUT and $\overline{\text{CS}}$ become TCK, TDI, TDO and TMS. In addition, the TRST pin becomes active.

Boundary scan testing using the JTAG interface is enabled in this mode. When the JTAG/ $\overline{\text{HOST}}$ pin is LOW, the dedicated JTAG interface is used. In this mode the TCK, TDI, TDO and TMS pins are active. This is the recommended mode for new designs.

4.17 Device Power-Up

Because the GS2972 is designed to operate in a multi-voltage environment, any power-up sequence is allowed. The Charge Pump, Phase Detector, Core Logic, Serial Digital Output and I/O Buffers can all be powered up in any order.

4.18 Device Reset

Note: At power-up, the device must be reset to operate correctly.

In order to initialize all internal operating conditions to their default states, hold the $\overline{\text{RESET}}$ signal LOW for a minimum of $t_{\text{reset}} = 1\text{ms}$ after all power supplies are stable. There are no requirements for power supply sequencing.

When held in reset, all device outputs will be driven to a high-impedance state.

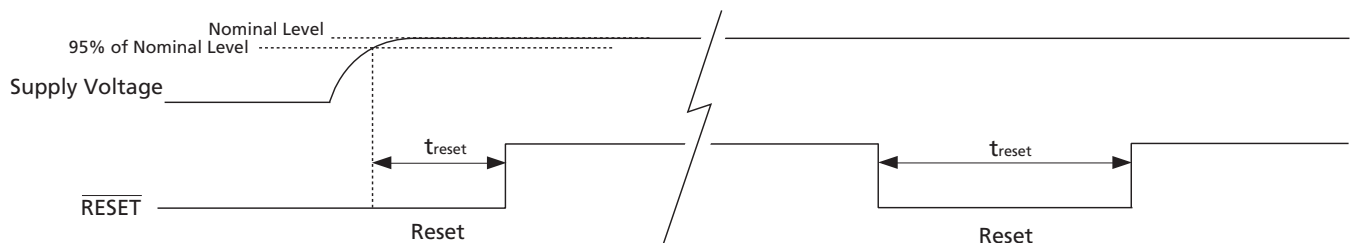
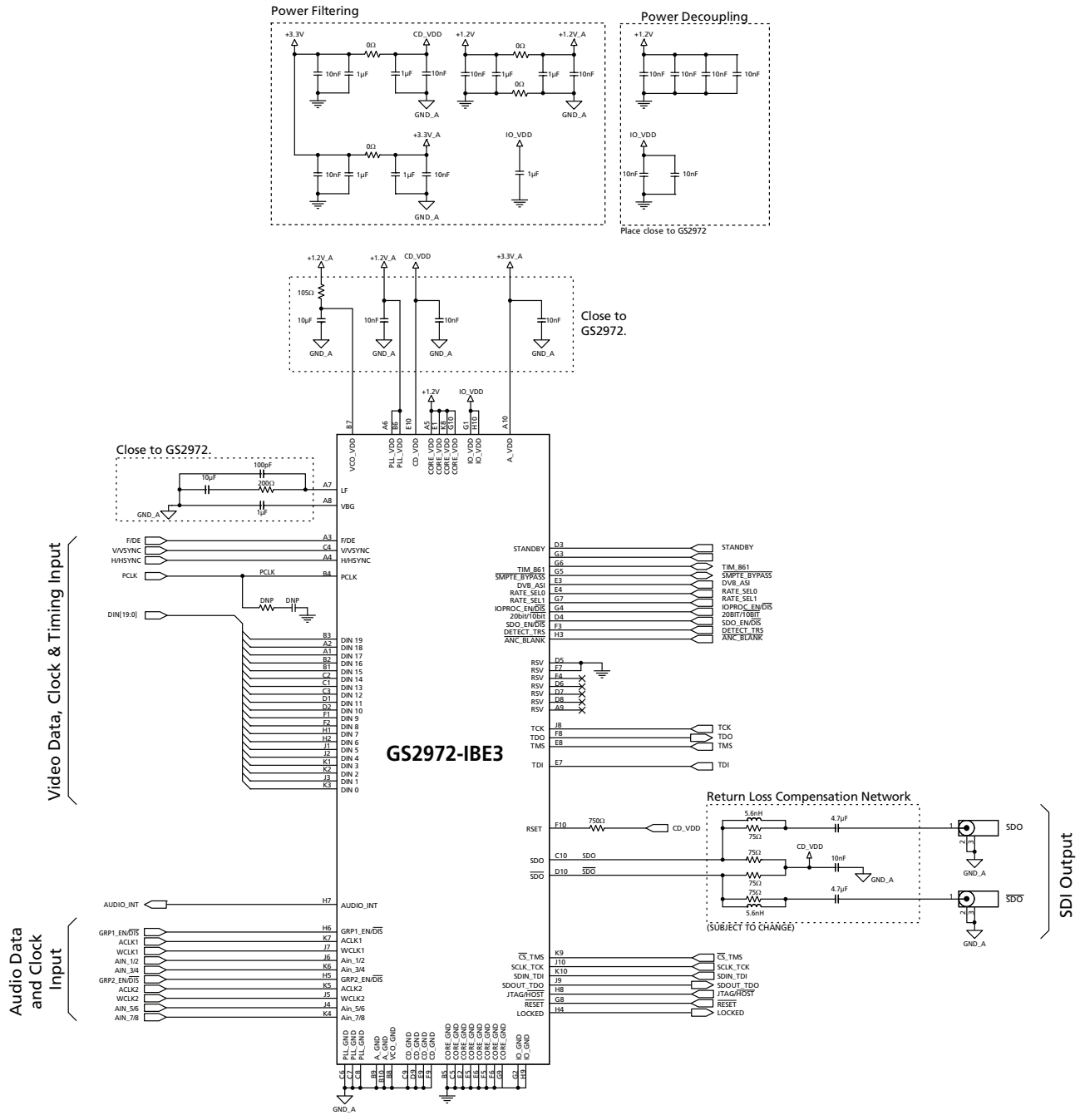


