

## TW2964

### 4-CH WD1 (960H)/D1 Compatible Video Decoders and Audio Codecs

FN8288  
Rev. 3.00  
April 11, 2014

## Features

### Video Decoder

- WD1 (960H) and D1 compatible video decoding operation and it is programmable each channel
- NTSC (M, 4.43) and PAL (B, D, G, H, I, M, N, N combination), PAL (60) support with automatic format detection
- Software selectable analog inputs allows any of 2 CVBS per one video ADC
- Built-in analog anti-alias filter
- Four 10-bit ADCs and analog clamping circuit for CVBS input
- Fully programmable static gain or automatic gain control for the Y channel
- Programmable white peak control for CVBS channel
- 4-H adaptive comb filter Y/C separation
- PAL delay line for color phase error correction
- Image enhancement with peaking and CTI
- Digital sub-carrier PLL for accurate color decoding
- Digital Horizontal PLL for synchronization processing and pixel sampling
- Advanced synchronization processing and sync detection for handling non-standard and weak signal
- Programmable hue, brightness, saturation, contrast, sharpness
- Automatic color control and color killer
- ITU-R 656 like YCbCr (4:2:2) output or time multiplexed output with 36/72/144MHz for WD1 or 27/54/108MHz for D1 format

### Audio Codec

- Integrated five audio ADCs processing and one audio DAC
- Provides multi-channel audio mixed analog output
- Support I2S/DSP Master/Slave interface for record output and playback input
- PCM 8/16-bit and u-Law/A-Law 8-bit for audio word length
- Programmable audio sample rate that covers popular frequencies of 8/16/32/44.1/48kHz

### Miscellaneous

- Two-wire MPU serial bus interface
- Integrated clock PLL for 144/108MHz clock output
- Power save and Power down mode
- Low power consumption
- Single 27MHz crystal for all standards and both WD1 and D1 format
- I/O pin compatible with TW2960 (Supply pins are different)
- 3.3V tolerant I/O
- 1.0V/3.3V power supply
- 100-pin and 128-pin LQFP packages

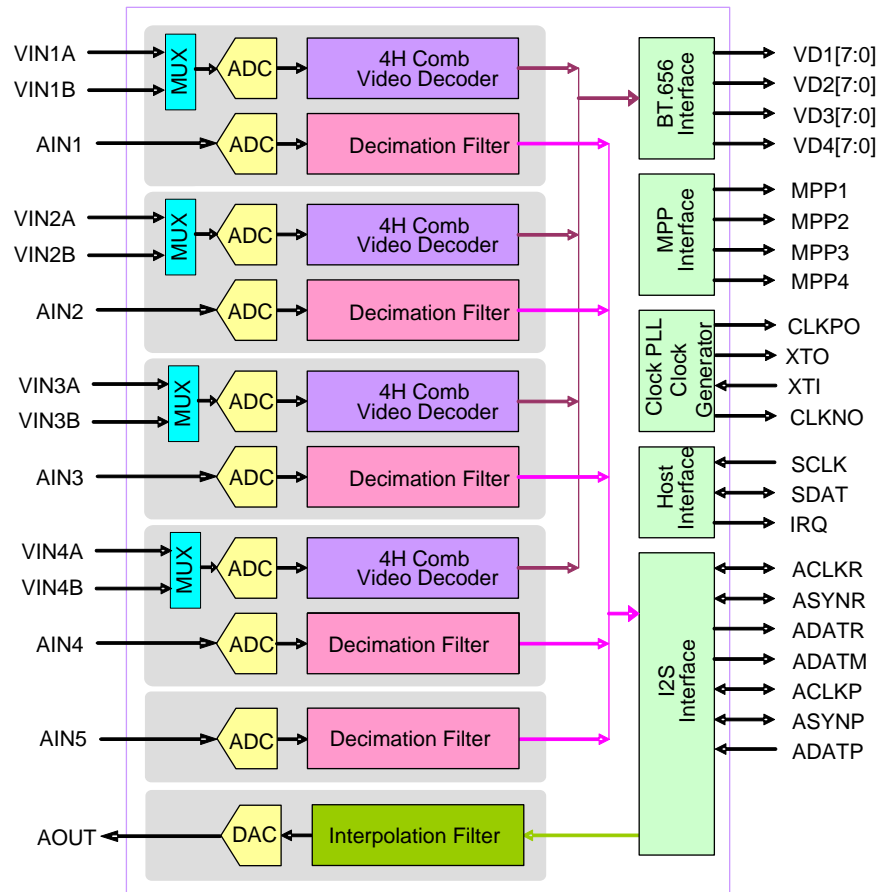


FIGURE 1. TW2964 BLOCK DIAGRAM

## Ordering Information

| <b>PART NUMBER<br/>(NOTE 1)</b> | <b>PART<br/>MARKING</b> | <b>PACKAGE<br/>(Pb-free)</b> | <b>PKG.<br/>DWG. #</b> |
|---------------------------------|-------------------------|------------------------------|------------------------|
| TW2964-LA2-CR                   | TW2964 LA2-CR           | 100 Lead LQFP (12mmx12mm)    | Q100.12x12             |
| TW2964-LA2-CR128                | TW2964 LA2-<br>CR128    | 128 Lead LQFP (14mmx14mm)    | Q128.14x14             |
| TW2964-LA2-CR128-EVAL           | Evaluation Board        |                              |                        |

**NOTE:**

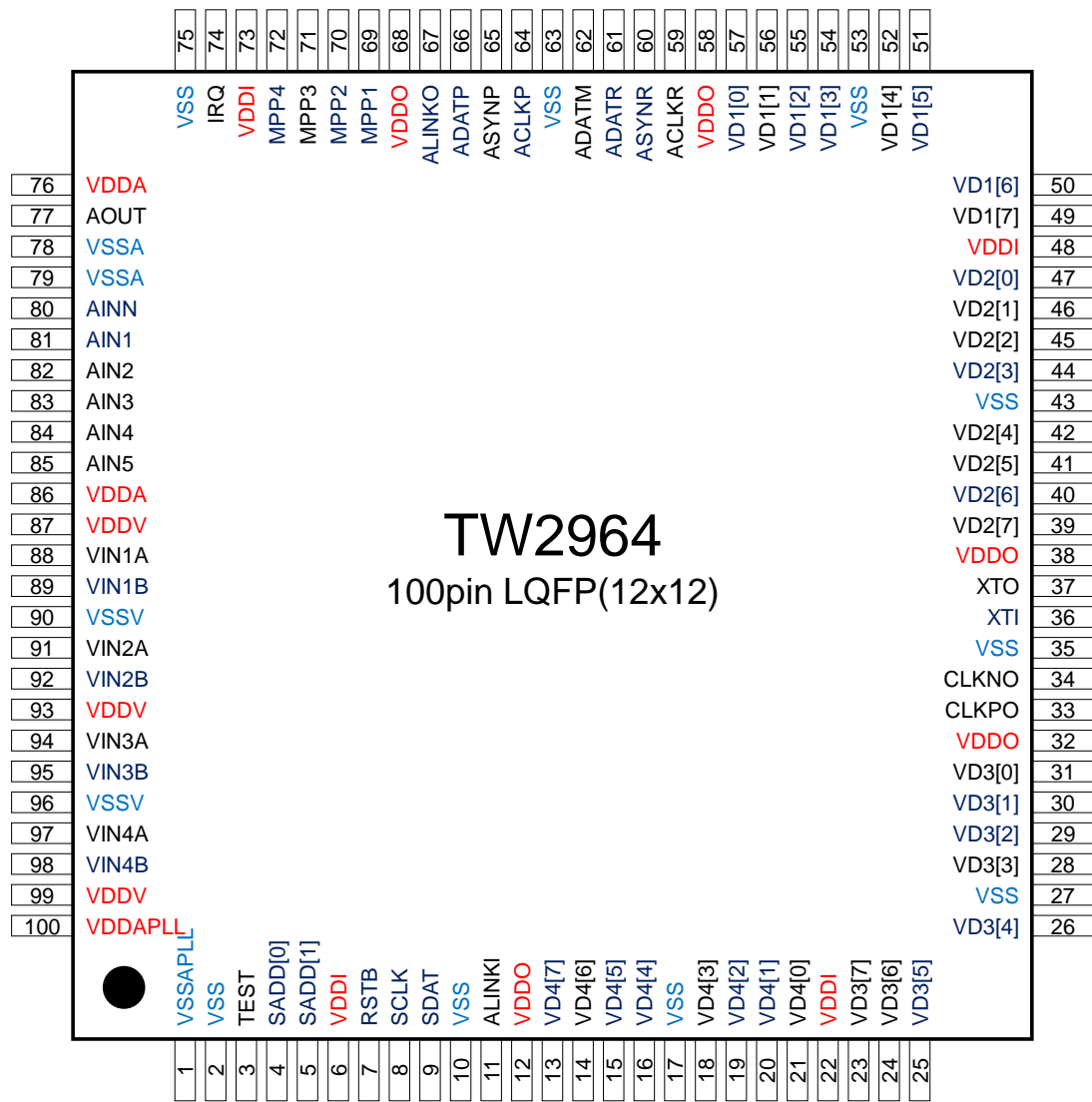
1. These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

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# Pin Diagrams





## Pin Descriptions

### Analog Video/Audio Interface Pins

| NAME  | NUMBER | TYPE | DESCRIPTION                           |
|-------|--------|------|---------------------------------------|
| VIN1A | 88     | A    | Composite video input A of channel 1. |
| VIN1B | 89     | A    | Composite video input B of channel 1. |
| VIN2A | 91     | A    | Composite video input A of channel 2. |
| VIN2B | 92     | A    | Composite video input B of channel 2. |
| VIN3A | 94     | A    | Composite video input A of channel 3. |
| VIN3B | 95     | A    | Composite video input B of channel 3. |
| VIN4A | 97     | A    | Composite video input A of channel 4. |
| VIN4B | 98     | A    | Composite video input B of channel 4. |
| AIN1  | 81     | A    | Audio input of channel 1.             |
| AIN2  | 82     | A    | Audio input of channel 2.             |
| AIN3  | 83     | A    | Audio input of channel 3.             |
| AIN4  | 84     | A    | Audio input of channel 4.             |
| AIN5  | 85     | A    | Audio input of channel 5.             |
| AINN  | 80     | A    | Audio input negative control.         |
| AOUT  | 77     | A    | Audio output.                         |



## Digital Video/Audio Interface Pins

| NAME     | NUMBER                            | TYPE | DESCRIPTION                                  |
|----------|-----------------------------------|------|--|
| VD1[7:0] | 49, 50, 51, 52,<br>54, 55, 56, 57 | O    | Video data output of channel 1.              |
| VD2[7:0] | 39,40,41,42,<br>44, 45, 46, 47    | O    | Video data output of channel 2.              |
| VD3[7:0] | 23, 24, 25, 26,<br>28, 29, 30, 31 | O    | Video data output of channel 3.              |
| VD4[7:0] | 13, 14, 15, 16,<br>18, 19, 20, 21 | O    | Video data output of channel 4.              |
| MPP1     | 69                                | IO   | HS/VS/FLD/ACTIVE/NOVID of channel 1.         |
| MPP2     | 70                                | IO   | HS/VS/FLD/ACTIVE/NOVID of channel 2.         |
| MPP3     | 71                                | IO   | HS/VS/FLD/ACTIVE/NOVID of channel 3.         |
| MPP4     | 72                                | IO   | HS/VS/FLD/ACTIVE/NOVID of channel 4.         |
| ACLKR    | 59                                | IO   | Audio serial clock input/output of record.   |
| ASYNR    | 60                                | IO   | Audio serial sync input/output of record.    |
| ADATR    | 61                                | O    | Audio serial data output of record.          |
| ADATM    | 62                                | O    | Audio serial data output of mixing.          |
| ACLKP    | 64                                | IO   | Audio serial clock input/output of playback. |
| ASYNP    | 65                                | IO   | Audio serial sync input/output of playback.  |
| ADATP    | 66                                | I    | Audio serial data input of playback.         |
| ALINKI   | 11                                | I    | Audio Multi-chip operation serial input.     |
| ALINKO   | 67                                | O    | Audio Multi-chip operation serial output.    |

## System Control Pins

| NAME      | NUMBER | TYPE | DESCRIPTION   |
|-----------|--------|------|---|
| RSTB      | 7      | I    | System reset.                                       |
| XTI       | 36     | I    | Crystal 27MHz connection or Oscillator clock input. |
| XTO       | 37     | O    | For crystal 27MHz connection.                       |
| CLKPO     | 33     | O    | 36/72/144MHz or 27/54/108MHz clock output.          |
| CLKNO     | 34     | O    | 36/72/144MHz or 27/54/108MHz clock output.          |
| TEST      | 3      | I    | Test pin. Connect to ground.                        |
| SCLK      | 8      | I    | Serial control clock line.                          |
| SDAT      | 9      | IO   | Serial control data line.                           |
| SADD[1:0] | 5,4    | I    | Serial control address.                             |
| IRQ       | 74     | O    | Interrupt request output.                           |

## Power and Ground Pins

| NAME    | NUMBER                            | TYPE | DESCRIPTION                                  |
|---------|-----------------------------------|------|--|
| VDDI    | 6, 22, 48, 73                     | P    | 1.0V Power for internal logic.               |
| VDDO    | 12, 32, 38, 58, 68                | P    | 3.3V Power for output driver.                |
| VSS     | 2, 10, 17, 27, 35, 43, 53, 63, 75 | G    | Ground for internal logic and output driver. |
| VDDV    | 87, 93, 99                        | P    | 3.3V Power for analog video ADC.             |
| VSSV    | 90,96                             | G    | Ground for analog video ADC.                 |
| VDDA    | 76,86                             | P    | 3.3V Power for analog audio.                 |
| VSSA    | 78,79                             | G    | Ground for analog audio.                     |
| VDDAPLL | 100                               | P    | 3.3V Power for clock PLL.                    |
| VSSAPLL | 1                                 | G    | Ground for clock PLL.                        |
| VDDDPLL | 127                               | P    | 3.3V Power for clock PLL. (128 pin only)     |
| VSSDPLL | 2                                 | G    | Ground for clock PLL. (128 pin only)         |

## Parametric Information

### ESD Rating

#### ESD Rating

|  |       |
|--|-------|
| Human Body Model (Analog video inputs to VSSV/VDDV).....   | 8000V |
| Human Body Model (Analog audio inputs to VSSA/VDDA).....   | 8000V |
| Human Body Model (Tested per JESD22-A114E, all pins) ..... | 7000V |
| Machine Model (Tested per JESD22-A115-A) .....             | 300V  |
| CDM Model (Tested per JESD22-C101) .....                   | 2000V |

### AC/DC Electrical Parameters

TABLE 1. ABSOLUTE MAXIMUM RATINGS

| PARAMETER  | SYMBOL            | MIN                       | TYP | MAX  | UNITS |
|--|-------------------|---------------------------|-----|------|-------|
| VDDV (Measured to VSSV)                                | VDDVM             | -                         | 3.3 | 3.96 | V     |
| VDDA (Measured to VSSA)                                | VDDAM             | -                         | 3.3 | 3.96 | V     |
| VDDAPLL (Measured to VSSAPLL)                          | VDDAPLLM          | -                         | 3.3 | 3.96 | V     |
| V DDI (Measured to VSS)                                | VDDIM             | -                         | 1.0 | 1.2  | V     |
| VDDO (Measured to VSS)                                 | VDDOM             | -                         | 3.3 | 3.96 | V     |
| Voltage on any Digital Signal Pin (See the note below) | -                 | VSS -0.5                  | -   | 3.96 | V     |
| Analog Video Input Voltage                             | -                 | VSSV - 0.5                | -   | 3.96 | V     |
| Analog Audio Input Voltage                             | -                 | VSSA - 0.5                | -   | 3.96 | V     |
| Storage Temperature                                    | T <sub>S</sub>    | -65                       | -   | +150 | °C    |
| Junction Temperature                                   | T <sub>J</sub>    | -40                       | -   | +125 | °C    |
| Reflow Soldering                                       | T <sub>PEAK</sub> | 255 +5/-0 (10-30 seconds) |     |      | °C    |

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

**This device employs high-impedance CMOS devices on all signal pins. It must be handled as an ESD-sensitive device. Voltage on any signal pin that exceeds the ranges list in Table 1 can induce destructive latch-up.**

TABLE 2. CHARACTERISTICS

| PARAMETER                   | SYMBOL  | MIN (NOTE 3) | TYP | MAX (NOTE 3) | UNITS |
|-----------------------------|---------|--------------|-----|--------------|-------|
| <b>SUPPLY</b>               |         |              |     |              |       |
| Power Supply — IO           | VDDO    | 3.0          | 3.3 | 3.6          | V     |
| Power Supply — Analog Video | VDDV    | 3.0          | 3.3 | 3.6          | V     |
| Power Supply — Analog Audio | VDDA    | 3.0          | 3.3 | 3.6          | V     |
| Power Supply — Clock PLL    | VDDAPLL | 3.0          | 3.3 | 3.6          | V     |
| Power Supply — Digital      | VDDI    | 0.9          | 1.0 | 1.1          | V     |

| PARAMETER   | SYMBOL               | MIN<br>(NOTE 3) | TYP | MAX<br>(NOTE 3)        | UNITS           |
|---|----------------------|-----------------|-----|------------------------|-----------------|
| VIN1A, VIN1B, VIN2A, VIN2B, VIN3A, VIN3B, VIN4A, VIN4B Input Range (AC Coupling Required) |                      | 0.5             | 1.0 | 1.4                    | V               |
| AIN1, AIN2, AIN3, AIN4, AIN5 Input Range (AC Coupling Required)                           |                      | 0.21            | 1.4 | 2.4                    | V               |
| Ambient Operating Temperature   | T <sub>A</sub>       | -40             |     | +85                    | °C              |
| Analog Video Supply Current   | I <sub>vddv</sub>    | -               | 80  | -                      | mA              |
| Analog Audio Supply Current   | I <sub>vdda</sub>    | -               | 21  | -                      | mA              |
| Clock PLL Supply Current  | I <sub>vddapll</sub> | -               | 5   | -                      | mA              |
| Digital I/O Supply Current  | I <sub>ddo</sub>     | -               | 28  | -                      | mA              |
| Digital Core Supply Current   | I <sub>ddi</sub>     | -               | 54  | -                      | mA              |
| <b>DIGITAL INPUTS</b>   |                      |                 |     |                        |                 |
| Input High Voltage (TTL)  | V <sub>IH</sub>      | 2.0             | -   | 3.6                    | V               |
| Input Low Voltage (TTL)   | V <sub>IL</sub>      | -0.3            | -   | 0.8                    | V               |
| Input High Voltage (XTI)  | V <sub>IH</sub>      | 2.0             | -   | V <sub>DDO</sub> + 0.5 | V               |
| Input Low Voltage (XTI)   | V <sub>IL</sub>      | -               | -   | 0.8                    | V               |
| Input High Current (V <sub>IN</sub> = V <sub>DD</sub> )                                   | I <sub>IH</sub>      | -               | -   | 10                     | μA              |
| Input Low Current (V <sub>IN</sub> = V <sub>SS</sub> )                                    | I <sub>IL</sub>      | -10             | -   | -                      | μA              |
| Input Capacitance (f = 1 MHz, V <sub>IN</sub> = 2.4V)                                     | C <sub>IN</sub>      | -               | 5   | -                      | pF              |
| <b>DIGITAL OUTPUTS</b>  |                      |                 |     |                        |                 |
| Output High Voltage (I <sub>OH</sub> = -2mA)  | V <sub>OH</sub>      | 2.4             | -   | V <sub>DDO</sub>       | V               |
| Output Low Voltage (I <sub>OL</sub> = 2mA)  | V <sub>OL</sub>      | -               | 0.2 | 0.4                    | V               |
| 3-State Current   | I <sub>oz</sub>      | -               | -   | 10                     | μA              |
| Output Capacitance  | C <sub>o</sub>       | -               | 5   | -                      | pF              |
| <b>ANALOG VIDEO INPUT</b>   |                      |                 |     |                        |                 |
| Analog Pin Input Voltage  | V <sub>i</sub>       | -               | 1   | -                      | V <sub>pp</sub> |
| Analog Pin Input Capacitance  | C <sub>A</sub>       | -               | 7   | -                      | pF              |
| <b>VIDEO ADCS</b>   |                      |                 |     |                        |                 |
| ADC Resolution  | ADCR                 | -               | 10  | -                      | bits            |
| ADC Integral Non-Linearity  | AINL                 | -               | ±1  | -                      | LSB             |
| ADC Differential Non-Linearity  | ADNL                 | -               | ±1  | -                      | LSB             |
| ADC Clock Rate  | f <sub>ADC</sub>     | -               | 27  | -                      | MHz             |
| Video Bandwidth (-3db)  | BW                   | -               | 10  | -                      | MHz             |

| PARAMETER                       | SYMBOL       | MIN<br>(NOTE 3) | TYP     | MAX<br>(NOTE 3) | UNITS    |
|---------------------------------|--------------|-----------------|---------|-----------------|----------|
| <b>HORIZONTAL PLL</b>           |              |                 |         |                 |          |
| Line Frequency (50Hz)           | $f_{LN}$     | -               | 15.625  | -               | kHz      |
| Line Frequency (60Hz)           | $f_{LN}$     | -               | 15.734  | -               | KHz      |
| Static Deviation                | $\Delta f_H$ | -               | -       | 6.2             | %        |
| <b>SUBCARRIER PLL</b>           |              |                 |         |                 |          |
| Subcarrier Frequency (NTSC-M)   | $f_{sc}$     | -               | 3579545 | -               | Hz       |
| Subcarrier Frequency (PAL-BDGI) | $f_{sc}$     | -               | 4433619 | -               | Hz       |
| Subcarrier Frequency (PAL-M)    | $f_{sc}$     | -               | 3575612 | -               | Hz       |
| Subcarrier Frequency (PAL-N)    | $f_{sc}$     | -               | 3582056 | -               | Hz       |
| Lock In Range                   | $\Delta f_H$ | $\pm 450$       | -       | -               | Hz       |
| <b>CRYSTAL SPEC</b>             |              |                 |         |                 |          |
| Nominal Frequency (Fundamental) |              | -               | 27      | -               | MHz      |
| Deviation (Note 2)              |              | -               | -       | $\pm 50$        | ppm      |
| Load Capacitance                | CL           | -               | 18      | -               | pF       |
| Series Resistor (ESR)           | RS           | -               | 50      | -               | $\Omega$ |
| <b>OSCILLATOR INPUT</b>         |              |                 |         |                 |          |
| Nominal Frequency               |              | -               | 27      | -               | MHz      |
| Deviation                       |              | -               | -       | $\pm 50$        | ppm      |
| Duty Cycle                      |              | -               | -       | 55              | %        |

## NOTE:

1. Supply current measurement is based on 0x93[2:0] = 6 setting. These bits should be set to 6 after power-on and resets. Lower settings will increase power consumption.
2. Crystal deviation is based on normal operation condition.
3. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

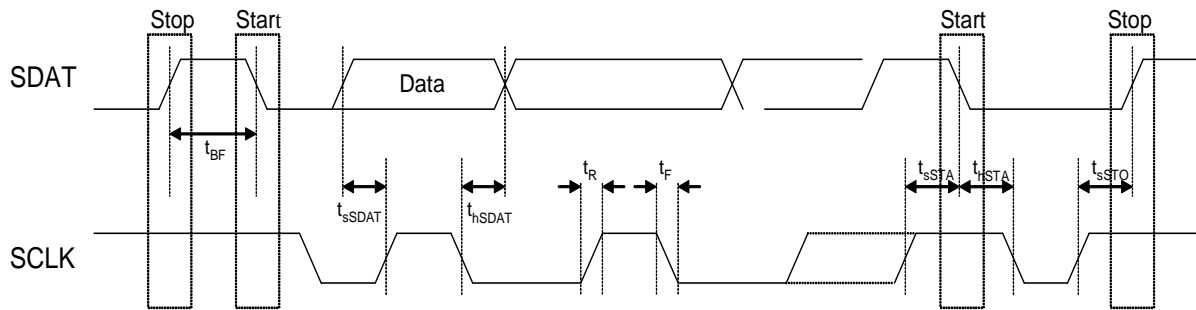
## Serial Host Interface Timing

| PARAMETER                            | SYMBOL      | MIN (NOTE 1) | TYP | MAX (NOTE 1) | UNITS |
|--------------------------------------|-------------|--------------|-----|--------------|-------|
| Bus Free Time between STOP and START | $t_{BF}$    | 740          |     |              | ns    |
| SDAT Setup Time                      | $t_{sSDAT}$ | 74           |     |              | ns    |
| SDAT Hold Time                       | $t_{hSDAT}$ | 50           |     | 900          | ns    |
| Setup Time for START Condition       | $t_{sSTA}$  | 370          |     |              | ns    |
| Setup Time for STOP Condition        | $t_{sSTOP}$ | 370          |     |              | ns    |
| Hold Time for START Condition        | $t_{hSTA}$  | 74           |     |              | ns    |
| Rise Time for SCLK and SDAT          | $t_R$       |              |     | 300          | ns    |
| Fall Time for SCLK and SDAT          | $t_F$       |              |     | 300          | ns    |
| Capacitive Load for each Bus Line    | $C_{BUS}$   |              |     | 400          | pF    |
| SCLK Clock Frequency                 | $f_{SCLK}$  |              |     | 400          | KHz   |

NOTE:

1. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

## Serial Host Interface Timing Diagram

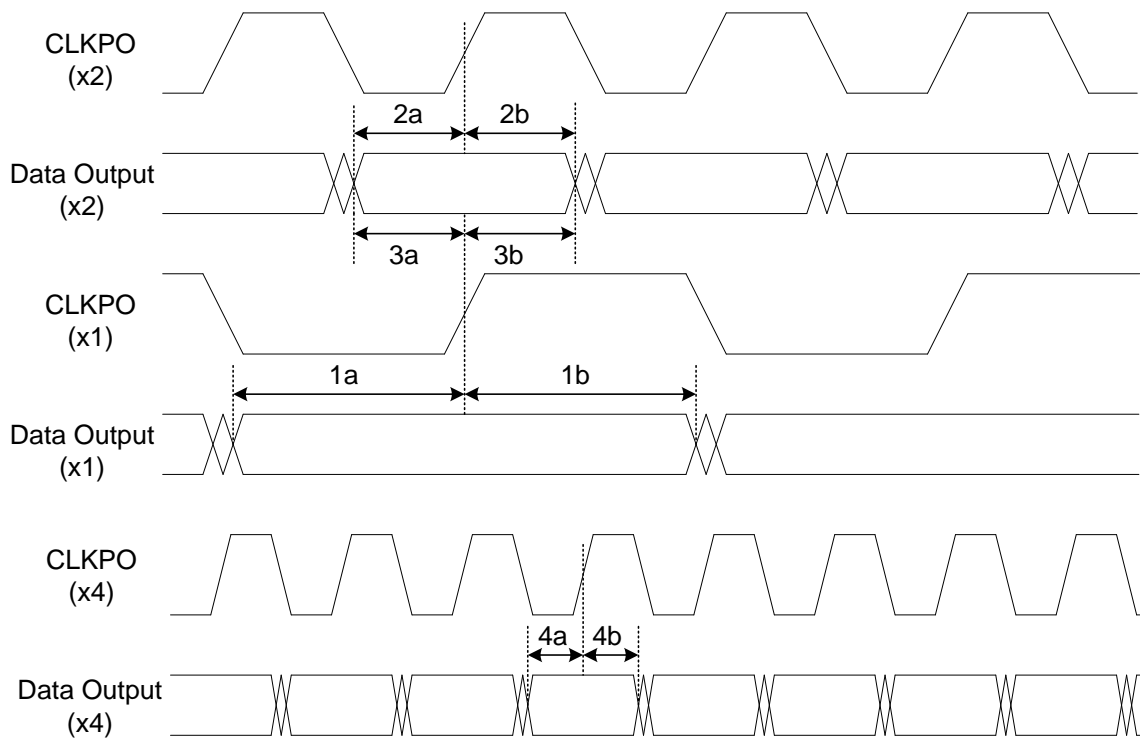


## CLKPO and Video Data Timing

| PARAMETER                              | SYMBOL | MIN (NOTE 2) | TYP | MAX (NOTE 2) | UNITS |
|--|--------|--------------|-----|--------------|-------|
| Setup from CLKPO(x1) to Video Data(x1) | 1a     | 8            |     | 10           | ns    |
| Hold from CLKPO(x1) to Video Data(x1)  | 1b     | 15           |     | 17           | ns    |
| Setup from CLKPO(x2) to Video Data(x2) | 2a     | 6            |     | 8            | ns    |
| Hold from CLKPO(x2) to Video Data(x2)  | 2b     | 3            |     | 6            | ns    |
| Setup from CLKPO(x1) to Video Data(x2) | 3a     | 8            |     | 10           | ns    |
| Hold from CLKPO(x1) to Video Data(x2)  | 3b     | 2            |     | 4            | ns    |
| Setup from CLKPO(x4) to Video Data(x4) | 4a     | 2            |     | 3.5          | ns    |
| Hold from CLKPO(x4) to Video Data(x4)  | 4b     | 3            |     | 4            | ns    |

NOTE:

1. CLKPO timing is related with CLKPO\_DEL register value. The following timing diagram is illustrated in the case that the CLKPO\_DEL is set to 0hex and CLKPO\_POL is set to 0. CLKNO timing is inversed CLKPO timing as default setting. CLKPO\_DEL/CLKNO\_DEL can make more timings.
2. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

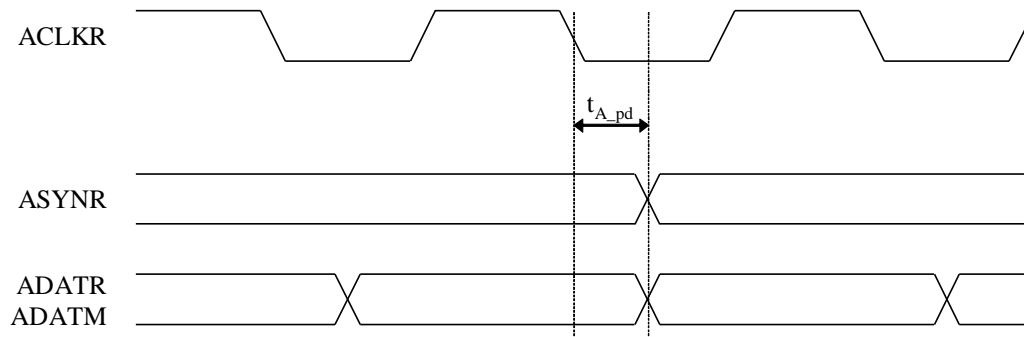


## Digital Serial Audio Interface Timing

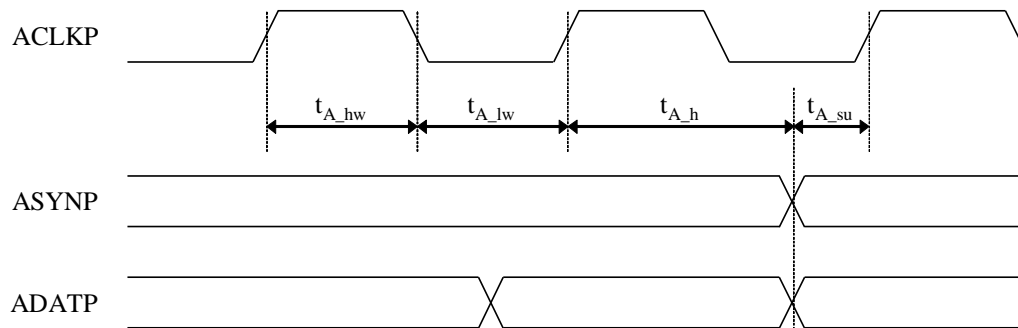
| PARAMETER                             | SYMBOL      | MIN (NOTE 2) | TYP | MAX (NOTE 2) | UNITS |
|---------------------------------------|-------------|--------------|-----|--------------|-------|
| ASYNR, ADATR, ADATM Propagation Delay | $T_{A\_pd}$ | 1.0          |     | 4            | ns    |
| ACLKP High Pulse Duration             | $T_{A\_hw}$ | 27           |     |              | ns    |
| ACLKP Low Pulse Duration              | $T_{A\_lw}$ | 54           |     |              | ns    |
| ASYNP, ADATP Setup Time               | $T_{A\_su}$ | 26           |     |              | ns    |
| ASYNP, ADATP Hold Time                | $T_{A\_h}$  | 25           |     |              | ns    |

NOTE:

1.  $T_{A\_lw}$  Min value and  $T_{A\_su}$  Min value are  $F_s=48\text{KHz}$  mode only. If  $F_s < 48\text{KHz}$ , these Min values are more bigger. High period of ACLKR/ACLKP is 36MHz one clock period.
2. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.



(A) RECORD AND MIX AUDIO(MASTER MODE)



(B) PLAYBACK AUDIO(MASTER MODE)



## Analog Audio Parameters

| PARAMETER   | SYMBOL | MIN<br>(NOTE 4) | TYP | MAX<br>(NOTE 4) | UNITS      |
|---|--------|-----------------|-----|-----------------|------------|
| <b>ANALOG AUDIO INPUT CHARACTERISTICS</b>           |        |                 |     |                 |            |
| AIN1-5 Input Impedance                              | RINX   | 9.5             |     |                 | k $\Omega$ |
| Interchannel gain mismatch                          |        |                 | 0.2 |                 | dB         |
| Input voltage range                                 |        | 0               | 1.4 | 2.4             | Vpp        |
| Full scale input voltage (peak to peak)<br>(Note 1) | ViFULL | 0.21            | 1.4 | 2.4             | Vpp        |
| Interchannel Isolation (Note 2)                     |        |                 | 85  |                 | dB         |
| <b>ANALOG AUDIO OUTPUT CHARACTERISTICS</b>          |        |                 |     |                 |            |
| AOUT Output Load Resistance                         | RLAO   | 300             |     |                 | ohm        |
| AOUT Load Capacitance                               | CLAO   |                 |     | 1               | nF         |
| AOUT Offset Voltage                                 | VOSAO  |                 |     | 300             | mV         |
| Full Scale Output Voltage (Note 3)                  | VoFULL |                 | 1.0 | 1.4             | Vpp        |

## NOTE:

1. Tested at input gain of 0 dB, Fin = 1kHz.
2. Tested at input gain of 0 dB, Fs=8kHz and 16kHz.
3. Tested at output gain of 0 dB, Fout = 1kHz.
4. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

# Video Decoder

## VIDEO DECODER OVERVIEW

The TW2964 is a low power NTSC/PAL video decoder chip that is designed for video surveillance applications. It consumes very low power in a typical composite input application. The available power down mode further reduces the power consumption. It uses the 1.0V for digital supply voltage and 3.3V for I/O and analog power. A single 27MHz crystal is all that needed to decode all analog video standards.

The video decoder decodes the base-band analog CVBS into digital 8-bit 4:2:2 YCbCr for output. It consists of analog front-end with input source selection, variable gain amplifier and analog-to-digital converters, Y/C separation circuit, multi-standard color decoder (PAL BGHI, PAL M, PAL N, combination PAL N, NTSC M, NTSC 4.43) and synchronization circuitry. The Y/C separation is done with high quality adaptive 4H (5-line) comb filter for reduced cross color and cross luminance. The advanced synchronization processing circuitry can produce stable pictures for non-standard signal as well as weak signal.

## Analog Front End

The analog front-end prepares and digitizes the AC coupled analog signal for further processing. Each channel has built-in anti-aliasing filter and 10-bit over-sampling ADCs. The characteristic of the filter is available in the filter curve section. The Y channel has additional 2-input multiplexer, and a variable gain amplifier for automatic gain control (AGC). It can support a maximum input voltage range of 1.4V without attenuation. Software selectable analog inputs allow two selectable composite video inputs.

## Sync Processor

The sync processor of TW2964 detects horizontal synchronization and vertical synchronization signals in the composite video or in the Y signal of an S-video or component signal. The processor contains a digital phase-locked-loop and decision logic to achieve reliable sync detection in stable signal as well as in unstable signals such as those from VCR fast forward or backward. It allows the sampling of the video signal in line-locked fashion.

## Y/C Separation

For NTSC and PAL standard signals, the luma/chroma separation can be done either by adaptive comb filtering or notch/band-pass filter combination. The default selection for NTSC/PAL is comb filter. The characteristics of the band-pass filter are shown in the filter curve section.

TW2964 employs high quality 4-H (5-line) adaptive comb filter to reduce artifacts like hanging dots and crawling dots. Due to the line buffer used in the comb filter, there is always two lines processing delay in the output images no matter what standard or filter option is chosen.

## Color Demodulation

The color demodulation of NTSC and PAL signal is done by first quadrature down mixing and then low-pass filtering. The low-pass filter characteristic can be selected for optimized transient color performance. For the PAL system, the PAL ID or the burst phase switching is identified to aid the PAL color demodulation.

The sub-carrier signal for use in the color demodulator is generated by direct digital synthesis PLL that locks onto the input sub-carrier reference (color burst). This arrangement allows any sub-standard of NTSC and PAL to be demodulated easily with single crystal frequency.

## AUTOMATIC CHROMA GAIN CONTROL

The Automatic Chroma Gain Control (ACC) compensates for reduced amplitudes caused by high-frequency loss in video signal. The range of ACC control is -6db to +26db.

## COLOR KILLER

For low color amplitude signals, black and white video or very noisy signals, the color will be suppressed or killed. The color killer uses the burst amplitude measurement as well as sub-carrier PLL status to switch-off the color.

## AUTOMATIC STANDARD DETECTION

The TW2964 has build-in automatic standard discrimination circuitry. The circuit uses burst-phase, burst-frequency and frame rate to identify NTSC or PAL color signals. The standards that can be identified are NTSC (M), NTSC (4.43), PAL (B, D, G, H, I), PAL (M), PAL (N), PAL (60) and SECAM. Each standard can be included or excluded in the standard recognition process by software control. The identified standard is indicated by the Standard Selection (SDT) register. Automatic standard detection can be overridden by software controlled standard selection. The SECAM standard can be recognized but not properly decoded.

TW2964 supports all common video formats as shown in Table 3. The video decoder needs to be programmed appropriately for each of the composite video input formats.

TABLE 3. VIDEO INPUT FORMATS SUPPORTED BY THE TW2964

| FORMAT                 | LINES | FIELDS | FSC          | COUNTRY               |
|------------------------|-------|--------|--------------|-----------------------|
| NTSC-M                 | 525   | 60     | 3.579545 MHz | U.S., many others     |
| NTSC-Japan<br>(Note 1) | 525   | 60     | 3.579545 MHz | Japan                 |
| PAL-B, G, N            | 625   | 50     | 4.433619 MHz | Many                  |
| PAL-D                  | 625   | 50     | 4.433619 MHz | China                 |
| PAL-H                  | 625   | 50     | 4.433619 MHz | Belgium               |
| PAL-I                  | 625   | 50     | 4.433619 MHz | Great Britain, others |
| PAL-M                  | 525   | 60     | 3.575612 MHz | Brazil                |
| PAL-CN                 | 625   | 50     | 3.582056 MHz | Argentina             |
| PAL-60                 | 525   | 60     | 4.433619 MHz | China                 |
| NTSC (4.43)            | 525   | 60     | 4.433619 MHz | Transcoding           |
| NTSC 50                | 625   | 50     | 3.579545 MHz |                       |

NOTE:

1. NTSC-Japan has 0 IRE setup.

## Component Processing

The TW2964 supports the brightness, contrast, color saturation and Hue adjustment for changing the video characteristic. The Cb and Cr gain can be adjusted independently for flexibility.

## SHARPNESS

The TW2964 also provides a sharpness control function through control registers. It provides the control up to +9db. The center frequency of the enhancement curve is selectable. A coring function is provided to prevent noise enhancement.

## COLOR TRANSIENT IMPROVEMENT

A programmable Color Transient Improvement circuit is provided to enhance the color bandwidth. Low level noise enhancement can be suppressed by a programmable coring logic. Overshoot and undershoot are also removed by special circuit to prevent false color generation at the color edge.

## VIDEO OUTPUT FORMAT

The TW2964 supports ITU-R BT.656 like format. All video data and timing signal of four channels are synchronous with the pins CLKPO or CLKNO output. Therefore, CLKPO or CLKNO can be connected to four channel interfaces for synchronizing data.

## CHANNEL ID

The channel ID can be inserted in the data stream using the CHID\_MD register. Two kinds of channel ID format can be supported. One is horizontal blanking code with channel ID and the other is ITU-R BT.656 sync code with channel ID. Each ITU-R BT.656 like data stream in 4x output data, 2x output data can have this Sync Code and Blanking Code. Table 4 shows this Channel ID format. Nibble data value **m** shows Video Decoder number to be output in this video stream.

TABLE 4. THE CHANNEL ID FORMAT FOR 4X960H, 2X960H TIME-MULTIPLEXED FORMAT

| CONDITION |        |       | 656 FVH VALUE |   |   | SAV/EAV CODE SEQUENCE |        |       |                  |
|-----------|--------|-------|---------------|---|---|-----------------------|--------|-------|------------------|
| Field     | Vtime  | Htime | F             | V | H | First                 | Second | Third | Fourth           |
| EVEN      | Blank  | EAV   | 1             | 1 | 1 | 0xFF                  | 0x00   | 0x00  | 0xFm             |
| EVEN      | Blank  | SAV   | 1             | 1 | 0 | 0xFF                  | 0x00   | 0x00  | 0xE <sub>m</sub> |
| EVEN      | Active | EAV   | 1             | 0 | 1 | 0xFF                  | 0x00   | 0x00  | 0xD <sub>m</sub> |
| EVEN      | Active | SAV   | 1             | 0 | 0 | 0xFF                  | 0x00   | 0x00  | 0xC <sub>m</sub> |
| ODD       | Blank  | EAV   | 0             | 1 | 1 | 0xFF                  | 0x00   | 0x00  | 0xB <sub>m</sub> |
| ODD       | Blank  | SAV   | 0             | 1 | 0 | 0xFF                  | 0x00   | 0x00  | 0xA <sub>m</sub> |
| ODD       | Active | EAV   | 0             | 0 | 1 | 0xFF                  | 0x00   | 0x00  | 0x9 <sub>m</sub> |
| ODD       | Active | SAV   | 0             | 0 | 0 | 0xFF                  | 0x00   | 0x00  | 0x8 <sub>m</sub> |

(a) ITU-R BT.656 Sync Code with Channel ID

| VIDEO            | H BLANKING CODE WITH CHANNEL ID |                   |                   |
|------------------|---------------------------------|-------------------|-------------------|
|                  | Y                               | CB                | CR                |
| VIN <sub>n</sub> | 8'h1 <sub>m</sub>               | 8'h8 <sub>m</sub> | 8'h8 <sub>m</sub> |

(b) Horizontal Blanking Code with Channel ID

As default, m = 0 Video1 656 data, m = 1 Video2 656 data, m = 2 Video3 656 data, m = 3 Video4 656 data. n = m+1.CH1NUM, CH2NUM, CH3NUM and CH4NUM registers can change this m value in each video channel output data if necessary.

## VIDEO LOSS OUTPUT

When NOVID\_656 register is set to 1, bit7 of Fourth byte of SAV/EAV code will be 0 when video signal is lost. This can be an optional set of 656 SAV/EAV code for no-video (video lost) specific application.

## ITU-R BT.656 LIKE FORMAT

In ITU-R BT.656 like format, SAV and EAV sequences are inserted into the data stream to indicate the active video time. It is noted that the number of active pixels per line is constant in this mode regardless of the actual incoming line length. The output timing is illustrated in Figure 2. The SAV and EAV sequences are shown in Table 5. An optional set of 656 SAV/EAV code sequence can be enabled to identify no-video status using the NOVID\_656 bit.

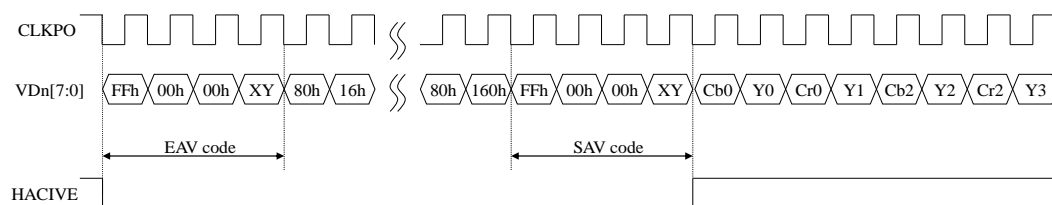


FIGURE 2. TIMING DIAGRAM OF ITU-R BT.656 LIKE FORMAT

TABLE 5. ITU-R BT.656 LIKE SAV AND EAV CODE SEQUENCE

| CONDITION |        |        | 656 FVH VALUE |   |   | SAV/EAV CODE SEQUENCE |        |       |        |                      |
|-----------|--------|--------|---------------|---|---|-----------------------|--------|-------|--------|----------------------|
| FIELD     | V TIME | H TIME | F             | V | H | FIRST                 | SECOND | THIRD | FOURTH |                      |
|           |        |        |               |   |   |                       |        |       | NORMAL | OPTION (NOTE NOTE:1) |
| EVEN      | Blank  | EAV    | 1             | 1 | 1 | 0xFF                  | 0x00   | 0x00  | 0xF1   | 0x71                 |
| EVEN      | Blank  | SAV    | 1             | 1 | 0 | 0xFF                  | 0x00   | 0x00  | 0xEC   | 0x6C                 |
| EVEN      | Active | EAV    | 1             | 0 | 1 | 0xFF                  | 0x00   | 0x00  | 0xDA   | 0x5A                 |
| EVEN      | Active | SAV    | 1             | 0 | 0 | 0xFF                  | 0x00   | 0x00  | 0xC7   | 0x47                 |
| ODD       | Blank  | EAV    | 0             | 1 | 1 | 0xFF                  | 0x00   | 0x00  | 0xB6   | 0x36                 |
| ODD       | Blank  | SAV    | 0             | 1 | 0 | 0xFF                  | 0x00   | 0x00  | 0xAB   | 0x2B                 |
| ODD       | Active | EAV    | 0             | 0 | 1 | 0xFF                  | 0x00   | 0x00  | 0x9D   | 0x1D                 |
| ODD       | Active | SAV    | 0             | 0 | 0 | 0xFF                  | 0x00   | 0x00  | 0x80   | 0x00                 |

NOTE:

- Option includes video loss information in ITU-R BT.656 like format.

## TWO CHANNEL ITU-R BT.656 TIME-MULTIPLEXED FORMAT WITH 54/72MHZ

The TW2964 supports two channels ITU-R BT.656 like time-multiplexed format with x2(54MHz/72MHz) that is useful to security application requiring two channel outputs through one channel video port. The CHMDn register enables the dual ITU-R BT.656 like time-multiplexed format and the MAINCHn/SELCHn register selects channel output to be multiplexed with its own channel on each VD pins. To de-multiplex the time-multiplexed data in the back end chip, the channel ID can be inserted in the data stream using the CHID\_MD register. Two kinds of channel ID format can be supported. One is horizontal blanking code with channel ID and the other is ITU-R BT.656 sync code with channel ID. Figure 3 and Figure 4 illustrate VFn[7:0]/CLKPO/CLKNO pin timing with x2(72MHz/54MHz),x1(27MHz/36MHz) clock output mode.

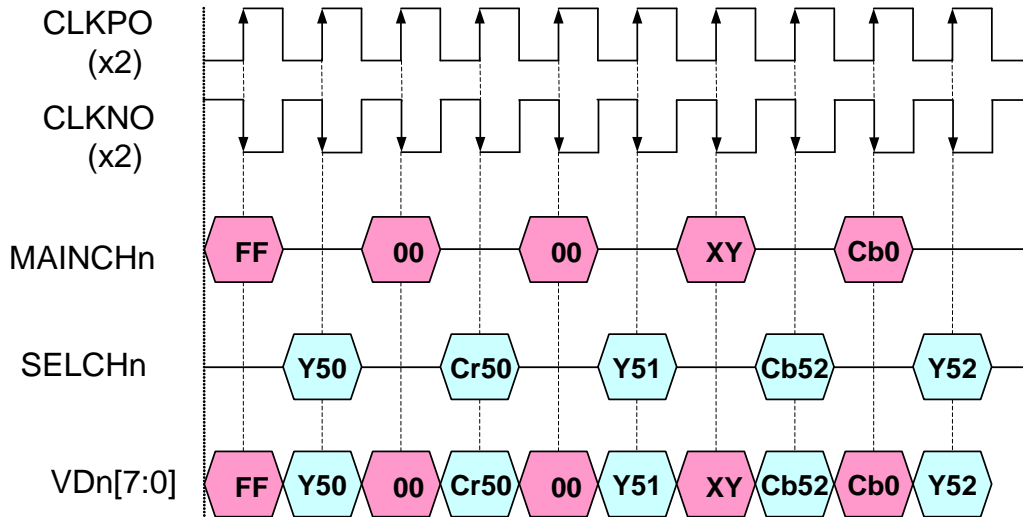


FIGURE 3. PIN OUTPUT TIMING OF TWO CHANNEL TIME-MULTIPLEXED FORMAT WITH X2 CLOCK

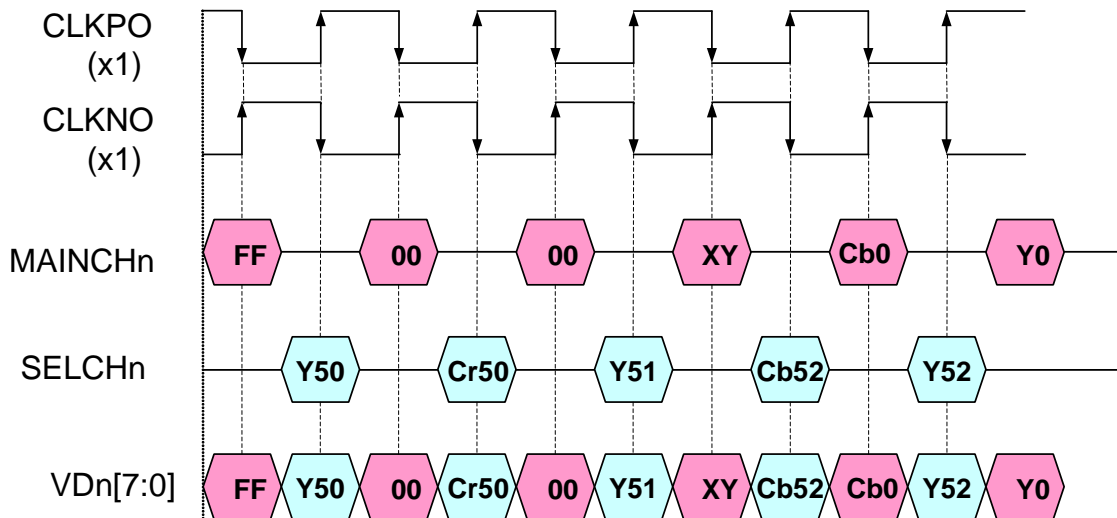


FIGURE 4. PIN OUTPUT TIMING OF TWO CHANNEL TIME-MULTIPLEXED FORMAT WITH X1 CLOCK.

### FOUR CHANNEL 960H TIME-DIVISION-MULTIPLEXED FORMAT WITH 108/144MHZ

Four channel of 960H/720H at 36MHz/27MHz video stream that are time-division-multiplexed at x4(144MHz/108MHz) data rate format is implemented in TW2964 for security surveillance application. In order to reduce pin counts (thus shrink chip size) on both decoder's digital output port and the input port of the back end compression Codec devices, TW2964 implements single 8-bit bus at 4 times the base band pixel clock rate of x1(36MHz/27MHz). While quadrupling the data rate on a single bus to meet the new requirement, individually, each channel data arrangement still retains the base band x1(36MHz/27MHz) ITU-R BT.656 like specification. For interface that can accept the new x4(144MHz/108MHz) clock bus, only one single clock at x4(144MHz/108MHz) is required. Embedded timing (SAV-EAV) code and Channel ID are inserted into each channel for de-multiplexing and separation of channel data.

Figure 5 depicts the temporal arrangement of the video data in x4(144MHz/108MHz) data rate. Each channel is byte level time-division multiplexed (TDM). Main clock is x4(144MHz/108MHz) clock

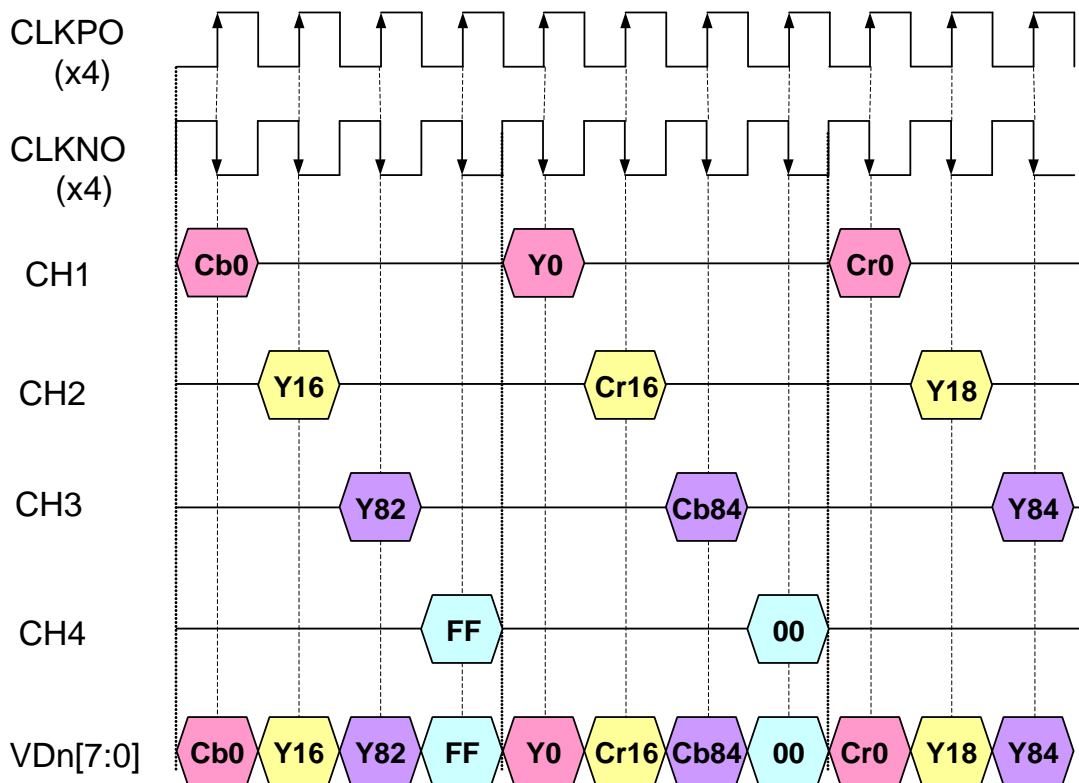


FIGURE 5. PIN OUTPUT TIMING OF 144MHZ 4 CH 960H TIME-DIVISION-MULTIPLEXED VIDEO DATA WITH X4 CLOCK

TABLE 6. SHOWS THE SPECIAL FORMAT OF ITU-R BT. 656 LIKE EMBEDDED TIMING CODE AND CHANNEL ID CODE

| CONDITION |        |        | 656 FVH VALUE |   |   | SAV-EAV CODE |        |       |        |      |      |      |
|-----------|--------|--------|---------------|---|---|--------------|--------|-------|--------|------|------|------|
| Field     | V-time | H-time | F             | V | H | First        | Second | Third | Fourth |      |      |      |
|           |        |        |               |   |   |              |        |       | Ch1    | Ch2  | Ch3  | Ch4  |
| EVEN      | BLANK  | EAV    | 1             | 1 | 1 | 0xFF         | 0x00   | 0x00  | 0xF0   | 0xF1 | 0xF2 | 0xF3 |
| EVEN      | BLANK  | SAV    | 1             | 1 | 0 | 0xFF         | 0x00   | 0x00  | 0xE0   | 0xE1 | 0xE2 | 0xE3 |
| EVEN      | ACTIVE | EAV    | 1             | 0 | 1 | 0xFF         | 0x00   | 0x00  | 0xD0   | 0xD1 | 0xD2 | 0xD3 |
| EVEN      | ACTIVE | SAV    | 1             | 0 | 0 | 0xFF         | 0x00   | 0x00  | 0xC0   | 0xC1 | 0xC2 | 0xC3 |
| ODD       | BLANK  | EAV    | 0             | 1 | 1 | 0xFF         | 0x00   | 0x00  | 0xB0   | 0xB1 | 0xB2 | 0xB3 |
| ODD       | BLANK  | SAV    | 0             | 1 | 0 | 0xFF         | 0x00   | 0x00  | 0xA0   | 0xA1 | 0xA2 | 0xA3 |
| ODD       | ACTIVE | EAV    | 0             | 0 | 1 | 0xFF         | 0x00   | 0x00  | 0x90   | 0x91 | 0x92 | 0x93 |
| ODD       | ACTIVE | SAV    | 0             | 0 | 0 | 0xFF         | 0x00   | 0x00  | 0x80   | 0x81 | 0x82 | 0x83 |

## OUTPUT ENABLING ACT

After power-up, the TW2964 registers have the default values. After RSTB pin is asserted and released, all registers have the default values. After reset, the TW2964 data outputs are tri-stated. The OE register should be written after reset to enable outputs desired.

## VIDEO OUTPUT CHANNEL SELECTION

If CHMDn[1:0] in Reg0xCA is set to 0hex, MAINCHn[1:0] in Reg0xCD selects one number of Video Channels to be output on VDn[7:0] pin as Single Channel ITU-R BT.656 like Format output. If CHMDn[1:0] in Reg0xCA is set to 1hex, MAINCHn[1:0] in Reg0xCD and SELCHn[1:0] in Reg0xCC select two numbers of Video Channels to be output on VDn[7:0] pin as Two Channel ITU-R BT.656 like Time-multiplexed Format output. If CHMDn[1:0] in Reg0xCA is set to 2hex, Four Channel ITU-R BT.656 like x4 Time-multiplexed Format is output on VDn[7:0] pin.

## EXTRA SYNC OUTPUT

The additional timing information such as syncs and field flag are also supported through the MPP pins. The video output timing is illustrated in Figure 6 and Figure 7. TW2964 HS/VS/FLD output function is compatible to TW9907 Video decoder HSYNC/VS/FLD output function. Start of VS timing is controlled by VSHT register(V timing) and OVSDLY register(H timing). End of VS timing is controlled by OVSEND register(V Timing). Start of FLD timing is controlled by OFDLY register(V timing). Start of HS timing is controlled by HSBEGIN register and End of HS timing is controlled by HSEND register.



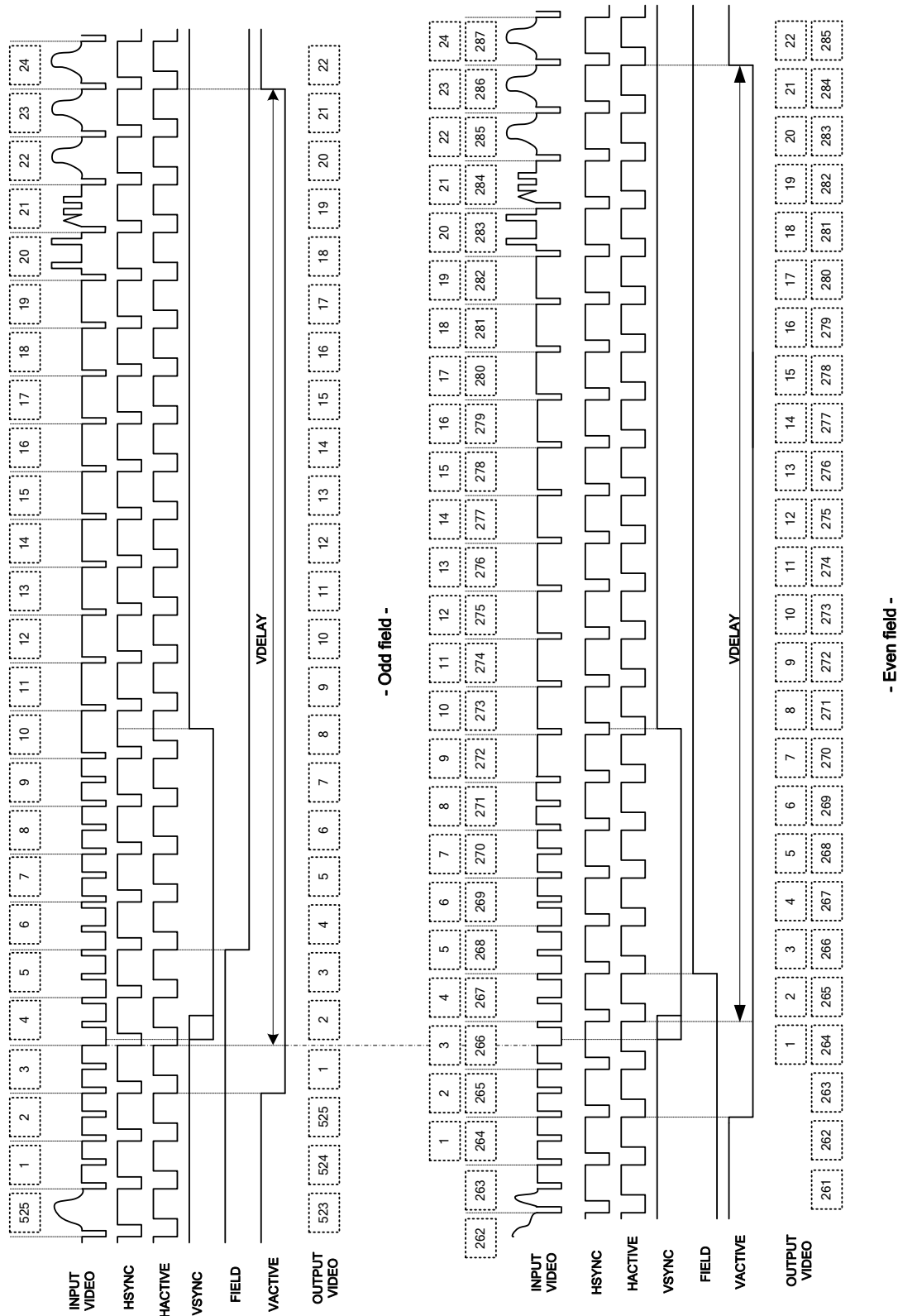


FIGURE 6. VERTICAL TIMING DIAGRAM FOR 60HZ/525 LINE SYSTEM

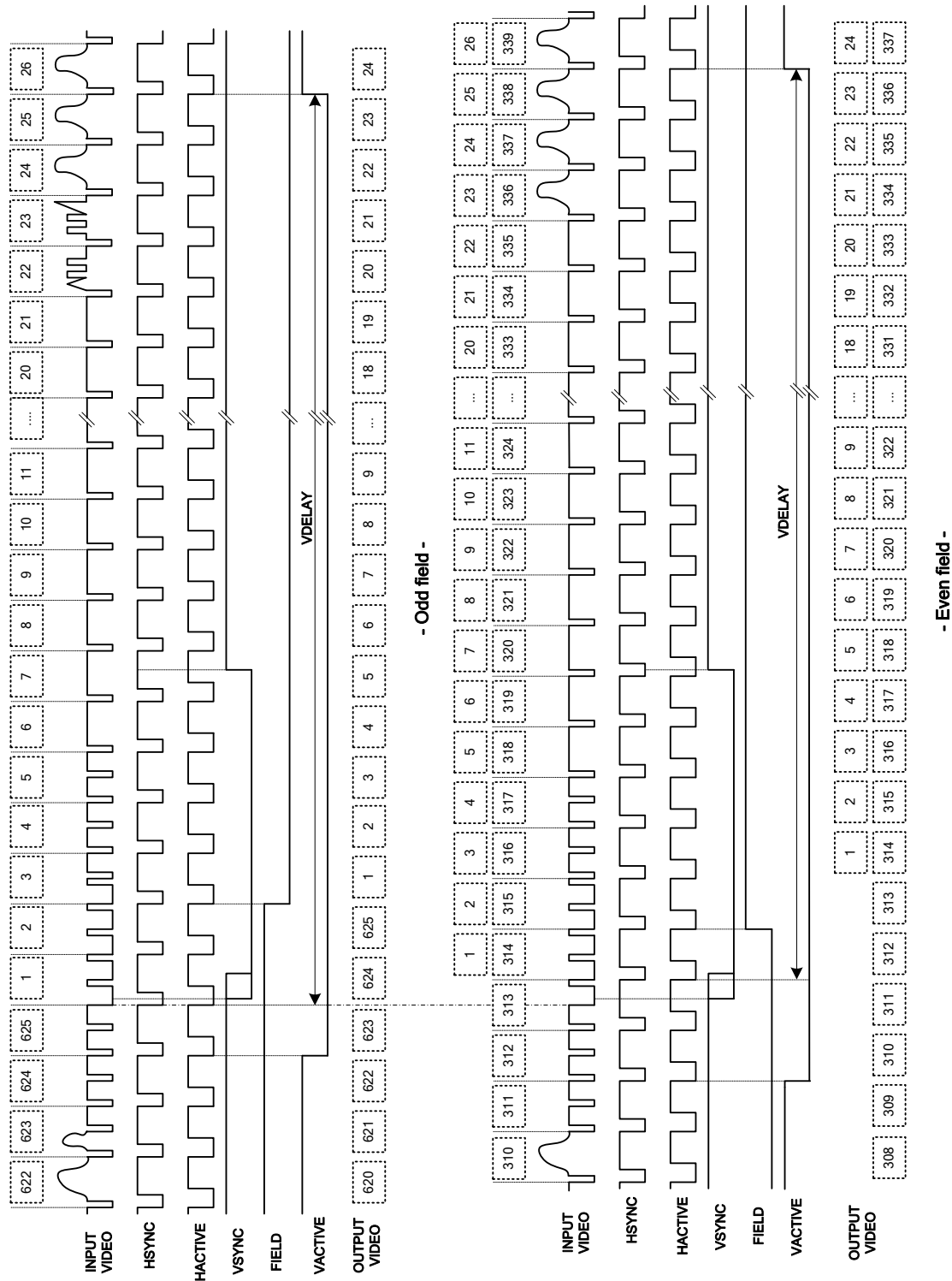


FIGURE 7. VERTICAL TIMING DIAGRAM FOR 50HZ/625 LINE SYSTEM

## Audio Codec

The audio codec in the TW2964 is composed of five audio Analog-to-Digital converters processing, one Digital-to-Analog converter, audio mixer, digital serial audio interface and audio detector shown as the Figure 8. The TW2964 can accept 5 analog audio signals and 1 digital serial audio data and produce 1 mixing analog audio signal and 2 digital serial audio data.

The level of analog audio input signal AIN1 ~ AIN5 can be adjusted respectively by internal programmable gain amplifiers that are defined via the AIGAIN1,AIGAIN2,AIGAIN3,AIGAIN4 and AIGAIN5 registers and then sampled by each Analog-to-Digital converters. The digital serial audio input data through the ACLKP, ASYNP and ADATP pins are used for playback function. To record audio data, the TW2964 provides the digital serial audio output via the ACLKR, ASYNR and ADATR pins.

The TW2964 can mix all of audio inputs including analog audio signal and digital audio data according to the predefined mixing ratio for each audio via the MIX\_RATIO1 ~ MIX\_RATIO5 and MIX\_RATIO6 registers. This mixing audio output can be provided through the analog and digital interfaces. The embedded audio Digital-to-Analog converter supports the analog mixing audio output whose level can be controlled by programmable gain amplifier via the AOGAIN register. The ADATM pin supports the digital mixing audio output and its digital serial audio timings are provided through the ACLKR and ASYNR pins that are shared with the digital serial audio record timing pins.

The main purpose of AIN5 is to make the standard I2S/DSP digital audio output on ADATM pin for special application. Usually, 4 AIN1/AIN2/AIN3/AIN4 audio data are only used on ADATR pin output.

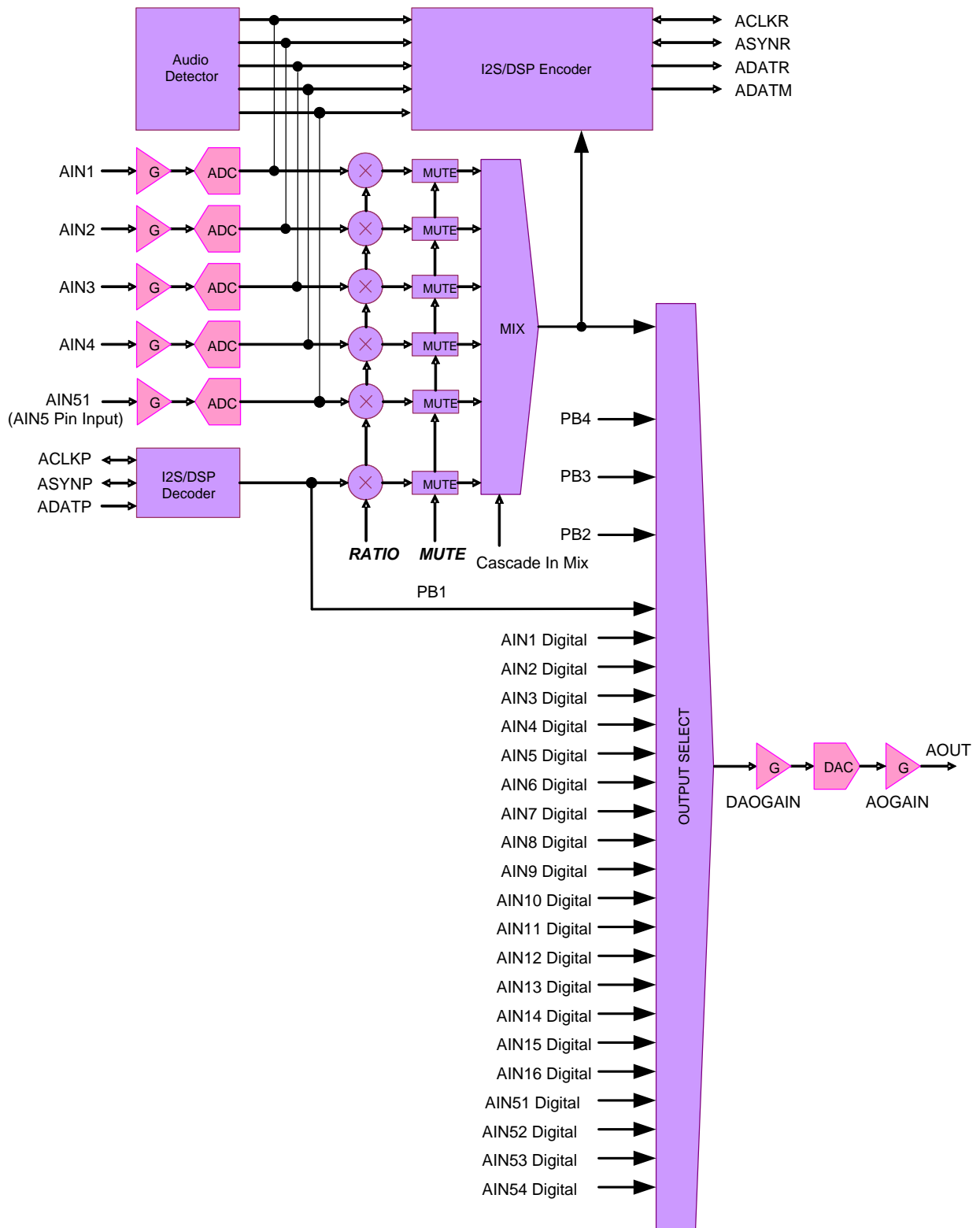


FIGURE 8. BLOCK DIAGRAM OF AUDIO CODEC

## AUDIO CLOCK MASTER/SLAVE MODE

The TW2964 has two types of Audio Clock modes. If ACLKRMAS<sub>TER</sub> register is set to 1, fs audio sample date is processed from audio clock internal ACKG (Audio Clock Generator) generates. In this master mode, ACLKR/ASYNR pins are output mode. ASYNROEN register for ASYNR pin should be set to 0 (output enable mode). If ACLKRMAS<sub>TER</sub> register is set to 0, fs audio sample rate is processed from audio clock on ACLKR pin input. 256xfs, 320xfs or 384xfs audio clock should be connected to ACLKR pin from external master clock source in this slave mode. ASYNR pin can be input or output by external Audio clock master in slave mode. ASYNR signal should change per fs audio sample rate in both master and slave mode. AIN5MD and AFS384 register set up Audio fs mode by following table.

| REGISTER |        | FS MODE |
|----------|--------|---------|
| AIN5MD   | AFS384 |         |
| 0        | 0      | 256xfs  |
| 1        | 0      | 320xfs  |
| 0        | 1      | 384xfs  |

## AUDIO DETECTION

The TW2964 has an audio detector for individual 5 channels. There are 2 kinds of audio detection method defined by the ADET\_TH. One is the detection of absolute amplitude and the other is of differential amplitude. For both detection methods, the accumulating period is defined by the ADET\_FILT register and the detecting threshold value is defined by the ADET\_TH1 ~ ADET\_TH5 registers. The detection of differential amplitude is recommended for most use. The status for audio detection is read by the STATE\_AVDET register and it also makes the interrupt request through the IRQ pin with the combination of the status for video loss detection.

## MULTI-CHIP OPERATION

TW2964 can output 16 channel audio data on ACLKR/ASYNR/ADATR output simultaneously. Therefore, up to 4 chips should be connected on most Multi-Chip application cases. SMD register selects Audio cascade serial interface mode. If SMD register is set to 2, ALINKI pin is audio cascade serial input and ALINKO pin is audio cascade serial output mode.

Each stage chip can accept 5 analog audio signals so that four cascaded chips will be 16-channel audio controller as default {AFS384, AIN5MD} = 00. The first stage chip provides 16ch digital serial audio data for record. Even though the first stage chip has only 1 digital serial audio data pin ADATR for record, the TW2964 can generate 16 channel data simultaneously using multi-channel method. In addition, each stage chip can support 4 channel record outputs that are corresponding with analog audio inputs. This first stage chip can also output 16 channel mixing audio data by the digital serial audio data and analog audio signal. The first stage chip accepts the digital serial audio data for playback. The digital playback data can be converted to analog signal by Digital-to-Analog converter in the first stage chip.

Several Master/Slave mode configurations are available. Figure 9 is the most recommended and demanded system with Clock Master mode (ACLKRMAS<sub>TER</sub> = 1). Figure 10 is the most recommended system with Clock Slave Sync Slave mode (ACLKRMAS<sub>TER</sub>=0, ASYNROEN=1). Other system combinations are also available if application need different type specific system. Figure 9 and Figure 10 show the most typical system.

In the following FIGURES, Mix1-16-51-54/Pb1 means Mix output of AIN1-16, AIN51-54 and Playback1. AIN1-16-51-54/Pb1 means one selected Audio output in AIN1-16-51-54/Pb1.

If one of TW2964s uses {AFS384, AIN5MD} = 01 or {AFS384, AIN5MD} = 10, all other cascaded TW2964 chips must set up same {AFS384 AIN5MD} mode together.

In Multi-Chip Audio operation mode, one same Oscillator clock source need to be connected to all TW2964 XTI pins.

If special application needs 108MHz XTI input, the RSTB pin input control needs to be considered. RSTB input controlled by MPP4 or MPP3 GPO output is one of the solutions. Another way needs XTI/RSTB timing control, as shown in Figure 9. RSTB/XTI timing control is not required in 27MHz XTI mode.