Figure 4-35: Reset Pulse

5. Application Reference Design

5.1 Typical Application Circuit



- Notes:**
1. DNP (Do Not Populate).
 2. The value of the series resistors on video data, clock, and timing connections should be determined by board signal integrity test (See Section 4.1.1).
 3. For analog power and ground isolation refer to PCB layout guide.
 4. For critical 3G signal layout refer to PCB layout guide.
 5. For impedance controlled signals refer to PCB layout guide.

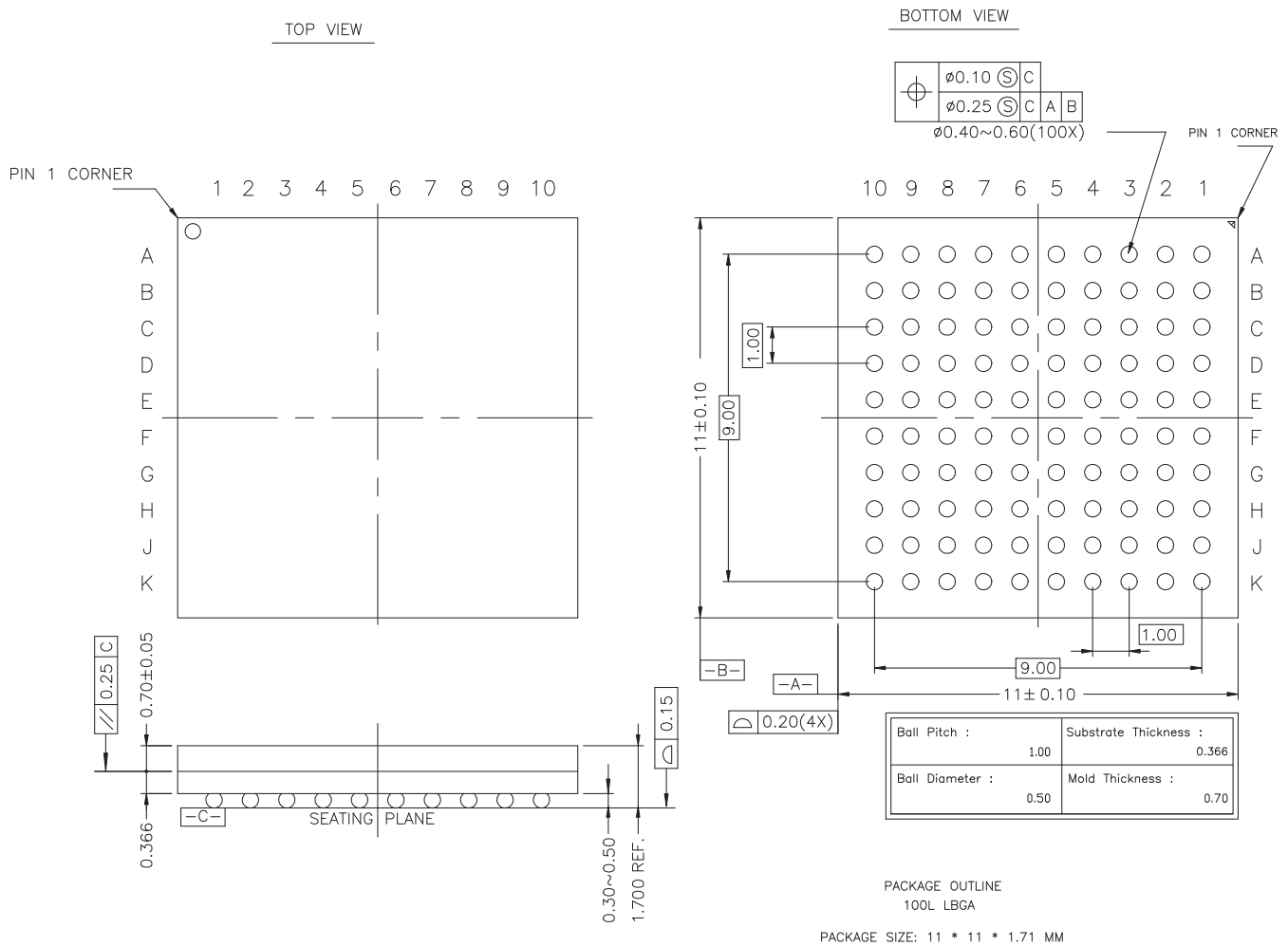
Figure 5-1: Typical Application Circuit

6. References & Relevant Standards

| | |
|----------------|---|
| SMPTE ST 125 | Component video signal 4:2:2 – bit parallel interface |
| SMPTE ST 259-C | 10-bit 4:2:2 Component and 4fsc Composite Digital Signals - Serial Digital Interface |
| SMPTE ST 260 | 1125 / 60 high definition production system – digital representation and bit parallel interface |
| SMPTE ST 267 | Bit parallel digital interface – component video signal 4:2:2 16 x 9 aspect ratio |
| SMPTE ST 272 | Formatting AES/EBU Audio and Auxiliary Data into Digital Video Ancillary Data Space |
| SMPTE ST 274 | 1920 x 1080 scanning analog and parallel digital interfaces for multiple picture rates |