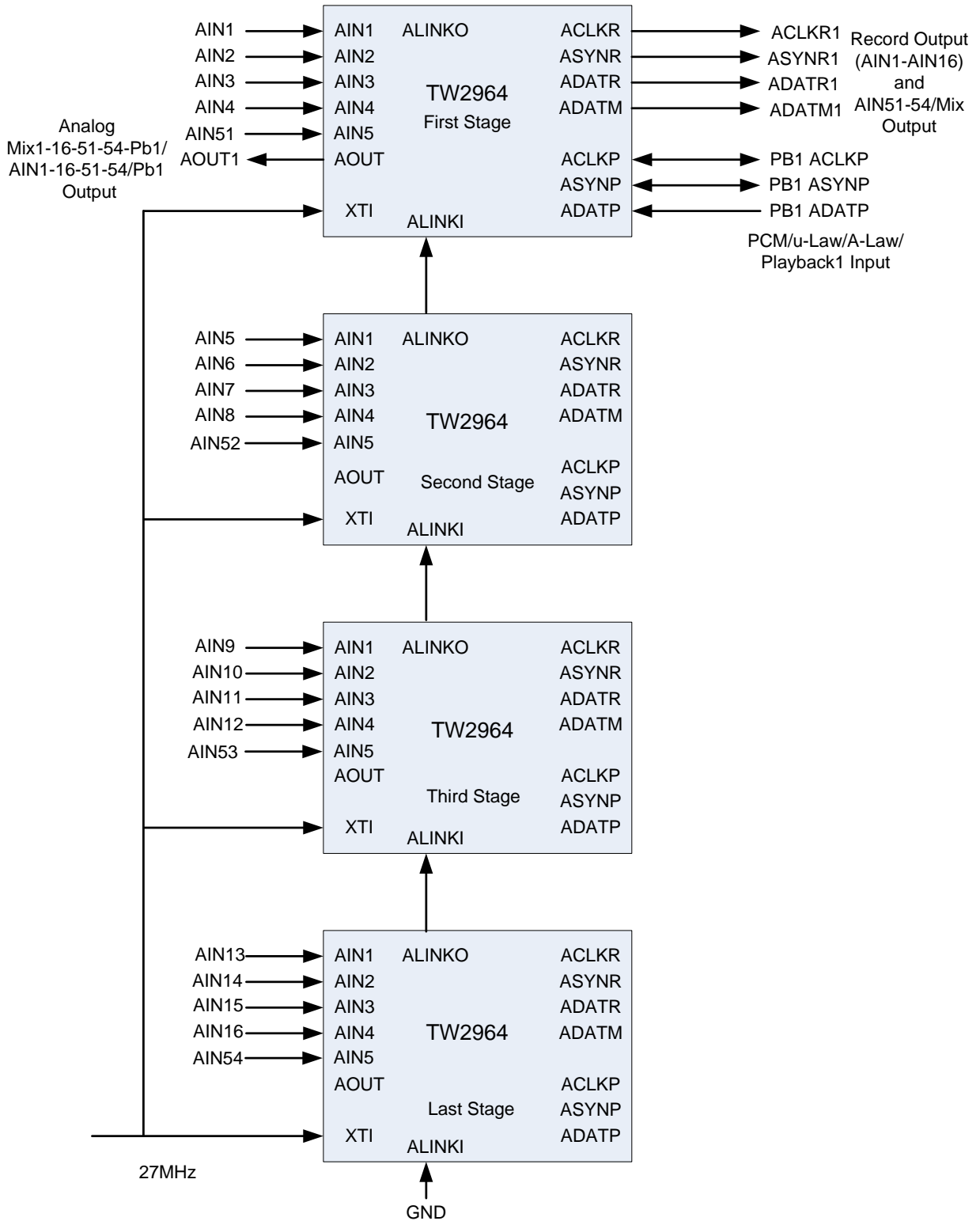


FIGURE 9. RECOMMENDED CLOCK MASTER CASCADE MODE SYSTEM

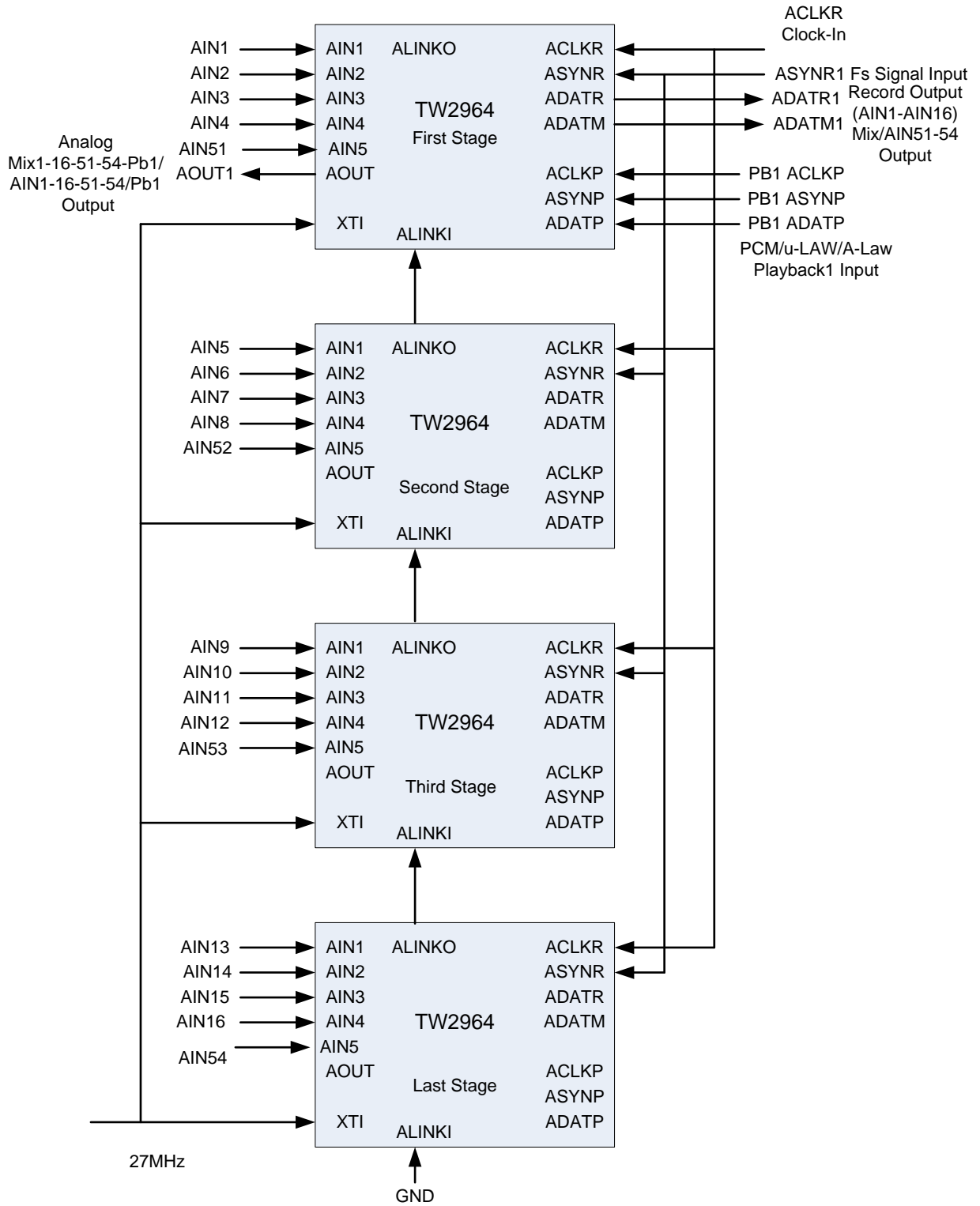


FIGURE 10. RECOMMENDED CLOCK SLAVE SYNC SLAVE CASCADE MODE SYSTEM



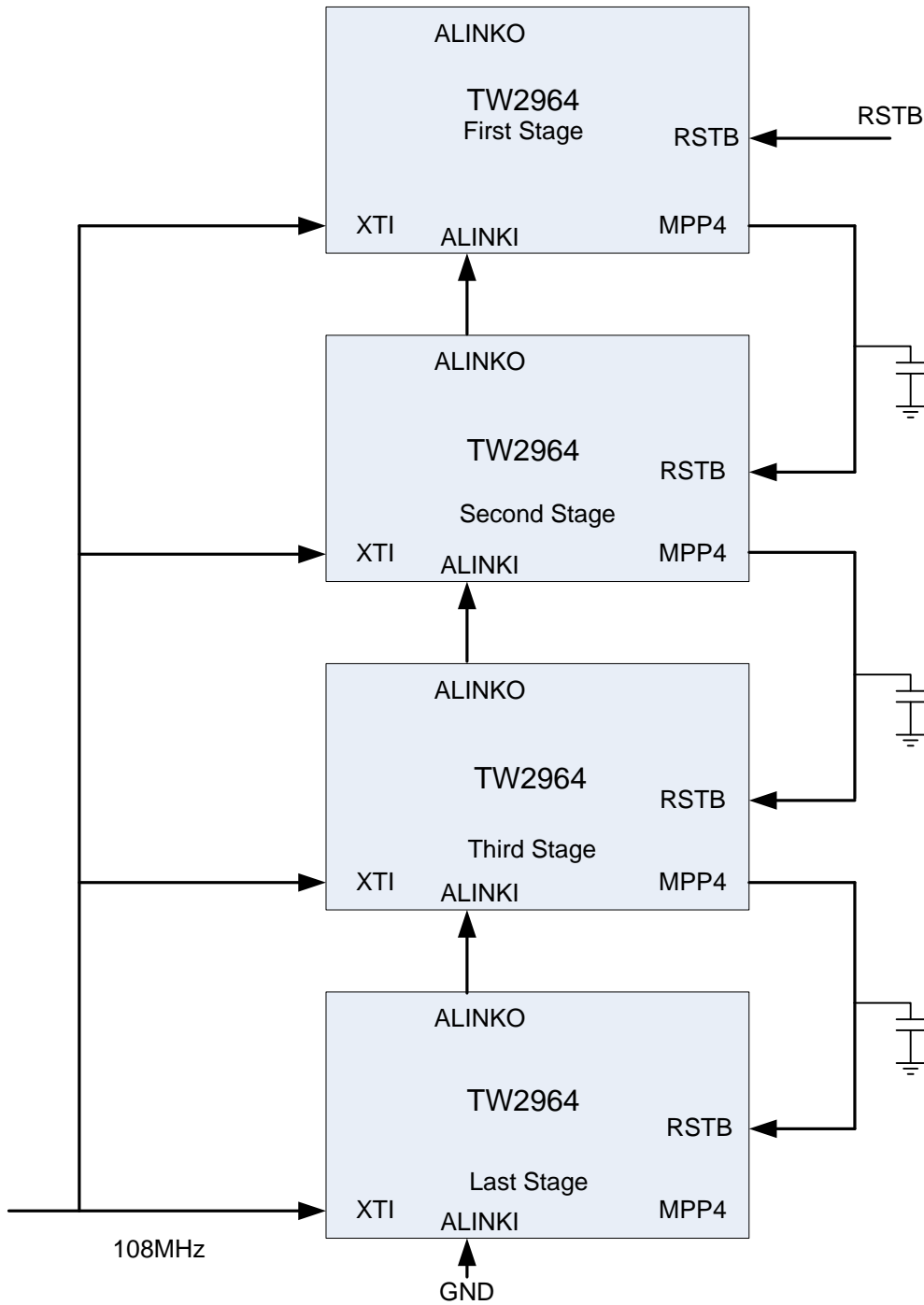
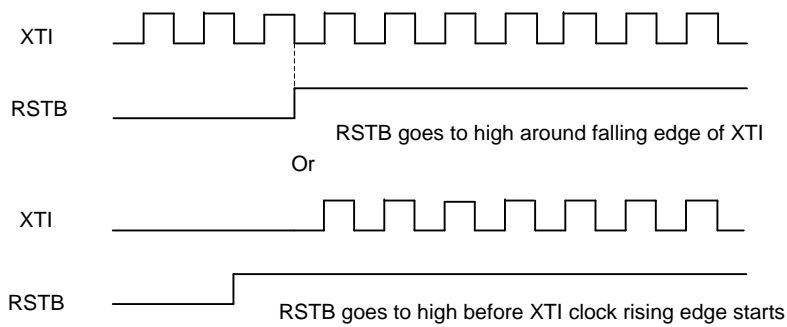
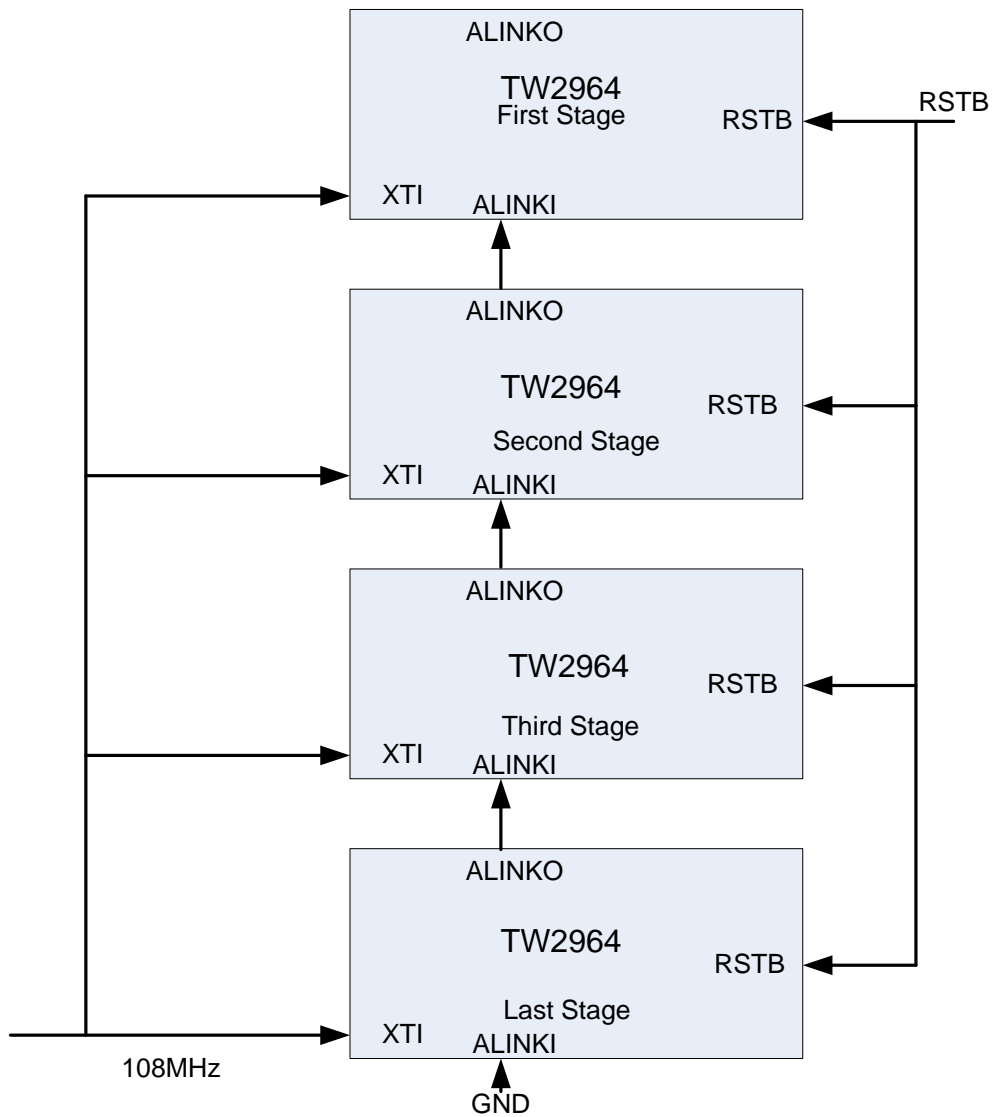


FIGURE 11. RSTB CONTROL BY MPP4GPO OUTPUT FOR 108MHZ XTI INPUT



**FIGURE 12. RSTB CONTROL FOR 108MHZ XTI INPUT**

## SERIAL AUDIO INTERFACE

There are 3 kinds of digital serial audio interfaces in the TW2964; the first is a recording output, the second is a mixing output and the third is a playback input. These 3 digital serial audio interfaces follow a standard I2S or DSP interface as shown in Figure 13.

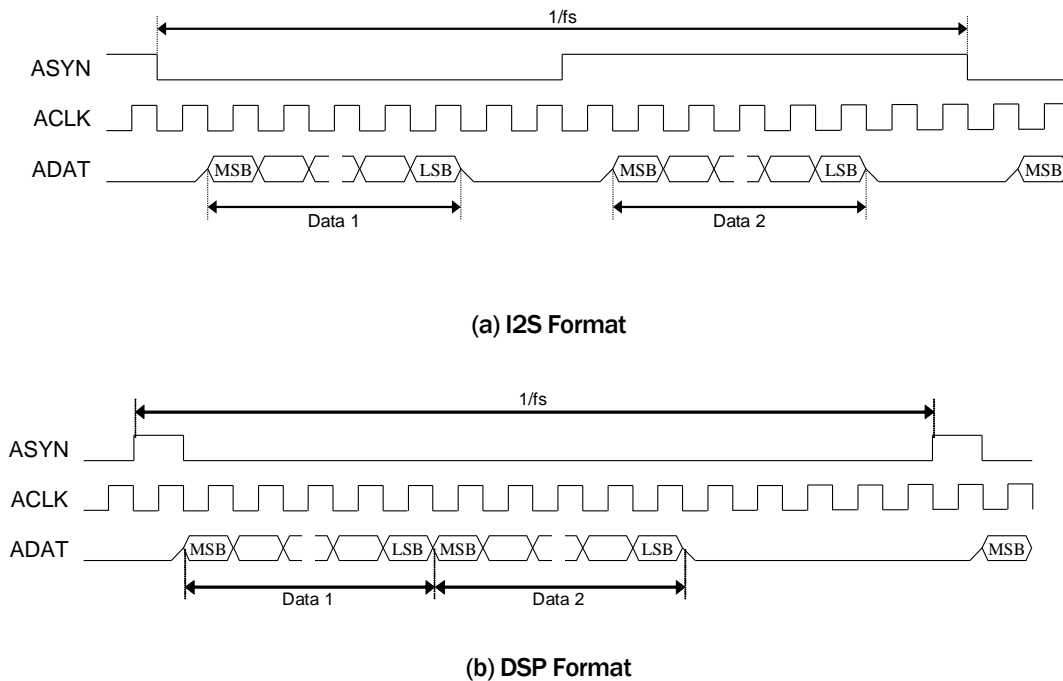


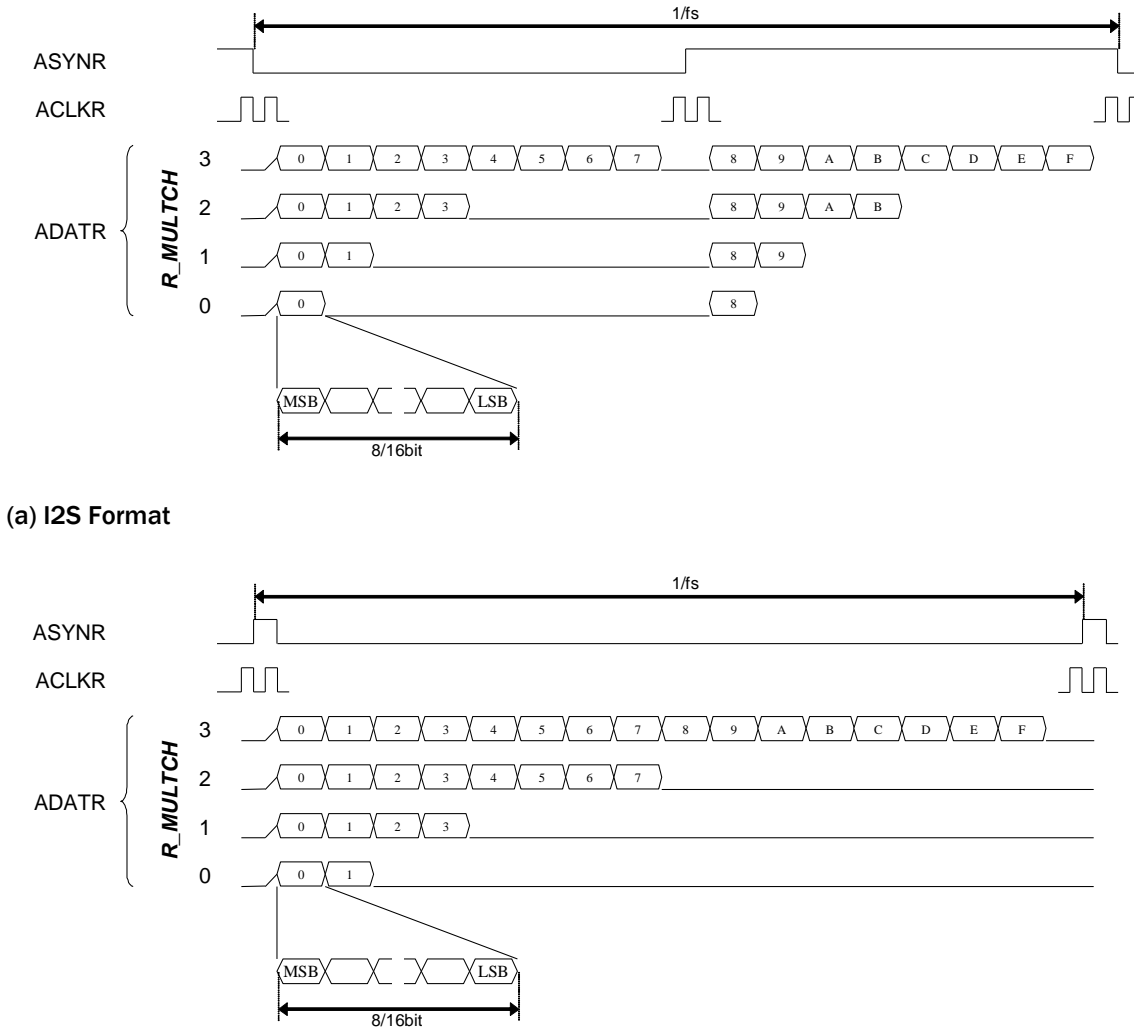
FIGURE 13. FIG13 TIMING CHART OF SERIAL AUDIO INTERFACE

### Playback Input

The serial interface using the ACLKP, ASYNP and ADATP pins accepts the digital serial audio data for the playback purpose. The ACLKP and ASYNP pins can be operated as master or slave mode. For master mode, these pins work as output pin and generate the standard audio clock and synchronizing signal. For slave mode, these pins are input mode and accept the standard audio clock and synchronizing signal. The ADATP pin is always input mode regardless of operating mode. One of audio data in left or right channel should be selected for playback audio by the PB\_LRSEL.

**Record Output**

To record audio data, the TW2964 provides the digital serial audio data through the ACLKR, ASYNR and ADATR pins. Sampling frequency comes from 256xfs, 320xfs or 384xfs audio system clock setting. Even though the standard I2S and DSP format can have only 2 audio data on left and right channel, the TW2964 can provide an extended I2S and DSP format which can have 16 channel audio data through ADATR pin. The R\_MULTCH defines the number of audio data to be recorded by the ADATR pin. ASYNR signal is always fs frequency rate. One ASYNR period is always equal to 256xACLKR clock length with AIN5MD=0. Figure 14 shows the digital serial audio data organization for multi-channel audio.



(a) I2S Format

(b) DSP Format

**FIGURE 14. TIMING CHART OF MULTI-CHANNEL AUDIO RECORD**

Table 7 shows the sequence of audio data to be recorded for each mode of the R\_MULTCH register. The sequences of 0 ~ F do not mean actual audio channel number but represent sequence only. The actual audio channel should be assigned to sequence 0 ~ F by the R\_SEQ\_0 ~ R\_SEQ\_F register. When the ADATM pin is used for record via the R\_ADATM register, the audio sequence of ADATM is also shown in Table 7.

**TABLE 7. SEQUENCE OF MULTI-CHANNEL AUDIO RECORD**

(a) I2S Format

| R_MULTCH | PIN   | LEFT CHANNEL |   |   |   |   |   |   |   | RIGHT CHANNEL |   |   |   |   |   |   |   |
|----------|-------|--------------|---|---|---|---|---|---|---|---------------|---|---|---|---|---|---|---|
| 0        | ADATR | 0            |   |   |   |   |   |   |   | 8             |   |   |   |   |   |   |   |
|          | ADATM | F            |   |   |   |   |   |   |   | 7             |   |   |   |   |   |   |   |
| 1        | ADATR | 0            | 1 |   |   |   |   |   |   | 8             | 9 |   |   |   |   |   |   |
|          | ADATM | F            | E |   |   |   |   |   |   | 7             | 6 |   |   |   |   |   |   |
| 2        | ADATR | 0            | 1 | 2 | 3 |   |   |   |   | 8             | 9 | A | B |   |   |   |   |
|          | ADATM | F            | E | D | C |   |   |   |   | 7             | 6 | 5 | 4 |   |   |   |   |
| 3        | ADATR | 0            | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8             | 9 | A | B | C | D | E | F |
|          | ADATM | F            | E | D | C | B | A | 9 | 8 | 7             | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

(b) DSP Format

| R_MULTCH | PIN   | LEFT/RIGHT CHANNEL |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|----------|-------|--------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0        | ADATR | 0                  | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|          | ADATM | F                  | E |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1        | ADATR | 0                  | 1 | 2 | 3 |   |   |   |   |   |   |   |   |   |   |   |   |
|          | ADATM | F                  | E | D | C |   |   |   |   |   |   |   |   |   |   |   |   |
| 2        | ADATR | 0                  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |   |   |   |   |   |   |   |   |
|          | ADATM | F                  | E | D | C | B | A | 9 | 8 |   |   |   |   |   |   |   |   |
| 3        | ADATR | 0                  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|          | ADATM | F                  | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

**Mix Output**

The digital serial audio data on the ADATM pin has 2 different audio data, which are mixing audio, and playback audio. The mixing digital serial audio data is the same as analog mixing output. The sampling frequency, bit width and number of audio for the ADATM pin are same as the ADATR pin because the ACLKR and ASYNR pins are shared with the ADATR and ADATM pins.

### AUDIO CLOCK SLAVE MODE DATA OUTPUT TIMING

TW2964 always output ASYNR/ADATR/ADATM by ACLKR falling edge triggered timing. ADATR/ADATM output data are always changing at next ACLKR falling edge triggered timing after ASYNR signal changes. If ASYNR is output, ADATR/ADATM output are always fixed to one ACLKR falling edge timing. However, if ASYNR is input, ADATR/ADATM output timing changes by ASYNR input timing.

ASYNR is ACLKR falling edge triggered input/output

If ASYNR is input and ASYNR input is ACLKR falling edge triggered input as ASYNR input signal is changing after ACLKR falling edge, or if ASYNR is output, TW2964 output ADATR/ADATM by ACLKR falling edge triggered timing as shown in the following FIGURES. ASYNR signal is changing during ACLKR = 0. TW2964 output ADATR/ADATM data after next ACLKR falling edge triggered timing with more than half ACLKR clock delay.

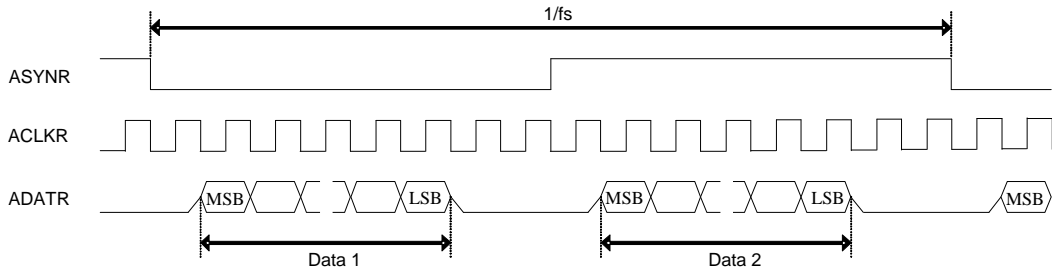


FIGURE 15. ACLKMASTER=0, RM\_SYNC=0

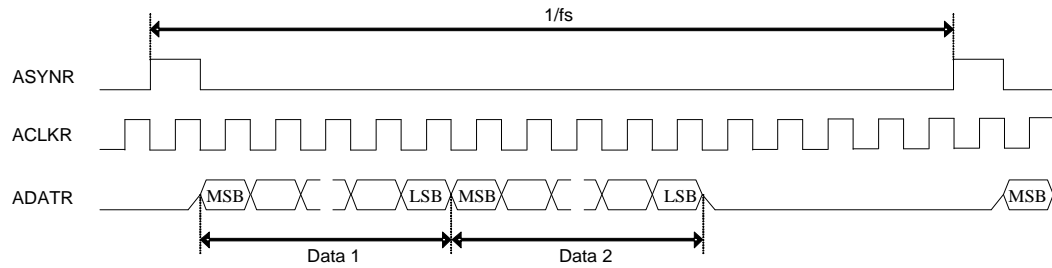
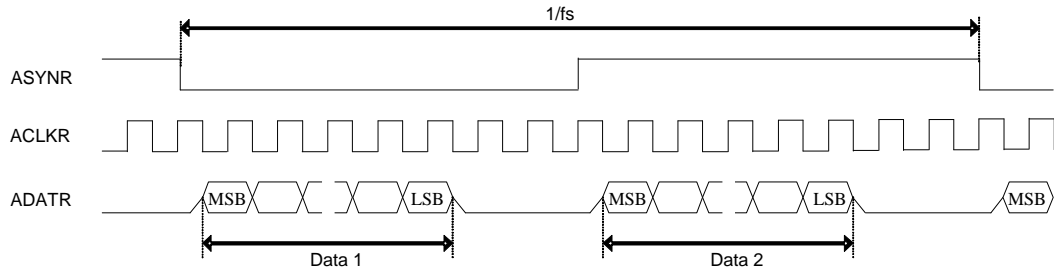


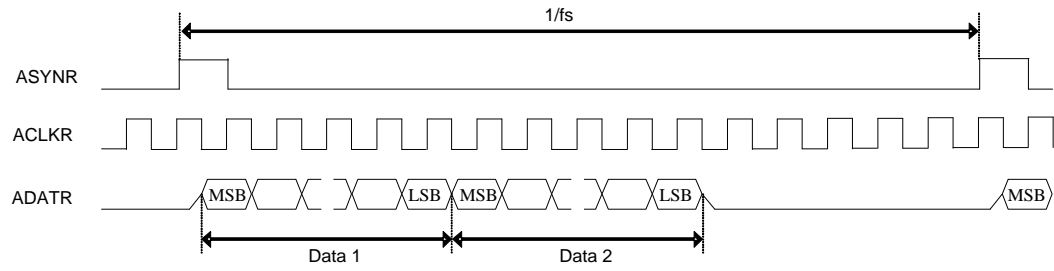
FIGURE 16. ACLKMASTER=0, RM\_SYNC=1

ASYNR is ACLKR rising edge triggered input

If ASYNR is input and ASYNR input is ACLKR rising edge triggered input as ASYNR input signal is changing after ACLKR rising edge, TW2964 output ADATR/ADATM by ACLKR falling edge triggered timing as shown in the following FIGURES. ASYNR signal is changing during ACLKR = 1. TW2964 output ADATR/ADATM data after next ACLKR falling edge triggered timing with less than half ACLKR clock delay.



**FIGURE 17. ACLKMASTER=0, RM\_SYNC=0, ASYNROEN=1**



**FIGURE 18. ACLKMASTER=0, RM\_SYNC=1, ASYNROEN=1**

### ACLKP/ASYNP SLAVE MODE DATA INPUT TIMING

The following 8 data input timings are supported. ADATPDLY register needs to be set up according to the difference of ADATP data input timings. Data1 is only used as default. The MSB bit is the first input bit as default PBINSWAP = 0. If PBINSWAP = 1, LSB bit is the first input bit.

ASYNP is ACLKP falling edge triggered input.

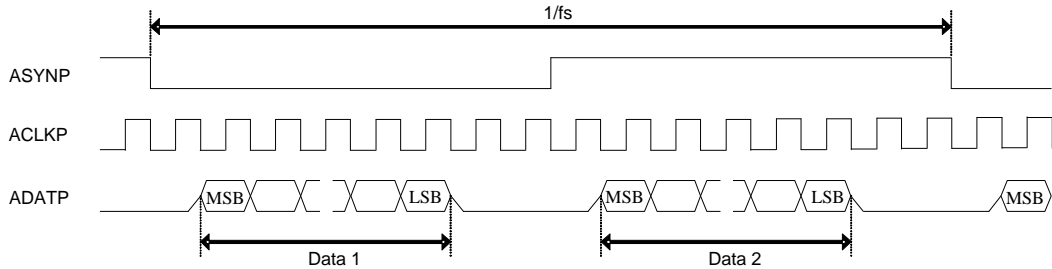


FIGURE 19. RM\_SYNC=0, PB\_MASTER=0, ADATPDLY=0

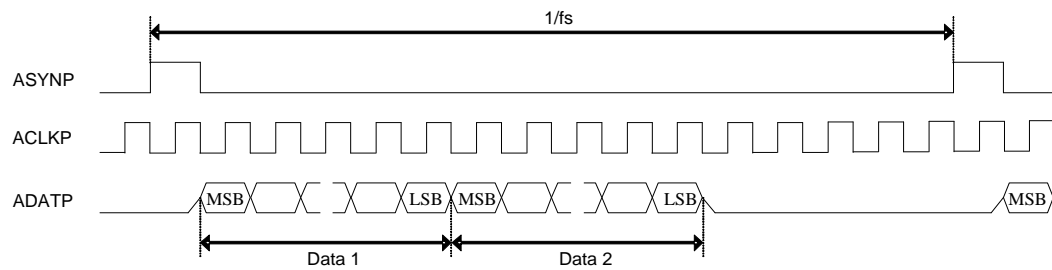


FIGURE 20. RM\_SYNC=1, PB\_MASTER=0, ADATPDLY=0

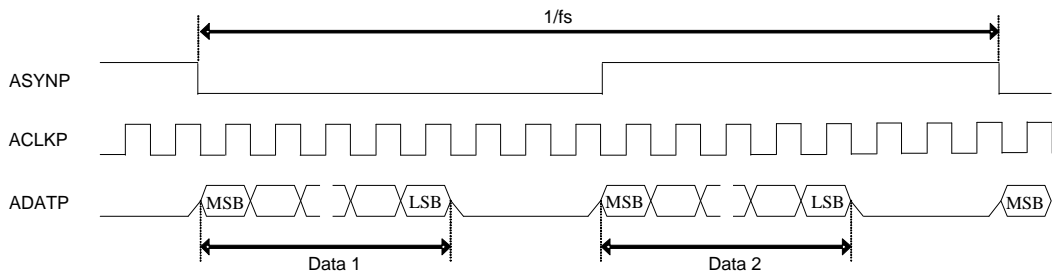


FIGURE 21. RM\_SYNC=0, PB\_MASTER=0, ADATPDLY=1



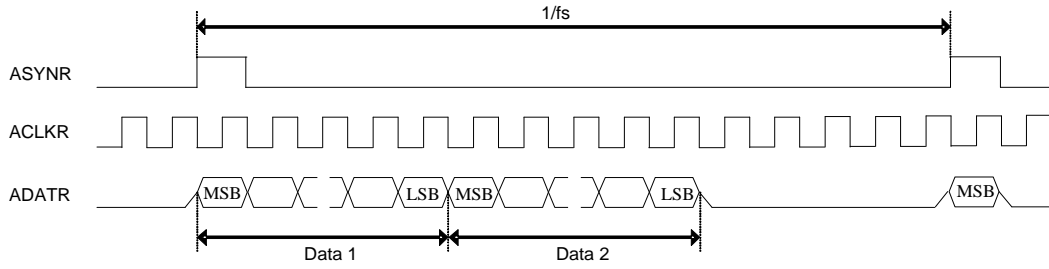


FIGURE 22. RM\_SYNC=1, PB\_MASTER=0, ADATPDLY=1

ASYNP is ACLKP rising edge triggered input.

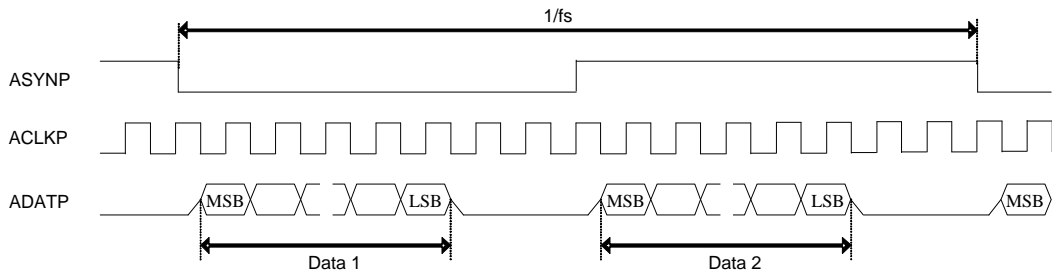


FIGURE 23. RM\_SYNC=0, PB\_MASTER=0, ADATPDLY=1

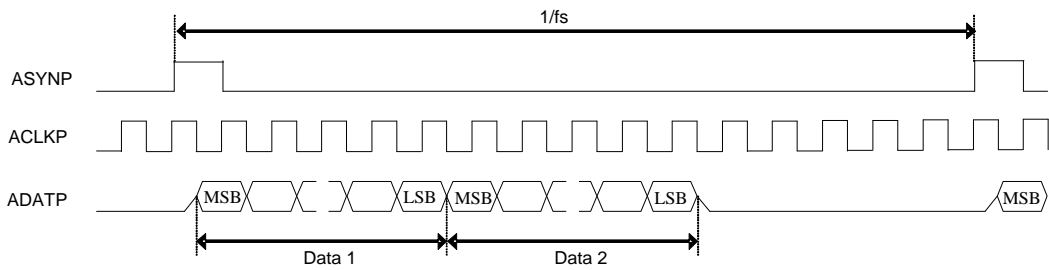


FIGURE 24. RM\_SYNC=1, PB\_MASTER=0, ADATPDLY=1

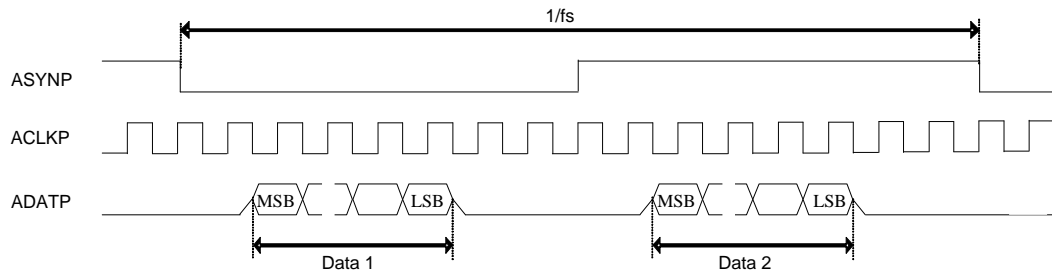


FIGURE 25. RM\_SYNC=0, PB\_MASTER=0, ADATPDLY=0

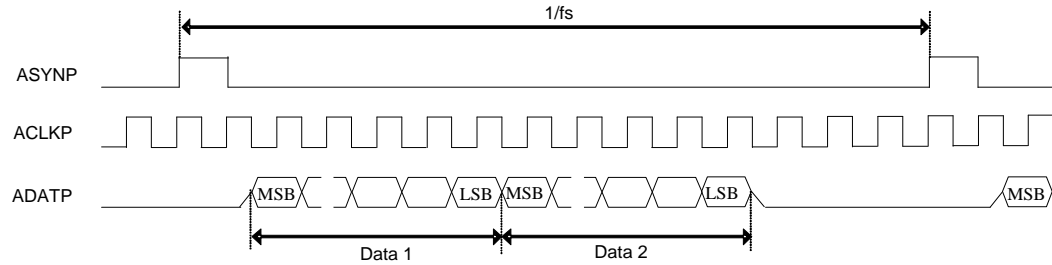


FIGURE 26. RM\_SYNC=1, PB\_MASTER=0, ADATPDLY=0

## AUDIO CLOCK GENERATION

TW2964 has built-in audio clock generator. The audio clock is digitally synthesized from the crystal clock input. The master audio clock frequency is programmable through ACKI register based following two equations.

$ACKI = \text{round} ( F_{AMCLK} / F_{27MHz} * 2^{23} )$ , it gives the Audio master Clock Nominal increment.

ACKI registers make audio\_source\_clock by 27MHz clock.

If MASCKMD=0, AMCLK=audio\_source\_clock. If MASCKMD=1, AMCLK=audio\_source\_clock/2.

AMCLK is used as audio system clock and audio ADC clock in Master clock mode.

The following table provides setting example of some common used audio frequency assuming XTI clock frequency of 27MHz. If ACLKRMASMASTER register bit is set to 1, following AMCLK is used as audio system clock with MASCKMD inside TW2964.

ACPL=1(Loop open) should be used in TW2964 system.

256xfs mode: AFS384 = 0, AIN5MD = 0, MASCKMD = 1.

| AMCLK(MHZ)          | ACKI [DEC] | ACKI [HEX] |
|---------------------|------------|------------|
| <b>256 X 16 KHZ</b> |            |            |
| 4.096               | 2545166    | 26-D6-0E   |
| <b>256 x 8 KHz</b>  |            |            |
| 2.048               | 1272583    | 13-6B-07   |

320xfs mode: AFS384 = 0, AIN5MD = 1, MASCKMD = 1.

| AMCLK(MHZ)          | ACKI [DEC] | ACKI [HEX] |
|---------------------|------------|------------|
| <b>320 x 16 KHz</b> |            |            |
| 5.12                | 3181457    | 30-8B-91   |
| <b>320 x 8 KHz</b>  |            |            |
| 2.56                | 1590729    | 18-45-C9   |

384xfs mode: AFS384 = 1, AIN5MD=0, MASCKMD = 1.

| AMCLK(MHZ)          | ACKI [DEC] | ACKI [HEX] |
|---------------------|------------|------------|
| <b>384 x 16 KHz</b> |            |            |
| 6.144               | 3817749    | 3A-41-15   |
| <b>384 x 8 KHz</b>  |            |            |
| 3.072               | 1908874    | 1D-20-8A   |

256xfs mode: AFS384=0,AIN5MD=0,MASCKMD=0.

| AMCLK(MHZ)           | ACKI [DEC] | ACKI [HEX] |
|----------------------|------------|------------|
| <b>256 x 48 KHz</b>  |            |            |
| 12.288               | 3817749    | 3A-41-15   |
| <b>256 x 44.1KHz</b> |            |            |
| 11.2896              | 3507556    | 35-85-65   |
| <b>256 x 32 KHz</b>  |            |            |
| 8.192                | 2545166    | 26-D6-0E   |
| <b>256 x 16 KHz</b>  |            |            |
| 4.096                | 1272583    | 13-6B-07   |
| <b>256 x 8 KHz</b>   |            |            |
| 2.048                | 636291     | 9-B5-83    |

320xfs mode: AFS384=0,AIN5MD=1,MASCKMD=0.

| AMCLK(MHZ)          | ACKI [DEC] | ACKI [HEX] |
|---------------------|------------|------------|
| <b>320 x 32 KHz</b> |            |            |
| 10.24               | 3181457    | 30-8B-91   |
| <b>320 x 16 KHz</b> |            |            |
| 5.12                | 1590729    | 18-45-C9   |
| <b>320 x 8 KHz</b>  |            |            |
| 2.56                | 795364     | C-22-E4    |

384xfs mode: AFS384=1,AIN5MD=0,MASCKMD=0.

| AMCLK(MHZ)          | ACKI [DEC] | ACKI [HEX] |
|---------------------|------------|------------|
| <b>384 x 32 KHz</b> |            |            |
| 12.288              | 3817749    | 3A-41-15   |
| <b>384 x 16 KHz</b> |            |            |
| 6.144               | 1908874    | 1D-20-8A   |
| <b>384 x 8 KHz</b>  |            |            |
| 3.072               | 954437     | E-90-45    |

### AUDIO CLOCK AUTO SETUP

If ACLKRMAS<sub>TER</sub> = 1 audio clock master mode is selected, and AFAUTO register is set to "1", TW2964 set up ACKI register by AFMD register value automatically. ACKI control input in ACKG module block is automatically set up to the required value by the condition of AFS384 and AFS384 register value.

| AFAUTO | AFMD | ACKG MODULE ACKI CONTROL INPUT VALUE           |
|--------|------|--|
| 1      | 0    | 8kHz mode value by each AFS384/AIN5MD case.    |
| 1      | 1    | 16kHz mode value by each AFS384/AIN5MD case.   |
| 1      | 2    | 32kHz mode value by each AFS384/AIN5MD case.   |
| 1      | 3    | 44.1kHz mode value by each AFS384/AIN5MD case. |
| 1      | 4    | 48kHz mode value by each AFS384/AIN5MD case.   |
| 0      | X    | ACKI register set up ACKI control input value. |

## Two-wire Serial Bus Interface

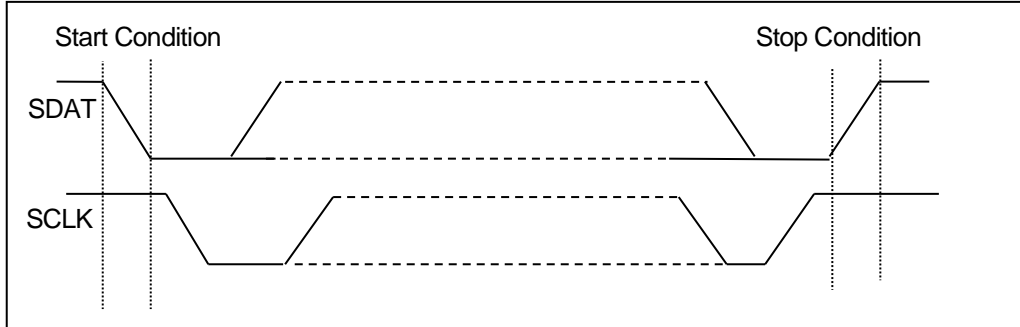


FIGURE 27. DEFINITION OF THE SERIAL BUS INTERFACE BUS START AND STOP

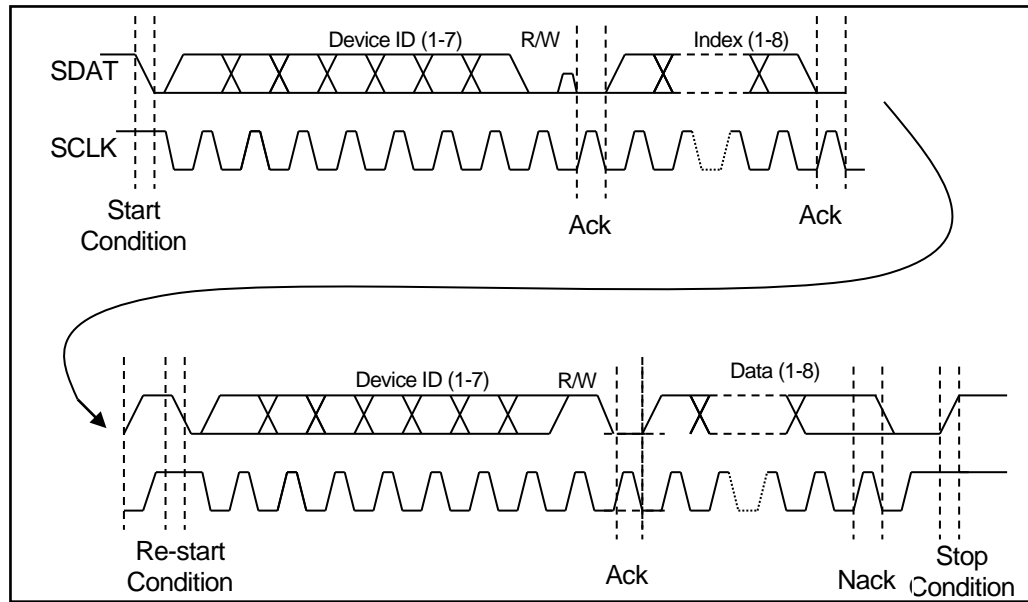


FIGURE 28. ONE COMPLETE REGISTER READ SEQUENCE VIA THE SERIAL BUS INTERFACE

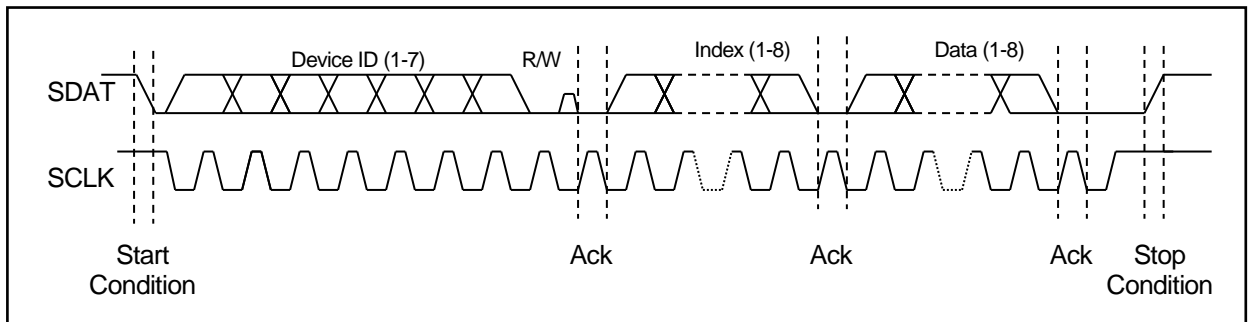


FIGURE 29. ONE COMPLETE REGISTER WRITE SEQUENCE VIA THE SERIAL BUS INTERFACE

The two wire serial bus interface is used to allow an external micro-controller to write control data to, and read control or other information from the TW2964 registers. SCLK is the serial clock and SDAT is the data line. Both lines are pulled high by resistors connected to VDD0. ICs communicate on the bus by pulling SCLK and SDAT low through open drain outputs. In normal operation the master generates all clock pulses, but control of the SDAT line alternates back and forth between the master and the slave. For both read and write, each byte is transferred MSB first, and the data bit is valid whenever SCLK is high.

The TW2964 is operated as a bus slave device. It can be programmed to respond to one of two 7-bit slave device addresses by tying the SIAD[1:0] (Serial Interface Address) pins to either VDD00 or VSS (See below Table) through a pull-up or pull-down resistor. The SIAD[1:0] pins are multi-purpose pins and must not tied to supply voltage or ground directly. If the SIAD[1:0] pins are tied to VDD0, then the least significant 2-bit of the 7-bit address is a “11”. If the SIAD[1:0] pins are tied to VSS then the least significant 2-bit of the 7-bit address is a “00”. The most significant 5-bits are fixed. The 7-bit address field is concatenated with the read/write control bit to form the first byte transferred during a new transfer. If the read/write control bit is high the next byte will be read from the slave device. If it is low the next byte will be a write to the slave. When a bus master (the host microprocessor) drives SDAT from high to low, while SCLK is high, this is defined to be a start condition (See Figure 27). All slaves on the bus listen to determine when a start condition has been asserted.

After a start condition, all slave devices listen for their device addresses. The host then sends a byte consisting of the 7-bit slave device ID and the R/W bit. This is shown in Figure 28. (For the TW2964, the next byte is normally the index to the TW2964 registers and is a write to the TW2964 therefore the first R/W bit is normally low.)

After transmitting the device address and the R/W bit, the master must release the SDAT line while holding SCLK low, and wait for an acknowledgement from the slave. If the address matches the device address of a slave, the slave will respond by driving the SDAT line low to acknowledge the condition. The master will then continue with the next 8-bit transfer. If no device on the bus responds, the master transmits a stop condition and ends the cycle. Notice that a successful transfer always includes nine clock pulses.

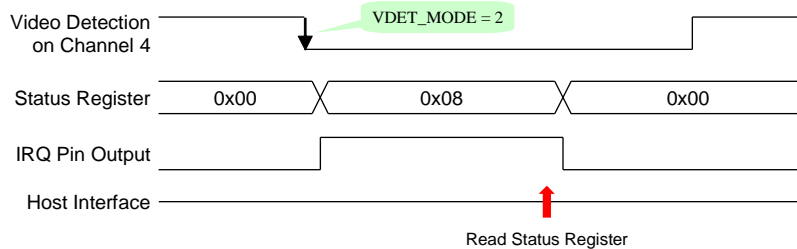
To write to the internal register of the TW2964, the master sends another 8-bits of data, the TW2964 loads this to the register pointed by the internal index register. The TW2964 will acknowledge the 8-bit data transfer and automatically increment the index in preparation for the next data. The master can do multiple writes to the TW2964 if they are in ascending sequential order. After each 8-bit transfer, the TW2964 will acknowledge the receipt of the 8-bits with an acknowledge pulse. To end all transfers to the TW2964 the host will issue a stop condition.

| SERIAL BUS INTERFACE 7-BIT SLAVE ADDRESS |   |   |   |   |         |         | READ/WRITE BIT    |
|--|---|---|---|---|---------|---------|-------------------|
| 0  | 1 | 0 | 1 | 0 | SIAD[1] | SIAD[0] | 1=Read<br>0=Write |

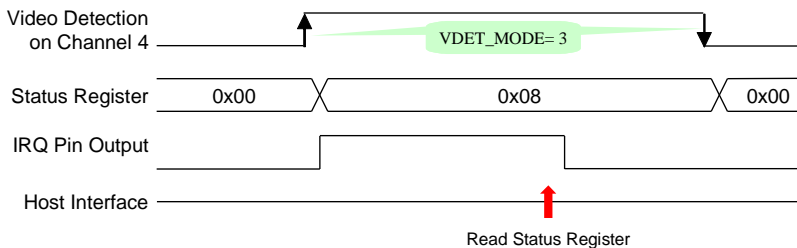
A TW2964 read cycle has two phases. The first phase is a write to the internal index register. The second phase is the read from the data register. (See FIGURE 28). The host initiates the first phase by sending the start condition. It then sends the slave device ID together with a 0 in the R/W bit position. The index is then sent followed by either a stop condition or a second start condition. The second phase starts with the second start condition. The master then resends the same slave device ID with a 1 in the R/W bit position to indicate a read. The slave will transfer the contents of the desired register. The master remains in control of the clock. After transferring eight bits, the slave releases and the master takes control of the SDAT line and acknowledges the receipt of data to the slave. To terminate the last transfer the master will issue a negative acknowledge (SDAT is left high during a clock pulse) and issue a stop condition.

### Interrupt Interface

The TW2964 provides the interrupt request function using an IRQ pin so that the host does not need to waste much resource to detect video or audio signal from TW2964. To use interrupt request function, the interrupt request should be enabled by the IRQENA and polarity of the IRQ pin should be selected by the IRQPOL. In addition, each channel of video and audio detection should be enabled by the AVDET\_ENA. Then, the interrupt mode should be defined by the VDET\_MODE and ADET\_MODE that control the time to request interrupt and set the status register AVDET\_STATE. Figure 30 shows operation of interrupt when the VDET\_MODE and/or ADET\_MODE are 2 and 3. The IRQ pin is cleared automatically by reading the AVDET\_STATE. When the VDET\_MODE and/or ADET\_MODE are 1 or 2, the status register AVDET\_STATE will also be cleared automatically by reading AVDET\_STATE. However, when the VDET\_MODE and/or ADET\_MODE are 3, the status register AVDET\_STATE will not be cleared automatically, but has the same value as actual status of video and audio detection flag.



(A) STATUS REGISTER OF AUTOMATIC CLEARED MODE



(B) STATUS REGISTER SAME AS VIDEO AND AUDIO DETECTION FLAG MODE

FIGURE 30. TIMING DIAGRAM OF INTERRUPT INTERFACE

## Clock PLL

The TW2964 has built-in clock PLL. It generates 108MHz clock and 144MHz clock from 27MHz input reference clock.

## XTI Clock Input

If XTI input needs special x2(54MHz or 72MHz),x4(108MHz or 144MHz) frequency, {MPP2,MPP1} pin pull-down setting during RSTB = 0 period support up to 400kbps two wire serial bus speed at all x1/x2/x4 XTI input mode.

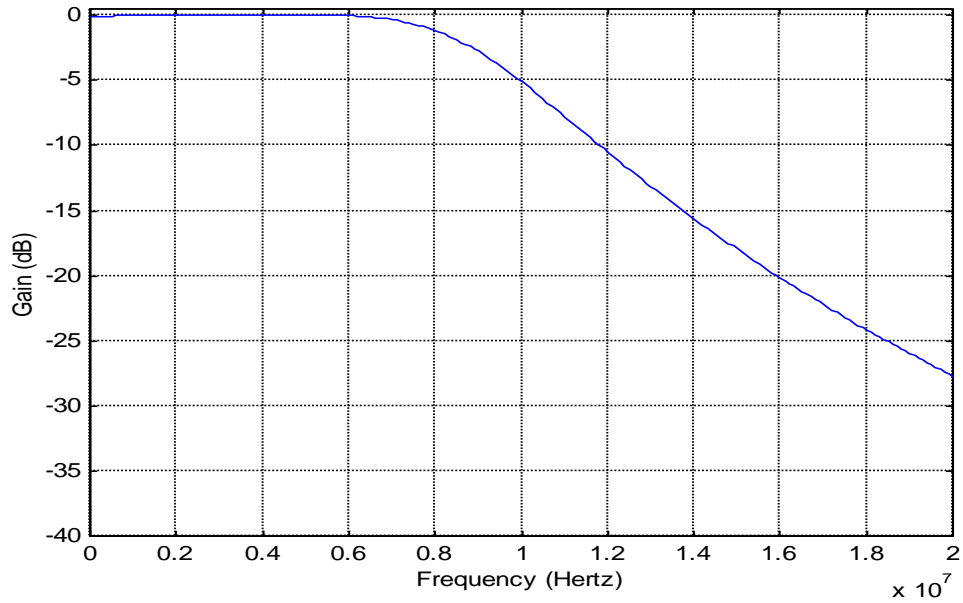
| MPP2      | MPP1      | SYSTEM CLOCK OF TWO WIRE SERIAL BUS INTERFACE | REQUIRED XTI INPUT FREQUENCY |
|-----------|-----------|---|------------------------------|
| NC        | NC        | XTI   | X1(27MHz or 36MHz)           |
| NC        | Pull-down | XTI/2   | X2(54MHz or 72MHz)           |
| Pull-down | NC        | XTI/4   | X4(108MHz or 144MHz)         |

Some normal functions are not available when XTI=27MHz is not used.

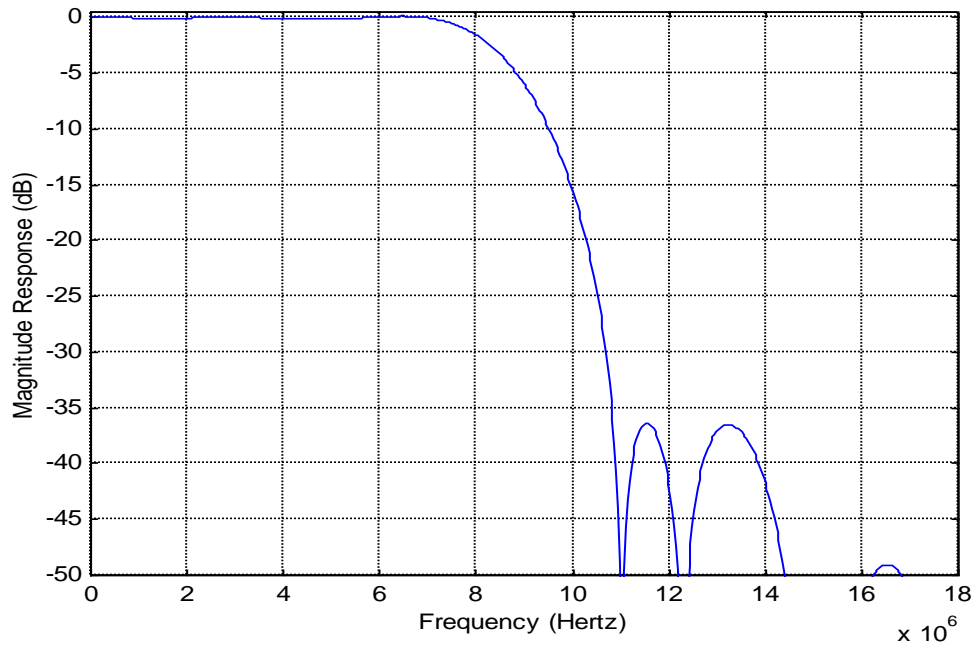


## Video Decoder Filter Curves

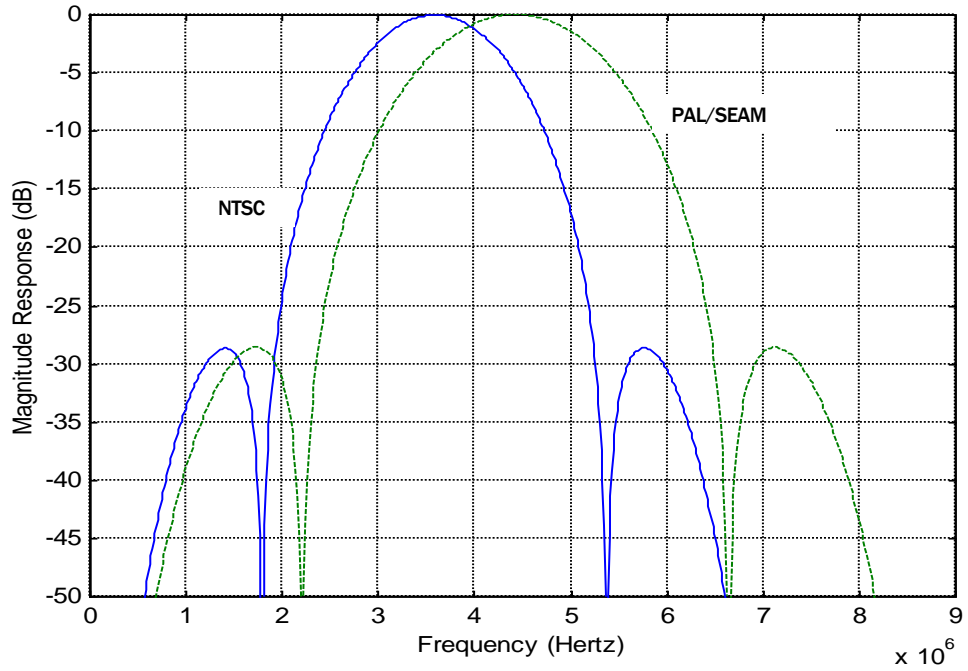
### ANTI-ALIAS FILTER



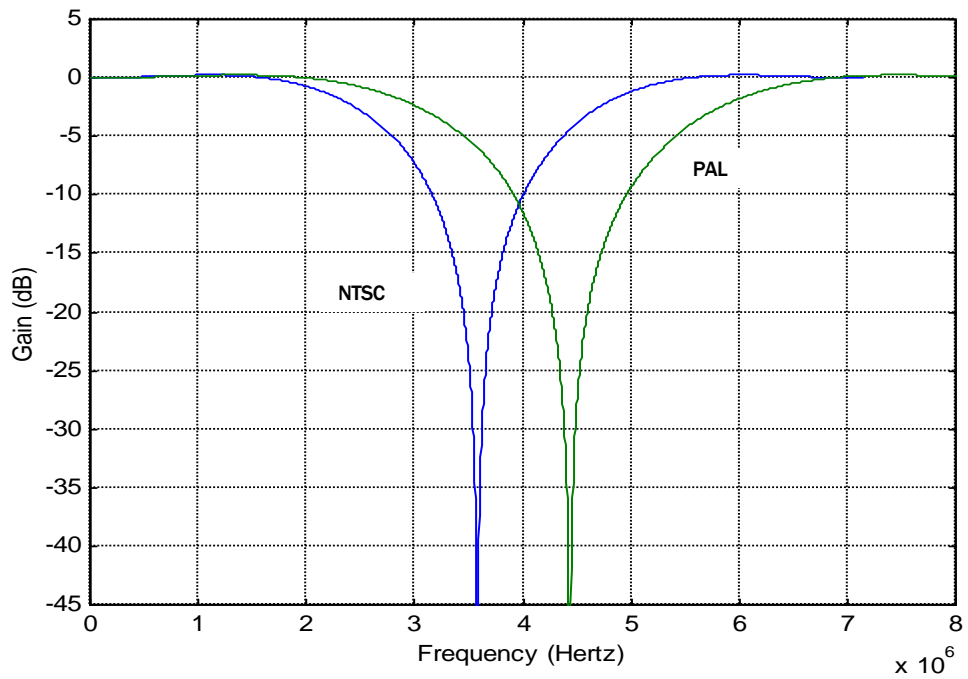
### DECIMATION FILTER



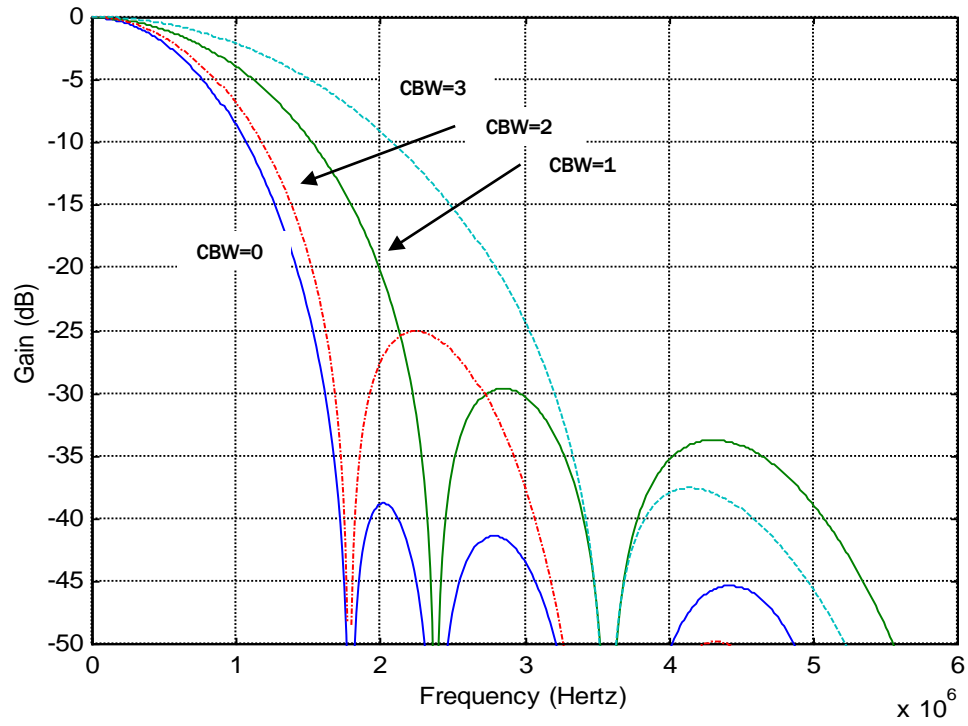
**CHROMA BAND PASS FILTER CURVES**



**LUMA NOTCH FILTER CURVE FOR NTSC AND PAL**

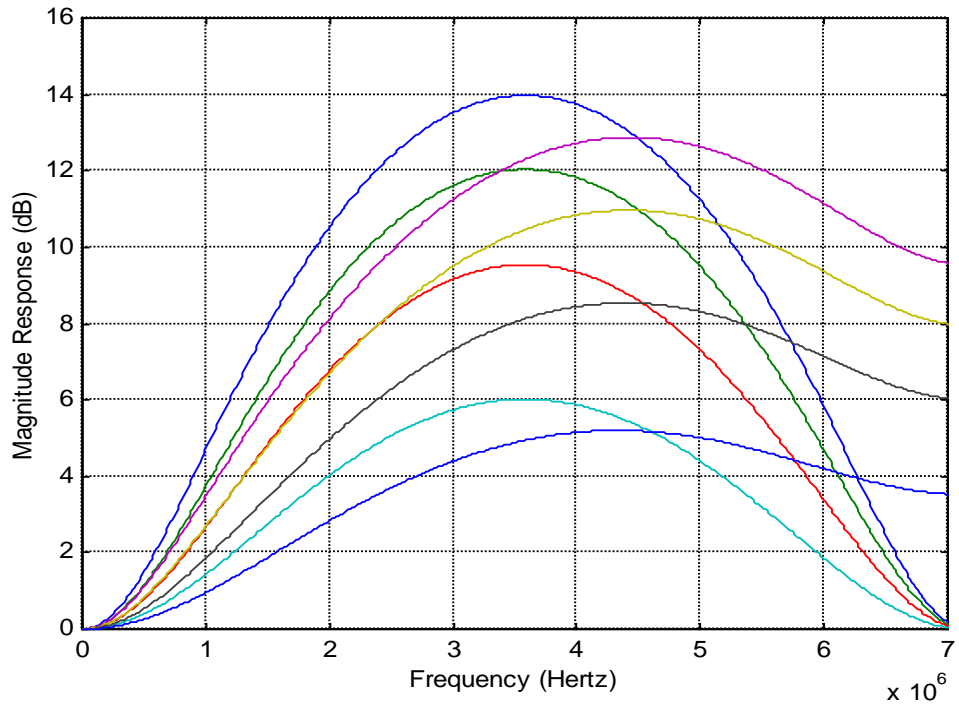


**CHROMINANCE LOW-PASS FILTER CURVE**

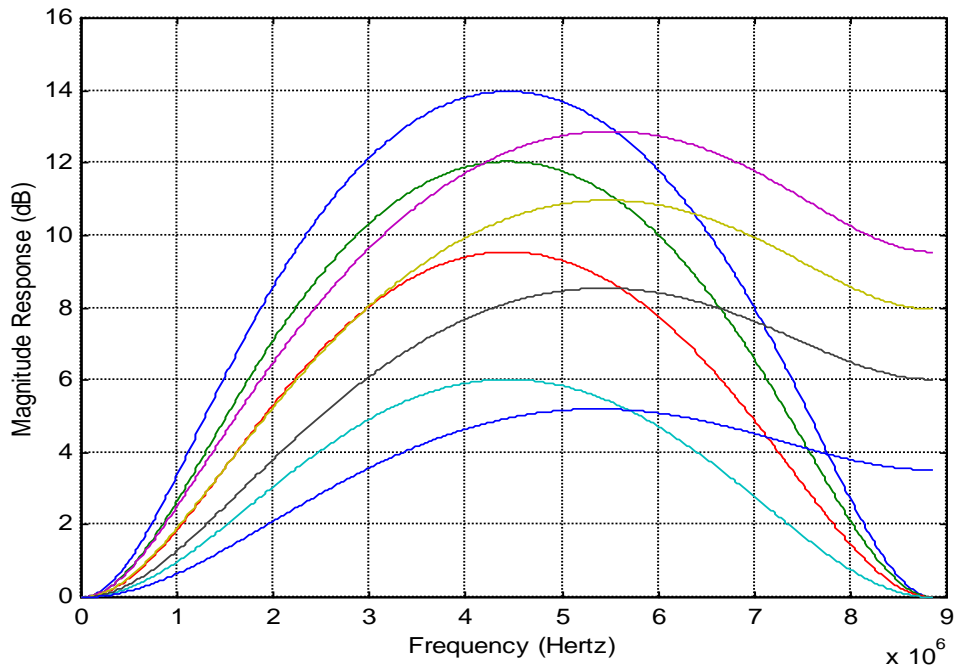


**PEAKING FILTER CURVES**

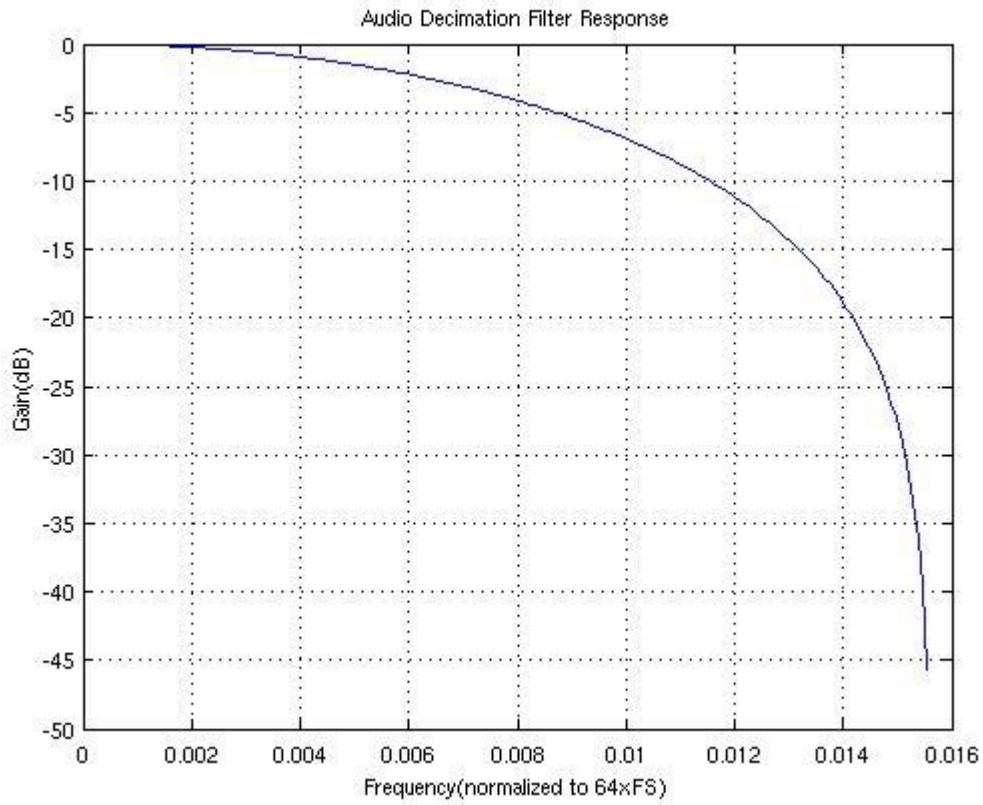
**NTSC**



**PAL**



## Audio Decimation Filter Response



(\*) 0.016 line = 0.016x64xFs

## Control Register REGISTER MAP

| Address |      |      |      | Mnemonic   | BIT7         | BIT6    | BIT5                | BIT4   | BIT3        | BIT2      | BIT1         | BIT0   |
|---------|------|------|------|------------|--------------|---------|---------------------|--------|-------------|-----------|--------------|--------|
| CH1     | CH2  | CH3  | CH4  |            |              |         |                     |        |             |           |              |        |
| 0x00    | 0x10 | 0x20 | 0x30 | VIDSTAT *  | VDLOSS*      | HLOCK*  | SLOCK*              | FLD*   | VLOCK*      | Reserved* | MONO*        | DET50* |
| 0x01    | 0x11 | 0x21 | 0x31 | BRIGHT     | BRIGHTNESS   |         |                     |        |             |           |              |        |
| 0x02    | 0x12 | 0x22 | 0x32 | CONTRAST   | CONTRAST     |         |                     |        |             |           |              |        |
| 0x03    | 0x13 | 0x23 | 0x33 | SHARPNESS  | SCURVE       | VSF     | CTI                 |        | SHARPNESS   |           |              |        |
| 0x04    | 0x14 | 0x24 | 0x34 | SAT_U      | SAT_U        |         |                     |        |             |           |              |        |
| 0x05    | 0x15 | 0x25 | 0x35 | SAT_V      | SAT_V        |         |                     |        |             |           |              |        |
| 0x06    | 0x16 | 0x26 | 0x36 | HUE        | HUE          |         |                     |        |             |           |              |        |
| 0x07    | 0x17 | 0x27 | 0x37 | CROP_HI    | VDELAY[9:8]  |         | VACTIVE[9:8]        |        | HDELAY[9:8] |           | HACTIVE[9:8] |        |
| 0x08    | 0x18 | 0x28 | 0x38 | VDELAY_LO  | VDELAY[7:0]  |         |                     |        |             |           |              |        |
| 0x09    | 0x19 | 0x29 | 0x39 | VACTIVE_LO | VACTIVE[7:0] |         |                     |        |             |           |              |        |
| 0x0A    | 0x1A | 0x2A | 0x3A | HDELAY_LO  | HDELAY[7:0]  |         |                     |        |             |           |              |        |
| 0x0B    | 0x1B | 0x2B | 0x3B | HACTIVE_LO | HACTIVE[7:0] |         |                     |        |             |           |              |        |
| 0x0C    | 0x1C | 0x2C | 0x3C | MVSN*      | SF*          | PF*     | FF*                 | KF*    | CSBAD*      | MCVSN*    | CSTRIPE*     | CTYPE* |
| 0x0D    | 0x1D | 0x2D | 0x3D | STATUS2*   | VCR*         | WKAIR*  | WKAIR1*             | VSTD*  | NINTL*      | 0         | 0            | 0      |
| 0x0E    | 0x1E | 0x2E | 0x3E | SDT        | DETSTUS*     | STDNOW* |                     |        | ATREG       | STANDARD  |              |        |
| 0x0F    | 0x1F | 0x2F | 0x3F | SDTR       | ATSTART      | PAL60EN | PALCNEN             | PALMEN | NTSC44EN    | SECAMEN   | PALBEN       | NTSCEN |
| 0xA0    | 0xA1 | 0xA2 | 0xA3 | NT50       | NT50         | CVSTD*  |                     |        | CVFMT       |           |              |        |
| 0xA4    | 0xA5 | 0xA6 | 0xA7 | IDCNTL     | IDX          |         | NSEN/SSEN/PSEN/WKTH |        |             |           |              |        |
| 0xC4    | 0xC5 | 0xC6 | 0xC7 | HREF*      | HREF*        |         |                     |        |             |           |              |        |