| SMPTE ST 291 | Ancillary Data Packet and Space Formatting |
| SMPTE ST 292 | Bit-Serial Digital Interface for High-Definition Television Systems |
| SMPTE ST 293 | 720 x 483 active line at 59.94Hz progressive scan production – digital representation |
| SMPTE ST 296 | 1280 x 720 scanning, analog and digital representation and analog interface |
| SMPTE ST 299 | 24-Bit Digital Audio Format for HDTV Bit-Serial Interface |
| SMPTE ST 305 | Serial Data Transport Interface |
| SMPTE ST 348 | High Data-Rate Serial Data Transport Interface (HD-SDTI) |
| SMPTE ST 352 | Video Payload Identification for Digital Television Interfaces |
| SMPTE ST 372 | Dual Link ST 292 Interface for 1920 x 1080 Picture Raster |
| SMPTE ST 424 | 3Gb/s Signal/Data Serial Interface |
| SMPTE ST 425 | 3Gb/s Signal/Data Serial Interface - Source Image Format Mapping |
| SMPTE RP165 | Error Detection Checkwords and Status Flags for use in Bit-Serial Digital Interfaces for Television |
| SMPTE RP168 | Definition of Vertical Interval Switching Point for Synchronous Video Switching |
| CEA 861 | Video Timing Requirements |

7. Package & Ordering Information

7.1 Package Dimensions



* THE BALL DIAMETER, BALL PITCH, STAND-OFF & PACKAGE THICKNESS ARE DIFFERENT FROM JEDEC SPEC M0192 (LOW PROFILE BGA FAMILY)