Note: \* Read only registers

| Address |     |     |     | Mnemonic   | BIT7        | BIT6       | BIT5         | BIT4        | BIT3        | BIT2      | BIT1     | BIT0     |
|---------|-----|-----|-----|------------|-------------|------------|--------------|-------------|-------------|-----------|----------|----------|
| CH1     | CH2 | CH3 | CH4 |            |             |            |              |             |             |           |          |          |
| 0x4F    |     |     |     | TESTOUTSEL | 0           | 0          | OETESTOUTSEL | TEST_OUTSEL |             |           |          |          |
| 0x50    |     |     |     | VDFREQ     | VD4FREQ     | VD3FREQ    | VD2FREQ      | VD1FREQ     | H960EN4     | H960EN3   | H960EN2  | H960EN1  |
| 0x51    |     |     |     | FBITINV    | 0           | 0          | 0            | 0           | FBITINV4    | FBITINV3  | FBITINV2 | FBITINV1 |
| 0x52    |     |     |     | ANADACTEST | VCM_SEL     | LPF_SEL    |              | BIAS_SEL    | AN_ADACTEST |           |          |          |
| 0x54    |     |     |     | ASAVE      | 0           | ADACLK_INV | DOUT_RST     | DIV_RST     | ACALEN      | ASAVE     |          |          |
| 0x55    |     |     |     | AAFLPF     | AAFLPF4     |            | AAFLPF3      |             | AAFLPF2     |           | AAFLPF1  |          |
| 0x56    |     |     |     | HASYNC     | HASYNC4     | HASYNC3    | HASYNC2      | HASYNC1     | HLEN4[8]    | HBLEM3[8] | HLEN2[8] | HLEN1[8] |
| 0x57    |     |     |     | HLEN1      | HBLEM1[7:0] |            |              |             |             |           |          |          |
| 0x58    |     |     |     | HLEN2      | HBLEM2[7:0] |            |              |             |             |           |          |          |

| Address |     |     |     | Mnemonic   | BIT7          | BIT6         | BIT5        | BIT4          | BIT3        | BIT2       | BIT1          | BIT0         |
|---------|-----|-----|-----|------------|---------------|--------------|-------------|---------------|-------------|------------|---------------|--------------|
| CH1     | CH2 | CH3 | CH4 |            |               |              |             |               |             |            |               |              |
| 0x59    |     |     |     | HLEN3      | HLEN3[7:0]    |              |             |               |             |            |               |              |
| 0x5A    |     |     |     | HLEN4      | HLEN4[7:0]    |              |             |               |             |            |               |              |
| 0x5B    |     |     |     | CKDS       | 0             | 0            | 0           | 0             | PLLCKOUT    | XTI36      | CKN_DS        | CLP_DS       |
| 0x5C    |     |     |     | BGCTL      | 0             | 0            | BGCTL       | VSWEN         | VSWNUM      |            |               |              |
| 0x5D    |     |     |     | CH2MISC2   | NKILL_2       | PKILL_2      | SKILL_2     | CBAL_2        | FCS_2       | LCS_2      | CCS_2         | BST_2        |
| 0x5E    |     |     |     | CH3MISC2   | NKILL_3       | PKILL_3      | SKILL_3     | CBAL_3        | FCS_3       | LCS_3      | CCS_3         | BST_3        |
| 0x5F    |     |     |     | CH4MISC2   | NKILL_4       | PKILL_4      | SKILL_4     | CBAL_4        | FCS_4       | LCS_4      | ICCS_4        | BST_4        |
| 0x60    |     |     |     | VCO        | CLK_DIFF      | CP_SEL       |             |               | LP_X8       |            | VCO           |              |
| 0x61    |     |     |     | XTIMD      | PLL_RST       | PLL_PD       | PLL_IREF    | DECOSC        | SEL_144_72  | SEL_108_54 | XTIMD         |              |
| 0x62    |     |     |     | MPP0E      | O36M4         | O36M3        | O36M2       | O36M1         | MPP40E      | MPP30E     | MPP20E        | MPP10E       |
| 0x63    |     |     |     | CH21NUM    | CH2NUM        |              |             |               | CH1NUM      |            |               |              |
| 0x64    |     |     |     | CH43NUM    | CH4NUM        |              |             |               | CH3NUM      |            |               |              |
| 0x65    |     |     |     | VDOEB      | 0             | 0            | 0           | VD40RD        | VD40EB      | VD30EB     | VD20EB        | VD10EB       |
| 0x67    |     |     |     | HZST       | HZST          |              |             |               |             |            |               |              |
| 0x68    |     |     |     | HZOOM_HI   | HZOOM4[9:8]   |              | HZOOM3[9:8] |               | HZOOM2[9:8] |            | HZOOM1[9:8]   |              |
| 0x69    |     |     |     | HZOOM1_LOW | HZOOM1[7:0]   |              |             |               |             |            |               |              |
| 0x6A    |     |     |     | HZOOM2_LOW | HZOOM2[7:0]   |              |             |               |             |            |               |              |
| 0x6B    |     |     |     | HZOOM3_LOW | HZOOM3[7:0]   |              |             |               |             |            |               |              |
| 0x6C    |     |     |     | HZOOM4_LOW | HZOOM4[7:0]   |              |             |               |             |            |               |              |
| 0x6D    |     |     |     | D1_NMGAIN  | NMGAIN720     |              |             |               | SHCOR720    |            |               |              |
| 0x6E    |     |     |     | PCLAMP720  | PCLAMP720     |              |             |               |             |            |               |              |
| 0x70    |     |     |     | ACLKPOL    | ACK36MD       | S2I_8BIT     | ACLKRPOL    | ACLKPPOL      | AFAUTO      | AFMD       |               |              |
| 0x71    |     |     |     | AINCTL     | I2S8MODE      | MASCKMD      | PBINSWAP    | ASYNRDLY      | ASYNPDLY    | ADATPDLY   | INLAWMD       |              |
| 0x72    |     |     |     | MRATIOMD   | MRATIOMD      | ADACTEST     | AOFFCORE    | DAORATIO      | DAOGAIN     |            |               |              |
| 0x73    |     |     |     | A5NUM      | Reserved      |              |             |               | AIN51FORM   | AINTPOFF   | A51DET_ENA    |              |
| 0x74    |     |     |     | A5DETST    | 0             | 0            | 0           | 0             | 0           | 0          | 0             | A5DET_STATE* |
| 0x75    |     |     |     | AADC50FS_H | 0             | 0            | 0           | 0             | 0           | 0          | AADC50FS[9:8] |              |
| 0x76    |     |     |     | AADC50FS_L | AADC50FS[7:0] |              |             |               |             |            |               |              |
| 0x77    |     |     |     | AUD5ADC_H  | 0             | 0            | 0           | 0             | 0           | 0          | AUD5ADC[9:8]  |              |
| 0x78    |     |     |     | AUD5ADC_L  | AUD5ADC[7:0]  |              |             |               |             |            |               |              |
| 0x79    |     |     |     | ADJAADC5_H | 0             | 0            | 0           | 0             | 0           | 0          | ADJAADC5[9:8] |              |
| 0x7A    |     |     |     | ADJAADC5_L | ADJAADC5[7:0] |              |             |               |             |            |               |              |
| 0x7B    |     |     |     | I2SO_RSEL  | 0             | 0            | 0           | I2SO_RSEL     |             |            |               |              |
| 0x7C    |     |     |     | I2SO_LSEL  | 0             | 0            | 0           | I2SO_LSEL     |             |            |               |              |
| 0x7D    |     |     |     | RECSEL5    | I2SRECSEL54   |              | I2SRECSEL53 |               | I2SRECSEL52 |            | I2SRECSEL51   |              |
| 0x7E    |     |     |     | ADATMI2S   | A5OUTOFF      | ADATM_I2SOEN | MIX_MUTE_A5 | ADET_TH5[4:0] |             |            |               |              |
| 0x7F    |     |     |     | AIGAIN5    | AIGAIN5       |              |             |               | MIX_RATIO5  |            |               |              |
| 0x80    |     |     |     | SRST       | 0             | 0            | AUDIORST    | VOUTRST       | VDEC4RST    | VDEC3RST   | VDEC2RST      | VDEC1RST     |

| Address |     |     |     | Mnemonic  | BIT7          | BIT6        | BIT5     | BIT4       | BIT3   | BIT2   | BIT1  | BIT0 |  |
|---------|-----|-----|-----|-----------|---------------|-------------|----------|------------|--------|--------|-------|------|--|
| CH1     | CH2 | CH3 | CH4 |           |               |             |          |            |        |        |       |      |  |
| 0x81    |     |     |     | ACNTL     | 0             | 0           | 0        | 0          | CLKPDN | 0      | YFLEN | 0    |  |
| 0x82    |     |     |     | ACNTL2    | CTEST         | YCLEN       | CKIPOL   | 0          | GTEST  | VLPF   | CKLY  | CKLC |  |
| 0x83    |     |     |     | CNTRL1    | PBW           | DEM         | IDSNS    | SET7       | COMB   | HCOMP  | YCOMB | PDLY |  |
| 0x84    |     |     |     | CKHY      | GMEN          | CKHY        |          | HSDLY      |        |        |       |      |  |
| 0x85    |     |     |     | SHCOR960  | SHCOR960      |             |          | VIN4       | VIN3   | VIN2   | VIN1  |      |  |
| 0x86    |     |     |     | CORING    | CTCOR         |             | CCOR     | VCOR       |        | CIF    |       |      |  |
| 0x87    |     |     |     | CLMPG     | CLPEND        |             |          | CLPST      |        |        |       |      |  |
| 0x88    |     |     |     | IAGC      | NMGAIN960     |             |          | WPGAIN     |        |        |       | 0    |  |
| 0x89    |     |     |     | AIN5MD    | ATHROUGH      | ASYN SERIAL | ACLKR128 | ACLKR64    | AFS384 | AIN5MD | 0     | 0    |  |
| 0x8A    |     |     |     | PEAKWT    | PEAKWT        |             |          |            |        |        |       |      |  |
| 0x8B    |     |     |     | CLMPL     | CLMPLD        | CLMPL       |          |            |        |        |       |      |  |
| 0x8C    |     |     |     | SYNCT     | SYNCTD        | SYNCT       |          |            |        |        |       |      |  |
| 0x8D    |     |     |     | MISSCNT   | MISSCNT       |             |          | HSWIN      |        |        |       |      |  |
| 0x8E    |     |     |     | PCLAMP960 | PCLAMP960     |             |          |            |        |        |       |      |  |
| 0x8F    |     |     |     | VCNTL1    | VLCKI         |             | VLCKO    | VMODE      | DETV   | AFLD   | VINT  |      |  |
| 0x90    |     |     |     | VCNTL2    | BSHT          |             |          | VSHT       |        |        |       |      |  |
| 0x91    |     |     |     | CKILL     | CKILMAX       |             |          | CKILMIN    |        |        |       |      |  |
| 0x92    |     |     |     | VTL       | HTL           |             |          | VTL        |        |        |       |      |  |
| 0x93    |     |     |     | LDLY      | CKLM          | YDLY        |          | PD_BIAS    | VSAVE  |        |       |      |  |
| 0x94    |     |     |     | MISC1     | HPLC          | EVCNT       | PALC     | SDET       | 0      | BYPASS | 0     |      |  |
| 0x95    |     |     |     | CBW       | HPM           |             | ACCT     |            | SPM    |        | CBW   |      |  |
| 0x96    |     |     |     | MISC2     | NKILL         | PKILL       | SKILL    | CBAL       | FCS    | LCS    | CCS   | BST  |  |
| 0x97    |     |     |     | CLMD      | FRM           |             | YNR      |            | CLMD   |        | PSP   |      |  |
| 0x98    |     |     |     | HSLWCTL   | HSBEGIN[3:0]  |             |          | HSEND[3:0] |        |        |       |      |  |
| 0x99    |     |     |     | HSBEGIN   | HSBEGIN[11:4] |             |          |            |        |        |       |      |  |
| 0x9A    |     |     |     | HSEND     | HSEND[11:4]   |             |          |            |        |        |       |      |  |



| Address |     |     |     | Mnemonic    | BIT7          | BIT6        | BIT5          | BIT4        | BIT3          | BIT2        | BIT1          | BIT0        |  |
|---------|-----|-----|-----|-------------|---------------|-------------|---------------|-------------|---------------|-------------|---------------|-------------|--|
| CH1     | CH2 | CH3 | CH4 |             |               |             |               |             |               |             |               |             |  |
| 0x9B    |     |     |     | OVSDLY      | OVSDLY        |             |               |             |               |             |               |             |  |
| 0x9C    |     |     |     | OVSEND      | 0             | OFDLY       |               |             | VSMODE        | OVSEND      |               |             |  |
| 0x9E    |     |     |     | NOVID       | VDELAYMD      | FC27        | CHID_MD       |             | NOVID_656     | EAVSWAP     | VIPCFG        | NTSC656     |  |
| 0x9F    |     |     |     | CLKODEL     | CLKNO_DEL     |             |               |             | CLKPO_DEL     |             |               |             |  |
| 0xAA    |     |     |     | AGCEN       | AGCEN4        | AGCEN3      | AGCEN2        | AGCEN1      | AGCGAIN4[8]   | AGCGAIN3[8] | AGCGAIN2[8]   | AGCGAIN1[8] |  |
| 0xAB    |     |     |     | AGCGAIN1    | AGCGAIN1[7:0] |             |               |             |               |             |               |             |  |
| 0xAC    |     |     |     | AGCGAIN2    | AGCGAIN2[7:0] |             |               |             |               |             |               |             |  |
| 0xAD    |     |     |     | AGCGAIN3    | AGCGAIN3[7:0] |             |               |             |               |             |               |             |  |
| 0xAE    |     |     |     | AGCGAIN4    | AGCGAIN4[7:0] |             |               |             |               |             |               |             |  |
| 0xAF    |     |     |     | VSHP21      | 0             | VSHP2       |               |             | 0             | VSHP1       |               |             |  |
| 0xB0    |     |     |     | VSHP43      | 0             | VSHP4       |               |             | 0             | VSHP3       |               |             |  |
| 0xB1    |     |     |     | CH8IDEN     | CH8IDEN       | 0           | 0             | 0           | CLPOE         | TESTVNUM    |               |             |  |
| 0xB2    |     |     |     | VDLOSSOE    | VADC_CKPOL4   | VADC_CKPOL3 | VADC_CKPOL2   | VADC_CKPOL1 | VDLOSSOE4     | VDLOSSOE3   | VDLOSSOE2     | VDLOSSOE1   |  |
| 0xB3    |     |     |     | AADC0FS_H   | AADC40FS[9:8] |             | AADC30FS[9:8] |             | AADC20FS[9:8] |             | AADC10FS[9:8] |             |  |
| 0xB4    |     |     |     | AADC10FS_L  | AADC10FS[7:0] |             |               |             |               |             |               |             |  |
| 0xB5    |     |     |     | AADC20FS_L  | AADC20FS[7:0] |             |               |             |               |             |               |             |  |
| 0xB6    |     |     |     | AADC30FS_L  | AADC30FS[7:0] |             |               |             |               |             |               |             |  |
| 0xB7    |     |     |     | AADC40FS_L  | AADC40FS[7:0] |             |               |             |               |             |               |             |  |
| 0xB8    |     |     |     | AUDADC_H*   | AUD4ADC[9:8]  |             | AUD3ADC[9:8]  |             | AUD2ADC[9:8]  |             | AUD1ADC[9:8]  |             |  |
| 0xB9    |     |     |     | AUD1ADC_L*  | AUD1ADC[7:0]  |             |               |             |               |             |               |             |  |
| 0xBA    |     |     |     | AUD2ADC_L*  | AUD2ADC[7:0]  |             |               |             |               |             |               |             |  |
| 0xBB    |     |     |     | AUD3ADC_L*  | AUD3ADC[7:0]  |             |               |             |               |             |               |             |  |
| 0xBC    |     |     |     | AUD4ADC_L*  | AUD4ADC[7:0]  |             |               |             |               |             |               |             |  |
| 0xBD    |     |     |     | ADJAADC_H*  | ADJAADC4[9:8] |             | ADJAADC3[9:8] |             | ADJAADC2[9:8] |             | ADJAADC1[9:8] |             |  |
| 0xBE    |     |     |     | ADJAADC1_L* | ADJAADC1[7:0] |             |               |             |               |             |               |             |  |
| 0xBF    |     |     |     | ADJAADC2_L* | ADJAADC2[7:0] |             |               |             |               |             |               |             |  |
| 0xC0    |     |     |     | ADJAADC3_L* | ADJAADC3[7:0] |             |               |             |               |             |               |             |  |
| 0xC1    |     |     |     | ADJAADC4_L* | ADJAADC4[7:0] |             |               |             |               |             |               |             |  |

| Address |     |     |     | Mnemonic | BIT7      | BIT6      | BIT5       | BIT4       | BIT3      | BIT2 | BIT1     | BIT0 |  |
|---------|-----|-----|-----|----------|-----------|-----------|------------|------------|-----------|------|----------|------|--|
| CH1     | CH2 | CH3 | CH4 |          |           |           |            |            |           |      |          |      |  |
| 0xC8    |     |     |     | MPP21    | GPP_VAL2  | MPP_MODE2 |            | GPP_VAL1   | MPP_MODE1 |      |          |      |  |
| 0xC9    |     |     |     | MPP43    | GPP_VAL4  | MPP_MODE4 |            | GPP_VAL3   | MPP_MODE3 |      |          |      |  |
| 0xCA    |     |     |     | CHMD     | CHMD4     |           | CHMD3      |            | CHMD2     |      | CHMD1    |      |  |
| 0xCB    |     |     |     | POLMPP   | POLMPP4   | POLMPP3   | POLMPP2    | POLMPP1    | Reserved  |      |          |      |  |
| 0xCC    |     |     |     | SELCH    | SELCH4    |           | SELCH3     |            | SELCH2    |      | SELCH1   |      |  |
| 0xCD    |     |     |     | MAINCH   | MAINCH4   |           | MAINCH3    |            | MAINCH2   |      | MAINCH1  |      |  |
| 0xCE    |     |     |     | ANAPWDN  | AAUTOMUTE | Reserved  | A_DAC_PWDN | A_ADC_PWDN | VADC_PWDN |      |          |      |  |
| 0xCF    |     |     |     | SMD      | SMD       |           | 0          | 0          | 0         | 0    | 0        | 0    |  |
| 0xD0    |     |     |     | AIGAIN21 | AIGAIN2   |           |            | AIGAIN1    |           |      |          |      |  |
| 0xD1    |     |     |     | AIGAIN43 | AIGAIN4   |           |            | AIGAIN3    |           |      |          |      |  |
| 0xD2    |     |     |     | R_MULTCH | M_RLSWAP  | RM_SYNC   | RM_PBSEL   |            | R_ADATM   |      | R_MULTCH |      |  |
| 0xD3    |     |     |     | R_SEQ10  | R_SEQ_1   |           |            | R_SEQ_0    |           |      |          |      |  |
| 0xD4    |     |     |     | R_SEQ32  | R_SEQ_3   |           |            | R_SEQ_2    |           |      |          |      |  |
| 0xD5    |     |     |     | R_SEQ54  | R_SEQ_5   |           |            | R_SEQ_4    |           |      |          |      |  |
| 0xD6    |     |     |     | R_SEQ76  | R_SEQ_7   |           |            | R_SEQ_6    |           |      |          |      |  |
| 0xD7    |     |     |     | R_SEQ98  | R_SEQ_9   |           |            | R_SEQ_8    |           |      |          |      |  |
| 0xD8    |     |     |     | R_SEQBA  | R_SEQ_B   |           |            | R_SEQ_A    |           |      |          |      |  |
| 0xD9    |     |     |     | R_SEQDC  | R_SEQ_D   |           |            | R_SEQ_C    |           |      |          |      |  |
| 0xDA    |     |     |     | R_SEQFE  | R_SEQ_F   |           |            | R_SEQ_E    |           |      |          |      |  |

| Address |     |     |     | Mnemonic     | BIT7          | BIT6        | BIT5        | BIT4          | BIT3        | BIT2        | BIT1        | BIT0         |  |
|---------|-----|-----|-----|--------------|---------------|-------------|-------------|---------------|-------------|-------------|-------------|--------------|--|
| CH1     | CH2 | CH3 | CH4 |              |               |             |             |               |             |             |             |              |  |
|         |     |     |     | AMASTER      | ADACEN        | AADCEN      | PB_MASTER   | PB_LRSEL      | PB_SYNC     | RM_8BIT     | ASYNROEN    | ACLKRMMASTER |  |
|         |     |     |     | MIX_MUTE     | LAWMD         |             | MIX_DERATIO | MIX_MUTE      |             |             |             |              |  |
|         |     |     |     | MIX_RATIO21  | MIX_RATIO2    |             |             | MIX_RATIO1    |             |             |             |              |  |
|         |     |     |     | MIX_RATIO43  | MIX_RATIO4    |             |             | MIX_RATIO3    |             |             |             |              |  |
|         |     |     |     | MIX_RATIOP   | AOGAIN        |             |             | MIX_RATIOP    |             |             |             |              |  |
|         |     |     |     | MIX_OUTSEL   | 0             | AADCCKPOL   | ADACCKPOL   | MIX_OUTSEL    |             |             |             |              |  |
|         |     |     |     | ADET         | AAMPMD        | ADET_FILTER |             | ADET_TH4[4]   | ADET_TH3[4] | ADET_TH2[4] | ADET_TH1[4] |              |  |
|         |     |     |     | ADET_TH21    | ADET_TH2[3:0] |             |             | ADET_TH1[3:0] |             |             |             |              |  |
|         |     |     |     | ADET_TH43    | ADET_TH4[3:0] |             |             | ADET_TH3[3:0] |             |             |             |              |  |
|         |     |     |     | ACKL_L       | ACKI[7:0]     |             |             |               |             |             |             |              |  |
|         |     |     |     | ACKI_M       | ACKI[15:8]    |             |             |               |             |             |             |              |  |
|         |     |     |     | ACKI_H       | 0             | 0           | ACKI[21:16] |               |             |             |             |              |  |
|         |     |     |     | ACKN_L       | ACKN[7:0]     |             |             |               |             |             |             |              |  |
|         |     |     |     | ACKN_M       | ACKN[15:8]    |             |             |               |             |             |             |              |  |
|         |     |     |     | ACKN_H       | 0             | 0           | 0           | 0             | 0           | 0           | ACKN[17:16] |              |  |
|         |     |     |     | SDIV         | 0             | 0           | SDIV        |               |             |             |             |              |  |
|         |     |     |     | LRDIV        | 0             | 0           | LRDIV       |               |             |             |             |              |  |
|         |     |     |     | ACCNTL       | APZ           | APG         |             | Reserved      | ACPL        | SRPH        | LRPH        |              |  |
|         |     |     |     | VMISC        | LIM16         | PBREFEN     | YCBCR422    | Reserved      | VBI_FRAM    | CNTL656     | CLKNF       | CLKPF        |  |
|         |     |     |     | CLKOCTL      | 0             | OE          | CLKNO_OEB   | CLKPO_OEB     | CLKNO_MD    |             | CLKPO_MD    |              |  |
|         |     |     |     | AVDET_MODE   | CLKNO_POL     | CLKPO_POL   | IRQENA      | IRQPOL        | ADET_MODE   |             | VDET_MODE   |              |  |
|         |     |     |     | AVDET_ENA    | AVDET_ENA     |             |             |               |             |             |             |              |  |
|         |     |     |     | AVDET_STATE* | AVDET_STATE   |             |             |               |             |             |             |              |  |
|         |     |     |     | TEST         | DEV_ID[6:5]*  |             | 0           | 0             | 0           | TEST        |             |              |  |
|         |     |     |     | DEV_ID*      | DEV_ID[4:0]*  |             |             |               |             | REV_ID      |             |              |  |

Note: \* Read only registers

## Register Descriptions

### 0X00(CH1)/0X10(CH2)/0X20(CH3)/0X30(CH4) – VIDEO STATUS REGISTER

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | VDLOSS   | R   | 1 = Video not present. (sync is not detected in number of consecutive line periods specified by MISSCNT register)<br>0 = Video detected. | 0     |
| 6   | HLOCK    | R   | 1 = Horizontal sync PLL is locked to the incoming video source.<br>0 = Horizontal sync PLL is not locked.                                | 0     |
| 5   | SLOCK    | R   | 1 = Sub-carrier PLL is locked to the incoming video source.<br>0 = Sub-carrier PLL is not locked.  | 0     |
| 4   | FIELD    | R   | 0 = Odd field is being decoded.<br>1 = Even field is being decoded.  | 0     |
| 3   | VLOCK    | R   | 1 = Vertical logic is locked to the incoming video source.<br>0 = Vertical logic is not locked.  | 0     |
| 2   | Reserved | R   | Reserved   | 0     |
| 1   | MONO     | R   | 1 = No color burst signal detected.<br>0 = Color burst signal detected.  | 0     |
| 0   | DET50    | R   | 0 = 60Hz source detected<br>1 = 50Hz source detected<br>The actual vertical scanning frequency depends on the current standard invoked.  | 0     |

### 0X01(CH1)/0X11(CH2)/0X21(CH3)/0X31(CH4) – BRIGHTNESS CONTROL REGISTER

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-0 | BRIGHT   | R/W | These bits control the brightness. They have value of -128 to 127 in 2's complement form. Positive value increases brightness. A value 0 has no effect on the data. | 00    |

### 0X02(CH1)/0X12(CH2)/0X22(CH3)/0X32(CH4) – CONTRAST CONTROL REGISTER

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-0 | CNTRST   | R/W | These bits control the luminance contrast gain. A value of 100 (64h) has a gain of 1. The range of adjustment is from 0% to 255% at 1% per step. | 64h   |

**0X03(CH1)/0X13(CH2)/0X23(CH3)/0X33(CH4) – SHARPNESS CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | SCURVE   | R/W | This bit controls the center frequency of the peaking filter. The corresponding gain adjustment is HFLT.<br><br>0 = low 1 = center   | 0     |
| 6   | VSF      | R/W | This bit is for internal used.   | 0     |
| 5-4 | CTI      | R/W | CTI level selection. 0 = None. 3 = highest.  | 1     |
| 3-0 | SHARP    | R/W | These bits control the amount of sharpness enhancement on the luminance signals. There are 16 levels of control with '0' having no effect on the output image. 1 through 15 provides sharpness enhancement with 'F' being the strongest. | 1     |

**0X04(CH1)/0X14(CH2)/0X24(CH3)/0X34(CH4) – CHROMA (U) GAIN REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-0 | SAT_U    | R/W | These bits control the digital gain adjustment to the U (or Cb) component of the digital video signal. The color saturation can be adjusted by adjusting the U and V color gain components by the same amount in the normal situation. The U and V can also be adjusted independently to provide greater flexibility. The range of adjustment is 0 to 200%. | 80    |

**0X05(CH1)/0X15(CH2)/0X25(CH3)/0X35(CH4) – CHROMA (V) GAIN REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-0 | SAT_V    | R/W | These bits control the digital gain adjustment to the V (or Cr) component of the digital video signal. The color saturation can be adjusted by adjusting the U and V color gain components by the same amount in the normal situation. The U and V can also be adjusted independently to provide greater flexibility. The range of adjustment is 0 to 200%. A value of 128 (80h) has gain of 100%. | 80    |

**0X06(CH1)/0X16(CH2)/0X26(CH3)/0X36(CH4) – HUE CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-0 | HUE      | R/W | These bits control the color hue as 2's complement number. They have value from +90° (7Fh) to -90° (80h) with an increment of 2.8°. The 2 LSB has no effect. The positive value gives greenish tone and negative value gives purplish tone. The default value is 0° (00h). This is effective only on NTSC and PAL system. | 00    |

**0X07(CH1)/0X17(CH2)/0X27(CH3)/0X37(CH4) – CROPPING REGISTER, HIGH**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7-6 | VDELAY_HI  | R/W | These bits are bit 9 to 8 of the 10-bit Vertical Delay register.   | 0     |
| 5-4 | VACTIVE_HI | R/W | These bits are bit 9 to 8 of the 10-bit VACTIVE register. Refer to description on Reg09 for its shadow register. | 1     |
| 3-2 | HDELAY_HI  | R/W | These bits are bit 9 to 8 of the 10-bit Horizontal Delay register.   | 0     |
| 1-0 | HACTIVE_HI | R/W | These bits are bit 9 to 8 of the 10-bit HACTIVE register.  | 2     |

**0X08(CH1)/0X18(CH2)/0X28(CH3)/0X38(CH4) – VERTICAL DELAY REGISTER, LOW**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7-0 | VDELAY_LO | R/W | These bits are bit 7 to 0 of the 10-bit Vertical Delay register. The two MSBs are in the CROP_HI register. It defines the number of lines between the leading edge of VSYNC and the start of the active video. | 12    |

**0X09(CH1)/0X19(CH2)/0X29(CH3)/0X39(CH4) – VERTICAL ACTIVE REGISTER, LOW**

| BIT | FUNCTION   | R/W | DESCRIPTION   | RESET |
|-----|------------|-----|---|-------|
| 7-0 | VACTIVE_LO | R/W | These bits are bit 7 to 0 of the 10-bit Vertical Active register. The two MSBs are in the CROP_HI register. It defines the number of active video lines per frame output.<br><br>The VACTIVE register has a shadow register for use with 50Hz source when ATREG of Reg0x1C is not set. This register can be accessed through the same index address by first changing the format standard to any 50Hz standard. | 20    |

**0X0A(CH1)/0X1A(CH2)/0X2A(CH3)/0X3A(CH4) – HORIZONTAL DELAY REGISTER, LOW**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7-0 | HDELAY_LO | R/W | <p>These bits are bit 7 to 0 of the 10-bit Horizontal Delay register. The two MSBs are in the CROP_HI register. It defines the number of pixels between the leading edge of the HSYNC and the start of the image cropping for active video.</p> <p>The HDELAY_LO register has two shadow registers for use with PAL and SECAM sources respectively. These register can be accessed using the same index address by first changing the decoding format to the corresponding standard.</p> | 0A    |

**0X0B(CH1)/0X1B(CH2)/0X2B(CH3)/0X3B(CH4) – HORIZONTAL ACTIVE REGISTER, LOW**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7-0 | HACTIVE_LO | R/W | <p>These bits are bit 7 to 0 of the 10-bit Horizontal Active register. The two MSBs are in the CROP_HI register. It defines the number of active pixels per line output.</p> | D0    |

**0X0C(CH1)/0X1C(CH2)/0X2C(CH3)/0X3C(CH4) – MACROVISION DETECTION**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | SF       | R   | This bit is for internal use.  | 0     |
| 6   | PF       | R   | This bit is for internal use.  | 0     |
| 5   | FF       | R   | This bit is for internal use.  | 0     |
| 4   | KF       | R   | This bit is for internal use.  | 0     |
| 3   | CSBAD    | R   | 1 = Macrovision color stripe detection may be un-reliable  | 0     |
| 2   | MVCSN    | R   | 1 = Macrovision AGC pulse detected.<br>0 = Not detected.   | 0     |
| 1   | CSTRIPE  | R   | 1 = Macrovision color stripe protection burst detected.<br>0 = Not detected.   | 0     |
| 0   | CTYPE    | R   | This bit is valid only when color stripe protection is detected, i.e. CSTRIPE=1.<br>1 = Type 2 color stripe protection<br>0 = Type 3 color stripe protection | 0     |



**0X0D(CH1)/0X1D(CH2)/0X2D(CH3)/0X3D(CH4) – CHIP STATUS II**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | VCR      | R   | VCR signal indicator.                              | 0     |
| 6   | WKAIR    | R   | Weak signal indicator 2.                           | 0     |
| 5   | WKAIR1   | R   | Weak signal indicator controlled by WKTH.          | 0     |
| 4   | VSTD     | R   | 1 = Standard signal      0 = Non-standard signal   | 0     |
| 3   | NINTL    | R   | 1 = Non-interlaced signal<br>0 = interlaced signal | 0     |
| 2-0 | Reserved | R   | Reserved   | 0h    |

**0X0E(CH1)/0X1E(CH2)/0X2E(CH3)/0X3E(CH4) – STANDARD SELECTION**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | DETSTUS  | R   | 0 = Idle      1 = detection in progress   | 0     |
| 6-4 | STDNOW   | R   | Current standard invoked<br>0 = NTSC(M)<br>1 = PAL (B,D,G,H,I)<br>2 = SECAM<br>3 = NTSC4.43<br>4 = PAL (M)<br>5 = PAL (CN)<br>6 = PAL 60<br>7 = Not valid               | 0     |
| 3   | ATREG    | R/W | 1 = Disable the shadow registers.<br>0 = Enable VACTIVE and HDELAY shadow registers value depending on standard   | 0     |
| 2-0 | STD      | R/W | Standard selection<br>0 = NTSC(M)<br>1 = PAL (B,D,G,H,I)<br>2 = SECAM(not supported)<br>3 = NTSC4.43<br>4 = PAL (M)<br>5 = PAL (CN)<br>6 = PAL 60<br>7 = Auto detection | 7     |

**0X0F(CH1)/0X1F(CH2)/0X2F(CH3)/0X3F(CH4) – STANDARD RECOGNITION**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | ATSTART  | R/W | Writing 1 to this bit will manually initiate the auto format detection process. This bit is a self-resetting bit. | 0     |
| 6   | PAL6_EN  | R/W | 1 = enable recognition of PAL60.<br>0 = disable recognition.  | 1     |
| 5   | PALN_EN  | R/W | 1 = enable recognition of PAL (CN).<br>0 = disable recognition.   | 1     |
| 4   | PALM_EN  | R/W | 1 = enable recognition of PAL (M).<br>0 = disable recognition.  | 1     |
| 3   | NT44_EN  | R/W | 1 = enable recognition of NTSC 4.43.<br>0 = disable recognition.  | 1     |
| 2   | SEC_EN   | R/W | 1 = enable recognition of SECAM.<br>0 = disable recognition.  | 1     |
| 1   | PALB_EN  | R/W | 1 = enable recognition of PAL (B,D,G,H,I).<br>0 = disable recognition.  | 1     |
| 0   | NTSC_EN  | R/W | 1 = enable recognition of NTSC (M).<br>0 = disable recognition.   | 1     |

**0X56(CH1/CH2/CH3/CH4) – HASYNC**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7   | HASYNC4   | R/W | 1: the length of EAV to SAV is set up and fixed by CH4 HBLEN registers.<br>0: the length of SAV to EAV is set up and fixed by CH4 HACTIVE registers. | 0     |
| 6   | HASYNC3   | R/W | 1: the length of EAV to SAV is set up and fixed by CH3 HBLEN registers.<br>0: the length of SAV to EAV is set up and fixed by CH3 HACTIVE registers. | 0     |
| 5   | HASYNC2   | R/W | 1: the length of EAV to SAV is set up and fixed by CH2 HBLEN registers.<br>0: the length of SAV to EAV is set up and fixed by CH2 HACTIVE registers. | 0     |
| 4   | HASYNC1   | R/W | 1: the length of EAV to SAV is set up and fixed by CH1 HBLEN registers.<br>0: the length of SAV to EAV is set up and fixed by CH1 HACTIVE registers. | 0     |
| 3   | HBLEN4[8] | R/W | Bit8 of CH4 HBLEN[8:0].Please see HBLEN description.   | 0     |
| 2   | HBLEN3[8] | R/W | Bit8 of CH3 HBLEN[8:0]. Please see HBLEN description.  | 0     |
| 1   | HBLEN2[8] | R/W | Bit8 of CH2 HBLEN[8:0]. Please see HBLEN description.  | 0     |
| 0   | HBLEN1[8] | R/W | Bit8 of CH1 HBLEN[8:0]. Please see HBLEN description.  | 0     |

**0X57(CH1)/0X58(CH2)/0X59(CH3)/0X5A(CH4) – HBLEN**

| BIT | FUNCTION                 | R/W | DESCRIPTION   | RESET |
|-----|--------------------------|-----|---|-------|
| 7-0 | HBLENn[7:0]<br>n=1,2,3,4 | R/W | These bits are effective when HASYNC bit is set to 1. These bits set up the length of EAV to SAV code when HASYNC bit is 1. Normal value is (Total pixel per line – HACTIVE) value. HBLENn[8] is 0 normally. HBLENn[8] is optional purpose only.<br><br>36MHz WD1 Vdeo Decoder mode.<br>NTSC/PAL-M(60Hz): B8h(184dec)=1144-960<br>PAL/SECAM(50Hz): C0h(192dec)=1152-960<br>27MHz D1 Vdeo Decoder mode.<br>NTSC/PAL-M(60Hz): 8Ah(138dec)=858-720<br>PAL/SECAM(50Hz): 90h(144dec)=864-720 | 90h   |

**0X68(CH1/CH2/CH3/CH4) – HZOOM\_HI**

| BIT | FUNCTION        | R/W | DESCRIPTION                    | RESET |
|-----|-----------------|-----|--------------------------------|-------|
| 7-6 | HZOOM4<br>[9:8] | R/W | Bit9-8 of CH4 HZOOM registers. | 0     |
| 5-4 | HZOOM3<br>[9:8] | R/W | Bit9-8 of CH3 HZOOM registers. | 0     |
| 3-2 | HZOOM2<br>[9:8] | R.W | Bit9-8 of CH2 HZOOM registers. | 0     |
| 1-0 | HZOOM1<br>[9:8] | R/W | Bit9-8 of CH1 HZOOM registers. | 0     |

**0X69(CH1)/0X6A(CH2)/0X6B(CH3)/0X6C(CH4) – HZOOM\_LOW**

| BIT | FUNCTION       | R/W | DESCRIPTION   | RESET |
|-----|----------------|-----|---|-------|
| 7-0 | HZOOM<br>[7:0] | R/W | Bit7-0 of Horizontal Zoom Up register. This register has Horizontal Zoom Up function together HZOOMn[9:8] by following equation.<br>$HZOOM[9:0] = 1024 \times \text{source H pixel number} / \text{output H pixel number}$ .<br>For example,<br>source H pixel number = 948<br>Output H pixel number = 960<br>$HZOOM[9:0] = 1024 \times 948 / 960 = 1011.2 = 3F3h$ .<br>If HZOOM=000h is set up, No HZOOM(path through) output. | 00h   |

**0XA0(CH1)/0XA1(CH2)/0XA2(CH3)/0XA3(CH4) – NT50**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | NT50     | R/W | 1 = Force decoding format to 50Hz NTSC.<br>0 = decoding format is set by register Standard Selection. | 0     |
| 6-4 | VSTD     | R/W | Reserved  | 0h    |
| 3-0 | CVFMT    | R/W | Reserved  | 8h    |

**0XA4(CH1)/0XA5(CH2)/0XA6(CH3)/0XA7(CH4) – ID DETECTION CONTROL**

| BIT | FUNCTION                           | R/W | DESCRIPTION   | RESET                      |
|-----|------------------------------------|-----|---|----------------------------|
| 7-6 | IDX                                | R/W | These two bits indicate which of the four lower 6-bit registers is currently being controlled. The write sequence is a two steps process unless the same register is written. A write of {ID,000000} selects one of the four registers to be written. A subsequent write will actually write into the register. | 0                          |
| 5-0 | NSEN /<br>SSEN /<br>PSEN /<br>WKTH | R/W | IDX = 0 controls the NTSC color carrier detection sensitivity (NSEN).<br>IDX = 1 controls the SECAM ID detection sensitivity (SSEN).<br>IDX = 2 controls the PAL ID detection sensitivity (PSEN).<br>IDX = 3 controls the weak signal detection sensitivity (WKTH).   | 1A /<br>20 /<br>1C /<br>11 |

**0XAA(CH1/CH2/CH3/CH4) – VIDEO AGC CONTROL**

| BIT | FUNCTION    | R/W | DESCRIPTION   | RESET |
|-----|-------------|-----|---|-------|
| 7   | AGCEN4      | R/W | Select Video AGC loop function on VIN4<br>0: AGC loop function enabled (recommended for most application cases)<br>1: AGC loop function disabled. Gain is set by AGCGAIN4 | 0     |
| 6   | AGCEN3      | R/W | Select Video AGC loop function on VIN3<br>0: AGC loop function enabled (recommended for most application cases)<br>1: AGC loop function disabled. Gain is set by AGCGAIN3 | 0     |
| 5   | AGCEN2      | R/W | Select Video AGC loop function on VIN2<br>0: AGC loop function enabled (recommended for most application cases)<br>1: AGC loop function disabled. Gain is set by AGCGAIN2 | 0     |
| 4   | AGCEN1      | R/W | Select Video AGC loop function on VIN1<br>0: AGC loop function enabled (recommended for most application cases)<br>1: AGC loop function disabled. Gain is set by AGCGAIN1 | 0     |
| 3   | AGCGAIN4[8] | R/W | AGCGAIN4 MSB bit  | 0     |
| 2   | AGCGAIN3[8] | R/W | AGCGAIN3 MSB bit  | 0     |
| 1   | AGCGAIN2[8] | R/W | AGCGAIN2 MSB bit  | 0     |
| 0   | AGCGAIN1[8] | R/W | AGCGAIN1 MSB bit  | 0     |

**0XAB(CH1)/0XAC(CH2)/0XAD(CH3)/0XAE(CH4) – VIDEO AGC CONTROL**

| BIT | FUNCTION     | R/W | DESCRIPTION   | RESET |
|-----|--------------|-----|---|-------|
| 7-0 | AGCGAIN[7:0] | R/W | To control the AGC Gain when AGC loop is disabled.<br><br>AGCGAIN bit7-0. | F0h   |

**0XC4(CH1)/0XC5(CH2)/0XC6(CH3)/0XC7(CH4) – H MONITOR**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-0 | HFREF    | R   | Horizontal line frequency indicator (Test purpose only) | X     |

**0X4F – TEST\_OUTSEL REGISTER**

| BIT | FUNCTION       | R/W | DESCRIPTION  | RESET |
|-----|----------------|-----|--|-------|
| 7-6 | Reserved       | R   | Reserved   | 00b   |
| 5   | OE_TEST_OUTSEL | R/W | Test Purpose function.<br><br>1: {MPP4.MPP3,VD4[7:0]} pins are output enable even if other pin output control registers are set up output disable/tri-state.<br>0: normal function.  | 0     |
| 4-0 | TEST_OUTSEL    | R/W | When OE_TEST_OUTSEL is 1,{MPP4,MPP3,VD4[7:0]} pins output following 10bit data.MPP4 is MSB bit9.VD4[0] is LSB bit0.<br>0h : CH1 10bit video ADC data<br>1h : CH2 10bit video ADC data<br>2h : CH3 10bit video ADC data<br>3h : CH4 10bit video ADC data<br>4h : CH1 10bit audio ADC data<br>5h : CH2 10bit audio ADC data<br>6h : CH3 10bit audio ADC data<br>7h : CH4 10bit audio ADC data<br>8h : CH5 10bit audio ADC data<br>9h : 10bit audio DAC input data<br>Bh : 10bit video GAIN D[8:0] input data TVNUM registers select. | 0     |

**0X50 – VDFREQ/H960EN**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | VD4FREQ  | R/W | 1 : VD4[7:0] pin output 36MHz video data.<br>0 : VD4[7:0] pin output 27MHz video data.    | 0     |
| 6   | VD3FREQ  | R/W | 1 : VD3[7:0] pin output 36MHz video data.<br>0 : VD3[7:0] pin output 27MHz video data.    | 0     |
| 5   | VD2FREQ  | R/W | 1 : VD2[7:0] pin output 36MHz video data.<br>0 : VD2[7:0] pin output 27MHz video data.    | 0     |
| 4   | VD1FREQ  | R/W | 1 : VD1[7:0] pin output 36MHz video data.<br>0 : VD1[7:0] pin output 27MHz video data.    | 0     |
| 3   | H960EN4  | R/W | 1 : Ch4 video decoder is in 36MHz WD1 mode.<br>0 : Ch4 video decoder is in 27MHz D1 mode. | 0     |
| 2   | H960EN3  | R/W | 1 : Ch3 video decoder is in 36MHz WD1 mode.<br>0 : Ch3 video decoder is in 27MHz D1 mode. | 0     |
| 1   | H960EN2  | R/W | 1 : Ch2 video decoder is in 36MHz WD1 mode.<br>0 : Ch2 video decoder is in 27MHz D1 mode. | 0     |
| 0   | H960EN1  | R/W | 1 : Ch1 video decoder is in 36MHz WD1 mode.<br>0 : Ch1 video decoder is in 27MHz D1 mode. | 0     |

**0X51 – FBITINV**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-4 | Reserved | R   |  | 0h    |
| 3   | FBITINV4 | R/W | 1 : F-bit in 4th byte of 656 EAV/SAV code is inverted.<br>0 : normal mode.F-bit is not inverted. | 0     |
| 2   | FBITINV3 | R/W | 1 : F-bit in 4th byte of 656 EAV/SAV code is inverted.<br>0 : normal mode.F-bit is not inverted. | 0     |
| 1   | FBITINV2 | R/W | 1 : F-bit in 4th byte of 656 EAV/SAV code is inverted.<br>0 : normal mode.F-bit is not inverted. | 0     |
| 0   | FBITINV1 | R/W | 1 : F-bit in 4th byte of 656 EAV/SAV code is inverted.<br>0 : normal mode.F-bit is not inverted. | 0     |

**0X52 – AUDIO DAC CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | VCM_SEL  | R/W | Reserved.  | 0     |
| 5-4 | LPF_SEL  | R/W | Audio DAC LPF corner frequency selection.<br>0h : 15.6kHz<br>1h : 7.8kHz<br>2h : Don't use<br>3h : 3.9kHz<br>4h,5h,6h : Don't use<br>7h : 2.6kHz   | 0     |
| 3   | BIAS_SEL | R/W | Bias selection.<br>0 : AVDD33 as the reference voltage.<br>1 : select bandgap voltage as the reference.  | 0     |
| 2-0 | ADACTEST | R/W | Audio DAC Test control.<br>0h : normal operation<br>1h : ibias places to the dac_out(Don't use)<br>2h : din_0 is placed to the dac_out(Don't use)<br>3h : both ibias and din_0 are placed at the dac_out(Don't use)<br>4h : disable output driver.Dac_out floating<br>5h : disable output driver,ibias places to dac_out<br>6h : disable output driver,din_0 places to dac_out<br>7h : don't use | 0     |

**0X54 – AUDIO ADC CONTROL 1**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7   | Reserved   | R   |  | 0     |
| 6   | ADACLK_INV | R/W | Audio DAC clock inversion.<br>0 : not inversed inside audio DAC.<br>1 : Clock is inversed inside audio DAC.                          | 0     |
| 5   | DOUT_RST   | R/W | Audio ADC digital output reset for all channel.<br>Test purpose only.<br>This bit must be set up to 0 again after 1 value is set up. | 0     |
| 4   | DIV_RST    | R/W | Audio ADC divider reset.Test purpose Only.<br>This bit must be set up to 0 again after 1 value is set up.                            | 0     |
| 3   | ACALEN     | RW  | Audio ADC Calibration control.Test purpose only.<br>This bit must be set up to 0 again after 1 value is set up.                      | 0     |
| 2-0 | ASAVE      | R/W | 7h : normal mode. Others : test purpose only.  | 7     |



**0X55 – VIDEO INPUT ANTI-ALIASING FILTER SELECTION**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-6 | AAFLPF4  | R/W | Ch4 Video input Anti-aliasing filter selection.<br>0h : 9MHz,0dB gain. 1h : 10MHz,-3.4dB gain.<br>2h : 7MHz,0db gain. 3h : 8MHz,-3.4dB gain. | 0     |
| 5-4 | AAFLPF3  | R/W | Ch3 Video input Anti-aliasing filter selection.<br>0h : 9MHz,0dB gain. 1h : 10MHz,-3.4dB gain.<br>2h : 7MHz,0db gain. 3h : 8MHz,-3.4dB gain. | 0     |
| 3-2 | AAFLPF2  | R/W | Ch2 Video input Anti-aliasing filter selection.<br>0h : 9MHz,0dB gain. 1h : 10MHz,-3.4dB gain.<br>2h : 7MHz,0db gain. 3h : 8MHz,-3.4dB gain. | 0     |
| 1-0 | AAFLPF1  | R/W | Ch1 Video input Anti-aliasing filter selection.<br>0h : 9MHz,0dB gain. 1h : 10MHz,-3.4dB gain.<br>2h : 7MHz,0db gain. 3h : 8MHz,-3.4dB gain. | 0     |

**0X5B – CLOCK OUTPUT PIN DRIVE SELECTION**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-4 | Reserved | R   |   | 0     |
| 3   | PLLCKOUT | R/W | 1 : IRQ pin output PLL 36MHz clock.<br>CLKPO pin output PLL 144MHz clock.<br>CLKNO pin output PLL 108MHz clock.<br>Test purpose only.<br>0 : normal mode.                         | 0     |
| 2   | XTI36    | R/W | 0 : XTI pin is normal 27MHz input.<br>1 : Special WD1 mode.XTI pin is one of<br>36MHz/72MHz/144MHz input.<br>27MHz/54MHz/108MHz D1 mode is not supported in<br>this special mode. | 0     |
| 1   | CKN_DS   | R/W | 0 : CLKNO pin output is 12mA current drive mode.<br>1 : CLKNO pin output is 16mA current drive mode.  | 0     |
| 0   | CKP_DS   | R/W | 0 : CLKPO pin output is 12mA current drive mode.<br>1 : CLKPO pin output is 16mA current drive mode.  | 0     |

**0X5C- BGCTL**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | Reserved | R   |   | 0     |
| 5   | BGCTL    | R/W | <p>0: Reg96[7:0] control all CH1/CH2/CH3/CH4 video.<br/> 1: Reg96[7:0] control only CH1 video.<br/> Reg5D[7:0] control only CH2 video.<br/> Reg5E[7:0] control only CH3 video.<br/> Reg5F[7:0] control only CH4 video.</p>  | 0     |
| 4   | VSWEN    | R/W | <p>0: Video Input VIN1A/VIN1B,VIN2A/VIN2B,<br/> VIN3A/VIN3B,VIN4A/VIN4B are selected by register<br/> VIN1/VIN2/VIN3/VIN4.<br/> 1: One Video input time of either VINnA or VINnB<br/> changes automatically by VSWNUM setting.</p>  | 0     |
| 3-0 | VSWNUM   | R/W | <p>One Video input time is (VSWNUM+1) frame time in<br/> VIN1A/VIN1B video when VSWEN=1.<br/> 0: 1 frame time in VIN1A/VIN1B video.<br/> 1: 2 frame time in VIN1A/VIN1B video.<br/> 2: 3 frame time in VIN1A/VIN1B video.<br/> .<br/> .<br/> F: 16 frame time in VIN1A/VIN1B video.</p> | 0     |

**0X5D – CH2 MISCELLANEOUS CONTROL II ON BGCTL=1**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | NKILL_2  | R/W | 1 = Enable noisy signal color killer function in NTSC mode.<br>0 = Disabled.   | 1     |
| 6   | PKILL_2  | R/W | 1 = Enable automatic noisy color killer function in PAL mode.<br>0 = Disabled.   | 1     |
| 5   | SKILL_2  | R/W | 1 = Enable automatic noisy color killer function in SECAM mode.<br>0 = Disabled.   | 1     |
| 4   | CBAL_2   | R/W | 0 = Normal output<br>1 = special output mode.  | 0     |
| 3   | FCS_2    | R/W | 1 = Force decoder output value determined by CCS.<br>0 = Disabled.   | 0     |
| 2   | LCS_2    | R/W | 1 = Enable pre-determined output value indicated by CCS when video loss is detected.<br>0 = Disabled.  | 0     |
| 1   | CCS_2    | R/W | When FCS is set high or video loss condition is detected when LCS is set high, one of two colors display can be selected.<br>1 = Blue color.<br>0 = Black. | 0     |
| 0   | BST_2    | R/W | 1 = Enable blue stretch.<br>0 = Disabled.  | 0     |

**0X5E – CH3 MISCELLANEOUS CONTROL II ON BGCTL=1**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | NKILL_3  | R/W | 1 = Enable noisy signal color killer function in NTSC mode.<br>0 = Disabled.   | 1     |
| 6   | PKILL_3  | R/W | 1 = Enable automatic noisy color killer function in PAL mode.<br>0 = Disabled.   | 1     |
| 5   | SKILL_3  | R/W | 1 = Enable automatic noisy color killer function in SECAM mode.<br>0 = Disabled.   | 1     |
| 4   | CBAL_3   | R/W | 0 = Normal output<br>1 = special output mode.  | 0     |
| 3   | FCS_3    | R/W | 1 = Force decoder output value determined by CCS.<br>0 = Disabled.   | 0     |
| 2   | LCS_3    | R/W | 1 = Enable pre-determined output value indicated by CCS when video loss is detected.<br>0 = Disabled.  | 0     |
| 1   | CCS_3    | R/W | When FCS is set high or video loss condition is detected when LCS is set high, one of two colors display can be selected.<br>1 = Blue color.<br>0 = Black. | 0     |
| 0   | BST_3    | R/W | 1 = Enable blue stretch.<br>0 = Disabled.  | 0     |

**0X5F – CH4 MISCELLANEOUS CONTROL II ON BGCTL=1**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | NKILL_4  | R/W | 1 = Enable noisy signal color killer function in NTSC mode.<br>0 = Disabled.   | 1     |
| 6   | PKILL_4  | R/W | 1 = Enable automatic noisy color killer function in PAL mode.<br>0 = Disabled.   | 1     |
| 5   | SKILL_4  | R/W | 1 = Enable automatic noisy color killer function in SECAM mode.<br>0 = Disabled.   | 1     |
| 4   | CBAL_4   | R/W | 0 = Normal output<br>1 = special output mode.  | 0     |
| 3   | FCS_4    | R/W | 1 = Force decoder output value determined by CCS.<br>0 = Disabled.   | 0     |
| 2   | LCS_4    | R/W | 1 = Enable pre-determined output value indicated by CCS when video loss is detected.<br>0 = Disabled.  | 0     |
| 1   | CCS_4    | R/W | When FCS is set high or video loss condition is detected when LCS is set high, one of two colors display can be selected.<br>1 = Blue color.<br>0 = Black. | 0     |
| 0   | BST_4    | R/W | 1 = Enable blue stretch.<br>0 = Disabled.  | 0     |

**0X60 – CLOK PLL CONTROL 1**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | CLK_DIFF | R/W | 1 : XTI pin to PLL REF clock input is differential input.<br>0 : XTI pin to PLL REF clock input is non-differential input. | 0     |
| 6-4 | CP_SEL   | R/W | Charge-pump current for PLL<br>0h : 1uA, 1h : 5uA, 2h : 10uA, 3h : 20uA,<br>4h : 40uA, 5h : 60UA, 6h : 80uA, 7h : 100uA.   | 2     |
| 3-2 | LP_X8    | R/W | Loop resistor for PLL<br>0h : 55.7K, 1h : 17.6K, 2h ; 8.81K, 3h : 6.23K  | 1     |
| 1-0 | VCO      | R/W | Select VCO gain for PLL<br>0h : 416MHz/V, 1h : 517MHz/V, 2h : 615MHz/V, 3h : 755MHz/V                                      | 2     |

**0X61 – VIDEO CLOCK SELECT**

| BIT | FUNCTION   | R/W | DESCRIPTION   | RESET |
|-----|------------|-----|---|-------|
| 7   | PLL_RST    | R/W | PLL module Reset#. Test purpose only.<br>1 : PLL module Reset#, 0 : PLL module is in normal mode.   | 0     |
| 6   | PLL_PD     | R/W | 1 : PLL module is in power down mode.<br>0 : PLL module is in normal mode.  | 0     |
| 5   | PLL_IREF   | R/W | PLL Current bias reference  | 0     |
| 4   | DECOSC     | R/W | Video Decoder system clock select.<br>0: (PLL output clock)/4 is selected for video decoder process.<br>1: Video decoder system clock is generated by XTI input crystal clock.  | 1     |
| 3   | SEL_144_72 | R/W | 1 : PLL module output 144MHz clock for D1 video decoder.<br>0 : PLL module output 72MHz clock. Test purpose only.   | 1     |
| 2   | SEL_108_54 | R/W | 1 : PLL module output 108MHz clock for D1 video decoder.<br>0 : PLL module output 54MHz clock. Test purpose only.   | 1     |
| 1-0 | XTIMD      | R/W | XTI pin input clock process control. If XTIMD=0/1/2, Clock PLL Output clock is not used for internal logic process.<br>0: XTI clock is directly used for all video decoder clock source.<br>1: XTI/2 clock is used for all video decoder clock source.<br>2: XTI/4 clock is used for all video decoder clock source.<br>3: PLL output clock is used for all video decoder clock source. | 3h    |

**0X62 – 036M/MPPOE**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | 036M4    | R/W | 0 : CH4 video decoder output 27MHz video data.<br>1 : CH4 video decoder output 36MHz video data. | 0     |
| 6   | 036M3    | R/W | 0 : CH3 video decoder output 27MHz video data.<br>1 : CH3 video decoder output 36MHz video data. | 0     |
| 5   | 036M2    | R/W | 0 : CH2 video decoder output 27MHz video data.<br>1 : CH2 video decoder output 36MHz video data. | 0     |
| 4   | 036M1    | R/W | 0 : CH1 video decoder output 27MHz video data.<br>1 : CH1 video decoder output 36MHz video data. | 0     |
| 3   | MPP4OE   | R/W | 0 : MPP4 pin is input 1 : MPP4 pin is output   | 0     |
| 2   | MPP3OE   | R/W | 0 : MPP4 pin is input 1 : MPP3 pin is output   | 0     |
| 1   | MPP2OE   | R/W | 0 : MPP2 pin is input 1 : MPP2 pin is output   | 0     |
| 0   | MPP1OE   | R/W | 0 : MPP1 pin is input 1 : MPP1 pin is output   | 0     |

**0X63 – CHANNEL ID 12**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-4 | CH2NUM   | R/W | Set up Channel ID number in VIN2A/VIN2B video decoder data output. | 1h    |
| 3-0 | CH1NUM   | R/W | Set up Channel ID number in VIN1A/VIN1B video decoder data output. | 0h    |

**0X64 – CHANNEL ID 34**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-4 | CH4NUM   | R/W | Set up Channel ID number in VIN4A/VIN4B video decoder data output. | 3h    |
| 3-0 | CH3NUM   | R/W | Set up Channel ID number in VIN3A/VIN3B video decoder data output. | 2h    |

**0X65 – VIDEO BUS TRI-STATE CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION | RESET |
|-----|----------|-----|-------------|-------|
|-----|----------|-----|-------------|-------|



|     |          |     |   |    |
|-----|----------|-----|---|----|
| 7-5 | Reserved | R   |   | 0h |
| 4   | VD4ORD   | R/W | Select the video channel output order on 4xD1 output mode.<br>0:Ch1->Ch2->Ch3->Ch4->Ch1->Ch2->Ch3->....(increase).<br>1:Ch4->Ch3->Ch2->Ch1->Ch4->Ch3->Ch2->....(decrease) | 0  |
| 3   | VD4OEB   | R/W | VD4[7:0] output tri-state control.<br>1: tri-state output VD4[7:0].<br>0: normal output VD4[7:0].   | 0  |
| 2   | VD3OEB   | R/W | VD3[7:0] output tri-state control.<br>1: tri-state output VD3[7:0].<br>0: normal output VD3[7:0].   | 0  |
| 1   | VD2OEB   | R/W | VD2[7:0] output tri-state control.<br>1: tri-state output VD2[7:0].<br>0: normal output VD2[7:0].   | 0  |
| 0   | VD1OEB   | R/W | VD1[7:0] output tri-state control.<br>1: tri-state output VD1[7:0].<br>0: normal output VD1[7:0].   | 0  |

**0X67 – HZST**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-0 | HZST     | R/W | HZOOM UP process start control.After this number's pixels passed out data process from internal hsync(pksync),Hzoom Up module starts it's zooming up process. | 80h   |

**0X6D – D1 NMGAIN/SHCOR**

| BIT | FUNCTION      | R/W | DESCRIPTION   | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | NMGAIN<br>720 | R/W | These bits control the normal AGC loop maximum correction value in 720H D1 video decoder. | 2h    |
| 3-0 | SHCOR<br>720  | R/W | These bits provide coring function for the sharpness control in 720H WD1 video decoder.   | 8h    |

**0X6E – D1 CLAMP POSITION REGISTER**

| BIT | FUNCTION      | R/W | DESCRIPTION   | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | PCLAMP<br>720 | R/W | These bits set the clamping position from the PLL sync edge in 720H D1 video decoder. | 38h   |

**0X70 – AUDIO CLOCK CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | ACK36MD  | R/W | 1 : 36MHz clock source is used for audio system clock.<br>Special purpose only.<br>0 : 27MHz clock source is used for audio system clock.  | 0     |
| 6   | S2I_8BIT | R/W | 0 : ACLKP/ASYNP/ADATP pin input is 16-bit control.<br>1 : ACLKP/ASYNP/ADATP pin input is 8-bit control.  | 0     |
| 5   | ACLKRPOL | R/W | ACLKR input signal polarity inverse.<br>0 : not inverted.<br>1 : inverts.  | 0     |
| 4   | ACLKPPOL | R/W | ACLKP input signal polarity inverse.<br>0 : not inverted.<br>1 : inverted.   | 0     |
| 3   | AFAUTO   | R/W | ACKI[21:0] control automatic set up with AFMD registers.<br>This mode is only effective when ACLKRMAS <sub>TER</sub> =1.<br>0 : ACKI[21:0] registers set up ACKI control.<br>1 : ACKI control is automatically set up by AFMD register values. | 1     |
| 2-0 | AFMD     | R/W | AFAUTO control mode.<br>0 : 8kHz setting (default).<br>1 : 16kHz setting.<br>2 : 32kHz setting.<br>3 : 44.1kHz setting.<br>4 : 48kHz setting.  | 0h    |

**0X71 – DIGITAL AUDIO INPUT CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | I2S8MODE | R/W | 8-bit I2S Record output mode.<br>0 : L/R half length separated output.<br>1 : One continuous packed output equal to DSP output format.   | 0     |
| 6   | MASCKMD  | R/W | Audio Clock Master ACLKR output wave format.<br>0 : High period is one 36MHz clock period.<br>1 : Almost duty 50-50% clock output on ACLKR pin. If this mode is selected, two times bigger number value need to be set up ACKI registers. If AFAUTO=1, ACKI control is automatically set up even if MASCKMD=1. SDIV=00h is used with this function normally. | 1     |
| 5   | PBINSWAP | R/W | Playback ACLKP/ASYNP/ADATP input data MSB-LSB swapping.<br>0 : Not swapping.<br>1 : Swapping.  | 0     |
| 4   | ASYNRDLY | R/W | ASYNR input signal delay.<br>0 : No delay.<br>1 : Add one 27MHz period delay in ASYNR signal input.  | 0     |
| 3   | ASYNPDLY | R/W | ASYNP input signal delay.<br>0 : No delay.<br>1 : Add one 36MHz period delay in ASYNP signal input.  | 0     |
| 2   | ADATPDLY | R/W | ADATP input data delay by one ACLKP clock.<br>0 : No delay. This is for I2S type 1T delay input interface.<br>1 : Add 1 ACLKP clock delay in ADATP input data. This is for left-justified type 0T delay input interface.   | 0     |
| 1-0 | INLAWMD  | R/W | Select u-Law/A-Law/PCM/SB data input format on ADATP pin.<br>0 : PCM input<br>1 : SB(Signed MSB bit in PCM data is inverted) input<br>2 : u-Law input<br>3 : A-Law input   | 0h    |

**0X72 – MIX RATIO VALUE 1**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | MRATIOMD | R/W | Audio Mixing ratio value divider control<br>0 : MIX_RATIO<br>0        0.25 (default)<br>1        0.31<br>2        0.38<br>3        0.44<br>4        0.50<br>5        0.63<br>6        0.75<br>7        0.88<br>8        1.00<br>9        1.25<br>10       1.50<br>11       1.75<br>12       2.00<br>13       2.25<br>14       2.50<br>15       2.75<br>1 : MIX_RATIO / 64 | 0     |
| 6   | ADACTEST | R/W | 0 : must be set up 0 in normal mode.<br>1 : test purpose only   | 0     |
| 5   | AOFFCORE | R/W | 0: Audio No-input Noise reduction on(Test purpose only)<br>1: Audio No-input Noise reduction off  | 1     |

**0X72 – MIX RATIO VALUE 2**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 4   | DAORATIO | R/W | Digital Audio Output Gain is controlled by following.<br>0: DAOGAIN<br><br>0            0.25<br>1            0.31<br>2            0.38<br>3            0.44<br>4            0.50<br>5            0.63<br>6            0.75<br>7            0.88<br>8            1.00(default)<br>9            1.25<br>10           1.50<br>11           1.75<br>12           2.00<br>13           2.25<br>14           2.50<br>15           2.75<br>1: DAOGAIN / 64 | 0     |
| 3-0 | DAOGAIN  | R/W | Digital Audio Output Gain. Gain is controlled with DAORATIO mode.   | 8h    |

**0X73 – A51DET\_ENA**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7-3 | Reserved   | R   | Reserved   | 00h   |
| 2   | AIN51FORM  | R/W | <p>AIN51/52/53/54 record output format selection. This bit is only effective when A51OUTOFF register is set to 0.<br/>When AIN1/2/3/4/51 and AIN6/7/8/9/52 are required to be continuous order in record output, 1 is necessary.</p> <p>0: If I2S mode(RM_SYNC=0)<br/> L dat : &lt;dat0&gt;&lt;dat1&gt;&lt;dat2&gt;&lt;dat3&gt;&lt;dat4&gt;&lt;dat5&gt;<br/> &lt;dat6&gt;&lt;dat7&gt;&lt;dat51&gt;&lt; dat52&gt;<br/> R dat : &lt;dat8&gt;&lt;dat9&gt;&lt;datA&gt;&lt;datB&gt;&lt;datC&gt;&lt;datD&gt;<br/> &lt;datE&gt;&lt;datF&gt;&lt;dat53&gt;&lt;dat54&gt;</p> <p>If DSP mode(RM_SYNC=1) all data are continuous.<br/> &lt;dat0&gt;&lt;dat1&gt;&lt;dat2&gt;&lt;dat3&gt;&lt;dat4&gt;&lt;dat5&gt;&lt;dat6&gt;<br/> &lt;dat7&gt;&lt;dat8&gt;&lt;dat9&gt;&lt;datA&gt;&lt;datB&gt;&lt;datC&gt;&lt;datD&gt;<br/> &lt;datE&gt;&lt;datF&gt;&lt;dat51&gt;&lt;dat52&gt;&lt;dat53&gt;&lt;dat54&gt;</p> <p>1: If I2S mode(RM_SYNC=0)<br/> L dat : &lt;dat0&gt;&lt;dat1&gt;&lt;dat2&gt;&lt;dat3&gt;&lt;dat51&gt;&lt;dat4&gt;<br/> &lt;dat5&gt;&lt;dat6&gt;&lt;dat7&gt;&lt;dat52&gt;<br/> R dat : &lt;dat8&gt;&lt;dat9&gt;&lt;datA&gt;&lt;datB&gt;&lt;dat53&gt;&lt;datC&gt;<br/> &lt;datD&gt;&lt; datE&gt;&lt; datF&gt;&lt;dat54&gt;</p> <p>If DSP mode(RM_SYNC=1) all data continuous.<br/> &lt;dat0&gt;&lt;dat1&gt;&lt;dat2&gt;&lt;dat3&gt;&lt; dat51&gt;&lt;dat4&gt;&lt;dat5&gt;<br/> &lt;dat6&gt;&lt;dat7&gt;&lt;dat52&gt;&lt;dat8&gt;&lt;dat9&gt;&lt;datA&gt;&lt;datB&gt;<br/> &lt;dat53&gt;&lt;datC&gt;&lt;datD&gt;&lt;datE&gt;&lt;datF&gt;&lt;dat54&gt;</p> | 0     |
| 1   | AINTPOFF   | R/W | 0 : must be set up 1 : test purpose only   | 0     |
| 0   | A51DET_ENA | R/W | <p>Enable state register updating and interrupt request of audio AIN51 (AIN5 input in this chip) detection for each input.</p> <p>0 : Disable state register updating and interrupt request<br/> 1 : Enable state register updating and interrupt request</p>  | 0     |

**0X74 – STATUS OF AUDIO 5 DETECTION**

| BIT | FUNCTION    | R/W | DESCRIPTION   | RESET |
|-----|-------------|-----|---|-------|
| 7-1 | Reserved    | R   |   | 00h   |
| 0   | A5DET_STATE | R   | <p>State of Audio AIN51( AIN5 input in this chip) detection.<br/>This bit is activated according ADET_MODE.</p> <p>0 : Inactivated<br/> 1 : Activated</p> | 0     |

**0X7B – ADATM I2S OUTPUT SELECT**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7-5 | Reserved  | R   |  | 0h    |
| 4-0 | I2SO_RSEL | R/W | Select R-channel output data on ADATM pin when ADATM_I2SOEN=1. * | 15h   |

**\*Note :**

Both I2SO\_RSEL and I2SO\_LSEL select output data by following order.

|         |   |
|---------|---|
| 0       | Select record audio of channel 1(AIN1)              |
| 1       | Select record audio of channel 2(AIN2)              |
| 2       | Select record audio of channel 3(AIN3)              |
| 3       | Select record audio of channel 4(AIN4)              |
| 4       | Select record audio of channel 5(AIN5)              |
| 5       | Select record audio of channel 6(AIN6)              |
| 6       | Select record audio of channel 7(AIN7)              |
| 7       | Select record audio of channel 8(AIN8)              |
| 8       | Select record audio of channel 9(AIN9)              |
| 9       | Select record audio of channel 10(AIN10)            |
| 10(Ah)  | Select record audio of channel 11(AIN11)            |
| 11(Bh)  | Select record audio of channel 12(AIN12)            |
| 12(Ch)  | Select record audio of channel 13(AIN13)            |
| 13(Dh)  | Select record audio of channel 14(AIN14)            |
| 14(Eh)  | Select record audio of channel 15(AIN15)            |
| 15(Fh)  | Select record audio of channel 16(AIN16)            |
| 16(10h) | Select playback audio of the first stage chip(PB1)  |
| 17(11h) | Select playback audio of the second stage chip(PB2) |
| 18(12h) | Select playback audio of the third stage chip(PB3)  |
| 19(13h) | Select playback audio of the last stage chip(PB4)   |
| 20(14h) | Select mixed audio.                                 |
| 21(15h) | Select record audio of channel 51(AIN51)(default)   |
| 22(16h) | Select record audio of channel 52(AIN52)            |
| 23(17h) | Select record audio of channel 53(AIN53)            |
| 24(18h) | Select record audio of channel 54(AIN54)            |
| Others  | no audio output.                                    |

**0X7C – ADATM I2S OUTPUT SELECT**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7-5 | Reserved  | R   |  | 0h    |
| 4-0 | I2SO_LSEL | R/W | Select L-channel output data on ADATM pin when ADATM_I2SOEN=1. * | 15h   |

\* Note : Please read 0x7B Note for detail description.

**0X7D – AIN51/52/53/54 RECORD OUTPUT**

| BIT | FUNCTION    | R/W | DESCRIPTION  | RESET |
|-----|-------------|-----|--|-------|
| 7-6 | I2SRECSEL54 | R/W | Select output data in bellow dat54 position.<br>0: AIN51, 1:AIN52, 2:AIN53, 3:AIN54. | 3h    |
| 5-4 | I2SRECSEL53 | R/W | Select output data in bellow dat53 position.<br>0: AIN51, 1:AIN52, 2:AIN53, 3:AIN54. | 2h    |
| 3-2 | I2SRECSEL52 | R/W | Select output data in bellow dat52 position.<br>0: AIN51, 1:AIN52, 2:AIN53, 3:AIN54. | 1h    |
| 1-0 | I2SRECSEL51 | R/W | Select output data in bellow dat51 position.<br>0: AIN51, 1:AIN52, 2:AIN53, 3:AIN54. | 0     |

These registers are only effective when A51OUTOFF=0. These registers function change under AIN51FORM control at that time as follows.

When AIN51FORM=0:

If I2S mode(RM\_SYNC=0),

L data : <dat0><dat1><dat2><dat3><dat4><dat5><dat6><dat7><dat51><dat52>

R data : <dat8><dat9><datA><datB><datC><datD><datE><datF><dat53><dat54>

If DSP mode(RM\_SYNC=1), all data are continuous.

<dat0><dat1><dat2><dat3><dat4><dat5><dat6><dat7><dat8><dat9><datA><datB><datC>

<datD><datE><datF><dat51><dat52><dat53><dat54>

When AIN51FORM=1:

If I2S mode(RM\_SYNC=0),

L data : <dat0><dat1><dat2><dat3><dat51><dat4><dat5><dat6><dat7><dat52>

R data : <dat8><dat9><datA><datB><dat53><datC><datD><datE><datF><dat54>

If DSP mode(RM\_SYNC=1), all data are continuous.