Figure 7-1: Package Dimensions

7.2 Packaging Data

Table 7-1: Packaging Data

| Parameter | Value |
|--|---|
| Package Type | 11mm x 11mm 100-ball LPGA |
| Package Drawing Reference | JEDEC M0192 (with exceptions noted in Package Dimensions on page 122). |
| Moisture Sensitivity Level | 3 |
| Junction to Case Thermal Resistance, θ_{j-c} | 10.4°C/W |
| Junction to Air Thermal Resistance, θ_{j-a} (at zero airflow) | 37.1°C/W |
| Junction to Board Thermal Resistance, θ_{j-b} | 26.4°C/W |
| Psi, ψ | 0.4°C/W |
| Pb-free and RoHS Compliant | Yes |

7.3 Marking Diagram

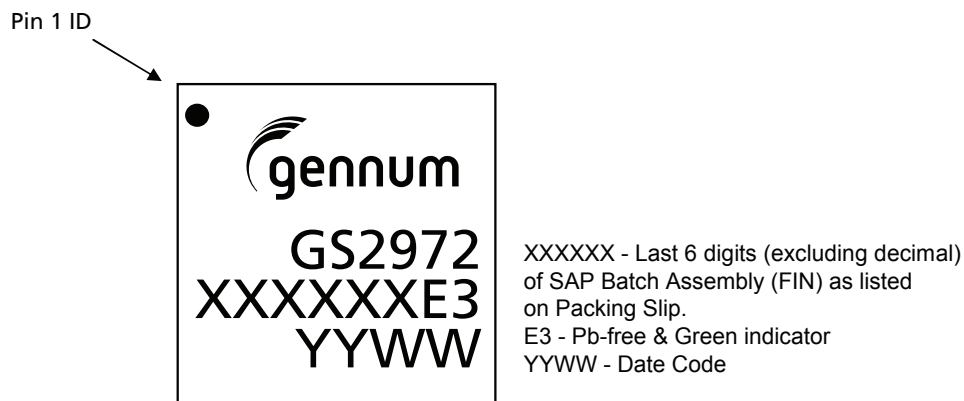


Figure 7-2: Marking Diagram

7.4 Solder Reflow Profiles

The GS2972 is available in a Pb-free package. It is recommended that the Pb-free package be soldered with Pb-free paste using the reflow profile shown in Figure 7-3.

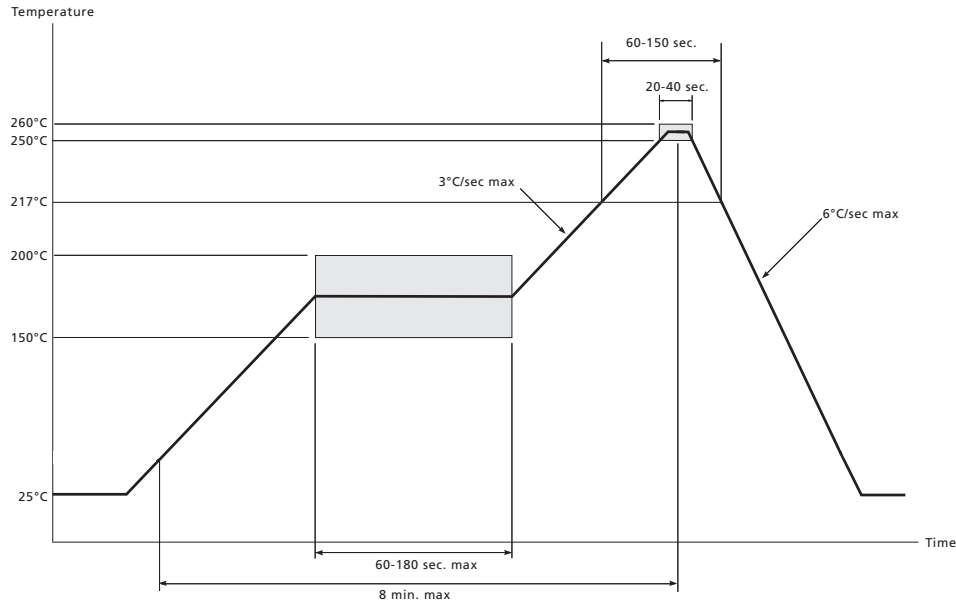


Figure 7-3: Pb-free Solder Reflow Profile

7.5 Ordering Information

Table 7-2: Ordering Information

| Part Number | Package | Pb-free | Temperature Range |
|-------------|--------------|---------|-------------------|
| GS2972-IBE3 | 100-ball BGA | Yes | -20°C to 85°C |



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