<dat0><dat1><dat2><dat3><dat51><dat4><dat5><dat6><dat7><dat52><dat8><dat9>

<datA><datB><dat53><datC><datD><datE><datF><dat54>

All other datN(N=0,1,2,,,,F) are selected by R\_SEQ\_N registers



**0X7E – A5OUTOFF**

| BIT | FUNCTION      | R/W | DESCRIPTION   | RESET |
|-----|---------------|-----|---|-------|
| 7   | A5OUTOFF      | R/W | AIN5 data output control on ADATR record signal.<br>0: output AIN51/AIN52/AIN53/AIN54 record data on ADATR.<br>1: not output AIN51/AIN52/AIN53/AIN54 record data on ADATR.  | 1     |
| 6   | ADATM_I2SOEN  | R/W | Define ADATM pin output 2 word data to make standard I2S output.<br>0:Mixing Data or Playback Input data are only output on ADATM pin by M_RLSWAP register.(default)<br>1:L/R data on ADATM pin is selected by I2SO_RSEL / I2SO_LSEL registers. | 0     |
| 5   | MIX_MUTE_A5   | R/W | MIX_MUTE_A5: Audio input AIN5 mute function control.<br>0:Normal<br>1:Muted   | 1     |
| 4-0 | ADET_TH5[4:0] | R/W | AIN5 threshold value for audio detection  | 03h   |

**0X80 – SOFTWARE RESET CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-6 | Reserved | R   | Reserved   | 00b   |
| 5   | AUDIORST | W   | A 1 written to this bit resets the Audio portion to its default state but all register content remains unchanged. This bit is self-resetting.          | 0     |
| 4   | VOUTrST  | W   | A 1 written to this bit resets Video data mux output logic to its default state but all register content remain unchanged. This bit is self-resetting. | 0     |
| 3   | VDEC4RST | W   | A 1 written to this bit resets the Video4 Decoder portion to its default state but all register content remain unchanged. This bit is self-resetting.  | 0     |
| 2   | VDEC3RST | W   | A 1 written to this bit resets the Video3 Decoder portion to its default state but all register content remain unchanged. This bit is self-resetting.  | 0     |
| 1   | VDEC2RST | W   | A 1 written to this bit resets the Video2 Decoder portion to its default state but all register content remain unchanged. This bit is self-resetting.  | 0     |
| 0   | VDEC1RST | W   | A 1 written to this bit resets the Video1 Decoder portion to its default state but all register content remain unchanged. This bit is self-resetting.  | 0     |

**0X81 – ANALOG CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-4 | Reserved | R/W |  | 0h    |
| 3   | CLKPDN   | R/W | 0 = Normal clock operation.<br>1 = All 4Ch Video Decoder System clock in power down mode, but the MPU INTERFACE module and output clocks (CLKP and CLKN) are still active. | 0     |
| 2   | Reserved | R/W |  | 0     |
| 1   | YFLEN    | R/W | Analog Video CH1/CH2/CH3/CH4 anti-alias filter control<br>1 = enable      0 = disable  | 1     |
| 0   | Reserved | R/W |  | 0     |

**0X82 – ANALOG CONTROL REGISTER2**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | CTEST    | R/W | Clamping control for debugging use.(Test purpose only)   | 0     |
| 6   | YCLEN    | R/W | 1 = Y channel clamp disabled (Test purpose only)<br>0 = Enabled.   | 0     |
| 5   | CKIPOL   | R/W | 1/4(27MHz or 36MHz) clock output signal rise/fall timing.<br>0 : change by 1/2(54MHz or 72MHz) clock output falling edge.<br>1 : change by 1/2(54MHz or 72MHz) clock output rising edge. | 0     |
| 4   | Reserved | R   |  | 0     |
| 3   | GTEST    | R/W | 1 = Test.(Test purpose only)<br>0 = Normal operation.  | 0     |
| 2   | VLPF     | R/W | Clamping filter control.   | 0     |
| 1   | CKLY     | R/W | Clamping current control 1.  | 0     |
| 0   | CKLC     | R/W | Clamping current control 2.  | 0     |

**0X83 – CONTROL REGISTER I**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | PBW      | R/W | 1 = Wide Chroma BPF BW<br>0 = Normal Chroma BPF BW   | 1     |
| 6   | DEM      | R/W | Reserved   | 1     |
| 5   | IDSNS    | R/W | Reserved.  | 0     |
| 4   | SET7     | R/W | 1 = The black level is 7.5 IRE above the blank level.<br>0 = The black level is the same as the blank level. | 0     |
| 3   | COMB     | R/W | 1 = Adaptive comb filter for NTSC<br>0 = Notch filter  | 1     |
| 2   | HCOMP    | R/W | 1 = operation mode 1. (recommended)<br>0 = mode 0.   | 1     |
| 1   | YCOMB    | R/W | 1 = Bypass Comb filter when no burst presence<br>0 = No bypass   | 0     |
| 0   | PDLY     | R/W | PAL delay line.<br>0 = enabled.    1 = disabled.   | 0     |

**0X84 – COLOR KILLER HYSTERESIS CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | GMEN     | R/W | Reserved.   | 0     |
| 6-5 | CKHY     | R/W | Color killer hysteresis.<br>0 – fastest    1 – fast    2 – medium    3 - slow | 00b   |
| 4-0 | HSDLY    | RW  | Reserved for test.  | 00h   |

**0X85 – VERTICAL SHARPNESS**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-4 | SHCOR960 | R/W | These bits provide coring function for the sharpness control in 960H WD1 video decoder. | 3     |
| 3   | VIN4     | R/W | Ch4 Video ADC input signal select. 0:VIN4A, 1:VIN4B                                     | 0     |
| 2   | VIN3     | R/W | Ch3 Video ADC input signal select. 0:VIN3A, 1:VIN3B                                     | 0     |
| 1   | VIN2     | R/W | Ch2 Video ADC input signal select. 0:VIN2A, 1:VIN2B                                     | 0     |
| 0   | VIN1     | R/W | Ch1 Video ADC input signal select. 0:VIN1A, 1:VIN1B                                     | 0     |

**0X86 – CORING CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-6 | CTCOR    | R/W | These bits control the coring for CTI.   | 1     |
| 5-4 | CCOR     | R/W | These bits control the low level coring function for the Cb/Cr output.                             | 0     |
| 3-2 | VCOR     | R/W | These bits control the coring function of vertical peaking.  | 1     |
| 1-0 | CIF      | R/W | These bits control the IF compensation level.<br>0 = None      1 = 1.5dB      2 = 3dB      3 = 6dB | 0     |

**0X87 – CLAMPING GAIN**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-4 | CLPEND   | R/W | These 4 bits set the end time of the clamping pulse. Its value should be larger than the value of CLPST. | 5     |
| 3-0 | CLPST    | R/W | These 4 bits set the start time of the clamping. It is referenced to PCLAMP position.                    | 0     |

**0X88 – INDIVIDUAL AGC GAIN**

| BIT | FUNCTION      | R/W | DESCRIPTION   | RESET |
|-----|---------------|-----|---|-------|
| 7-4 | NMGAIN<br>960 | R/W | These bits control the normal AGC loop maximum correction value for 960H WD1 video deocder. | 4     |
| 3-1 | WPGAIN        | R/W | Peak AGC loop gain control.   | 1     |
| 0   | Reserved      | R   | Reserved  | 0     |

**0X89 – AUDIO FS MODE CONTROL**

| BIT | FUNCTION    | R/W | DESCRIPTION  | RESET |
|-----|-------------|-----|--|-------|
| 7   | ATHROUGH    | R/W | 0: must be set up in normal mode.<br>1: test purpose only.   | 0     |
| 6   | ASYN SERIAL | R/W | ALINKO/ALINKI bit rate.<br>0: 27MHz.Effective for all Fs clock mode.<br>1: 13.5MHz.Effective for Fs 8kHz/16kHz mode.   | 0     |
| 5   | ACLKR128    | R/W | ACLKR clock output mode for special 16x8bit(total 128bit) data interface.<br>0: ACLKR output is normal.<br>1: the number of ACLKR clock per fs is 128.This function is effective with RM_8BIT=1 8-bit mode (special purpose).                          | 0     |
| 4   | ACLKR64     | R/W | ACLKR clock output mode for special 4 word output interface.ACLKRMAS TER=1 mode only.<br>0: ACLKR output is normal<br>1: the number of ACLKR clock per fs is 64.   | 0     |
| 3   | AFS384      | R/W | Special Audio fs Sampling mode.<br>0: Audio fs Sampling mode is normal 256xfs if AIN5=0.<br>1: Audio fs Sampling mode is 384xfs mode.  | 0     |
| 2   | AIN5MD      | R/W | Audio Input process mode.<br>0: AIN1/AIN2/AIN3/AIN4 4 Audio input only process. This mode is 256xfs if AFS384=0.In this mode, AIN5 input is not processed.<br>1: AIN1/AIN2/AIN3/AIN4/AIN5 5 Audio input process. This mode is 320xfs Mode if AFS384=0. | 0     |
| 1-0 | Reserved    | R   |  | 0h    |

**0X8A – WHITE PEAK THRESHOLD**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-0 | PEAKWT   | R/W | These bits control the white peak detection threshold. Setting 'FF' can disable this function. | D8    |

**0X8B– CLAMP LEVEL**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | CLMPLD   | R/W | 0 = Clamping level is set by CLMPL.<br>1 = Clamping level preset at 60d. | 1     |
| 6-0 | CLMPL    | R/W | These bits determine the clamping level of the Y channel.                | 3C    |

**0X8C– SYNC AMPLITUDE**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | SYNCTD   | R/W | 0 = Reference sync amplitude is set by SYNCT.<br>1 = Reference sync amplitude is preset to 38h. | 1     |
| 6-0 | SYNCT    | R/W | These bits determine the standard sync pulse amplitude for AGC reference.                       | 38    |

**0X8D – SYNC MISS COUNT REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-4 | MISSCNT  | R/W | These bits set the threshold for horizontal sync miss count threshold. | 4     |
| 3-0 | HSWIN    | R/W | These bits determine the VCR mode detection threshold.                 | 4     |

**0X8E – WD1 CLAMP POSITION REGISTER**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-0 | PCLAMP<br>960 | R/W | These bits set the clamping position from the PLL sync edge in 960H WD1 video decoder. | 36h   |

**0X8F – VERTICAL CONTROL I**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | VLCKI    | R/W | Vertical lock in time.<br>0 = fastest      3 = slowest.   | 0     |
| 5-4 | VLCKO    | R/W | Vertical lock out time.<br>0 = fastest      3 = slowest.  | 0     |
| 3   | VMODE    | R/W | This bit controls the vertical detection window.<br>1 = search mode.<br>0 = vertical count down mode. | 0     |
| 2   | DETV     | R/W | 1 = recommended for special application only.<br>0 = Normal Vsync logic                               | 0     |
| 1   | AFLD     | R/W | Auto field generation control<br>0 = Off            1 = On  | 0     |
| 0   | VINT     | R/W | Vertical integration time control.<br>1 = short                      0 = normal                       | 0     |

**0X90 – VERTICAL CONTROL II**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-5 | BSHT     | R/W | Burst PLL center frequency control.                              | 0     |
| 4-0 | VSHT     | R/W | Vsync output delay control in the increment of half line length. | 00    |

**0X91 – COLOR KILLER LEVEL CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | CKILMAX  | R/W | These bits control the amount of color killer hysteresis. The hysteresis amount is proportional to the value. | 1     |
| 5-0 | CKILMIN  | R/W | These bits control the color killer threshold. Larger value gives lower killer level.                         | 38    |



**0X92 – COMB FILTER CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION                               | RESET |
|-----|----------|-----|---|-------|
| 7   | HTL      | R/W | 0 = adaptive mode      1 = fixed comb     | 0     |
| 6-4 | HTL      | R/W | Adaptive Comb filter threshold control 1. | 4     |
| 3-0 | VTL      | R/W | Adaptive Comb filter threshold control 2. | 4     |

**0X93 – LUMA DELAY**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | CKLM     | R/W | Color Killer mode.<br>0 = normal      1 = fast ( for special application)                    | 0     |
| 6-4 | YDLY     | R/W | Luma delay fine adjustment. This 2's complement number provides -4 to +3 unit delay control. | 3     |
| 3   | PD_BIAS  | R/W | Video ADC PD_BIAS.   | 0     |
| 2-0 | VSAVE    | R/W | Video ADC power save.<br>0: Highest power    7: Lowest power                                 | 0     |

**0X94 – MISCELLANEOUS CONTROL I**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | HPLC     | R/W | Reserved for internal use.   | 0     |
| 6   | EVCNT    | R/W | 1 = Even field counter in special mode.<br>0 = Normal operation            | 0     |
| 5   | PALC     | R/W | Reserved for future use.   | 0     |
| 4   | SDET     | R/W | ID detection sensitivity. A '1' is recommended.                            | 1     |
| 3   | Reserved | R/W |  | 0     |
| 2   | BYPASS   | R/W | It controls the standard detection and should be set to '1' in normal use. | 1     |
| 1-0 | Reserved | R/W |  | 0     |

**0X95 – LOOP CONTROL REGISTER**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | HPM      | R/W | Horizontal PLL acquisition time.<br>3 = Fast 2 = Auto1 1 = Auto2 0 = Normal | 2     |
| 5-4 | ACCT     | R/W | ACC time constant<br>0 = No ACC 1 = slow 2 = medium 3 = fast                | 2     |
| 3-2 | SPM      | R/W | Burst PLL control.<br>0 = Slowest 1 = Slow 2 = Fast 3 = Fastest             | 1     |
| 1-0 | CBW      | R/W | Chroma low pass filter bandwidth control.<br>Refer to filter curves.        | 1     |

**0X96 – MISCELLANEOUS CONTROL II**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | NKILL    | R/W | 1 = Enable noisy signal color killer function in NTSC mode.<br>0 = Disabled.   | 1     |
| 6   | PKILL    | R/W | 1 = Enable automatic noisy color killer function in PAL mode.<br>0 = Disabled.   | 1     |
| 5   | SKILL    | R/W | 1 = Enable automatic noisy color killer function in SECAM mode.<br>0 = Disabled.   | 1     |
| 4   | CBAL     | R/W | 0 = Normal output<br>1 = special output mode.  | 0     |
| 3   | FCS      | R/W | 1 = Force decoder output value determined by CCS.<br>0 = Disabled.   | 0     |
| 2   | LCS      | R/W | 1 = Enable pre-determined output value indicated by CCS when video loss is detected.<br>0 = Disabled.  | 0     |
| 1   | CCS      | R/W | When FCS is set high or video loss condition is detected when LCS is set high, one of two colors display can be selected.<br>1 = Blue color.<br>0 = Black. | 0     |
| 0   | BST      | R/W | 1 = Enable blue stretch.<br>0 = Disabled.  | 0     |

**0X97 – CLAMP MODE**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | FRM      | R/W | Free run mode control<br>0 = Auto, 2 = default to 60Hz, 3 = default to 50Hz | 0     |
| 5-4 | YNR      | R/W | Y HF noise reduction<br>0 = None, 1 = smallest, 2 = small, 3 = medium       | 0     |
| 3-2 | CLMD     | R/W | Clamping mode control.<br>0 = Sync top, 1 = Auto, 2 = Pedestal, 3 = N/A     | 1     |
| 1-0 | PSP      | R/W | Slice level control<br>0 = low            1 = medium    2 = high            | 1     |

**0X98 – HSLOWCTL**

| BIT | FUNCTION     | R/W | DESCRIPTION                          | RESET |
|-----|--------------|-----|--------------------------------------|-------|
| 7-4 | HSBEGIN[3:0] | R/W | HSYNC Start position Control Bit3-0. | 0     |
| 3-0 | HSEND[3:0]   | R/W | HSYNC End position Control Bit3-0.   | 0     |

**0X99 – HSBEGIN**

| BIT | FUNCTION      | R/W | DESCRIPTION                           | RESET |
|-----|---------------|-----|---------------------------------------|-------|
| 7-0 | HSBEGIN[11:4] | R/W | HSYNC Start position Control Bit11-4. | 13h   |

**0X9A – HSEND**

| BIT | FUNCTION    | R/W | DESCRIPTION                         | RESET |
|-----|-------------|-----|-------------------------------------|-------|
| 7-0 | HSEND[11:4] | R/W | HSYNC End position Control Bit11-4. | 1Fh   |

**0X9B – OVSDLY**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-0 | OVSDLY   | R/W | VSYNC Start position. Control H position on VSYNC start. | 44h   |

**0X9C – OVSEND**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | Reserved | R   |  | 0     |
| 6-4 | OFDLY    | R/W | FIELD output delay.<br>0h : 0H line delay FIELD output. Internal fld direct output mode.<br>1h-7h : 1H-7H line delay FIELD output. | 2     |
| 3   | VSMODE   | R/W | 1:VSYNC output is HACTIVE-VSYNC mode.<br>0:VSYNC output is HSYNC-VSYNC mode.   | 0     |
| 2-0 | OVSEND   | R/W | Line delay for VSYNC end position.   | 0     |

**0X9E – NOVID**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7   | VDELAYMD  | R/W | 0 : normal VDELAY mode.<br>1 : Optional VDELAY mode.   | 0     |
| 6   | FC27      | R/W | 1 : normal ITU-R656 operation 0 : Reserved   | 1     |
| 5-4 | CHID_MD   | R/W | Select the Channel ID format for time-multiplexed output<br>0h : No channel ID (default)<br>1h : CHID with the specific ITU-R BT.656 sync Code<br>2h : CHID with the specific horizontal blanking code<br>3h : CHID with the specific ITU-R BT.656 sync & horizontal blanking code | 0     |
| 3   | NOVID_656 | R/W | 0 : Normal ITU-R BT.656 SA/EAV(default)<br>1 : AN optional set of ITU-R BT.656 SAV/EAV code for No-video status  | 0     |
| 2   | EAVSWAP   | R/W | 1 : EAV-SAV code is swapped.(special purpose only)<br>0 : EAV-SAV code is not swapped(standard 656 output mode)  | 0     |
| 1   | VIPCFG    | R/W | Set up Bit7 in 4th byte of EAV/SAV code.<br>1 : Standard ITU-R656 code format.(It's also VIP task-A code format.)<br>0 : Old VIP task-B code format.   | 1     |
| 0   | NTSC656   | R/W | 1 : Number of Even Field Video output line is (the number of Odd field Video output line – 1).This bit is required for ITU-R BT.656 output for 525 line system standard.<br>0 : Number of Even Field Video output line is same as the number of Odd field Video output line.       | 0     |

**0X9F – CLOCK OUTPUT DELAY CONTROL REGISTER**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7-4 | CLKNO_DEL | R/W | Control the clock delay of CLKNO pin.<br>0h/1h/3h/7h/Fh values are effective.<br>0h : no delay.<br>1h : about 0.26ns more delay,<br>3h : about 0.52ns more delay,<br>7h : about 0.77ns more delay,<br>Fh : about 0.96ns more delay | 0h    |
| 3-0 | CLKPO_DEL | R/W | Control the clock delay of CLKPO pin.<br>0h/1h/3h/7h/Fh values are effective.<br>0h : no delay.<br>1h : about 0.26ns more delay,<br>3h : about 0.52ns more delay,<br>7h : about 0.77ns more delay,<br>Fh : about 0.96ns more delay | 0h    |

**0XAF – VERTICAL PEAKING LEVEL CONTROL 1/2**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | Reserved | R   |   | 0     |
| 6-4 | VSHP2    | R/W | Select CH2 Video Vertical peaking level. (*)<br>0 : none. 7 : highest | 0     |
| 3   | Reserved | R   |   | 0     |
| 2-0 | VSHP1    | R/W | Select CH1 Video Vertical peaking level. (*)<br>0 : none. 7 : highest | 0     |

\*Note: VSHP must be set to '0' if Reg0x83 COMB = 0.

**0XB0 – VERTICAL PEAKING LEVEL CONTROL 3/4**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | Reserved | R   |   | 0     |
| 6-4 | VSHP4    | R/W | Select CH4 Video Vertical peaking level. (*)<br>0 : none. 7 : highest | 0     |
| 3   | Reserved | R   |   | 0     |
| 2-0 | VSHP3    | R/W | Select CH3 Video Vertical peaking level. (*)<br>0 : none. 7 : highest | 0     |

\*Note: VSHP must be set to '0' if Reg0x83 COMB = 0.



**0XB1 – CH8IDEN**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | CH8IDEN  | R/W | <p>Video Channel ID number has following value in Sync Code and Horizontal Blanking Code with CH1NUM, CH2NUM, CH3NUM and CH4NUM.</p> <p>0 : 4 channel ID Only output<br/>           VIN1A/VIN1B : CH1NUM[3:0]<br/>           VIN2A/VIN2B : CH2NUM[3:0]<br/>           VIN3A/VIN3B : CH3NUM[3:0]<br/>           VIN4A/VIN4B : CH4NUM[3:0]</p> <p>1 : 8 channel ID output<br/>           VIN1A : {1'b0,CH1NUM[2:0]}<br/>           VIN2A : {1'b0,CH2NUM[2:0]}<br/>           VIN3A : {1'b0,CH3NUM[2:0]}<br/>           VIN4A : {1'b0,CH4NUM[2:0]}<br/>           VIN1B : {1'b1,CH1NUM[2:0]}<br/>           VIN2B : {1'b1,CH2NUM[2:0]}<br/>           VIN3B : {1'b1,CH3NUM[2:0]}<br/>           VIN4B : {1'b1,CH4NUM[2:0]}</p> | 0     |
| 6-4 | Reserved | R/W |   | 0     |
| 3   | CLPOE    | R/W | <p>0 : normal mode.</p> <p>1 : Test purpose only.This is video clamp control signal output purpose.MPP1/MPP2/MPP3/MPP4 pins output following clamp control signal. n=1,2,3,4.<br/>           MPP4=CLMPDNXn, MPP3 =CLMPUPXn<br/>           MPP2=CLMPDNn, MPP1=CLMPUPn<br/>           When TESTVNUM=0,CH1 video clamp control signal output.<br/>           When TESTVNUM=1,CH2 video clamp control signal output.<br/>           When TESTVNUM=2,CH3 video clamp control signal output.<br/>           When TESTVNUM=3,CH4 video clamp control signal output.</p>  | 0     |
| 2-0 | TESTVNUM | R/W | <p>Test purpose only.<br/>           See CLPOE description for one of other function with this registers.<br/>           When OE_TEST_OUTSEL=1 and TEST_OUTSEL=Bh,<br/>           {MPP4,MPP3,VD4[7:0]} pins output video PGA gain control signal D[8:0] according to TESTVNUM value as follows.<br/>           0h : CH1 Video video PGA gain control signal D[8:0] output.<br/>           1h : CH2 Video video PGA gain control signal D[8:0] output.<br/>           2h : CH3 Video video PGA gain control signal D[8:0] output.<br/>           3h : CH4 Video video PGA gain control signal D[8:0] output.</p>   | 0     |

**0XB2 – VDLOSS OUTPUT**

| BIT | FUNCTION    | R/W | DESCRIPTION  | RESET |
|-----|-------------|-----|--|-------|
| 7   | VADC_CKPOL4 | R/W | 1 : CH4 video ADC clock polarity is inverted. 0 : not inverted.  | 0     |
| 6   | VADC_CKPOL3 | R/W | 1 : CH3 video ADC clock polarity is inverted. 0 : not inverted.  | 0     |
| 5   | VADC_CKPOL2 | R/W | 1 : CH2 video ADC clock polarity is inverted. 0 : not inverted.  | 0     |
| 4   | VADC_CKPOL1 | R/W | 1 : CH1 video ADC clock polarity is inverted. 0 : not inverted.  | 0     |
| 3   | VDLOSSOE4   | R/W | 0 : not output VDLOSS4 on MPP4 pin (default).<br>1 : VIN4A/VIN4B Video Decoder VDLOSS4 output on MPP4 pin. | 0     |
| 2   | VDLOSSOE3   | R/W | 0 : not output VDLOSS3 on MPP3 pin (default).<br>1 : VIN3A/VIN3B Video Decoder VDLOSS3 output on MPP3 pin. | 0     |
| 1   | VDLOSSOE2   | R/W | 0 : not output VDLOSS2 on MPP2 pin (default).<br>1 : VIN2A/VIN2B Video Decoder VDLOSS2 output on MPP2 pin. | 0     |
| 0   | VDLOSSOE1   | R/W | 0 : not output VDLOSS1 on MPP1 pin (default).<br>1 : VIN1A/VIN1B Video Decoder VDLOSS1 output on MPP1 pin. | 0     |

**0XB3 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-6 | AADC4OFS[9:8] | R/W | Ch4 Digital ADC input data offset control bit9-8. | 0h    |
| 5-4 | AADC3OFS[9:8] | R/W | Ch3 Digital ADC input data offset control bit9-8. | 0h    |
| 3-2 | AADC2OFS[9:8] | R/W | Ch2 Digital ADC input data offset control bit9-8. | 0h    |
| 1-0 | AADC1OFS[9:8] | R/W | Ch1 Digital ADC input data offset control bit9-8. | 0h    |

Digital ADC input data offset control. Digital ADC input data is adjusted by  $ADJAADCn = AUDnADC + AADCnOFS$ .

AUDnADC is 2's formatted Analog Audio ADC output.

AADCnOFS is adjusted offset value by 2's format.

**0XB4 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | AADC1OFS[7:0] | R/W | Ch1 Digital ADC input data offset control bit7-0. | 00h   |

**0XB5 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | AADC2OFS[7:0] | R/W | Ch2 Digital ADC input data offset control bit7-0. | 00h   |

**0XB6 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | AADC3OFS[7:0] | R/W | Ch3 Digital ADC input data offset control bit7-0. | 00h   |

**0XB7 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | AADC4OFS[7:0] | R/W | Ch4 Digital ADC input data offset control bit7-0. | 00h   |

**0X75 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-2 | Reserved      | R   |   | 0h    |
| 1-0 | AADC5OFS[9:8] | R/W | Ch5 Digital ADC input data offset control bit9-8. | 0h    |

Digital ADC input data offset control. Digital ADC input data is adjusted by  $ADJAADCn = AUDnADC + AADCnOFS$ .

AUDnADC is 2's formatted Analog Audio ADC output.

AADCnOFS is adjusted offset value by 2's format.

**0X76 – AUDIO ADC DIGITAL INPUT OFFSET CONTROL**

| BIT | FUNCTION      | R/W | DESCRIPTION                                       | RESET |
|-----|---------------|-----|---|-------|
| 7-0 | AADC5OFS[7:0] | R/W | Ch5 Digital ADC input data offset control bit7-0. | 00h   |

**0XB8 – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7-6 | AUD4ADC[9:8] | R   | Bit9-8 of Ch4 Analog Audio ADC Digital Output Value by 2's format. | X     |
| 5-4 | AUD3ADC[9:8] | R   | Bit9-8 of Ch3 Analog Audio ADC Digital Output Value by 2's format. | X     |
| 3-2 | AUD2ADC[9:8] | R   | Bit9-8 of Ch2 Analog Audio ADC Digital Output Value by 2's format. | X     |
| 1-0 | AUD1ADC[9:8] | R   | Bit9-8 of Ch1 Analog Audio ADC Digital Output Value by 2's format. | X     |

**0XB9 – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7-0 | AUD1ADC[7:0] | R   | Bit7-0 of Ch1 Analog Audio ADC Digital Output Value by 2's format. | X     |

**0XBA – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7-0 | AUD2ADC[7:0] | R   | Bit7-0 of Ch2 Analog Audio ADC Digital Output Value by 2's format. | X     |

**0XBB – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION   | RESET |
|-----|--------------|-----|---|-------|
| 7-0 | AUD3ADC[7:0] | R   | Bit7-0 of Ch3 Analog Audio ADC Digital Output Value by 2's format.. | X     |

**0XBC – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7-0 | AUD4ADC[7:0] | R   | Bit7-0 of Ch4 Analog Audio ADC Digital Output Value by 2's format. | X     |

**0X77 – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7-2 | Reserved     | R   |  | 00h   |
| 1-0 | AUD5ADC[9:8] | R   | Bit9-8 of Ch5 Analog Audio ADC Digital Output Value by 2's format. | X     |

**0X78 – ANALOG AUDIO ADC DIGITAL OUTPUT VALUE**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7-0 | AUD5ADC[7:0] | R   | Bit7-0 of Ch5 Analog Audio ADC Digital Output Value by 2's format. | X     |

**0XBDB – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-6 | ADJAADC4[9:8] | R   | Bit9-8 of Ch4 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |
| 5-4 | ADJAADC3[9:8] | R   | Bit9-8 of Ch3 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |
| 3-2 | ADJAADC2[9:8] | R   | Bit9-8 of Ch2 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |
| 1-0 | ADJAADC1[9:8] | R   | Bit9-8 of Ch1 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

The value shows the first input data in front of Digital Audio Decimation Filtering process.

**0XBEB – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-0 | ADJAADC1[7:0] | R   | Bit7-0 of Ch1 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

**0XBFB – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-0 | ADJAADC2[7:0] | R   | Bit7-0 of Ch2 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

**0XC0 – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-0 | ADJAADC3[7:0] | R   | Bit7-0 of Ch3 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

**0XC1 – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-0 | ADJAADC4[7:0] | R   | Bit7-0 of Ch4 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

**0X79 – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-2 | Reserved      | R   |  | 00h   |
| 1-0 | ADJAADC5[9:8] | R   | Bit9-8 of Ch5 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

**0X7A – ADJUSTED ANALOG AUDIO ADC DIGITAL INPUT VALUE**

| BIT | FUNCTION      | R/W | DESCRIPTION  | RESET |
|-----|---------------|-----|--|-------|
| 7-0 | ADJAADC5[7:0] | R   | Bit7-0 of Ch5 adjusted Audio ADC Digital Input Data Value by 2's format. | X     |

**0XC8 – MPP PIN OUTPUT MODE CONTROL**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7   | GPP_VAL2  | R/W | Write value select the general purpose value through the MPP2 pin output. Read value shows MPP2 pin input status.<br><br>0 : "0" value, 1 : "1" value  | 0     |
| 6-4 | MPP_MODE2 | R/W | Select the output mode for MPP2 pin.<br><br>Followings show the status when POLMPP2 register is set to 0. If POLMPP2 register is set to 1, following values have inversed status.<br><br>0 : Horizontal sync output. Low is H-sync active.<br><br>1 : Vertical sync output. Low is V-sync active.<br><br>2 : Field flag output. Low is field1 (Odd), High is field2 (Even).<br><br>3 : Horizontal active signal output. High is H-active.<br><br>4 : Vertical active & horizontal active signal output. High is VH-active.<br><br>5 : 27MHz clock output. This clock is made from XTI source.<br><br>6 : Vertical sync & horizontal sync signal output. Low is sync active.<br><br>7:GPP_VAL. Same as GPP_VAL2 register value.<br><br>If VDLOSSOE2 register is set to "1", vdloss2 signal is output to MPP2 pin and these MPP_MODE2 function is not effective. | 0h    |
| 3   | GPP_VAL1  | R/W | Write value select the general purpose value through the MPP1 pin output. Read value shows MPP1 pin input status.<br><br>0 : "0" value, 1 : "1" value  | 0     |
| 2-0 | MPP_MODE1 | R/W | Select the output mode for MPP1 pin.<br><br>Followings show the status when POLMPP1 register is set to 0. If each POLMPP1 register is set to 1, following values have inversed status.<br><br>0 : Horizontal sync output. Low is H-sync active.<br><br>1 : Vertical sync output. Low is V-sync active.<br><br>2 : Field flag output. Low is field1 (Odd), High is field2 (Even).<br><br>3 : Horizontal active signal output. High is H-active.<br><br>4 : Vertical active & horizontal active signal output. High is VH-active.  | 0h    |

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
|     |          |     | <p>5 : 27MHz clock output.This cloock is made from XT1 source.</p> <p>6 : Vertical sync &amp; horizontal sync signal output. Low is sync active.</p> <p>7 : GPP_VAL.Same as GPP_VAL1 register value.</p> <p>If VDLOSSOE1 register is set to "1", vdlloss1 signal is output to MPP1 pin and these MPP_MODE1 function is not effective.</p> |       |



**0XC9 – MPP PIN OUTPUT MODE CONTROL**

| BIT | FUNCTION  | R/W | DESCRIPTION   | RESET |
|-----|-----------|-----|---|-------|
| 7   | GPP_VAL4  | R/W | Write value select the general purpose value through the MPP4 pin output. Read value shows MPP4 pin input status.<br><br>0 : "0" value, 1 : "1" value   | 0     |
| 6-4 | MPP_MODE4 | R/W | Select the output mode for MPP4 pin.<br><br>Followings show the status when POLMPP4 register is set to 0. If POLMPP4 register is set to 1, following values have inversed status.<br><br>0 : Horizontal sync output. Low is H-sync active.<br><br>1 : Vertical sync output. Low is V-sync active.<br><br>2 : Field flag output. Low is field1 (Odd), High is field2 (Even).<br><br>3 : Horizontal active signal output. High is H-active.<br><br>4 : Vertical active & horizontal active signal output. High is VH-active.<br><br>5 : 27MHz clock output. This clock is made from XTI source.<br><br>6 : Vertical sync & horizontal sync signal output. Low is sync active.<br><br>7 : GPP_VAL. Same as GPP_VAL4 register value.<br><br>If VDLOSSOE4 register is set to "1", vdlloss4 signal is output to MPP4 pin and these MPP_MODE4 function is not effective. | 0h    |
| 3   | GPP_VAL3  | R/W | Write value select the general purpose value through the MPP3 pin output. Read value shows MPP3 pin input status.<br><br>0 : "0" value, 1 : "1" value   | 0     |
| 2-0 | MPP_MODE3 | R/W | Select the output mode for MPP3 pin.<br><br>Followings show the status when POLMPP3 register is set to 0. If each POLMPP3 register is set to 1, following values have inversed status.<br><br>0: Horizontal sync output. Low is H-sync active.<br><br>1 : Vertical sync output. Low is V-sync active.<br><br>2 : Field flag output. Low is field1 (Odd), High is field2 (Even).<br><br>3 : Horizontal active signal output. High is H-active.<br><br>4 : Vertical active & horizontal active signal output. High is VH-active.  | 0h    |

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
|     |          |     | <p>5 : 27MHz clock output.This cloock is made from XTl source.</p> <p>6 : Vertical sync &amp; horizontal sync signal output. Low is sync active.</p> <p>7 : GPP_VAL.Same as GPP_VAL3 register value.</p> <p>If VDLOSSOE3 register is set to "1", vdlloss3 signal is output to MPP3 pin and these MPP_MODE3 function is not effective.</p> |       |

**OXCA – VIDEO CHANNEL OUTPUT CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | CHMD4    | R/W | Select video bus output mode on 8bit VD4[7:0] pin.<br>0 : Single Channel ITU-R BT.656 format output.<br>1 : Two Channel ITU-R BT.656 Time-multiplexed format output.<br>2 : Four Channel ITU-R BT.656 Time-multiplexed format output. | 0h    |
| 5-4 | CHMD3    | R/W | Select video bus output mode on 8bit VD3[7:0] pin.<br>0 : Single Channel ITU-R BT.656 format output.<br>1 : Two Channel ITU-R BT.656 Time-multiplexed format output.<br>2 : Four Channel ITU-R BT.656 Time-multiplexed format output. | 0h    |
| 3-2 | CHMD2    | R/W | Select video bus output mode on 8bit VD2[7:0] pin.<br>0 : Single Channel ITU-R BT.656 format output.<br>1 : Two Channel ITU-R BT.656 Time-multiplexed format output.<br>2 : Four Channel ITU-R BT.656 Time-multiplexed format output. | 0h    |
| 1-0 | CHMD1    | R/W | Select video bus output mode on 8bit VD1[7:0] pin.<br>0 : Single Channel ITU-R BT.656 format output.<br>1 : Two Channel ITU-R BT.656 Time-multiplexed format output.<br>2 : Four Channel ITU-R BT.656 Time-multiplexed format output. | 0h    |

**0XCB -POLMPP**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7   | POLMPP4  | R/W | Select MPP4 pin output polarity.<br>0 : normal, 1 : inverse polarity. | 0     |
| 6   | POLMPP3  | R/W | Select MPP3 pin output polarity.<br>0 : normal, 1 : inverse polarity. | 0     |
| 5   | POLMPP2  | R/W | Select MPP2 pin output polarity.<br>0 : normal, 1 : inverse polarity. | 0     |
| 4   | POLMPP1  | R/W | Select MPP1 pin output polarity.<br>0 : normal, 1 : inverse polarity. | 0     |
| 3-0 | Reserved | R/W |   | 0h    |

**0XCC – 2ND CHANNEL SELECTION**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-6 | SELCH4   | R/W | Select 2nd video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD4 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 0h    |
| 5-4 | SELCH3   | R/W | Select 2nd video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD3 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 3h    |
| 3-2 | SELCH2   | R/W | Select 2nd video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD2 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : Ch4 video output | 2h    |
| 1-0 | SELCH1   | R/W | Select 2nd video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD1 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 1h    |

**0XCD – 1ST CHANNEL SELECTION**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-6 | MAINCH4  | R/W | Select 1st video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD4 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 3h    |
| 5-4 | MAINCH3  | R/W | Select 1st video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD3 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 2h    |
| 3-2 | MAINCH2  | R/W | Select 1st video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD2 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 1h    |
| 1-0 | MAINCH1  | R/W | Select 1st video output channel on Two Channel ITU-R BT.656 Time-multiplexed Format on VD1 pin<br><br>0 : CH1 video output<br>1 : CH2 video output<br>2 : CH3 video output<br>3 : CH4 video output | 0h    |

**0XCE – ANALOG POWER DOWN CONTROL**

| BIT | FUNCTION   | R/W | DESCRIPTION   | RESET |
|-----|------------|-----|---|-------|
| 7   | AAUTOMUTE  | R/W | 1 : When input Analog data is less than ADET_TH level, output PCM data will be 0x0000(0x00).Audio DAC data input is 0x200.<br>0 : No effect | 0     |
| 6   | Reserved   | R/W |   | 0     |
| 5   | A_DAC_PWDN | R/W | Power down the audio DAC.<br>0 : Normal operation<br>1 : Power down   | 0     |
| 4   | A_ADC_PWDN | R/W | Power down the audio ADC.<br>0 : Normal operation<br>1 : Power down   | 0     |
| 3-0 | VADC_PWDN  | R/W | Power down the video ADC.<br>V_ADC_PWDN[3:0] stands for CH4 to CH1.<br>0 : Normal operation<br>1 : Power down                               | 0h    |

**0XCF – SERIAL MODE CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7-6 | SMD      | R/W | Set up cascade Audio Serial mode.<br>When SMD=2hex or 3hex, ALINKO pin output cascaded audio serial data. When SMD=0hex, ALINKO pin output is tri-state.<br>00 : No Serial mode. ALINKO pin is tri-state output.<br>10 : ALINKO pin is Serial out pin. ALINKI pin is Serial input pin. | 0h    |
| 5-0 | Reserved | R/W |  | 0h    |

**0XD0, 0XD1, 0X7F - ANALOG AUDIO INPUT GAIN**

| INDEX | BIT | FUNCTION | R/W | DESCRIPTION   | RESET |           |     |   |    |
|-------|-----|----------|-----|---|-------|-----------|-----|---|----|
| 0xD0  | 7-4 | AIGAIN2  | R/W | Select the amplifier's gain for each analog audio input AIN1/2/3/4/5.<br><br>0     0.25<br>1     0.31<br>2     0.38<br>3     0.44<br>4     0.50<br>5     0.63<br>6     0.75<br>7     0.88<br>8     1.00<br>9     1.25<br>10    1.50<br>11    1.75<br>12    2.00<br>13    2.25<br>14    2.50<br>15    2.75 | 6h    |           |     |   |    |
| 0xD1  |     | AIGAIN4  | R/W |   |       |           |     |   |    |
| 0x7F  |     | AIGAIN5  | R/W |   |       |           |     |   |    |
| 0xD0  | 3-0 | AIGAIN1  | R/W |   | 6h    |           |     |   |    |
| 0xD1  |     | AIGAIN3  | R/W |   |       |           |     |   |    |
| 0x7F  |     |          |     |   |       | MIXRATIO5 | R/W | Audio input AIN5 ratio value for audio mixing | 0h |



**OXD2 – NUMBER OF AUDIO TO BE RECORDED**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | M_RLSWAP | R/W | <p>Define the sequence of mixing and playback audio data on the ADATM pin.</p> <p>If RM_SYNC=0 : I2S format,</p> <p>0 : Mixing audio on position 0 and playback audio on position 8<br/>1 : Playback audio on position 0 and mixing audio on position 8</p> <p>If RM_SYNC=1 : DSP format,</p> <p>0 : Mixing audio on position 0 and playback audio on position 1<br/>1 : Playback audio on position 0 and mixing audio on position 1</p> | 0     |
| 6   | RM_SYNC  | R/W | <p>Define the digital serial audio data format for record and mixing audio on the ACLKR, ASYNR, ADATR and ADATM pin.</p> <p>0 : I2S format      1 : DSP format</p>   | 0     |
| 5-4 | RM_PBSEL | R/W | <p>Select the output PlayBackIn data for the ADATM pin.</p> <p>0      First Stage PalyBackIn audio<br/>1      Second Stage PalyBackIn audio<br/>2      Third Stage PalyBackIn audio<br/>3      Last Stage PalyBackIn audio</p>   | 0h    |
| 3-2 | R_ADATM  | R/W | <p>Select the output mode for the ADATM pin.</p> <p>0 : Digital serial data of mixing audio<br/>1 : Digital serial data of ADATR format record audio<br/>2 : Digital serial data of ADATM format record audio</p>  | 0h    |
| 1-0 | R_MULTCH | R/W | <p>Define the number of audio for record on the ADATR pin.</p> <p>0      2 audios<br/>1      4 audios<br/>2      8 audios<br/>3      16 audios</p> <p>Number of output data is limited as shown on Sequence of Multi-channel Audio Record table. In addition, each output position data are selected by R_SEQ_0/R_SEQ_1/.../R_SEQ_F registers.</p>   | 0h    |

### 0XD3, 0XD4, 0XD5, 0XD6, 0XD7, 0XD8, 0XD9, 0XDA – SEQUENCE OF AUDIO TO BE RECORDED

| INDEX | BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-------|-----|----------|-----|--|-------|
| 0xD3  | 7-4 | R_SEQ1   | R/W | Define the sequence of record audio on the ADATR pin.<br>Refer to Figure 14 and Table 7 for the detail of the R_SEQ_0 ~ R_SEQ_F.<br>The default value of R_SEQ_0 is "0", R_SEQ_1 is "1", and R_SEQ_F is "F".<br><br>0     AIN1<br>1     AIN2<br>2     AIN3<br>:     :<br>:     :<br>14    AIN15<br>15    AIN16 | 1h    |
|       | 3-0 | R_SEQ0   | R/W |  | 0h    |
| 0xD4  | 7-4 | R_SEQ3   | R/W |  | 3h    |
|       | 3-0 | R_SEQ2   | R/W |  | 2h    |
| 0xD5  | 7-4 | R_SEQ5   | R/W |  | 5h    |
|       | 3-0 | R_SEQ4   | R/W |  | 4h    |
| 0xD6  | 7-4 | R_SEQ7   | R/W |  | 7h    |
|       | 3-0 | R_SEQ6   | R/W |  | 6h    |
| 0xD7  | 7-4 | R_SEQ9   | R/W |  | 9h    |
|       | 3-0 | R_SEQ8   | R/W |  | 8h    |
| 0xD8  | 7-4 | R_SEQB   | R/W |  | Bh    |
|       | 3-0 | R_SEQA   | R/W |  | Ah    |
| 0xD9  | 7-4 | R_SEQD   | R/W |  | Dh    |
|       | 3-0 | R_SEQC   | R/W |  | Ch    |
| 0xDA  | 7-4 | R_SEQF   | R/W |  | Fh    |
|       | 3-0 | R_SEQE   | R/W |  | Eh    |

**0XDB –MASTER CONTROL**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7   | ADACEN     | R/W | Audio DAC Function mode<br>0 : Audio DAC function disable(test purpose only)<br>1 : Audio DAC function enable  | 1     |
| 6   | AADCEN     | R/W | Audio ADC Function mode<br>0 : Audio ADC function disable(test purpose only)<br>1 : Audio ADC function enable  | 1     |
| 5   | PB_MASTER  | R/W | Define the operation mode of the ACLKP and ASYNP pin for playback.<br><br>0 : All type I2S/DSP Slave mode(ACLKP and ASYNP is input)<br>1 : TW2964 type I2S/DSP Master mode (ACLKP and ASYNP is output)   | 0     |
| 4   | PB_LRSEL   | R/W | Select audio data to be used for playback input.<br>If PB_SYNC=0 I2S format,<br>0 : 1st Left channel audio data(default),<br>1 : 1st Right channel audio data.<br>If PB_SYNC=1 DSP format,<br>0 : 1st input audio data.<br>1 : 2nd input audio data                                  | 0     |
| 3   | PB_SYNC    | R/W | Define the digital serial audio data format for playback audio on the ACLKP, ASYNP and ADATP pin.<br><br>0 : I2S format                    1 : DSP format  | 0     |
| 2   | RM_8BIT    | R/W | Define output data format per one word unit on ADATR pin.<br>0 : 16bit one word unit output<br>1 : 8bit one word unit packed output  | 0     |
| 1   | ASYNROEN   | R/W | Define input/output mode on the ASYNR pin.<br>1 : ASYNR pin is input            0 : ASYNR pin is output  | 1     |
| 0   | ACLKRMASER | R/W | Define input/output mode on the ACLKR pin and set up audio system processing.<br>0 : ACLKR pin is input. External 256xfs or 320fs or 384xfs clock should be connected to ACLKR pin by AIN5MD/AFS384 setting.<br>1 : ACLKR pin is output. Internal ACKG generates audio system clock. | 0     |

**0XDC – U-LAW/A-LAW OUTPUT AND MIX MUTE CONTROL**

| BIT | FUNCTION    | R/W | DESCRIPTION   | RESET |
|-----|-------------|-----|---|-------|
| 7-6 | LAWMD       | R/W | Select u-Law/A-Law/PCM/SB data output format on ADATR and ADATM pin.<br>0 : PCM output<br>1 : SB(Signed MSB bit in PCM data is inverted) output<br>2 : u-Law output<br>3 : A-Law output   | 0     |
| 5   | MIX_DERATIO | R/W | Disable the mixing ratio value for all audio.<br>0 : Apply individual mixing ratio value for each audio<br>1 : Apply nominal value for all audio commonly   | 0     |
| 4-0 | MIX_MUTE    | R/W | Enable the mute function for each audio. It effects only for mixing.<br><br>MIX_MUTE[0] : Audio input AIN1.<br>MIX_MUTE[1] : Audio input AIN2.<br>MIX_MUTE[2] : Audio input AIN3.<br>MIX_MUTE[3] : Audio input AIN4.<br>MIX_MUTE[4] : Playback audio input.<br><br>0 : Normal      1 : Muted. | 10h   |

**0XDD – MIX RATIO VALUE**

| BIT | FUNCTION   | R/W | DESCRIPTION                                   | RESET |
|-----|------------|-----|---|-------|
| 7-4 | MIX_RATIO2 | R/W | Audio input AIN2 ratio value for audio mixing | 0     |
| 3-0 | MIX_RATIO1 | R/W | Audio input AIN1 ratio value for audio mixing | 0     |

**0XDE – MIX RATIO VALUE**

| BIT | FUNCTION   | R/W | DESCRIPTION                                   | RESET |
|-----|------------|-----|---|-------|
| 7-4 | MIX_RATIO4 | R/W | Audio input AIN4 ratio value for audio mixing | 0     |
| 3-0 | MIX_RATIO3 | R/W | Audio input AIN3 ratio value for audio mixing | 0     |

**0XDF – ANALOG AUDIO OUTPUT GAIN**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7-4 | AOGAIN     | R/W | Define the amplifier gain for analog audio output.<br>0    0.25<br>1    0.31<br>2    0.38<br>3    0.44<br>4    0.50<br>5    0.63<br>6    0.75<br>7    0.88<br>8    1.00<br>9    1.25<br>10   1.50<br>11   1.75<br>12   2.00<br>13   2.25<br>14   2.50<br>15   2.75 | 8h    |
| 3-0 | MIX_RATIOP | R/W | Playback audio input ratio value for audio mixing.   | 0h    |

**0XE0 – MIX OUTPUT SELECTION 1**

| BIT | FUNCTION  | R/W | DESCRIPTION   | RESET |
|-----|-----------|-----|---|-------|
| 7   | Reserved  | R   |   | 0     |
| 6   | AADCCKPOL | R/W | 1 : Analog Audio ADC input clock polarity inverse<br>0 : not inverse.                     | 0     |
| 5   | ADACCKPOL | R/W | 1 : Analog Audio DAC input clock polarity inverse at digital portion.<br>0 : not inverse. | 0     |

**OXE0 – MIX OUTPUT SELECTION 2**

| BIT | FUNCTION   | R/W | DESCRIPTION   | RESET |
|-----|------------|-----|---|-------|
| 4-0 | MIX_OUTSEL | R/W | Define the final audio output for analog and digital mixing out.<br>0 Select record audio of channel 1<br>1 Select record audio of channel 2<br>2 Select record audio of channel 3<br>3 Select record audio of channel 4<br>4 Select record audio of channel 5<br>5 Select record audio of channel 6<br>6 Select record audio of channel 7<br>7 Select record audio of channel 8<br>8 Select record audio of channel 9<br>9 Select record audio of channel 10<br>10(Ah) Select record audio of channel 11<br>11(Bh) Select record audio of channel 12<br>12(Ch) Select record audio of channel 13<br>13(Dh) Select record audio of channel 14<br>14(Eh) Select record audio of channel 15<br>15(Fh) Select record audio of channel 16<br>16(10h) Select playback audio of the first stage chip PB1<br>17(11h) Select playback audio of the first stage chip PB2<br>18(12h) Select playback audio of the last stage chip PB3<br>19(13h) Select playback audio of the first stage chip PB4<br>20(14h) Select mixed audio<br>21(15h) Select record audio of channel AIN51<br>22(16h) Select record audio of channel AIN52<br>23(17h) Select record audio of channel AIN53<br>24(18h) Select record audio of channel AIN54<br>Others no sound. Default 1Fh. | 1Fh   |

**OXE1 – AUDIO DETECTION PERIOD AND AUDIO DETECTION THRESHOLD**

| BIT | FUNCTION     | R/W | DESCRIPTION  | RESET |
|-----|--------------|-----|--|-------|
| 7   | AAMPMD       | R/W | Define the audio detection method.<br>0 : Detect audio if absolute amplitude is greater than threshold(Test purpose only)<br>1 : Detect audio if differential amplitude is greater than threshold(recommended) | 1     |
| 6-4 | ADET_FILT    | R/W | Select the filter for audio detection<br>0 : Wide LPF.<br>7 : Narrow LPF   | 7     |
| 3   | ADET_TH4[4]* | R/W | MSB bit of AIN4 threshold value for audio detection.   | 0     |
| 2   | ADET_TH3[4]* | R/W | MSB bit of AIN3 threshold value for audio detection.   | 0     |
| 1   | ADET_TH2[4]* | R/W | MSB bit of AIN2 threshold value for audio detection.   | 0     |
| 0   | ADET_TH1[4]* | R/W | MSB bit of AIN1 threshold value for audio detection.   | 0     |

\* Note:

ADET\_TH :Define the threshold value for audio detection.

ADET\_TH1: Audio input AIN1.

ADET\_TH2: Audio input AIN2.

ADET\_TH3: Audio input AIN3.

ADET\_TH4: Audio input AIN4.

ADET\_TH5: Audio input AIN5.

0:Low value (default)

. .

31:High value

**0XE2 – AUDIO DETECTION THRESHOLD**

| BIT | FUNCTION      | R/W | DESCRIPTION   | RESET |
|-----|---------------|-----|---|-------|
| 7-4 | ADET_TH2[3:0] | R/W | Bit3-0 of AIN2 threshold value for audio detection. | 3h    |
| 3-0 | ADET_TH1[3:0] | R/W | Bit3-0 of AIN1 threshold value for audio detection. | 3h    |

**0XE3 – AUDIO DETECTION THRESHOLD**

| BIT | FUNCTION      | R/W | DESCRIPTION   | RESET |
|-----|---------------|-----|---|-------|
| 7-4 | ADET_TH4[3:0] | R/W | Bit3-0 of AIN4 threshold value for audio detection. | 3h    |
| 3-0 | ADET_TH3[3:0] | R/W | Bit3-0 of AIN3 threshold value for audio detection. | 3h    |

**AUDIO CLOCK INCREMENT****0XF0 – AUDIO CLOCK INCREMENT**

| BIT | FUNCTION  | R/W | DESCRIPTION   | RESET |
|-----|-----------|-----|---|-------|
| 7-0 | ACKI[7:0] | R/W | ACKI[7:0], these bits control ACKI Clock Increment in ACKG block. | 23h   |

**0XF1 – AUDIO CLOCK INCREMENT**

| BIT | FUNCTION   | R/W | DESCRIPTION  | RESET |
|-----|------------|-----|--|-------|
| 7-0 | ACKI[15:8] | R/W | ACKI[15:8], these bits control ACKI Clock Increment in ACKG block. | 48h   |

**0XF2 – AUDIO CLOCK INCREMENT**

| BIT | FUNCTION    | R/W | DESCRIPTION   | RESET |
|-----|-------------|-----|---|-------|
| 7-6 | Reserved    | R   |   | 0h    |
| 5-0 | ACKI[21:16] | R/W | ACKI[21:16], these bits control ACKI Clock Increment in ACKG block. | 07h   |



**0XF3 – AUDIO CLOCK NUMBER**

| BIT | FUNCTION  | R/W | DESCRIPTION | RESET |
|-----|-----------|-----|-------------|-------|
| 7-0 | ACKN[7:0] | R/W | Reserved.   | 00h   |

**0XF4 – AUDIO CLOCK NUMBER**

| BIT | FUNCTION   | R/W | DESCRIPTION | RESET |
|-----|------------|-----|-------------|-------|
| 7-0 | ACKN[15:8] | R/W | Reserved.   | 01h   |

**0XF5 – AUDIO CLOCK NUMBER**

| BIT | FUNCTION    | R/W | DESCRIPTION | RESET |
|-----|-------------|-----|-------------|-------|
| 7-2 | Reserved    | R   |             | 00h   |
| 1-0 | ACKN[17:16] | R/W | Reserved.   | 0h    |

**0XF6 – SERIAL CLOCK DIVIDER**

| BIT | FUNCTION | R/W | DESCRIPTION   | RESET |
|-----|----------|-----|---|-------|
| 7-6 | Reserved | R   |   | 0     |
| 5-0 | SDIV     | R/W | These bits control SDIV Serial Clock Divider in ACKG block. | 00h   |

**0XF7 – LEFT/RIGHT CLOCK DIVIDER**

| BIT | FUNCTION | R/W | DESCRIPTION | RESET |
|-----|----------|-----|-------------|-------|
| 7-6 | Reserved | R   |             | 0     |
| 5-0 | LRDIV    | R/W | Reserved.   | 20h   |

**0XF8 – AUDIO CLOCK CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | APZ      | R/W | These bits control Loop in ACKG block.   | 1     |
| 6-4 | APG      | R/W | These bits control Loop in ACKG block.   | 4h    |
| 3   | Reserved | R/W |  | 0     |
| 2   | ACPL     | R/W | These bits control Loop closed/open in ACKG block.<br>0: Loop closed(special purpose only)<br>1 :Loop open(normal function mode) | 1     |
| 1   | SRPH     | R/W | Reserved.  | 0     |
| 0   | LRPH     | R/W | Reserved.  | 0     |

**0XF9 – VIDEO MISCELLANEOUS FUNCTION CONTROL**

| BIT | FUNCTION | R/W | DESCRIPTION  | RESET |
|-----|----------|-----|--|-------|
| 7   | LIM16    | R/W | 0 : Output ranges are limited to 2~254<br>1 : Output ranges are limited to 16~235 for Y and 16~239 for CbCr  | 0     |
| 6   | PBREFEN  | R/W | Audio ACKG Reference (refin) input select for test purpose. When ACPL=1, this function is no effect.<br>0 : ACKG has video VRST refin input selected by VRSTSEL register<br>1 : ACKG has audio ASYNP refin input | 1     |
| 5   | YCBCR422 | R/W | Control YCbCr 4:2:2 output mode<br>0 : Normal 4:2:2 output mode<br>1 : Averaging 4:2:2 output mode   | 0     |
| 4   | Reserved | R/W |  | 0     |
| 3   | VBI_FRAM | R/W | Test purpose only.   | 0     |
| 2   | CNTL656  | R/W | Select invalid data value.<br>0 : 0x80 and 0x10 code will be output as invalid data during active video line.<br>1 : 0x00 code will be output as invalid data during active video line.                          | 0     |
| 1   | CLKNF    | R/W | CLKNO pin output mode.<br>0 : output one of 27MHz/54MHz/108MHz.<br>1 : output one of 36MHz/72MHz/144MHz.   | 0     |
| 0   | CLKPF    | R/W | CLKPO pin output mode.<br>0 : output one of 27MHz/54MHz/108MHz.<br>1 : output one of 36MHz/72MHz/144MHz.   | 0     |

**OXFA – OUTPUT ENABLE CONTROL AND CLOCK OUTPUT CONTROL**

| BIT | FUNCTION  | R/W | DESCRIPTION   | RESET |
|-----|-----------|-----|---|-------|
| 7   | Reserved  | R/W |   | 0     |
| 6   | OE        | R/W | Control the tri-state of output pin<br>0 : Outputs are Tri-state except clock output (CLKPO, CLKNO) pin<br>1 : Outputs are enabled  | 0     |
| 5   | CLKNO_OEB | R/W | Control the tri-state of CLKNO pin<br>0 : Output is enabled (default)<br>1 : Output is Tri-state  | 0     |
| 4   | CLKPO_OEB | R/W | Control the tri-state of CLKPO pin<br>0 : Output is enabled<br>1 : Output is Tri-state  | 0     |
| 3-2 | CLKNO_MD  | R/W | Control the clock frequency of CLKNO pin<br>0 : 27MHz or 36MHz clock output<br>1 : 54MHz or 72MHz clock output<br>2 : 108MHz or 144MHz clock output<br>3 : always 0 value | 0h    |
| 1-0 | CLKPO_MD  | R/W | Control the clock frequency of CLKPO pin<br>0 : 27MHz or 36MHz clock output<br>1 : 54MHz or 72MHz clock output<br>2 : 108MHz or 144MHz clock output<br>3 : always 0 value | 0h    |

**0XFB – CLOCK POLARITY CONTROL**

| BIT | FUNCTION  | R/W | DESCRIPTION  | RESET |
|-----|-----------|-----|--|-------|
| 7   | CLKNO_POL | R/W | Polarity inverse control on output CLKNO signal just before CLKNO pin.<br>0 : Not inverted.<br>1 : Polarity inverse.   | 0     |
| 6   | CLKPO_POL | R/W | Polarity inverse control on output CLKPO signal just before CLKPO pin.<br>0 : Not inverted.<br>1 : Polarity inverse.   | 0     |
| 5   | IRQENA    | R/W | Enable/Disable the interrupt request through the IRQ pin.<br>0 : Disable    1 : Enable   | 0     |
| 4   | IRQPOL    | R/W | Select the polarity of interrupt request through the IRQ pin.<br>0 : Falling edge requests the interrupt and keeps its state until cleared<br>1 : Rising edge requests the interrupt and keeps its state until cleared   | 0     |
| 3-2 | ADET_MODE | R/W | Define the polarity of state register and interrupt request for audio detection.<br>0 : No interrupt request by the audio detection<br>1 : Make the interrupt request rising only when the audio signal comes in<br>2 : Make the interrupt request falling only when the audio signal goes out<br>3 : Make the interrupt request rising and falling when the audio comes in and goes out | 3     |
| 1-0 | VDET_MODE | R/W | Define the polarity of state register and interrupt request for video detection.<br>0 : No interrupt request by the video detection<br>1 : Make the interrupt request rising only when the video signal comes in<br>2 : Make the interrupt request falling only when the video signal goes out<br>3 : Make the interrupt request rising and falling when the video comes in and goes out | 3     |

**0XFC – ENABLE VIDEO AND AUDIO DETECTION**

| BIT | FUNCTION  | R/W | DESCRIPTION   | RESET |
|-----|-----------|-----|---|-------|
| 7-0 | AVDET_ENA | R/W | <p>Enable state register updating and interrupt request of video and audio detection for each input.</p> <p>[0] : Video input VIN1.<br/>           [1] : Video input VIN2.<br/>           [2] : Video input VIN3.<br/>           [3] : Video input VIN4.<br/>           [4] : Audio input AIN1.<br/>           [5] : Audio input AIN2.<br/>           [6] : Audio input AIN3.<br/>           [7] : Audio input AIN4.</p> <p>0 : Disable state register updating and interrupt request<br/>           1 : Enable state register updating and interrupt request</p> | FFh   |

**0XFD – STATUS OF VIDEO AND AUDIO DETECTION**

| BIT | FUNCTION    | R/W | DESCRIPTION   | RESET |
|-----|-------------|-----|---|-------|
| 7-0 | AVDET_STATE | R/W | <p>State of Video and Audio detection.</p> <p>These bits are activated according VDET_MODE and ADET_MODE.</p> <p>[0] : Video input VIN1.<br/>           [1] : Video input VIN2.<br/>           [2] : Video input VIN3.<br/>           [3] : Video input VIN4.<br/>           [4] : Audio input AIN1.<br/>           [5] : Audio input AIN2.<br/>           [6] : Audio input AIN3.<br/>           [7] : Audio input AIN4.</p> <p>0      Inactivated<br/>           1      Activated</p> | 00h   |

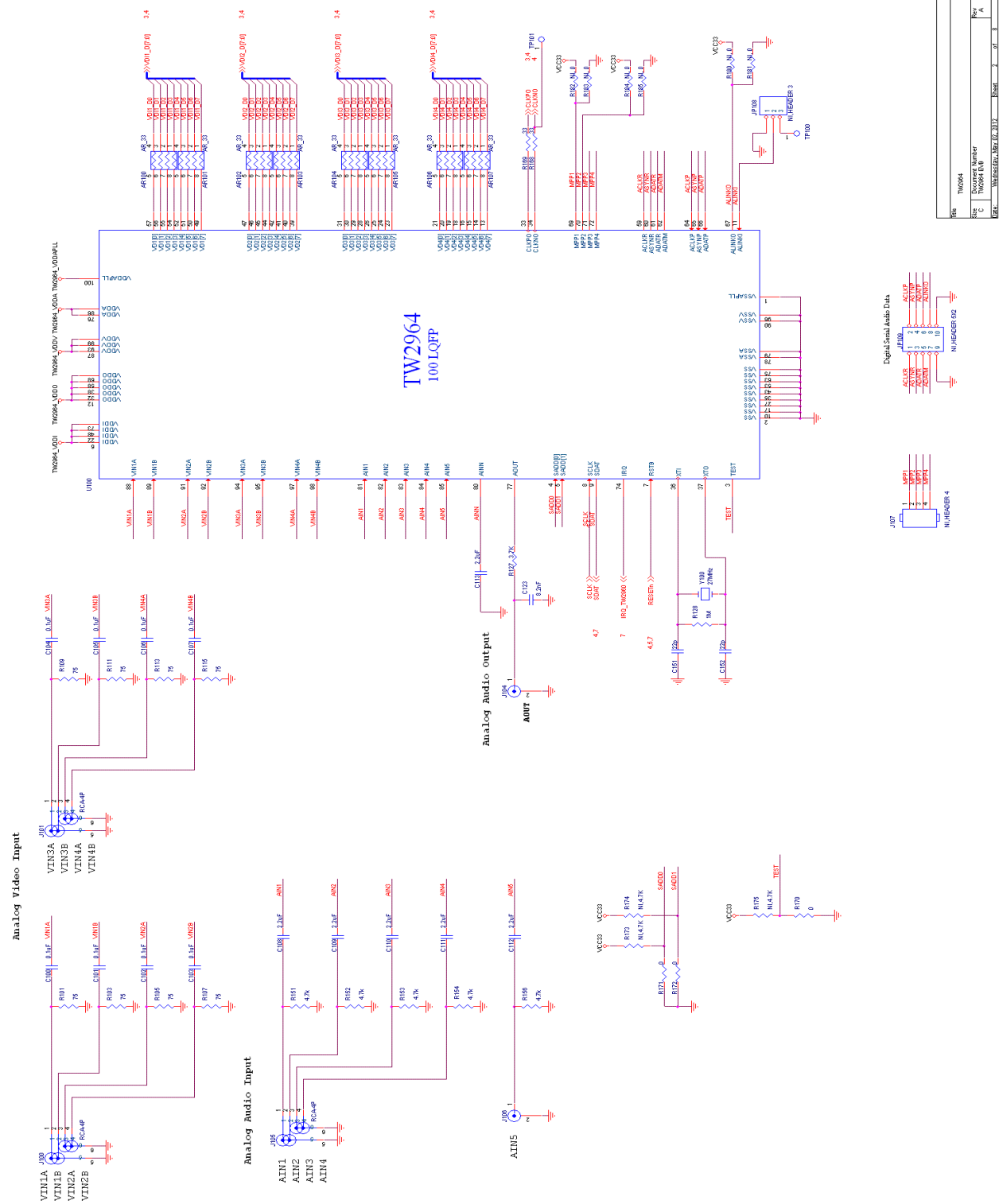
**0XFE – DEVICE ID AND REVISION ID FLAG**

| BIT | FUNCTION    | R/W | DESCRIPTION   | RESET |
|-----|-------------|-----|---|-------|
| 7-6 | DEV_ID[6:5] | R   | Bit6-5 of Device ID. Together with 0xFF[7:3] indicate TW2964 product ID code.<br>DEV_ID=7'h1C | 0     |
| 5-3 | Reserved    | R   |   | 0     |
| 2-0 | TEST        | R/W | Test purpose only. This must be 0 in normal mode.   | 0     |

**0XFF – DEVICE ID AND REVISION ID FLAG**

| BIT | FUNCTION    | R/W | DESCRIPTION          | RESET |
|-----|-------------|-----|----------------------|-------|
| 7-3 | DEV_ID[4:0] | R   | Bit4-0 of Device ID. | 1Dh   |
| 0   | REV_ID      | R   | The revision number. | 0h    |

# Application Schematic



|              |                      |
|--------------|----------------------|
| Rev          | TW2964               |
| Docu. Number | TC2964-EB            |
| Ver.         | Ver. 0.0 (1/11/2011) |
| Sheet        | 3 of 3               |
| Rev          | A                    |

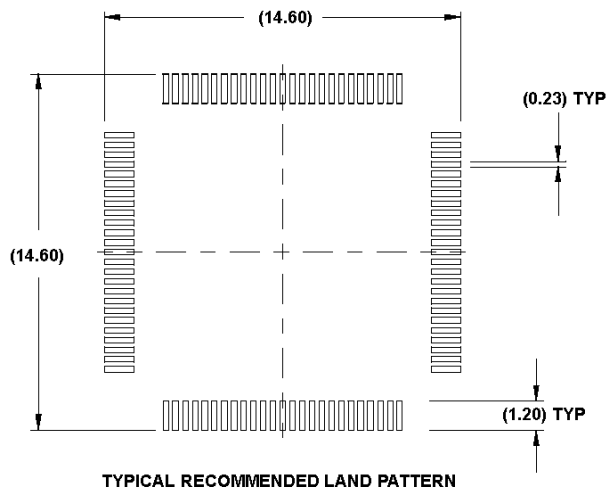
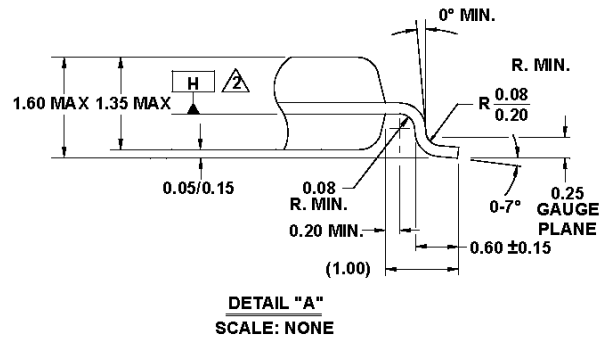
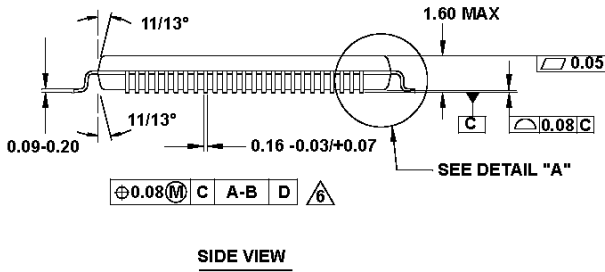
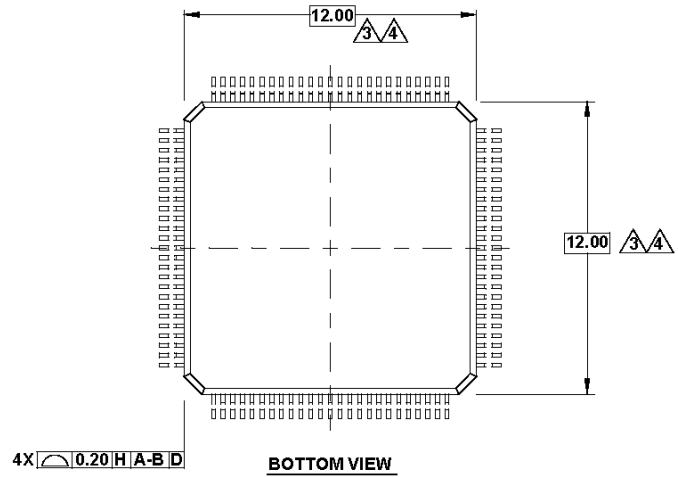
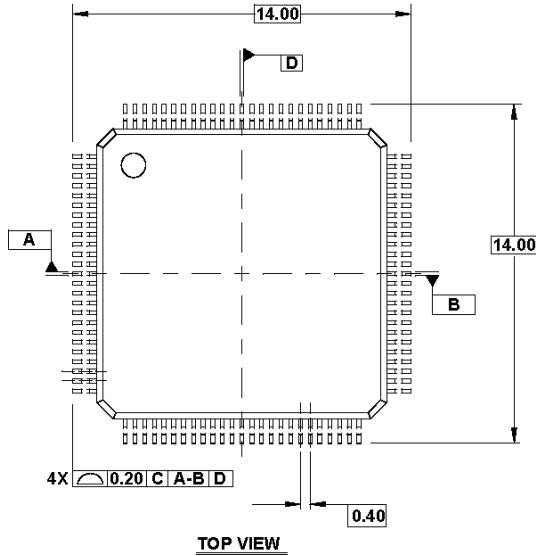


# Package Outline Drawing

## Q100.12X12

100 LEAD LOW PLASTIC QUAD FLATPACK PACKAGE (LQFP)

Rev 1, 6/11

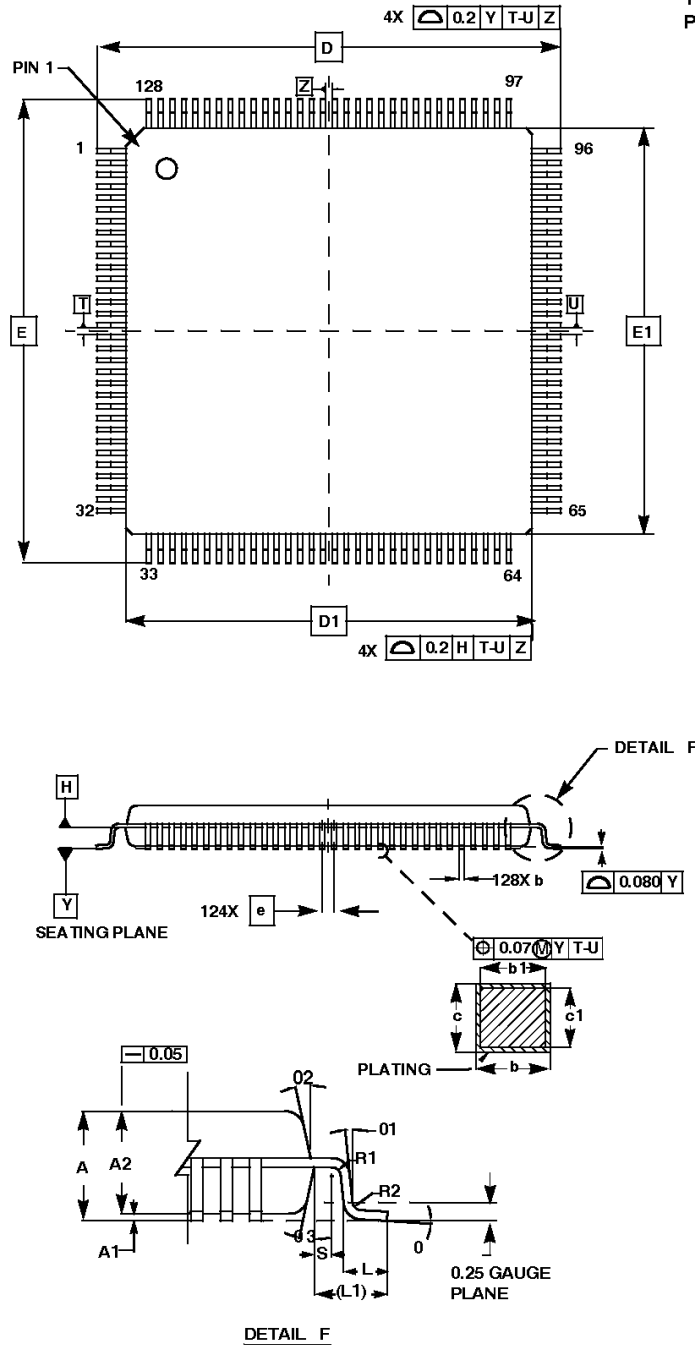


**NOTES:**

1. All dimensioning and tolerancing conform to ANSI Y14.5-1982.
2. Datum plane H located at mold parting line and coincident with lead, where lead exits plastic body at bottom of parting line.
3. Dimensions do not include mold protrusion. Allowable mold protrusion is 0.25mm per side.
4. These dimensions to be determined at datum plane H.
5. Package top dimensions are smaller than bottom dimensions and top of package will not overhang bottom of package.
6. Dimension does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm total in excess of the dimension at maximum material condition. Dambar cannot be located on the lower radius or the foot.
7. Controlling dimension: millimeter.
8. This outline conforms to JEDEC publication 95 registration MS-026, variation ADE.
9. Dimensions in ( ) are for reference only.

# Package Outline Drawing

**Q128.14x14**  
 128 LEAD LOW PLASTIC QUAD FLATPACK PACKAGE .4 MM PITCH



| SYMBOL | MILLIMETERS |      |      | NOTES |
|--------|-------------|------|------|-------|
|        | MIN         | NOM  | MAX  |       |
| A      | -           |      | 1.60 | -     |
| A1     | 0.05        |      | 0.15 | -     |
| A2     | 1.35        | 1.40 | 1.45 | -     |
| b      | 0.13        | 0.16 | 0.23 | 4     |
| b1     | 0.13        | -    | 0.19 | -     |
| c      | 0.09        | -    | 0.20 | -     |
| c1     | 0.09        | -    | 0.16 | -     |
| D      | 16 BSC      |      |      | -     |
| D1     | 14 BSC      |      |      | 3     |
| E      | 16 BSC      |      |      | -     |
| E1     | 14 BSC      |      |      | 3     |
| L      | 0.45        | 0.60 | 0.75 | -     |
| L1     | 1.00 REF    |      |      | -     |
| R1     | 0.08        | -    | -    | -     |
| R2     | 0.08        | -    | 0.20 | -     |
| S      | 0.20        | -    | -    | -     |
| 0      | 0°          | 3.5° | 7°   | -     |
| 01     | 0°          | -    | -    | -     |
| 02     | 11°         | 12°  | 13°  | -     |
| 03     | 11°         | 12°  | 13°  | -     |
| N      | 128         |      |      | -     |
| e      | 0.40 BSC    |      |      | -     |

Rev. 1 7/11

**NOTES:**

1. Dimensions are in millimeters. Dimensions in ( ) for Reference Only.
2. Dimensions and tolerances per AMSEY14.5M-1994.
3. Dimensions D1 and E1 are excluding mold protrusion. Allowable protrusion is 0.25 per side. Dimensions D1 and E1 are exclusive of mold mismatch and determined by datum plane H.
4. Dimension b does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum b dimension by more than 0.08mm. Dambar cannot be located at the lower radius or the foot. Minimum space between protrusion and an adjacent lead is 0.07 mm.

## Life Support Policy

These products are not authorized for use as critical components in life support devices or systems.

## Revision History

| DATE             | REVISION | CHANGE   |
|------------------|----------|--|
| December 5, 2012 | FN8288.1 | Initial release.   |
| March 15, 2013   | FN8288.2 | Removed "Coming Soon" from TW2964-LA2-CR128 in "Ordering Information" on page 3.<br>Added parts to ordering information table:<br>TW2964L-LA2-CR128<br>TW2964-LA2-CR128-EVAL |
| April 11, 2014   | FN8288.3 | Removed parts from the ordering information table:<br>TW2964L-LA2-CR and TW2964L-LA2-CR128   |

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